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IMPLICATIONS OF CHANGES IN COMMODITY PRICES AND INCOME ON NUTRIENT AVAILABILITY AMONG HOUSEHOLDS IN NORTHERN NIGERIA

S.O. AKINLEYE

Department of Economics, University of Lagos, Lagos, Nigeria.

ABSTRACT

Food calorie intake has been found to have a strong empirical linkage with both human health and productivity. This study sets out to determine the probable influence of price and income changes on the availability of food nutrients to households in Northern Nigeria. Demand elasticities were obtained from survey respondents and the nutritional effects of changes arising from changes in income and prices were computed using both the Almost Ideal Demand System (AIDS) methodology and a technique developed by Huang. The findings show that yam, maize and guinea corn are the foods that would have the greatest implications for the nutrient status of the households. The study concludes with the likely applications of the methodology used to derive nutrient elasticities.

Keywords: Food, demand, AIDS, elasticities, nutritional implications, Northern Nigeria

INTRODUCTION

Nigeria, Africa's most populous country, is the single largest geographical unit in West Africa which occupies a land area of 923,768 square kilometers and is situated between longitude 30^0 and 150^0 East, and latitude 40^0 and 140^0 North (CBN, 2000). The country lies entirely within the tropics with two main vegetation zones; the rain forest and savanna zones, reflecting the amount of rainfall and its spatial distribution. The wet and dry seasons are the two major seasons in the country. With an estimated 140 million citizens, Nigeria is Africa's most populous country – and the fourth largest economy in Africa, with a national economy of USD40 billion – and boasts an abundance of natural and human resources. Nigeria is also the world's thirteenth largest oil producer, and the sixth largest oil exporter among member countries of the Organization of Petroleum Exporting Countries (OPEC). Oil provides 95 per cent of foreign exchange earnings, 20 per cent of GDP and 65 per cent of budgetary revenues. Based on these figures, Nigeria is expected to be a rich country given the enormous human and mineral resources available in the country. However, the opposite situation holds. The country is rich but the citizens are poor. Poverty in Nigeria encompasses a very complex society: regional climatic and ethnic differences are reinforced by different historical and socioeconomic legacies. Aigbokhan (2000) states that the contribution to poverty tends to be higher in Northern Nigeria than in Southern Nigeria and that while the intensity of poverty is declining in the south, it is rising in the north. The south is the economic centre of the country with economic activities much higher in the region. For instance, of all the

industries in the country only 19 per cent are located in the North, with Kano and Kaduna in the northwest zone having a lion share of 70 per cent. Furthermore, the combined industries of all the 19 northern states represents just one-third of industries located in Lagos state alone (Adamu, 2003).

Low economic activities in the north are reflected on the living conditions of the people of the region in comparison with the south. For instance, in the National Consumer Survey, the national average household expenditure was N5, 194 and the northwest zone had the least figure of N2, 941. Similar picture applies to household income and level of poverty with Northeast and Northwest occupying the bottom scale respectively. Furthermore, looking at professional data in Nigeria, the north is said to have only 10 per cent of engineers; 15 per cent of professors; 10 per cent of architects and 25 per cent of lawyers (Adamu, 2003). The proportion of undernourished children is significantly higher in the north.

Given that food consumption and expenditure decisions have long-term diet and health consequences and a direct effect on development; and the importance of per capita food intake on human welfare and productivity through its influence on the capability of man to perform work and the attitude of man towards the work. This study intends to derive the nutritional implications of the demand for food on Northern Nigeria and the effect or otherwise of unit changes in prices and income on the availability of nutrients to households in Northern Nigeria.

MATERIALS AND METHODS

The data used for this study was the National Consumer Survey (NCS) of the Federal Office of Statistics (FOS), Nigeria. This is the most comprehensive household level survey to date in Nigeria. A two-stage stratified random sampling technique was used in sample design. As a first stage, a list of all Nigerian households was obtained from the National Population Commission (NPC). This list is based on the enumeration areas (EA) used for census purposes. Within each enumeration area, five Household Units (HU) were chosen randomly using a table of random numbers.

The data set for this analysis are the portions dealing with the household characteristics and household food consumption behaviour in the 1996/1997 NCS which are targeted at all households in Nigeria. The data set provides detailed records on the money value, quantity and the types of food purchased by the households over a one-week period.

Data Analysis

A model of household demand for the different food items which compete for the household budget allocation requires a complete demand system framework. Because of its theoretical consistency with the postulate that households maximise utility (minimise cost) in their consumption decision making process, and its flexibility to encompass broad ranges of behaviour, the Almost Ideal Demand System (AIDS) was selected for modelling household behaviour. The basis for the AIDS approach comes from the minimisation of cost or expenditure function (Deaton and Muellbauer, 1980).

