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Research article

Households' Rice Demand Response to Changes in Price, Income and Coping Strategies during Food Inflation in Nigeria: Evidence from Oyo State

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Abstract. Food price is a main driver of inflation that erodes the purchasing power of households. The study examined demand response to changes in price of rice during food price inflation in Nigeria using sampled households from Oyo State. A multi-stage sampling procedure was used to select 174 households for the study. Primary data were obtained on types of rice, frequency and quantity bought, reasons for demand, price variations and coping strategies. Descriptive statistics and Quadratic Almost Ideal Demand System (QUAIDS) that take into account the non-linear impact of income changes was used for data analysis. Over 70% of households' demand was for imported long grain rice, local brown and wet grain rice and local brown and dry grain rice. The expenditure elasticities of both local short brown wet rice (LSBWR) and imported short grain rice (ISGR) was positive and <1 indicating that they were normal and necessary food items. Strategies mainly used to cope with rice price and households' income changes include: substitution of rice with other food types, preparation of rice with other foods to reduce quantity of rice in meals and reduction of rice demand. Even though price intervention may not lead to a significant effect on rice demand, an improvement in technology will lead to reduction in the cost of rice production and eventually reduce the price of local rice, enhance high demand and encourage producers to increase production.

Keywords: consumer responsiveness, compensated elasticity, uncompensated elasticity, LSBWR, LSBDR, ISGR, ILGR, QUAIDS.
JEL codes: D01, D11, D12, D15, E31, H31, J28, R22.

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HIGHLIGHTS

- Over 70% of households' still buy rice, especially the imported long-grain type during food inflation in Nigeria.
- Income elasticities of local brown wet and imported short-grain rice are positive.

- Although own-price elasticities of all rice types are negative, imported short-grain rice is highly elastic.
- Main coping strategy used by households during food inflation is substitution. Policy to increase households' income is needed to protect them from higher prices.

1. INTRODUCTION

Everyone consumes food. As a result, everyone is affected to some degree by food price changes. Economic laws have shown an inverse relationship between the prices of goods and services and the value of money in an economy. Other things being equal, as prices rise over time, a given amount of money will be able to purchase fewer and fewer goods. In the presence of inflation, a given level of households' income will buy less goods and services. Food inflation is a general increase in the prices of food or a decline of purchasing power of a given currency over time. The causes of food inflation are not unconnected with sharp and continuous decline of the value of the naira (for instance, one United States Dollar (USD) exchanging between ₦410 – ₦420 over a long period of times in Nigeria), attacks on farms, forex scarcity leading to an increase in cost of imported items like food, raw materials, and machinery with food insecurity as a major consequence. Scarcity of dollars leads to speculative product hoarding which again leads to artificial scarcity and an attendant increase in the prices of food.

Rice demand response (DR) is defined as the changes in quantity of rice consumers are willing and able to buy compared to their normal consumption patterns in response to changes in price of rice, the price of close substitutes, the price of complementary items, and household income as well as by several non-economic factors including tastes and preferences, family size, age of family members, geographic location, shopping behaviour, and lifestyle choices (Adeyonu *et al.,* 2021). In many countries of Africa, rice is a staple food and constitutes a major part of the diet. Over the past three decades, rice has witnessed a steady increase in demand and hence producing it is also gaining an important place in the food security policy of many countries (Saka, Lawal, 2009). Cadoni and Angelucci (2013), posited that rice is an essential food item for most people in sub-Saharan Africa, especially West Africa, and forms over 20% of the global calorie intake.

In Nigeria, rice is known to be the fourth most consumed food item in terms of calories (Cadoni, Angelucci, 2013) and a major component of Nigerians diet (Okunola, Bamgboye, 2016). Nigerians consume both local and imported (short and long grain) rice in different proportions. Brown rice (unrefined) is healthier than refined grains and its consumption is linked to a decreased incidence of type 2 diabetes (Sun *et al.,* 2010). The LSBWR is a whole grain mostly short and has bran and germ with about 32% moisture content compared with the LSBDR rice which contains about 10% moisture content (Arije *et al.,* 2019). Brown rice (whether wet or dry) has more nutrients and health benefits than white rice (Ologbon *et al.,* 2012). Some of the major local varieties of rice produced and consumed are: "Ofada", "Abakaliki", "Bida" and "Igbemo". Ofada rice is a short, robust brown grain with red kernels widely cultivated in all the ofada rice-producing areas of four states (Ondo, Ogun, Oyo, and Osun) in the Southwestern part of Nigeria (Danbaba *et al.,* 2011). Abakaliki Rice is the name for the local type that is grown in the Southeastern part of Nigeria and comes from Abakaliki rice mill in Ebonyi State. The polished ones come out white while unpolished ones can also come out brown. Igbemo rice is a local cultivar having bold extra-long grain with mean sphericity of 0.4 ± 0.03 indigenous to Ekiti State in Southwest Nigeria, while Bida rice are those produced in Bida town and the neighboring states in Niger State, Nigeria. Other varieties of rice produced and consumed in Nigeria include: FARO 44 released by the National Cereals Research Institute (NCRI) which is a slender long grain with mean sphericity of 0.43 ± 0.18, ITA 150, a slender long grain with mean sphericity 0.41 ± 0.04 released by the International Institute for Tropical Agriculture (IITA), and NERICA 1, a bold grain with mean sphericity of 0.48 ± 0.05 released from the West Africa Rice Development Agency (WARDA) now renamed as Africa Rice Center (Okunola, Bamgboye, 2016).

The rice (polished rice) imported to Nigeria are of different shapes (long, medium and short) but the long and short grain rice are popular. According to the International Rice Research Institute (IRR) classification, rice grain is long if it is <6.61 mm in length, medium if between 5.51 to 6.6 mm in length and short if < 5.50 mm in length (IRR, 1996). In addition, the long grain rice is cylindrically longer compared with the short grain rice which is shorter and wider.

Over the years, the rate of increase in demand for rice in Nigeria as the largest consumer of rice has been higher than its counterparts in the West Africa region (Tondel *et al.,* 2020; Okpiaifo *et al.,* 2020). Between 2011 and 2019, rice consumption in Nigeria rose from 5.6 million to 6.9 million tons (Morse, 2019). According to Erhabor and Ojogbo (2011), rice has gone beyond

being just referred to as a normal good in Nigeria and has become a necessary commodity that takes an average of 21-25% of a rice-consuming household's food budget share.

