

## THE DEMAND FOR RICE BY HOUSEHOLDS IN NIGERIA: A QUADRATIC ALMOST IDEAL DEMAND SYSTEM APPROACH

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### Abstract

*In Nigeria, households' per capita calorie consumption is below the required level and this in turn has reduced food security and productivity among households. Rice is a high calorie given food item that has contributed to the improved nutritional status and welfare of Nigerians. Therefore, the study determined the demand for rice in Nigeria as a means of enhancing calorie intake and food security status among households. The study used Harmonised National Living standard survey (HNLSS) data obtained from National Bureau of Statistics. 32,012 households comprising rural (24,941) and urban (8,071) sectors were used. The methods of data analysis include descriptive statistics, probit regression analysis and Quadratic Almost Ideal Demand System (QUAIDS.) The study revealed that Per-capita expenditure on rice is lowest among rural (₦2, 275.48) and North-west (₦2, 019.17) residents. It is also lower among male headed households. Rice is a necessity (0.801) and could serve as substitute for luxury food items such as beans (0.919) and other cereals (0.199). Gender, sectoral and regional food policy measures should be options in increasing rice demand among households in Nigeria in order to ensure increase per calorie intake.*

**Key words:** rice demand, budget share, QUAIDS, elasticity, luxury goods

### INTRODUCTION

According to [23], rice is recognised as a major food item for five out of every ten households globally serving about 80% of their calorie requirements. Rice is of a distinct significance in economic transformation as its grains are used extensively as food; constituting the principal food of half of the human race [18]. From African perspective, Nigeria is the largest consumer of rice in the West African region and its demand for rice has been soaring at a very fast rate over the years [13], with a widened demand-supply gap [6]. In the country, rice is the most important staple food crop, both for food security and cash income. It also constitutes 21% to 24% of total food expenditure among city and community dwellers [19].

Rice, as an essential food item plays a vital role in economic advancement. The physical availability and price has direct effect on the food security status and well-being of families. [7], particularly amongst the poorer segments of population, both in the rural and urban sub-sectors. Of all the basic food

commodities in Nigeria, rice is of particular importance having contributed to the socioeconomic well-being of Nigeria both as a major element in the nation's food security calculations and as a commodity for internal commercial transactions [14]. For a healthy balance diet, a man needs 2,500Kcal a day to maintain body weight, while a woman needs 2,000Kcal a day. This is not being achieved in most developing countries like Nigeria where the per capita calorie consumption is below the required threshold level. The effect of which is reduced productivity in the country; thus, the need for this study.

Moreover, there exists a dearth of studies on rice demand by households at the country level in relation to variations in rice intake, income level, food prices (own price and price of substitutes) and other factors influencing households' demand for rice. This is the recognised vacuum this research intends to fill. In averting price and income shocks, amending households' consumption in response to changes in price of rice and income of households is of great importance.

In developing countries, known for allocation of higher budget share on food [8], consumer expenditure surveys are particularly useful because they can provide information on specific sub-population of households that are more likely to be affected by changes in commodity prices or income of the households.

The aims of the research are: to estimate the budget share of households on rice in Nigeria, establish the compensated and uncompensated elasticity of households' demand for rice and determine the factors influencing the demand for rice by households in Nigeria.

Food demand studies have become an area of focus globally, most especially in the third world where budget share on food take a significant portion of the household income. Thus, the studies unravel how variations in price, income and taxation policies influence food demand.[12]. Analysis of Food demand is germane due to its high correlation with standard of living resource base of households in Nigeria. Another pertinent reason for carrying out this research is due to the large disparity in rice demand between city and rural dwellers.

It is discovered that there is more demand for this produce in urban area than in rural area. This gap is due to the different income levels of the populace in these different areas

From empirical perspective, [1], and [4] adopted Almost Ideal Demand System (AIDS) model in analysing the demand for food. Also, [21], examined "Households' Demand Structure for Rice Consumption in Kaduna State" using primary data. LA-AIDS model, Logit model and Z- statistics were also adopted for the analysis. [15] estimated the demand for rice in Nigeria using Ordinary Least Square (OLS) model.

