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RESEARCH ARTICLE

Domestic Consumption Pattern of Cereal Commodities in Nigeria

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ABSTRACT

The present research empirically study the demand pattern of cereal commodities for domestic use in Nigeria using time series data which spanned from 1966 to 2018. The data covered the domestic quantities and price series of the five most important domestically used cereal commodities. The sources of the data were FAO and USDA databases and the collected data were analyzed using descriptive statistics and linear approximate almost ideal demand system (LA/AIDS). The empirical evidence showed that all the considered goods were normal goods and mostly a necessity except for wheat which is a luxury. In addition, domestic consumption of these commodities was sensitive to changes in their respective prices. With wheat been a luxury commodity, it can be inferred that an increase in per capita income would tend to bring about a paradigm shift from the consumption of staple foods to non-staple food (wheat). This indicates that households tend to diversify their diet composition. Also, it was observed that most of the good pairs are complementary (uncompensated cross-price elasticity) while on the other hand (compensated cross-price elasticity), most of the good pairs are substitutes. The empirical evidence showed the income effect which owes to price changes for all the selected commodities to be moderate. Therefore, onus lies on the policymakers to embark on mass production of wheat in order to free the country from wheat food insecurity bondage caused by external influence, an impediment to the barometer that strikes a balance between the forces of demand and supply.

Introduction

Theil (1965) and Mudassar *et al*. (2012) reported that in applied economics the topic of consumer demand analysis is one of the oldest. In Nigeria as well as across the globe, for the past few decades, consumers' demand for food commodities and its dynamic has cut the attention of many researchers. The recentunprecedentedrisein the country's food prices has renewed the interest of researchers in re-conducting an empirical detail analysis of consumers' fooddemand. Despite the substantial progress made by the country in enhancing its per capita consumption for major food items *viz*. cereals, pulses, animal protein, fish and vegetables, unfortunately, evidence from the agglomerated data revealed that low incomes and diet deficiencies havesucceeded in forming a vicious cycle around the large proportion of the nation's population (FAO, 2018). Considering food security, this orgy development is a major setback to the not long ago positive picture of the total calories and protein intakes of the country. It is a known fact that the large share of the total household income is spent on food items, and inequalities continue to persist in food consumption across the existing income categories in the country.

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One of the biggest challenges facing Nigeria is how to feed its buoying population of approximately 180 million. Succinctly, policymakers are faced with the dilemma of adopting a liberal trade policy vis-à-vis intervening in markets to ensure food security, especially for the poor. With the accelerated growth rate, the major questions before the Nigerian policymakers are: What will happen to the country's demand for food in particular and agricultural products in general? Will the country be able to feed itself or continue to subsist on importation? These are pertinent matters that will continue to re-echo since the nation is faced with the problem of demand deficit due to the continuous growth in its population.

Therefore, it is very important to conduct a study on the current specific demand elasticity estimates, as income and price elasticities of demand would not only increase our horizon of understanding the country's economic behavior but can also enhance our vision on the matrix of policy. Haq *et al.* (2011) reported that empirical research on food consumption patterns can provide evidence on consumers' responsiveness to price and expenditure changes that are useful in designing a country's food policies. Elasticity estimates of price and income for different classes of foods can help in setting administered prices and in designing subsidy and tax policies as well as in determining the impacts of these policies on poverty. To formulate a long-term policy on food security and poverty reduction in a developing country, there is a need to understand how different classes of households respond to changes in the prices of different food items (Haq *et al.*, 2011; Mudassar *et al.*, 2012).It is against this background that this research was conceptualized to determine the domestic consumption pattern of cereal goods in Nigeria. Thus, the outcome of this research would fill the information gap concerning the domestic consumption pattern of cereal commodities in Nigeria.

Materials and Methods

The present research used time series data which covered domestic consumptions and prices for wheat, rice, maize, sorghum and millet. The data were sourced from the data bank of FAO and USDA. The collected data were analyzed using descriptive statistics and linear approximate almost ideal demand system (LA/AIDS). The price data were deflated using the consumer price index (CPI) of the country so as to eliminate the problem of inflationary trend.