Nigeria's rice production as indicated in Figure 1 rose from 3.7 million metric tons in 2017 to 4.0 million metric tons in 2018. In spite of this, only 57% of the 6.7 million metric tons of rice consumed in Nigeria annually is produced locally, leading to a deficit of about 3 million metric tons which is sourced through rice importation. To stimulate local production, the Nigerian Government banned importation of rice in 2019 with commendable research conducted to ensure a steady and reliant rice industry in Nigeria. In spite of this, rice production marginally rose from 4.9 million metric tons in 2000 to 5.0 million in 2021, leading to a deficit of about 2 million metric tons (Fig. 1) which is either imported or smuggled into the country illegally. A large proportion of studies on rice only focused on improving the supply side of the Nigerian rice industry through improved production efficacy (Shehu *et al*, 2007), increased returns (Onoja, Herbert, 2012), improved technologies (Saka, Lawal, 2009) among others, with a gap in the literature on demand response of households, response to changes in rice prices and household income during food inflation.

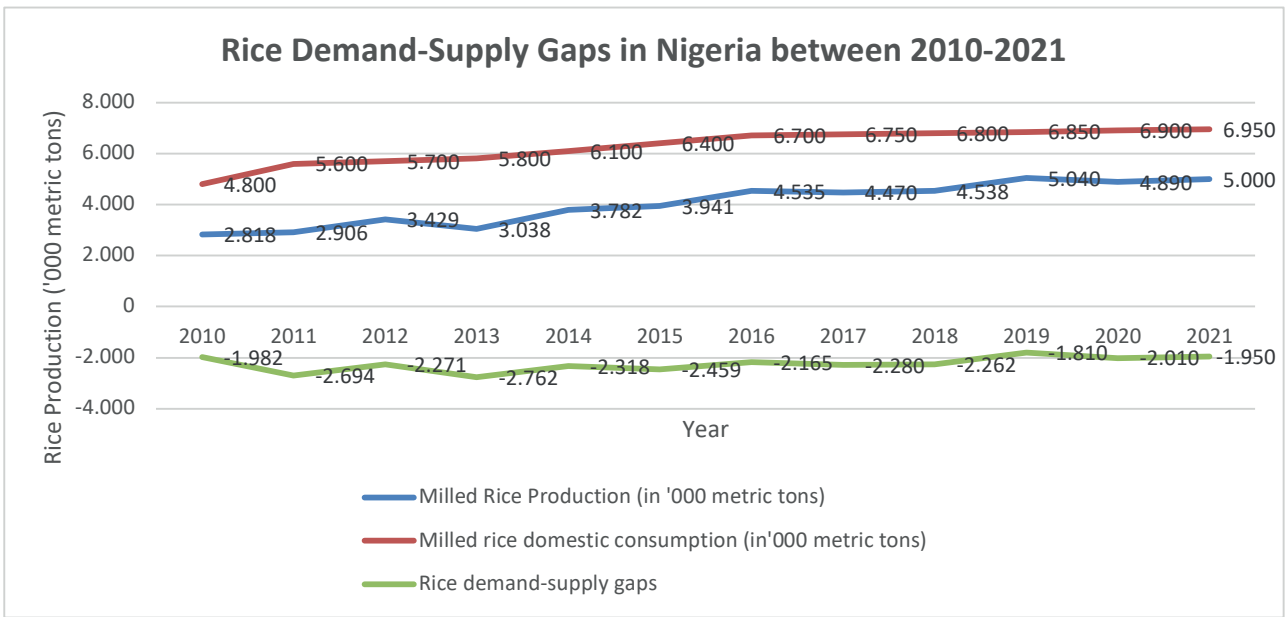
Therefore, this study attempts address the following questions: (i) What is the households' rice demand pattern during food inflation? (ii) How does households rice DR change with price and income during food price inflation? (iii) What are the various coping strategies used by households against changes in the price of rice?

To address these questions, the broad objective of the study is to assess rice demand response to price and income changes among households during a food price inflationary period in Oyo State, Nigeria. The specific objectives of this study are:

1. assess the nature and households' rice demand pattern in the study area;
2. estimate compensated and uncompensated households' elasticities rice demand in the study area;
3. identify the various coping strategies against changes in the price of rice.

The study is unique because it estimated price, income and cross-price elasticities of demand for rice types during food inflation using a complete demand system, instead of a partial demand modelling approach often adopted, for all food groups in Nigeria. To the best of our knowledge this is hard to find in the food demand literature. The estimated elasticities are important for policy purposes. The study concentrated on four types of rice [LSBDR, LSBWR, ISGR and imported long grain rice (ILGR)] that are consumed in the study area. The findings contribute not only to the existing literature on food demand but to food inflation.

Fig. 1. Trends of rice demand-supply gaps in Nigeria between 2010-2021.