The focal point of this research is on the demand for rice in Nigeria revealing urban and rural gap. Also, this study varies from the aforementioned in the use of secondary data obtained from Harmonized National Living

Standard Survey (HNLSS) adopting Quadratic Almost Ideal System (QUAIDS) model as the empirical tool.

## MATERIALS AND METHODS

Harmonized Nigeria Living Standard Survey, (HNLSS), 2010 collected by the National Bureau of Statistics [16] was used for the study. Data used comprised a total of 32,012 households across the rural (24,941) and urban (8,071) sectors. Descriptive statistics, budget share index, probit regression analysis and Quadratic Almost Ideal Demand System (QUAIDS) were the analytical techniques adopted.

$$w_r = \sum_{i=1}^n \frac{X_{ri}}{X_i}$$

### Model Specification

#### Budget share index

Budget share index is expressed as:

where:

$w_r$  = Budget share on rice by  $i^{\text{th}}$  household

$X_{ri}$  = Expenditure on rice by  $i^{\text{th}}$  household (₦).

$X_i$  = Total expenditure on grains considered by  $i^{\text{th}}$  households (₦)

$n$  = total number of respondents.

#### Probit Model

It is expressed as

$$Z_i = b_0 + \sum_{j=1}^n b_j X_j + u$$

where:

$Z_i$  is the unobservable level of stimulus for the  $i^{\text{th}}$  household, [24].

This is represented as (1, for rice purchaser, 0 for non- rice purchaser)

$b_j$  = parameters to be estimated

$X_j$  = identified explanatory variables as highlighted under the **Quadratic Almost Ideal Demand System (QUAIDS) Model**

Quadratic Almost Ideal Demand System (QUAIDS) was adopted to establish the determinants of households' demand for different food groups in Nigeria and across sectors, as stated in the equation below:

$$w_i = \alpha_i + \sum_{j=1}^n \gamma_{ij} \ln p_j + \beta_i \ln \left[ \frac{m}{a(p)} \right] + \frac{\lambda_i}{b(p)} \left\{ \ln \left[ \frac{m}{a(p)} \right] \right\}^2$$

In line with [10]; [11], socioeconomic characteristics of the households were also incorporated to influence preferences through the intercept in equation as:

$$\alpha_i = \rho_{io} + \sum_{j=1}^s \rho_{ij} d_j$$

where:  $d_j$  is the  $j$ th socioeconomic variable of which there are  $S$ . This approach is adopted to incorporate the demographic variables because of its easiness [22].

$I_j$  = food groups;

$\alpha_i, \lambda, \beta, \gamma$  = parameters to be estimated

$W_i$  = Average expenditure share of households on food item  $i$

$\alpha_i$  = Average value of budget share in the absence of price and income effects.

$\beta_i$  = parameters that determine whether goods are luxuries or necessities

$\gamma_{ij}$  = Effects on the budget of item  $i$  of 1% change in the prices of items in group  $j$

$P_j$  = price of item  $j$  (₦)

$d_j$  = Vectors of socioeconomic and demographic variables.

$U_i$  = error term.

The uncompensated or Marshallian price elasticities are stated as  $e_{ij}^u = \mu / w_i - \delta_{ij}$  where  $\delta_{ij}$  is the Kronecker delta which is equal to one when  $i = j$ , otherwise  $\delta_{ij} = 0$ . Using the Slutsky equation,  $e_{ij}^c = e_{ij}^u + w_j e_i$ , the compensated (Hicksian) price elasticities can

be estimated and used to measure the symmetry and negativity conditions by examining the matrix with elements  $w_i [e_{ij}^c]$ , which should be symmetric and negative semi-definite.

**Dependent variable:**

$W_i$  = budget share on rice and other grains

**Independent variables:**

$P_1$  = Price of rice (₦)

$P_2$  = Price of Beans (₦).

$P_3$  = Price of Maize (₦)

$P_4$  = Price of other cereal (₦). (Guinea corn, millet, wheat)

Socio-economic variables:

$X_1$  = Sector (rural = 1, 0 = urban)

$X_2$  = Household size

$X_3$  = Sex (1 male, 0 female)

$X_4$  = Age (Years)

$X_5$  = Households' income (₦).