Empirical Model

Following Anwarul-Huq *et al.* (2004); Awal *et al.* (2008) Babar *et al.* (2011), using the budget share form, the LA/AIDS model is given below:

$$\omega_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i \ln\left[\frac{X}{P^*}\right] + \varepsilon_i \tag{1}$$

$$\ln P^* = \sum_j w_j \ln P_j \tag{2}$$

The restrictions on the parameters of the AIDS equation (1) are:

$$\sum_i \alpha_i = 1. \sum_i \beta_i = 0. \sum_j \gamma_{ij} = 0, (Adding -$$
$$up\ condition, Engel\ Aggregation \tag{3}$$

$$\sum_j \gamma_{ij} = 0\ (homogeneity\ condition) \tag{4}$$

$$\gamma_{ij} = \gamma_{ji}(Symmetry\ condition) \tag{5}$$

Where, ω_i= budget share of the ith commodity (i.e. $\omega_i = P_iQ_i/X$); P_j = is the price of the jthcommodity; X = total household expenditure on all the food items considered for the study; P^*= stone price index; ε_i= stochastic term, and it is assumed to be zero and has constant variance; α_i= intercept; γ_{ij} = price coefficient; and, β_i = expenditure coefficient. Blanciforti and Green (1983); Awal *et al.* (2008) stated that the model that uses Stone's geometric price index is referred to as the "Linear Approximate Almost Ideal Demand System (LA/AIDS)".

The demand elasticities are calculated as the functions of the estimated parameters and they have standard implications.

The expenditure elasticity ($\in_i$) which measures the sensitivity of demand in response to changes in consumption expenditure is specified as follow:

$$\in_i = 1 + \left(\frac{\beta_i}{\omega_i}\right) \tag{6}$$

$$\in_i = \frac{MBS}{ABS} \tag{7}$$

Price elasticity is estimated in two ways viz. uncompensated (Marshallian) elasticity that contains both price and income effects, and the compensated (Hicksian) elasticity which contain only price effect.

The uncompensated own-price elasticity ($\in_{ii}$) and the cross-price elasticity ($\in_{ij}$) measures how a change in the price one product affects the demand of itself and that of the other products respectively, with the total expenditure and other prices being held constant i.e. *ceteris paribus*. The Marshallian own and cross-price elasticities are shown below (Babar *et al.*, 2011):

$$\in_{ii} = \left(\frac{\gamma_{ii}}{\omega_i}\right) - (\beta_i + 1) \tag{8}$$

$$\in_{ij} = \left(\frac{\gamma_{ij}}{\omega_i}\right) - (\beta_i\omega_i/\omega_j) \tag{9}$$

The Hicksian own and cross-price elasticities ($\in_{ii}^*\ and\ \in_{ij}^*$) which measures the price effects on the demand assuming the real expenditure ($X/_{P^*}$) is constant is given as follows (Babar *et al.* 2011):

$$\in_{ii}^* = \left(\frac{\gamma_{ii}}{\omega_i}\right) + (\omega_i - 1) \tag{10}$$

$$\in_{ij}^* = \left(\frac{\gamma_{ij}}{\omega_i}\right) + \omega_j \tag{11}$$

Besides, the compensated price elasticity can be estimated by using $\in_i$, $\in_{ii}$ and $\in_{ij}$, and the permutation is as follow:

$$\in_{ij}^* = \in_{ij} + \in_i * \omega_i \tag{12}$$

Babar *et al.* (2011) reported that the sign of the estimated $\in_{ij}^*$ indicates the substitutability or complementarily between the destinations under consideration. A commodity pair is denoted as a complement or substitute if their compensated cross-price elasticity is negative or positive respectively.

Based on the value of expenditure elasticity, a food item is classified as a necessity/necessary commodity ($0 < \epsilon_i < 1$), a luxury commodity ($\epsilon_i > 1$) or a Giffen / inferior commodity ($\epsilon_i < 0$).

In absolute term, the demand for aparticular commodity is price elastic (inelastic) if the elasticity value of its own-price is larger than unity (less than unity).