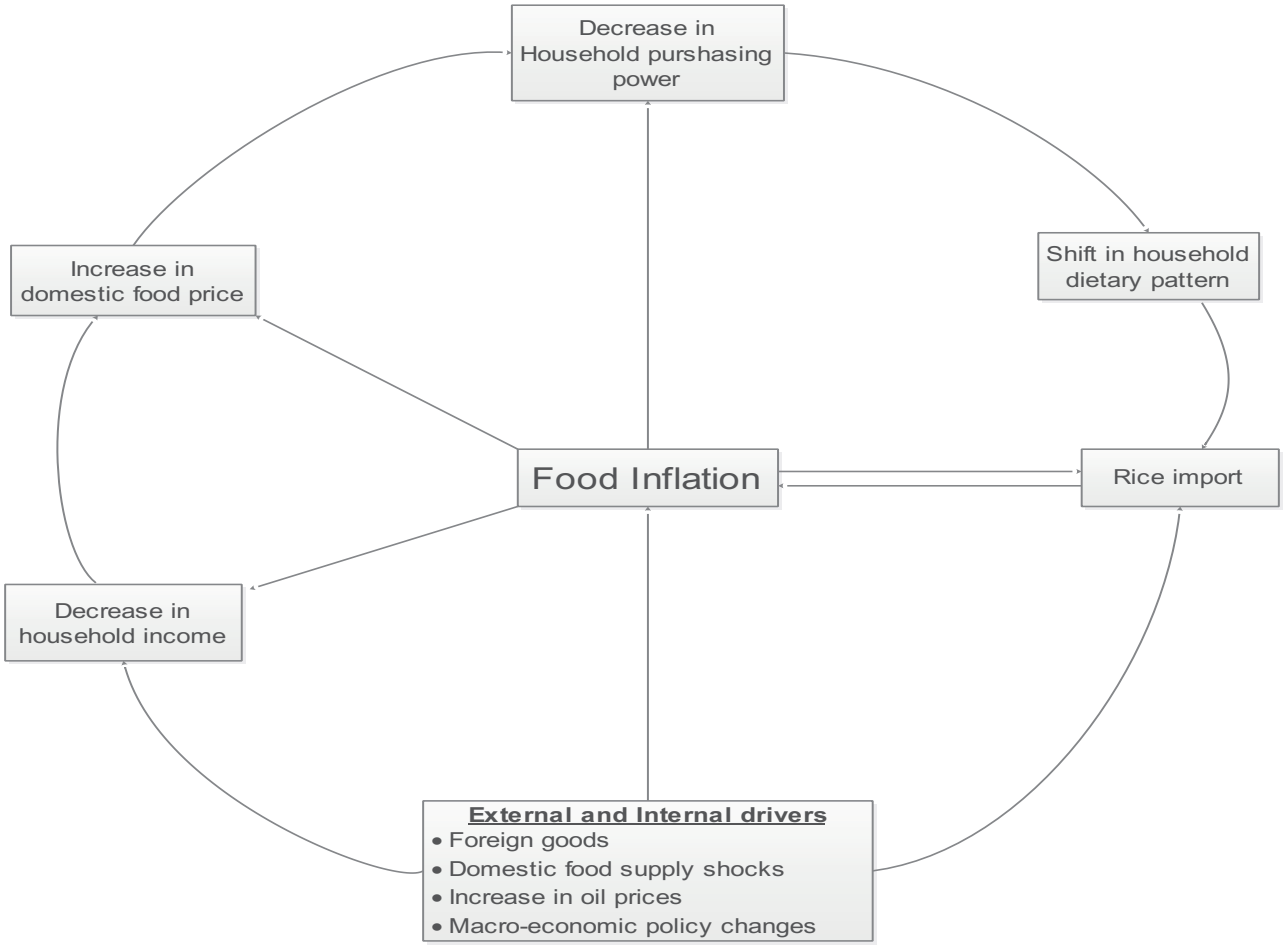
Source: Authors from USDA (2022) rice data outlook.

2. CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

Estimating household demand is similar to the evaluation of household consumption behaviour in response to price shocks and changes in income of households. The theoretical model is based on the Engel Curve Framework, which explains the relationship between household expenditure on a specific commodity and household income (Chai, Moneta, 2010). Allocation of expenditure in the household is a function of the household's demographic characteristics like size, income group, age, gender and prices. Household food demand patterns are affected by food supply, food prices (local and international food shocks) and the percentage of the household's expenditure (income) dedicated to consumption during food inflation. Food inflation is usually caused by rising domestic prices due to limited supply that is unable to meet domestic demand. Households' food habits and patterns are altered as a result of rising food prices thereby forcing households to eat less nutritious or expensive meals (Fig. 2). Rice imports are the solution to stabilize domestic rice prices and reduce food inflation. Households that dedicate a higher percentage of their total income to food are likely to experience higher food inflation since an increase in the price of a consumer basket means that more money is spent on consumption compared to those households whose proportion of money spent on food is small (Capehart, Richardson, 2008). Consumers prefer to spend all of their wealth or income on food because more is always at least as good as less and consumers are never satiated.

A good number of relevant literature studies were reviewed so as to gain adequate and proper insight into the various modes of approaches to food demand estimation. Adeyonu *et al.* (2021), examined food DR to rising food prices among farming households in Nigeria using the three waves of the General Household Survey

Fig. 2. Links between food demand response to income, prices and inflation.



(Panel) conducted between 2010 and 2016 with the use of Quadratic Almost Ideal Demand System (QUAIDs), with major findings that escalating prices result in a welfare loss of household expenditure on commodity groups such as rice, wheat, pulses, tubers and other food and non-food items. Otunaiya and Shittu (2014) in their study using this same model found the expenditure (income) elasticity of demand for some vegetables (bitter leaf and eggplant) to be negative, which is similar to the evidence from Ogundari (2014) for vegetable oil and cereals. Olorunfemi (2013), estimated the demand for food in Ondo State, Nigeria; using the QUAIDS model the research result revealed that the estimated expenditure elasticities for all food are positive and statistically significant at 5%, indicating that all the food items are normal goods and that rice, beans, yam-flour, meat, vegetable and fruits are luxury goods. However, in the study, garri, yam, bread and plantain are all necessities. Similarly, Abramovsky *et al.* (2012) estimated the demand system for Mexico using QUAIDS; Blow *et al.* (2015), also used QUAIDS to model the United State consumer expenditure data for non-durable goods. Obayelu *et al.* (2009), in their study on Cross-sectional analysis of food demand in Northern-central Nigeria used the QUAIDS model to estimate price and expenditure elasticities of six food groups (roots and tubers, cereals, legumes, animal protein, fruits and vegetables, fats and oil) consumed. The result showed that all six food groups analysed were price inelastic, income elasticity showed that animal protein consumption was most affected by income variations, while fats and oil were less so and the factors that positively affected demand for legumes, fats and oil, animal protein, cereals and roots and tubers were household size, level of education, primary occupation and access to credit.

Others past studies that have also applied QUAIDS as appropriate demand models include: Gould and Villarreal (2006) using food expenditure data from urban China, Molina and Gil (2005) applied QUAIDS to aggregate consumption data from Peru, Abdulai and Aubert (2004) on Tanzanian food expenditure data, Abdulai (2002) on the food expenditure data from Switzerland, Fisher *et al.* (2001) on the US aggregate consumption data, Moro and Sckokai (2000) on Italian food expenditure data, Banks *et al.* (1997) and Blundell and Robin (1999) on consumption goods expenditure data from the United Kingdom, Meenkashi and Ray (1999) using Indian food expenditure data.