## RESULTS AND DISCUSSIONS

Table 1 highlights the socio-economic characteristics of the households in Nigeria. Across urban and rural sectors and the pooled data, about 8 out of 10 respondents, in the country, were within the working age range of 18 to 60 years. Also, the mean age of almost 48 years indicates that majority belonged to the active and productive age.

Table 1. Demographic Characteristics of Households in Nigeria

Variables	Pooled		Rural		Urban	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
<b>Age</b>						
<18	40.00	0.12	33.00	0.13	7.00	0.087
18-60	26,340.00	79.79	19,986.00	80.13	6,354.00	78.726
>60	6,632.00	20.09	4,922.00	19.74	1,710.00	21.187
Mean	47.67		47.62		47.83	
<b>Gender</b>						
Male	28,033	84.918	21,624	86.701	6,409	79.408
Female	4,979	15.082	3,317	13.299	1,662	20.592
<b>Household Size</b>						
1-3	13,092	39.658	9,321	37.372	3,771	46.723
4-6	13,078	39.616	10,076	40.399	3,002	37.195
>6	6,842	20.726	5,544	22.228	1,298	16.082
Mean	4.442		4.582		4.012	

Source: Results from Harmonised National Living Standard Survey Data.

Male headed households constituted over 80% of the total respondents in the pooled data and

rural sector, while they were 79% in the urban sector. This implies that households in Nigeria

are mostly headed by male. Majority of households in villages and cities and Nigeria, as a whole, had a moderate household size of less than six, with the means being 4 for both the urban and the pooled data, while rural respondents had mean household size of five. As illustrated in Table 2, expenditure on rice and beans was higher in urban sector (₦3,540.99 and ₦2,773.64) than in rural sector

(₦2,275.48 and ₦2,415.03) respectively. However, rural respondents spent higher on maize and other cereals than their urban counterpart.

The implication of this is that households residing in urban areas have preference for rice and beans, compared to the rural dwellers that tend to prefer maize and other cereals such as guinea corn and millet.

Table 2. Per Capita Expenditure on Selected Grain across Sector in Nigeria

	<b>Pooled</b>	<b>Rural</b>	<b>Urban</b>
	(₦)	(₦)	(₦)
<b>Rice</b>	2,584.88	2,275.48	3,540.99
<b>Maize</b>	1,162.23	1,298.71	740.49
<b>Beans</b>	2,502.71	2,415.03	2,773.64
<b>Other cereals</b>	2,651.26	3,150.43	987.25

Source: Source: Results from Harmonised National Living Standard Survey Data.

Table 3 reveals the demand for rice and other cereals across the six zones in Nigeria. Residents in the South-South, Southwest and North- Central zones spent the most on rice (₦2,699.91 ₦3,002.98 and ₦3,296.30 respectively), while those residing in Southeast spent the most on beans

(₦2,759.14). However, residents in the Northern divide of the country expended the most on other cereals (guinea corn, millet, wheat). It is clear from these results that the demand for rice is higher in the South than in the North.

Table 3. Zonal Analysis of Households' Expenditure on Selected Grains in Nigeria

	<b>South-South</b>	<b>South East</b>	<b>South West</b>	<b>North Central</b>	<b>North East</b>	<b>North West</b>
<b>Food Items</b>	<b>Per capita expenditure (₦)</b>					
<b>Rice</b>	<b>2699.91</b>	2514.14	<b>3002.98</b>	3296.30	2177.19	2019.17
<b>Maize</b>	262.58	669.93	459.86	2337.58	2024.77	1198.44
<b>Beans</b>	1972.15	<b>2759.14</b>	2789.25	2406.38	3255.56	2077.32
<b>Others</b>	60.68	107.36	397.28	<b>3649.68</b>	<b>4222.01</b>	<b>5564.94</b>

Source: Results from Harmonised National Living Standard Survey Data.

The analysis of households' decision to consume rice was estimated using probit regression as shown in Table 4.

Sex, prices of rice and maize and household income were significant at  $p < 0.01$ . Household size was significant at  $p < 0.05$ . Unit increase in the prices of rice and maize would increase the probability of households to consume rice by 62.61% and 87.61% respectively, indicating that households would be willing to demand for rice if the price of rice and maize is increased. The decision to consume rice by male headed households increases by 0.1103, relative to the female respondents, an indication that male headed households have

higher probability of consuming rice than their female counterpart.