The Hicksian elasticity indicates the change in demand for a commodity due to a price variation, when the real expenditure change caused by the aforementioned price variation is compensated by an expenditure variation so that satisfaction/utility is kept constant.

Results and Discussion

Summary Statistics of the Variables

A cursory review of the summary statistics showed the country average annual budget shares on wheat, rice, millet, maize and sorghum to be 0.117, 0.171, 0.191, 0.257 and 0.264 respectively, with a conditional expenditure of ₦438.23million (Table 1). On average, wheat, rice, millet, maize and sorghum accounted for 11.7%, 17.1%, 19.1%, 25.7% and 26.4% respectively, of the average annual expenditure incurred by the country on cereal commodities. Sorghum and maize had an overwhelming dominance in the domestic consumption expenditure of the studied area. Thus, these average annual budget shares for the country are true 95% of the time within the intervals of 0.117±0.038, 0.171±0.047, 0.191±0.052, 0.257±0.066 and 0.264±0.0499; and an annual conditional expenditure within ₦438.23±637. The implication is that the country would expend ₦0.117, ₦0.171, ₦0.191, ₦0.257 and ₦0.264 on the domestic consumption of wheat, rice, millet, maize and sorghum respectively, for a naira budget on these cereal crops.

It can be observed that sorghum had the highest proportion while wheat has the least proportion. On the average, the quantity consumed was observed to be highest for sorghum (5.3 thousand MT), then trailed by millet (4.1 thousand MT) and then wheat with the least (1.495 thousand MT). Therefore, it can be inferred that sorghum is consumed more in the country possibly because of its low price in relation to that of the other available cereals in the market. In addition, the domestic use of sorghum for both human and animal consumptions in the country is high when compared to the other cereal commodities. Sorghum is processed into flour, paste, snacks, confectionaries etc and consumed by humans while the raw material is consumed directly by the large stock of livestock which abounds in the country especially the northern axis of the country. The reason for the least share proportion of wheat is because of its high cost as the bulk of the domestic supply is imported.

The standard deviation results of the budget shares showed high inconsistencies in the consumption of all the cereal commodities under the study. In addition, the variation in the annual average expenditure been high implied that the country exhibitsinconsistent behavior on the expenditure of commonly consumed cereal commodities during the period of study. Thus, this may be due to the imbalance in the supply and demand of cereal commodities which are relatively unstable in the studied area.

Table 1. Summary statistics of the variables

Items	Mean	SD	Minimum	Maximum
Quantity (thousand Million metric ton)				
Rice	2130.48	16.23.22	250	5800
Millet	4128.94	1842.49	910	9064
Sorghum	5296.96	2160.52	2298	9950
Maize	3939.52	2553.20	933	8900
Wheat	1494.94	1208.80	131	4160
Budget share				
ω_{rice}	0.1704504	0.0465497	0.062282	0.404545
ω_{millet}	0.1913878	0.05169	0.034063	0.420037
$\omega_{sorghum}$	0.2642629	0.0499325	0.155066	0.407234
ω_{maize}	0.2565193	0.0661397	0.125155	0.382357
ω_{wheat}	0.1173795	0.0378641	0.030053	0.33247
Prices (₦)				
P_{rice}	19028.65	23741.41	110	75138
P_{millet}	15091.81	20503.02	40	73913
$P_{sorghum}$	15112.19	20584.57	35	79452
P_{maize}	16878.71	22925.06	46	82452
P_{wheat}	19413.17	24121.27	75	80500
Annual expenditure (₦)				
Rice	74,696,665	109,051,261	27500	3.34E+08
Millet	83,872,077	142,656,107	69880	6.7E+08
Sorghum	115,808,182	174,466,505	113260	7.35E+08
Maize	112,414,725	167,912,959	43746	6.18E+08
Wheat	51,439,337	77,877,946	9825	2.85E+08
EXP	438,230,987	7.249E+14	294867	2.58E+09

Source: Authors' own computation, 2020

Note: ω and P means budget share and Price respectively.