Adetunji and Rauf (2012), investigated household demand for meat in Southwest Nigeria using the Almost Ideal Demand System (AIDS) Model. Ogunniyi, Oladejo and Akinniyi (2012) used the same model to investigate households demand for processed fruits in Abeokuta Metropolis of Ogun State, Nigeria, while Robert (2009) examined yam consumption patterns in Ghanaian urban communities with quarterly household panel data collected from four urban centres with both AIDS and QUAIDS. It was discovered by Robert that the shares of food budget that households allocated to yam generally increased during the peak harvest season and dropped during lean season across all urban centres in Ghana.

The study by Haq *et al.* (2009), employed the Linear Approximate of Almost Ideal Demand System (LA/AIDS) in estimating the own and cross price compensated and uncompensated elasticities and expenditure elasticities of food demand in Pakistan (Northwest frontier province). Their results showed all the food items were normal, while rice, fruits, meat and other food products were found to be expenditure elastic as compared to wheat, vegetables, milk and cooking oil and also that Hicksian own and cross-price elasticities move closely with the Marshallian elasticities. Ezedinma *et al.* (2006) in their study on urban household demand for meat and meat products in Nigeria used the LA/AIDS method to aggregate a portion of the data on meat and meat products namely beef, mutton/goat, chicken, fish, eggs and milk. Their results indicated that urban demand for meat products will increase significantly as incomes increases, suggesting potential market opportunities, especially for poultry. In a similar study, Taljaard (2003) used the LA/AIDS model to estimate the demand for meat in South Africa. Hayat *et al.* (2016), estimated LA/AIDS for the demand analysis of selected food commodities in Pakistan. This study based on estimated values of elasticities, found that vegetables, sugar, pulses, grains ghee and food grains are necessities while meat and milk are the luxuries. Other studies such as Haq *et al.* (2011), Aziz *et al.* (2011), Khalil and Yousaf (2012) also analysed income and price elasticities of food items with LA/AIDS from data collected in Pakistan.

Omonona *et al.* (2009), employed a two-stage LA/AIDS model to examine micro level data on household consumption of four food groups (grains, roots/tubers vegetables/fruits and meat/fish) in their study on household food demand in semi-urban and rural households in south-west Nigeria. Their study showed that aggregate food demand in the study area is inelastic to price changes, with the exception of grain and aggregate expenditure elasticities also revealed that meat/fish are luxury foods while the others are necessities. Erhabor and Ojogho (2011) applied LA/AIDS in examining the demand analysis for rice in the Edo, Delta and Lagos states area of Nigeria. The results indicated that at higher levels of income, expenditure share of rice decreased,

marginal expenditure share was high for meat or fish followed by rice indicating that food demand pattern would not be substantially changed, even with an increase in future food expenditure. Canh (2008) applied LA/AIDS to calculate income and price elasticities for three different components of food categories and found that rice food and meat/fish are normal goods, while non-rice food is a luxury.

Vu (2020), applied the modified Almost Ideal Demand System (MAIDS) to estimate food demand patterns in Vietnam. The results indicated that all food has positive expenditure elasticities and negative own-price elasticities in Vietnam and demand is affected by income, price, as well as socio-economic and geographic factors.

In Egypt, Dawoud and Seham (2013), analysed the changes in food expenditure patterns over time with special emphasis on the differences between urban and rural sectors using Weighted Least Squares (WLS). It was discovered that food consumption expenditure patterns have changed over the five consecutive survey periods as a result of economic changes.

The reviewed literature revealed the gap in the empirical literature on households' rice demand response to changes in price, income and how rice consuming households cope during inflation. This study will therefore add to the existing literature on households' rice demand response to price and income through the use of the QUAIDS model as an appropriate approach. The model is an extended form of the AIDS model that approximates non-linear Engel curves in empirical analysis (Xie *et al.,* 2004).

3. MATERIALS AND METHODS

3.1. Study area

The study was conducted in Oyo State. Oyo State is located in the Southwest (SW) geopolitical zone of Nigeria; it consists of 33 Local Government Areas (LGAs) which include Akinyele, Afijio, Ibadan Northwest, Ibarapa Central among others. The state covers a total of 28,454 square kilometres of land mass and is bounded to the South by Ogun State, to the North by Kwara State and to the East by Osun State. The landscape consists of old hard rocks and dome shaped hills, which rise gently from about 500 metres in the Southern part and reach a height of about 1.219 metres a.s.l. in the Northern part. According to the 2006 census, the state population was 5,501,589 comprising 2,809,840 males and 2,781,749 females (NPC, 2006). Agriculture is the major source of income for the greatest number of the people and the mainstay of the economy. Climate in the state favours the growth of food crop such as yam, cassava, millet, maize, rice, plantain, rice, palm tree, cashew among others. Three vegetation regions are identified, namely: forest, savannah and derived savannah. Ibadan/Ibarapa zone falls within the forest region while Ogbomosho and Oyo zones are in the derived savannah region.

The data collected were on the demographic characteristics (sex, age and educational level, household size, and household income) from household heads or their representatives where the heads were not available. Data were also collected on the households' rice consumption with respect to the types, frequency, quantity, price and expenditure on rice consumed by the households per week.

3.2. Sampling Procedure

A multi-stage sampling technique was employed in the selection of the sample in this study. The data were collected in 2021. The first stage involved random selection of five (5) LGAs which are Ibadan North, Ibadan Northeast, Egbeda, Ogbomosho South and Oyo East out of the thirty-three LGAs in the state. The second stage involved the random selection of three (3) wards each out of the five (5) LGAs. The final stage involved the random selection of 12 households from each selected ward which gave a total of 180 households, out of this, 174 were found useful for the study and the remaining 6 discarded due to incomplete information. Data were collected with the aid of a structured questionnaire and administered through the assistance of trained enumerators.