A unit increase in household size would reduce the likelihood of rice demand by 0.8%, indicating that respondents with larger household size have lower probability of consuming rice, relative to those with smaller household size. Increases in households' income would increase the decision of households to demand for rice. In other words, higher income earning households have the tendency to demand more for rice than those with lower income.

The factors influencing households' demand for rice and other cereals were highlighted in Table 5. The Inverse Mills Ratio (IMR)

ensures that the sample is devoid of the problem of selectivity bias.

Table 4. Factors Determining the Decision of Households to Demand for Rice

Budget Share on Rice	Coefficient	Standard error	Z	Significance
Sector	-0.0003	0.0186	-0.02	0.987
Household size	-0.0084	0.0033	-2.58	0.010**
Household sex	0.1104	0.0228	4.84	0.000***
Household age	-0.0004	0.0005	-0.81	0.417
Price of rice	0.6262	0.0987	6.34	0.000***
Price of maize	0.8761	0.1111	7.89	0.000***
Price of beans	0.0542	0.0805	0.67	0.501
Price of other cereals	-0.0271	0.0670	-0.39	0.699
Total income	0.4707	0.0123	38.43	0.000***
Constant	-11.1449	0.8086	-13.78	0.000***

Source: Results from Harmonised National Living Standard Survey Data.

That is, the selected sample is a true representation of the entire population. Sector and sex of household heads were the factors affecting households' demand for rice in Nigeria. The expenditure share for rice among rural households increases by 0.71%; compared to urban sector. This is expected as rural households spend larger share of their earnings on food. This is corroborated by the findings of [9], where demand for staple is higher in rural sector (though not significant) than the urban. Also, male respondents' demand for rice is reduced by 0.26%, in comparison to female.

Sector prices of maize and beans were the factors influencing households' demand for maize in Nigeria. The demand for maize will increase by 0.5757 and reduce by 0.496, for every unit increase in prices of maize and beans respectively, implying that the demand for maize tends to reduce with increase in price for beans.

Rural residents' demand for maize reduces by 0.0033, relative to those that dwell in the cities. Thus, city dwellers demand more of maize than those residing in rural areas in Nigeria.

Table 5. Determinants of Households' Demand for Rice in Nigeria

Variables	Rice	Maize	Beans	Other cereals
Price Coefficients				
Price	0.0033 (0.10)			
Pmaize	-0.0112 (-0.15)	0.5757 (2.92)***		
Pbeans	0.03446 (0.45)	-0.4962 (-2.81)***	0.3668 (1.88)*	
Pothers	-0.0265 (-1.14)	-0.0684 (-0.86)	0.0949 (1.31)	-0.0002 (-0.00)
Households' Characteristics				
Sector	0.0071 (6.90)***	-0.0033 (-3.84)***	0.0014 (0.91)	-0.0058 (-2.81)***
Hhsize	-0.0002 (-1.14)	0.0002 (1.61)	-0.0001 (-0.37)	0.0000 (0.01)
Hhsex	-0.0026 (-1.80)*	0.0000 (0.00)	-0.0037 (-1.67)*	0.0063 (2.56)***
Hhage	0.0000 (1.32)	0.00003 (1.42)	-0.0000 (-0.96)	-0.0000 (-0.42)
Lny	-0.0042 (-1.63)	-0.0036 (-1.58)	-0.0115 (-4.46)***	0.0194 (5.65)***
IMR	-0.0010 (-0.65)	0.0386 (2.78)***	0.0356 (2.58)***	-0.0643 (-3.69)***

\*\*\* Significant at 1 per cent

\*\* Significant at 5 per cent

\*Significant at 10 per cent

Source: Results from Harmonised National Living Standard Survey Data.

Household income, price of beans and sex are the significant determinants of households' demand for beans at 1, 10 and 10 per cents levels respectively. As price of beans increases by a unit, the demand for beans increases by 0.3668, indicating households' high preference for beans despite increase in its price. However, as income of households increases by a naira, the demand for beans is reduced by 1.15%. This implies that the consumption of beans tends to reduce as income of households increases in Nigeria. The implication is that as income of households rises, they tend to buy more expensive substitutes of beans such as meat, fish and chicken. The demand for beans is reduced by 0.0037 for male headed households, compared to those headed by female. This is an indication that households headed by female consume more of beans than those headed by male.