Furthermore, the marginal budget shares of the country's cereal consumption are 0.175 for wheat; 0.150 for rice; 0.21 for maize, 0.11 for sorghum and 0.157 for millet (Table 2). This implies that if the annual income is increased by 100 percent the budget shares forwheat, rice, maize, sorghum and millet would increase by 17.46%, 15.03%, 20.597%, 11.36% and 15.72%, respectively.

Table 2. Marginal budget share (marginal propensity to consume) for the selected food items

Commodity	ABS	MBS	MBS%
ω_{rice}	0.17045	0.150319	15.03188
ω_{millet}	0.191388	0.157238	15.72379
$\omega_{sorghum}$	0.264263	0.113593	11.3593
ω_{maize}	0.256519	0.20597	20.59696
ω_{wheat}	0.11738	0.174634	17.46344

Source: Authors' own computation, 2020
Note: ABS and MBS means Average Budget Share and Marginal Budget Share respectively.

Demand Pattern of Cereal Consumption

OLS estimates of LA/AIDS model

A perusal of the Table showed the OLS estimates of the LA/AIDS model for the commodities to be reliable for predictions as evident from their respective diagnostic statistics *viz.* the LM test statistics for homoscedasticity and autocorrelation which were different from zero at 10% degree of freedom. In addition, the Durbin-Watson statistics were within a plausible or acceptable region. All the subsequent diagnostic tests *viz.*test for a structural break or change in the parameters (Cusum test), adequacy of the model specification

(RESET test), Arch effect test and Chow test are within the acceptable margin.Of the thirty parameter estimates, fifteen were observed to be different from zero at 10% error gap (Table 3). Based on the consumer theory, the estimated results were consistent as there is no evidence of violation of the homogeneity and symmetry properties as indicated by the significance of the Chi-square test statistics.

The coefficient of multiple determination values ranged from 0.7588 to 0.4377 with maize having the upper limit while millet has the lower limit. It was observed that seventeen out of the thirty parameter estimates were within the acceptable margin that is different from zero at 10% degree of freedom. The empirical evidence showed that sorghum and millet witnessed a positive trend growth as evidenced by the significance of their respective intercept parameters. Thus, it implies the presence of exogenous growth in sorghum and millet, independent of price and income movement. It was observed that the budget share of wheat decreased with increases in its own-price and price of rice while it increased with an increase in the price of millet. The budget share of rice decreased with an increase in the price of wheat, and increased with increases in its own-price and price of sorghum. For maize, its budget share decreased with increases in the prices of millet and wheat while it increased with an increase in the price of rice. The budget share of sorghum is inversely related to its own-price and that of millet, and directly related to that of maize. Besides, the budget share of millet decreased with an increase in the price of rice and increased when there is an increase in the price of wheat.