3.3. Analytical Techniques

The data obtained from the field were analysed using various analysis methods which include: Descriptive Statistics, Likert Scale, QUAIDS. Households' responses to price (own-price and cross-price of rice demand for local, imported and both local and imported rice) and income changes are estimated in the form of expenditure and price elasticity through the use of QUAIDS Model following Banks *et al.* (1997). In QUAIDS, expenditure share equations are quadratic functions of the logarithm of total expenditure. The model was considered appropriate for this study because it takes into account mutual interdependence of a number of commodities in consumers' budget decisions and makes demand projections after taking into account income distribution and variations in some of their demographic characteristics (Mittal, 2010). This model is expressed in Equation (1)

$$w_i = \alpha + \sum_{j=1}^{K} \gamma_{ij} \ln p_j + \beta \ln\left\{\frac{m}{P(p)}\right\} + \frac{\lambda_i}{b(p)}\left[\ln\left\{\frac{m}{P(p)}\right\}\right]^2 + \sum_{j=1}^{K} \hat{c}_{ij} D_{st}^h + \varepsilon_i \quad (1)$$

Where:
α, β, γ, λ – parameters estimated
γ_{ij} - estimated coefficient of prices for rice.
w_i - Household expenditure share of ith type of rice.
w_1 - expenditure share on LSBWR
w_2 - expenditure share on LSBDR
w_3 - expenditure share on ISGR
w_4 – expenditure share on ILGR
p – Stone's price index
ln p_j = nominal price of the jth food commodity
ln m = log of household's total expenditure on all food in the demand system (₦/month)
D^h_{st} = Demographic variables:
D_1 = Age of household head (years)
D_2 = Household size (no of persons)
D_3= Sex of household heads (1 if male, otherwise 0)
ε_i = Error term

The Marshallian uncompensated price elasticities were calculated from:

$$e_{ij}^u = \frac{\mu}{w_i} - \delta_{ij} \quad (2)$$

The Hicksian or compensated price elasticities were calculated as follows:

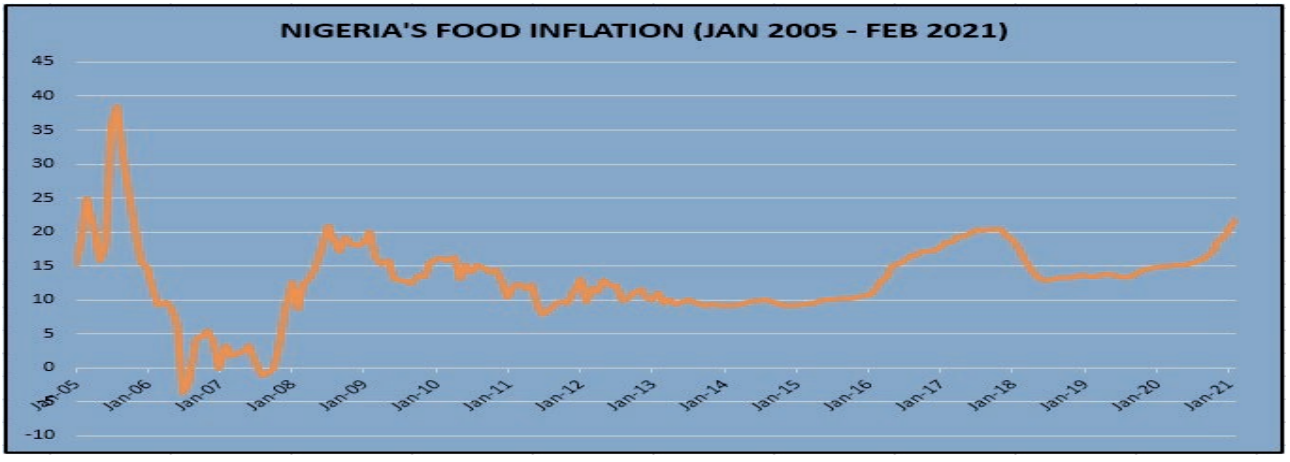
$$e_{ij}^c = e_{ij}^u + w_j e_i \quad (3)$$

4. RESULTS AND DISCUSSION

4.1. Stylist Fact about Food Inflation in Nigeria

Food inflation in Nigeria averaged 11.6% from 1996 until 2019, reaching an all-time high of 39.5% in September 2001 and a record low of -17.5% in January 2000 (Trading Economics, 2022). The country is still struggling with rising food prices, because it largely depends on agricultural imports, especially grains to meet the demand gap as indicated in Fig. 1. Inflation in Nigeria has been in double-digits since 2016 (Fig. 3), impacted by food-related pressure and currency weakness. The country's inflation rate is higher than other African countries (Fig. 4). Further acceleration of food inflation rate may not be unconnected to closure of land borders in 2019, the outbreak of the COVID -19 pandemic in 2020, conflict between farmers and herders, climate change and changes in monetary policy (Ezeanyeji *et al.,* 2021; Bello, Sanusi, 2019; Moser, 1995). The rapid changes in food prices affect consumers whose income remains unchanged, thereby affecting food items in their budget. Food inflation in Nigeria which has been on average 12.2% from 1996, rose as high as 22.9% more expensive than in 2020 and 39.54% in September 2021 (NBS, 2022). In 2014, according to the National Bureau of Statistics, a 50 kg bag of rice averaged ₦10,000. At the end of June 2020, a 50 kg bag of rice went for an average of ₦26,000. In many parts of Nigeria, in December 2021, a 50 kg bag of short-grain foreign rice sold for ₦24,000, and long-grain between ₦26,000 and ₦27,000; while local rice sold for ₦23,000 compared to January 2022, when a 50 kg bag of local rice was sold for between ₦24,000 and ₦25,000

Fig. 3. Trends of average food prices in Nigeria between 2005-2021.



Source: Compiled data from the National Bureau of Statistics, Nigeria from various issues. Available at https://nairametrics.com/2021/03/18/food-inflation-rate-in-nigeria-surges-to-highest-in-over-15-years/.

and a 50 kg bag of short-grain imported rice sold for between ₦30,000 and ₦32,000 (NBS, 2022).