Lastly, the factors affecting the demand for other cereals by households in Nigeria are sector, income and sex at one percent level of probability. Rural households' demand for other cereals is reduced by 0.0058, relative to those in urban sector, implying higher consumption of other cereals by the urban households, relative to those in the

communities. The demand for other cereals by male respondents increases by 0.67%, in comparison to females. A unit increase in the income of the households tends to increase their demand for other cereals by 0.0194. This is in line with the findings of [5]; [9] that revealed higher demand for staples among high income earning households. This reveals that high income earners consume more of other cereals (millet, guinea corn, wheat) than those earning low income.

The uncompensated own price elasticity estimates of the identified food items show that rice and maize are price inelastic having values less than unity, while beans and other cereals are price elastic, with values greater than unity. These are shown in Table 6.

The cross price elasticity estimates revealed that negative value indicates complementarity between two food items, while positive value implies the goods are substitutes. In view of this, maize could serve as complement for rice, while rice can act as substitutes for beans and other cereals.

Also, maize could substitute beans, while beans could replace rice, maize and other cereals. Lastly, other cereals could also replace maize and rice.

Table 6. (Marshallian /Uncompensated) Price and Income Elasticity of Demand

Commodity	Rice	Maize	Bean	Others
<b>Price coefficient</b>				
Price of rice	<b>-0.982</b>	-0.300	0.404	0.078
Price of maize	-0.005	<b>-0.698</b>	0.196	1.344
Price of beans	0.121	0.233	<b>-2.022</b>	-1.403
Price of other cereals	0.086	-0.101	0.177	<b>-1.083</b>

Source: Harmonised National Living Standard Survey, 2010.

As revealed in Table 7, own price (compensated) elasticity of demand revealed that rice, maize and other cereals are price inelastic; signifying that proportionate

increase in prices of these grains would lead to less than proportionate decrease in their demand [2]; [17].

Table 7. (Hicksian/Compensated) Price and Income Elasticity of Demand

Commodity	Rice	Maize	Bean	Others
<b>Price coefficient</b>				
Price of rice	-0.774	-0.129	0.564	0.339
Price of maize	-0.222	-0.877	0.029	1.071
Price of beans	0.919	0.890	-1.409	-0.401
Price of other cereals	0.199	0.132	0.395	-0.726
Income	0.801	0.837	3.069	1.094

Source: Results from Harmonised National Living Standard Survey Data.

However, the demand for beans is price elastic, as it reveals more than proportionate decrease in its demand due to a proportionate increase in its price. Cross price elasticity estimates show that rice can serve as substitute for beans and other cereals, while maize can complement rice. Furthermore, maize can substitute beans and other cereals, with rice serving as complement. On the other hand, beans can serve as substitute for all the identified grains/cereals. Lastly, other cereals (guinea corn, millet and wheat) could complement beans. Rice and maize are observed to be income inelastic (necessity food items) corroborating the findings of (Abdulai, 2002; [3]; [20]; [17]; [9] and [15] that major staple foods are necessities. However, beans and other cereals are income elastic (luxury food items).

## CONCLUSIONS

Rice is a major staple in Nigeria with high calorie content which could improve the food security situation of the population. It is made clear in the study that expenditure on rice is higher in the metropolis than in villages.

Also, the northern divide of the country spends less on rice relative to their southern counterpart. Sector and sex are the factors influencing rice demand in Nigeria. Elasticity estimates revealed that rice is price and income inelastic and could substitute for beans and other cereals.

From the foregoing, gender and regional specific food policy options that would increase the consumption of rice among male headed households and residents in the northern region of the country is of importance in order to increase their calorie intake to ensure food security status among the particular groups.

Also, since beans and other cereals are regarded as luxury food items, rice, as a necessity food item, could serve as a perfect substitute for both, thereby eliminating the price stress of consuming these luxury food items from low income earners in Nigeria.

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