Table 3. Parameter estimates of the LA/AIDS

Price items	Rice	Millet	Sorghum	Maize	Wheat
Intercept	0.0473(0.2029) 0.23^{NS}	0.6113(0.3335) 1.83*	1.7080(0.2677) 6.38***	0.2918(0.2795) 1.04^{NS}	-0.2643(0.1982) 1.33^{NS}
P_{rice}	0.0376(0.0179) 2.10**	-0.0604(0.0294) -2.05**	-0.0321(0.0236) 1.36^{NS}	0.1458(0.0246) 5.92***	-0.0445(0.0175) 2.55**
P_{millet}	-0.0086(0.0278) 0.31^{NS}	0.00498(0.0456) 0.11^{NS}	-0.0653(0.0366) 1.78*	-0.09397(0.0383) 2.46**	0.0687(0.0271) 2.53**
$P_{sorghum}$	0.0465(0.0262) 1.78*	-0.0557(0.0430) 1.29^{NS}	-0.1880(0.0345) 5.45***	0.0319(0.0361) 0.88^{NS}	0.0414(0.0256) 1.62^{NS}
P_{maize}	-0.0326(0.0293) 1.11^{NS}	-0.0113(0.0481) 0.24^{NS}	0.1448(0.0386) 3.75***	-0.0269(0.0403) 0.67^{NS}	0.0039(0.0286) 0.13^{NS}
P_{wheat}	-0.0358(0.0123) 2.92***	0.0801(0.0201) 3.98***	0.0050(0.0162) 0.31^{NS}	-0.0572(0.0169) 3.38***	-0.0411(0.01197) 3.43***
Expenditure	-0.0105(0.0226) 0.47^{NS}	-0.0366(0.0371) 0.99^{NS}	-0.1476(0.0298) 4.96***	-0.0339(0.0311) 1.09^{NS}	0.0316(0.0221) 1.43^{NS}
R^2	0.7433	0.4377	0.6117	0.7588	0.6299
F-statistic	19.785***	5.318***	10.76***	21.49***	11.62***
Autocorrelation (LM)	12.012(0.112)^{NS}	14.62(0.146)^{NS}	30.56(0.105)^{NS}	0.247(0.264)^{NS}	16.72(0.212)^{NS}
D-W statistic	1.97	2.02	2.12	2.05	2.35
Heteroscedasticity (LM)	12.32(0.420)^{NS}	16.76(0.159)^{NS}	32.19(0.225)^{NS}	13.90(0.21)^{NS}	13.49(0.334)^{NS}
Arch LM test	2.34(0.125)^{NS}	25.81(0.104)^{NS}	4.094(0.663)^{NS}	2.42(0.61)^{NS}	17.40(0.235)^{NS}
Normality test (χ^2)	7.083(0.028)**	5.517(0.063)*	7.347(0.025)**	5.547(0.062)*	3.141(0.207)^{NS}
RESET test	0.286(0.595)^{NS}	0.345(0.234)^{NS}	0.246(0.981)^{NS}	1.412(0.255)^{NS}	1.575(0.217)^{NS}
CUSUM test	1.651(0.106)^{NS}	-1.059(0.296)^{NS}	-0.873(0.387)^{NS}	-0.037(0.97)^{NS}	0.226(0.290)^{NS}
Chow test	0.52(0.812)^{NS}	0.321(0.938)^{NS}	1.365(0.251)^{NS}	0.758(0.625)^{NS}	1.039(0.783)^{NS}

Source: Authors' own computation, 2020
Note: Values in ( ) are standard deviation while *** ** * ^{NS}means significant at 1%, 5%, 10% and non-significant, respectively

Expenditure elasticity

A cursory review of the expenditure elasticity conformstothe*a priori* expectation i.e has the expected sign (Table 4). The expenditure elasticitiesof all the cereal commodities are positive while that of the own-price elasticitiesare negative across the selected commodities. Because of the economic situation in Nigeria, the expenditure elasticities of these selected commodities are relatively high. This implies that all of the selected commodities are very important foods given that they fulfilled the fundamental needs of the populace as many of the households, especially the poor are constrained with tight budgetary allocation. The empirical evidence showed the commodities *viz*. rice, maize, sorghum and millet to be necessities i.e. necessary goods as evidenced from their respective expenditure elasticities which were less than unity, while wheat is a luxury good as revealed by its expenditure elasticity which is greater than unity. For the necessary commodities, these results conform to the findings of Makama *et al*. (2017) while for the wheat it contradicts their findings as they classified wheat to be a necessary commodity. However, these researchers did not include millet in their study. In addition, all the selected commodities are normal goods as evidenced by their respective income elasticities which were positively signed. Thus, it is expected that wheat will experience an increase in demand when the gross per capita income increases in tandem with the overall growth of the country's economy or GDP. Because of the low purchasing power (poverty) in the country, people would respond more towards the consumption of wheat as their income increases. Therefore, it can be inferred that households would tend to diversify their diets as their per capita income increases, thus anincrease in the consumption of non-staple food rather than staple foods. In relative terms, a decrease in the per capita real income will lead to a reductionin the per capita expenditure allocation on wheat in the studied area.The income elasticities of the necessary goods were inelastic while that of the luxury commodity was elastic, indicating that a percent change in the per capita income would lead to a less and greater than proportional changes in the demand for the necessary goods (former) and the luxury good (latter), respectively. A percent increase in the per capita income would lead to 1.488%, 0.803%, 0.882%, 0.430% and 0.822% increases in wheat, rice, maize, sorghum and millet respectively.