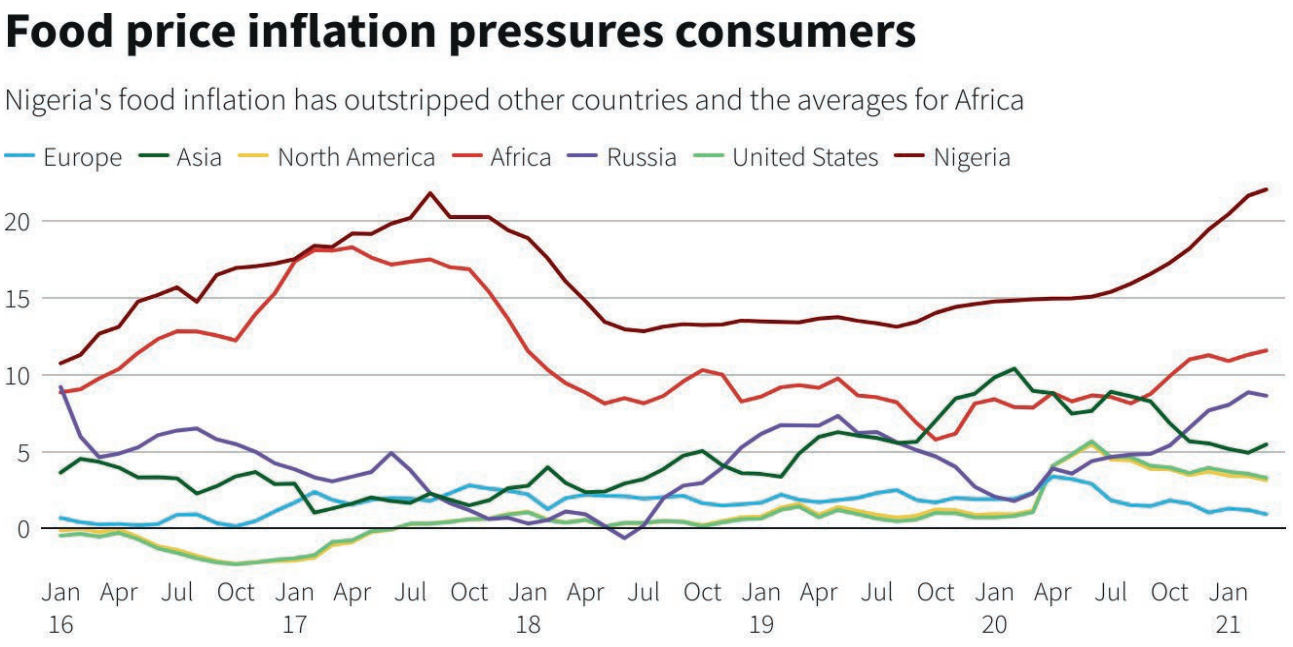
4.2. Households Rice Demand and Income Elasticity

Findings from the study revealed that a larger proportion (70.1%) of households had per capita weekly rice demand of between 1-3 kg ($\bar{x}$= 3.10 kg, Standard Deviation (SD) ±1.85 kg) of ILGR, 50% per capita weekly ISGR demand of 1-3 kg ($\bar{x}$= 4.35 kg, SD ± 2.67 kg); 70% per capita weekly lSBWR rice demand of 1-3 kg ($\bar{x}$= 3.30 kg, SD ± 1.42 kg) and 73.5% had per weekly LSBDR demand of 1-3 kg ($\bar{x}$= 2.79 kg, SD ± 1.32 kg). This by implication, shows that many households' demand for both long grain imported rice, LSBWR as well as LSBDR fell during food inflation in the study area.

Price and households' income variations have been significant determinants of rice demand. Income and price elasticity provide valuable information on how consumers react to changes in price and income. The income elasticities (IE) articulates the change in quantity demanded of the food item due to change in household income. The results in Table 1 of the QUAIDS model revealed that expenditure terms (beta) are statistically significant in all four expenditure share equations. Results showed that IEs of LSBWR, ISGR and ILGR were significant. LSBWR and ISGR were found to be normal and necessities for household consumption with positive coefficients of less than one. This result is consistent with that of Onyeneke *et al.* (2020) and Zhou *et al.* (2015) who posited that most primary food products such as rice are normal and necessities. The estimated result showed that the IE of LSBWR is 0.09, indicating that a 10% rise in households' income stimulates LSBWR demand by 0.9%. This result however, disagrees with Ogunleke and Baiyegunhi (2019) who found that, as income increases, demand and consumption of local brown rice decreases in South-western Nigeria but corroborates the classical microeconomics that demand is a positive function of income for normal goods.

Similarly, the IE of ISGR of 0.15 indicates that a 10% rise in households' income leads to 1.5% increase in demand of ISGR. ILGR appears to be an inferior item during food inflation since the expenditure elasticity of demand for this type of rice is -0.08. This means that if households' income increases by 10%, expenditures on ILGR are likely to reduce by 0.8%. It is not surprising that the study found an inverse relationship between demand for ILGR and income in the study area. The

Fig. 4. Food inflation trends in Nigeria between 2016-2021.



Source: UN-FAO (2021).

possible explanations for this could be that households with higher income probably want to consume more of other types of rice like the LSBDR as a result of the higher nutritional quality as maintained by Gyimah-Brempong *et al. (*2016) and Ayinde *et al.* (2013) compared with ILGR.

The gamma-parameters in the model captured the responsiveness of demand to variations in relative prices, including both the own price of good i and the prices of other goods j. Most of the price effects are significantly different from zero at the 5% significance level. This suggests that there is much quantity response to movement in relative prices. For instance, a change in the price of LSBWR leads to a systemic change in the expenditure share of LSBWR, ISGR and ILGR by 39% 65%, and 33% respectively. Also, the quadratic expenditure terms (lambda) are similar to the linear expenditure term with a minor difference. The lambdas regulate the effects of the second order coefficient on budget shares (thus allowing for nonlinear Engel curves) whereas the beta parameters only regard expenditure and budget shares as a linear relation. Three of the lambda parameters estimates are statistically significant. This confirms the relevance of the quadratic term extension of the linear AIDS.

The coefficient of sex is a negative and significant factor that influences expenditure share of LSBDR. This indicates that the fewer the male members in the household, the greater the expenditure share on LSBDR. This is a noteworthy finding considering the core role women play in household food choice (PrOpCom, 2009), and is in agreement with the study of Tomlins *et al.* (2007) who stated that sex is one of the factors that influence households' expenditure share on rice.