Own-price elasticity

The results of the Marshallian (uncompensated) own-price elasticity is consistent with the economic theory which stipulated an inverse relationship i.e. negativity of the elasticity coefficient, indicating that the demand curve is negatively sloped. Besides, the Hicksian (compensated) own-price elasticity conforms to the *a priori* expectation as all the selected commodity elasticity coefficients were negatively signed. The negative signs displayed by both the uncompensated and compensated own-price elasticity showed the inverse relationship between the price of a normal commodity and its demand (Table 4). Between the uncompensated and compensated own-price elasticities, a

substantial difference was observed, thus indicating a substantial income effect. This is contrary to the findings of Makama*et al*. (2017) who found substitution effect i.e. price effect to be stronger than income effect.

It was observed that the own-price elasticities of wheat, rice and sorghum were different from 10% degree of freedom, implying that the consumers were quite responsive to changes in price while adjusting their consumption of the corresponding commodity. The demand for rice and millet react in-elastic to their own-prices while for the remaining selected cereals its response was elastic as indicated by their respective coefficients which were less than unity for the former and greater than unity for the latter. Therefore, it can be inferred that rice and millet are less sensitive to price change while sorghum, maize and wheat are highly sensitive to changes in the price level.

The uncompensated own-price elasticity is composed of two components *viz*. price or substitute effect and income effect. The uncompensated own-price elasticity estimate for wheat demand showed that if the price of wheat plummets by 10% the demand for wheat per capita would surge by 16.67%. Of this increase in per capita demand, 15.70% is purely due to price/substitution effect as indicated by the compensated own-price elasticity. Furthermore, the income effect due to the decrease in the price accounted for the remaining 0.97% (i.e. 16.67-15.70) increase in the wheat demand due to the increase in the real income as the absolute amount of the money income remains unchanged. If an increase in per capita income by 10% is accompanied by a 10% decrease in the price of wheat, thus the demand for wheat would increase by 31.55% (i.e. 16.67+14.88).

For rice, maize, sorghum and millet, if their respective prices (own-price elasticities) plummeted by 10%, their respective per capita demands would increase by 5.67%, 11.23%, 15.79% and 9.39% respectively. Of these total increases in the per capita demands, 4.89%, 9.85%, 14.67% and 7.71% in respect of rice, maize, sorghum and millet owe purely to price/substitution effect as evidenced by their respective compensated own-price elasticities. The income effect due to the decrease in the prices accounted for the remaining 0.79%, 1.38%, 1.11% and 1.69% increase in the demand for rice, maize, sorghum and millet respectively, which owe to the increase in real income as the absolute amount of the money income remains unchanged. Therefore, if an increase in the per capita income by 10% is accompanied by a 10% decrease in the prices for rice, maize, sorghum and millet, their demands respectively would increase by 14.49%, 19.26%, 20.08% and 17.61%.

However, an increase in the per capita income represents a shift in the demand curve for wheat that normally leads to an increase in the price of the reference commodity. Thus, information on the supply elasticity of wheat is very necessary for the estimation of the resultant equilibrium level for wheat consumption in the studied area. The income effect due to price changes for all the selected commodities was moderate. This owes to the fact that the shares of these selected commodities in the household expenditure were almost

moderate, thus, changes in their prices had moderate effects on the real income.

In absolute terms, the compensated own-price elasticities were less than the uncompensated ones, an indication that a rise or fall in the price of the respective commodities would have a considerable effect on the real expenditure. Also, it implies that the price responsivenesses of the different food items were income-dependent, such that when income is held constant i.e. *ceteris paribus*, the responsiveness of households to the prices of food tends to be low. Generally, all the food crops with in-elastic own-price elasticity both for uncompensated and compensated means they are integral items of the household's diet.

Table 4. Expenditure (income) elasticity, Marshallian and Hicksian own-price elasticities

Commodity	Expenditure	Marshallian own-price	Hicksian own-price
Rice	0.881891	-0.56704	-0.48853
Millet	0.821567	-0.93913	-0.77049
Sorghum	0.429849	-1.57858	-1.46728
Maize	0.80294	-1.12263	-0.9845
Wheat	1.487776	-1.66662	-1.57037

Source: Authors' own computation, 2020

Cross-price elasticity

Cursory reviews of the matrices of the uncompensated and compensated cross-price elasticities show most of the cross-elasticity valuesin absolute terms to be lower than the values of the expenditure and own-price elasticities.The Marshallian cross-price elasticity shows the "gross" cross-effect that encompasses both the price/substitution and income effects (Table 5), while the Hicksian cross-price elasticity represents the pure price effect i.e. only the substitution effect or the net effect of change in price on demand (Table 6). Of the ten uncompensated cross-price elasticities, four were positively signed while six were negatively signed; indicating the former to be gross substitutes and the latter to be complementary goods. The reverse is the case for the compensated cross-price elasticity as six out of the ten cross-price elasticities were positive while the remaining four were negative, signifying that the former are gross substitutes while the latter are complementary commodities.The empirical evidence showed some of the signs of the cross-price elasticities for uncompensated and compensated to be contrary. For example, the uncompensated cross-price elasticity showed millet and rice to be complementary goods while the compensated cross-price elasticity revealed that they are substitutes. In other words, the total effect of a change in the price of millet on the demand for rice indicated that millet and rice are 'gross' complements while the compensated cross-price elasticity been positive, implying that millet and rice were 'net' substitutes.

Anwarul-Huq *et al.* (2004); Awal *et al.* (2008) posited that the uncompensated cross-price elasticity is ambiguous and suggested that when information about substitution possibility is required, compensated cross-price elasticity should be used i.e. is the most appropriate. Though, strong expenditure effects play a role.

Table 5. Marshallian cross-price elasticity for the selected food items

Items	D_{rice}	D_{millet}	$D_{sorghum}$	D_{maize}	D_{wheat}
D_{rice}	**-0.56704**	-0.27827	-0.07322	0.864997	-0.73125
D_{millet}	-0.07193	**-0.93913**	-0.13525	-0.50582	0.961708
$D_{sorghum}$	0.552522	-0.22517	**-1.57858**	0.236432	0.512643
D_{maize}	-0.34548	-0.00889	0.657343	**-1.12263**	-0.02435
D_{wheat}	-0.39487	0.461058	0.056313	-0.31945	**-1.66662**

Source: Authors' own computation, 2020
Note: Own-price elasticities are written in bold letters

Table 6. Hicksian cross-price elasticity for the selected food items

Items	D_{rice}	D_{millet}	$D_{sorghum}$	D_{maize}	D_{wheat}
D_{rice}	**-0.48853**	-0.20513	-0.03495	0.936479	-0.59881
D_{millet}	0.109091	**-0.77049**	-0.04701	-0.34101	1.267093
$D_{sorghum}$	0.780858	-0.01246	**-1.46728**	0.444326	0.897852
D_{maize}	-0.19377	0.116937	0.731288	**-0.9845**	0.231587
D_{wheat}	-0.33781	0.454981	0.084123	-0.26751	**-1.57037**

Source: Authors' own computation, 2020
Note: Own-price elasticities are written in bold letters

Conclusion

Based on these findings it can be inferred that rice and millet are integral items of household diets as both the uncompensated and compensated own-prices are inelastic. All the selected commodities were normal goods with almost all been necessary goods except for wheat that is a luxury commodity. In tandem with the overall economic growth of the country, wheat is expected to witness an increase in demand when the gross per capita income increases. Therefore, it is very obvious that the households diversify their diets as their per capita income increases, thus leading to more consumption of non-staple food and less of staple foods. Sorghum tends to have the highest budgetary share; an indication that the good has many domestic purposes *viz.* food paste, confectionaries, food flour and animal feeds etc. The empirical evidence showed the income effect which owes to price changes for all the selected commodities to be moderate. Also, for the uncompensated cross-price elasticity more than half of the cross-price elasticities in the matrix were complimentary goods while the reverse was the case with the compensated cross-price elasticity. Therefore, the onus lies on the policymakers to swiftly intervene by increasing the production of wheat so as to contain the excess of external influence on the food security of wheat which is the bane of the imbalance in the market forces.

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