Household size is negative and significantly related to ISGR indicating that, the smaller the household size, the higher the expenditure share on ISGR. This result is consistent with Almas *et al.* (2019) who found that household size negatively relates to food consumption expenditure. Contrary to this, the coefficient of age of the household heads was positive and significant to expenditure share for the ISGR indicating that as age increases, the expenditure share on ISGR increases.

The above results suggest that the quantity of rice bought is a function of relative price and income movement during food inflation in the study area.

4.3. Own-price elasticity for rice types

Compensated price elasticity shows a change in quantity demand because of a change in prices by capturing only the substitution effect. Uncompensated elasticity, on the other hand, captures both the substitution as well as the income effect. The uncompensated own price and cross elasticity matrix is presented in Table 2, while the compensated own price and cross elasticity matrix is shown in Table 3. The own price elasticities are shown in bold figures along the major diagonal in Tables 2 and 3. The uncompensated and compensated own-price elasticities are negative for all rice types, this is consistent with consumer demand theory. The nega-

Tab. 1. Estimated Parameters of QUAIDS with Demographic Variables.

Budget Share(w_i)	Intercept (α)	Commodity Price				Estimated Coefficient		Household Demographics		
		LSBWR	LSBDR	ISGR	ILGR	Estimated Expenditure	Estimated Price	Sex	Age	Household Size
LSBWR	3.0663**	3.9603				0.0910**	1.0559**	0.0037	-0.0004	0.0053
	(1.2914)	(3.4811)				(0.0369)	(0.4189)	(0.0071)	(0.0005)	(0.0036)
LSBDR	-0.3097	-0.7969	0.3157			-0.0265	-0.2145	-0.0174*	-0.0004	0.0025
	(-0.8310)	(1.3793)	(0.6755)			(0.0282)	(0.3065)	(0.0095)	(0.0004)	(0.0033)
ISGR	-3.9136**	-6.5219	1.0798	10.4689		0.1467***	-1.6795***	0.0006	0.0016**	-0.0094*
	(1.5538)	(4.3867)	(1.8316)	(7.0521)		(0.0509)	(0.5229)	(0.0113)	(0.0007)	(0.0055)
ILGR	2.1571*	3.3586	-0.5986	-5.0268	2.2668	-0.0822*	0.8381*	0.01319	-0.0008	0.0015
	(1.2184)	(2.1999)	(1.0682)	(4.1342)	(2.7778)	(0.0439)	(0.4531)	(0.0151)	(0.0007)	(0.0057)
Rho (demographic effects on expenditures)								169.6599	10.9158	-61.9932

Statistical level of significance is denoted as *, **, *** for 10%, 5%, and 1% respectively, values in parenthesis are standard error.
LBWR – Local Short Brown Wet Rice, LSBDR – Local Short Brown Dry Rice, ISGR – Imported Short Grain Rice, ILGR – Imported Long Grain Rice.
Source: Author's calculation from the QUAIDS model (2021).

tive own price elasticities indicate that an increase in the price of rice results in a decrease in its demand. LSBWR, ISGR and ILGR are relatively own price elastic, while LSBDR is own price inelastic. This is in agreement with Hoang (2018) and Obalola *et al.* (2021) whose findings showed that demand for rice with respect to prices is relatively inelastic compared to other foods. ISGR is highly elastic with own price elasticity of -1.92, suggesting that when the price of ISGR increases by 1% its demand will reduce by 1.92%.

The uncompensated own-price elasticity of LSBWR showed that a 1% fall in LSBWR price would stimulate an increase of 1.16% in demand (Tab. 2). Where the substitution effect is 1.05% (Tab. 1), it means that an increase of 1.16% in LSBWR demand due to a 1% price reduction had a 1.05% pure price effect, and the income effect of a 1% price fall on LSBWR demand was 0.11% (that is, 1.16-1.05%). A 1% reduction in rice price might raise income per capita by 1%, which would raise demand by 1.25% (that is, 1.16 + 0.09%). However, an increase in per capita income would signify a move in the local rice (brown and wet) demand curve that would usually lead to an upsurge in LSBWR prices (Tab. 1, 2, 3).

4.4. Cross-price elasticity

The compensated price elasticity measures the strength of the pure substitution effects on consumption of the rice types under consideration. The compensated price elasticity assumes that the household has been compensated with income to keep the household utility constant. The estimates reveal the substitutability and complementarity effects. Negative cross-price elasticities show complementarity, while positive cross-price elasticities indicate substitutability. It is worth noting that the increase in price of one commodity will result in an increase in the demand for that commodity's substitutes and a decrease in the demand for its complements. Cross-price elasticity less than 1 indicates that there is weak response of the rice type to changes in the price of other types of rice.

The uncompensated cross-price elasticity results show positive cross-price elasticity of LSBWR to LSBDR, indicating that LSBWR price and LSBDR demand change in a similar direction. So, it can be established that a 10% fall in LSBWR price would decrease household demand for LSBDR by 3.0% (Tab. 2). The results of LSBWR to LSBDR cross-price elasticity (compensated), which is the change in LSBWR price on LSBDR demand, showed that demand for LSBDR would reduce by 4.1% with a 10% reduction in LSBWR price, while effect of LSBWR price on ISGR implied that demand for ISGR would increase by 25.9% with a 10% rise in the price of LSBWR and demand for ILGR would reduce by 32.3% with a 10% reduction in LSBWR (Tab. 3). This finding is similar to Gyimah-Brempong and Kuku-Shittu (2016) who found that both local and imported rice are complements and characterized by low substitutability (Demont *et al.*, 2013).

4.5. Households Coping Strategies on rice demand during food inflation

Huge, impulsive and unanticipated increases in food prices force people to adjust quickly. Consumer purchasing power reduces and households are pressed closer to or below the poverty line. Results of how households cope in their rice demand response to changes in price and income presented in Table 4 revealed substitution of rice by other grain crops as the predominant strategy used to

Tab. 2. Uncompensated (Marshallian) Price Elasticity Matrix.

	LSBWR	LSBDR	ISGR	ILGR
LSBWR	**-1.1619**	0.3025	-3.0955	2.7116
	(4.0414)	(3.1148)	(3.0093)	(2.6057)
LSBDR	0.3590	**-0.2998**	-3.0730	0.5577
	(4.1948)	(5.3122)	(3.7042)	(3.2456)
ISGR	-0.8732	-0.5895	**-1.9270**	0.7510
	(0.8829)	(0.8058)	(1.4130)	(1.0856)
ILGR	0.8408	0.2148	-0.6074	**-1.2057**
	(0.7541)	(0.6975)	(1.0751)	(1.2138)

Note**:** Values in parentheses are standard error, LSBWR – Local Short Brown Wet Rice, LSBDR – Local Short Brown Dry Rice, ISGR – Imported Short Grain Rice, ILGR – Imported Long Grain Rice.
Source: Author's calculation from the QUAIDS model (2021).

Tab. 3. Compensated (Hicksian) Price Elasticity Matrix.

	LSBWR	LSBDR	ISGR	ILGR
LSBWR	**-1.0565**	0.4131	-2.5863	3.2297
	(4.0414)	(3.1107)	(3.0074)	(2.6147)
LSBDR	0.5743	**-0.4593**	-2.3386	1.3049
	(4.1975)	(5.3060)	(3.738)	(3.2628)
ISGR	-0.7548	-0.5018	**-1.5966**	-0.3400
	(0.8813)	(0.8044)	(1.4116)	(1.0872)
ILGR	0.9235	0.2761	-0.3250	**-0.8747**
	(0.7534)	(0.6964)	(1.0692)	(1.2168)

Note**:** Values in parentheses are standard errors, LSBWR – Local Short Brown Wet Rice, LBDR – Local Short Brown Dry Rice, ISGR – Imported Short Grain Rice, ILGR – Imported Long Grain Rice.
Source: Author's calculation from the QUAIDS model (2021).

cope during food inflation ($\bar{x}$= 2.68), followed by preparation of other food types such as beans, spaghetti alongside with rice to reduce quantity of rice being consumed ($\bar{x}$= 2.49), outright reduction in the quantity of rice consumed ($\bar{x}$= 2.45).These findings are consistent with other past studies such as Kodithuwakku and Weerahewa (2011) who found that most households had to substitute their food to local products to cut down consumption during the times of food price hikes in Sri Lanka.

5. CONCLUSION AND RECOMMENDATIONS

Food inflation has been on the increase for some time in Nigeria and the situation is getting worse especially after the COVID-19 outbreak in 2019. The main thrust of this paper is therefore to look at the household demand responses to changes in prices of one of the most important foods consumed by almost everyone in the country (rice) and households' income using data collected from Oyo State. The study analysed the data with the use of QUAIDS. Results show that all own price elasticities are negative, which suggests that an increase in the price of any of the commodities results in a decrease in demand for that particular commodity. The positive expenditure elasticities of LSBWR and ISGR imply that these are normal and necessary foods, indicating that expenditures on food items rise with increase in households' income. This is consistent with the consumer demand theory. Cross-price elasticities among rice types showed weak substitution effects of a price change. It was also observed that demand for LSBWR and ISGR have positive expenditure elasticities of less than 1, indicating they are normal and necessary food, while that of LSBDR and ILGR has negative elasticity values showing that they are inferior food. Households prefer the imported to locally produced rice due to its perceived greater ease of preparation.

Based on the findings of this research, the following recommendations have been put forward:

1. Because rice is one of the main foods consumed by households in the study, an increase in price of this commodity is not desirable especially by those with a low income. Any policy that aims to reduce import tariffs and other taxes to lower domestic prices and increase household total income is essential to protect the low-income population from higher prices.
2. It is important that the Nigerian government rethink its land border policy of 2018 with Benin, Togo, Niger, Cameroon and Chad affecting staple food commodities like rice. This is important because enforcement of the policy has not really been able to solve the problem but has led to rising food inflation thereby reducing the relative purchasing power of households as indicated in Figure 2.
3. Adequate policy framework aimed at reducing the cost of production and increasing supply of local rice should be pursued as this will also invariably enhance demand for local rice by households as rice was estimated to be own-price inelastic.
4. Adoption of innovative practices should be encouraged that will cause a reduction in production costs

Tab. 4. Coping Strategies used by households on demand for rice during food inflationary period.

Strategies	SA Frequency	A Frequency	D Frequency	SD Frequency	Mean	Rank
Substitution of rice by other grain crops	124	240	80	23	2.68	1
Preparation of other food types such as beans, spaghetti alongside with rice to reduce quantity of rice being consumed	124	189	82	39	2.49	2
Outright reduction in the quantity of rice being consumed	92	207	92	36	2.45	3
Consumption of other different types of less costly rice	80	159	154	24	2.40	4
Reduction in non-rice and non-food expenditure to maintain quantity of rice consumed	140	117	118	41	2.39	5
Restriction of rice consumption by adults in order to feed small children	58	147	140	33	2.34	6
Reduction in the amount spent on other types of food consumed	88	126	1467	37	2.28	7
Reduction in the frequency of rice being cooked and consumed	96	150	96	52	2.26	8
Reduction in ration of rice being served to household members	80	114	90	71	2.04	9
Suspension of rice consumption in the house	108	42	144	61	2.04	10
Purchasing consumed rice on credit	56	81	140	63	1.95	11
Taking out a loan to purchase rice	81	43	23	14	1.75	12

Note**:** SA, A, D and SD means Strongly Agree, Agree, Disagree and Strongly Disagree respectively.
Source: Households field survey by authors (2021).

and invariably encourage farmers to produce more rice, leading to increasing supply.

One of the limitations of this study is that evidence from data sourced from household heads may not reflect the experiences of individual member of all households in Oyo State, nor all types of rice consumed within the state. We do not make any attempt to analyse, for example, how the analysis is affecting the homeless population, households across the different LGAs. We acknowledge these drawbacks, as well as recognizing that behind the data we used are millions of households and other types of rice beyond the four in this study.

Future research studies can (i) compare households' rice demand response to changes in price, income and coping strategies across LGAs of the selected state, compare the selected state with other states within the SW, or states from other geopolitical zones with more other types of rice consumed by households, (ii) analyse dynamics of households' rice demand response to changes in price and income using longitudinal household survey data such as the Living Standards Measurement Study (LSMS) dataset and (iii) analyse rice demand response to changes in price, income and coping strategies among the homeless population.

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