However, the true AIDS model is non-linear and is thus therefore difficult to estimate. The model estimated in this study is a linear approximation of the strict AIDS model (LA-AIDS) and it corresponds to those used by Savadogo and Brandt (1988), Fulponi

(1989), Mergos and Donatos (1989) and Soe *et al.* (1994). The model hypothesises that the portion of total expenditure that accrues to a particular commodity (or budget share) is related to prices and income as follows:

$$w_j = a^* + b_j \log(M / P^*) + \sum_{j=1}^{n} c_{ij} \log p_j \quad (1)$$

where, i = 1,..., n

n = number of food items

w_i = average budget share of commodity

M = total nominal expenditure on all goods

p_j = price of the jth good

P* is a price index defined as:

$$P^* = a_0^* + a_k^* \log P_k + \tfrac{1}{2} \sum_{k}^{n} \sum_{=1}^{n} c_{kj} \log p_k \log p \quad (2)$$

Equation (2) allows the AIDS flexibility but complicates the estimation procedure of eq. (1) which is nonlinear in the parameters. In empirical work, the following geometric rice index is often used instead:

$$\log P = w_j \log P_j \quad (3)$$

where, w_j is the budget share of food item j. Deaton and Muellbauer and others found in their application that Stones index P closely approximates P*. This results in the following linear (in the parameters) demand system:

$$w_j = a_i + b_j \log(M / P) + \sum_{i}^{n} c_{ij} \log p_j \quad (4)$$

Adding a disturbance term completes the equation.

$$w_{ih} = a_i + b_j \log m + \sum c_{ij} \log p_j + U_{ih} \quad (5)$$

i = 1, ….,n

where, i indexes commodity prices; m = M/P is real income and u random error.

The parameter a_i represents the average value of the budget share in the absence of price and income effects. The parameters b_i and c_{ij} represent the effects on the expenditure share of good i of a 1 per cent change in real income of price of good j. A positive (negative) b_i indicates that the good has an income elasticity greater (less) than unity. Similarly, a good for which c_{ij} is negative (positive) has an own price elasticity greater (less) than 1 in absolute value. When c_{ij} is positive (negative), the goods are considered substitutes (complements).

The formulae and procedures for the computation of elasticities after Beggs (1988) and Green and Alston (1990) are:

income elasticities

$$\varsigma_{iy} = 1 + b_i / w_i \quad (6)$$

own-price elasticities

$$\varsigma_{ii} = c_{ii} / w_{ii} - (1 + b_i) \quad (7)$$

cross-price elasticities

$$\varsigma_{ih} = c_{ih} / w_i - b_i w_h / w_i \quad (8)$$

Furthermore, a technique used by Huang (1996) was employed to explore the linkage of the demand model to nutrient availability. To do this, information about the nutrient

values of each food consumed is needed. Let a_{ki} be the amount of the kth nutrient obtained from a unit of the ith food. The total amount of that nutrient obtained from various foods, say Φ_k may be expressed as

$$\Phi_k = \Sigma_{i} a_{ki} q_i \quad \text{(9)}$$

Equation 9 is referred to by Huang as the consumption technology of consumer behaviour. The values of a_{ki}'s for non-foods will be assigned zero, thus the terms associated with non-foods will disappear. This equation, including all foods consumed, plays a central role in the transformation of food demands into nutrient availability. By substituting a demand equation for the quantity variable of Equation (9), changes in consumer nutrient availability become

$$d\Phi_k = \Sigma_{i} a_{ki} [\Sigma_j (\delta q_i / \delta p_i) dp_i + (\delta q_i / \delta m) dm] \quad \text{(10)}$$

Furthermore, the relative changes of consumer nutrient availability can be expressed as functions of the relative changes in food prices and per capita income as follows:

$$d\Phi_k / d\Phi = \Sigma_j (\Sigma_i e_{ij} a_{ki} q_i / \Phi k) dp_j p_j + (\Sigma_i \eta_i a_{ki} q_i / \Phi k) dm/m = \Sigma_j \Pi_{kj} dp_j / p_j + \varrho_k dm/m \quad \text{(11)}$$

where, $\Pi_{kj} = \Sigma_i e_{ij} a_{ki} q_i / \Phi_k$ is a price elasticity measure relating the effect of the jth food price on the availability of the kth nutrient, and ϱ_k represents the effect of income on the availability of that nutrient.

Obviously, the measurement represents the weighted average of all own- and cross-price elasticities (e_{ij}'s) in response to the jth price with each weight expressed as the share of each food's contribution to the kth nutrient ($a_{ki}q_i/\Phi_k$'s). Similarly, the measurement of ϱ_k represents the weighted average of all income elasticities (η_i's) with each weight again expressed as the share of each food's contribution to the kth nutrient. Thus the general calculation of nutrient elasticity matrix, say N, for the case of ℓ nutrients and n foods can be obtained as a product of multiplying matrix S by matrix D as follows:

$$N = S^* D \quad \text{(12)}$$

where N is the ℓ x $(n+1)$ matrix of nutrient elasticities in response to changes of food prices and income, S is the ℓ x n matrix with entries of each row indicating a food's share of a particular nutrient, and D is the n x $(n + 1)$ matrix of demand elasticities. From these nutrient elasticity measurements, a change in a particular food price or per capita income will affect all food quantities demanded through the interdependent demand relationships and thus cause the levels of consumer nutrient availability to change simultaneously.

RESULTS AND DISCUSSION

Socioeconomic Characteristics of Respondents

The summary of the socioeconomic characteristics of the respondents are as presented in Table 1. The distribution of households according to the sex of the household head shows that males constitute the overwhelming majority (94%). Similarly, 88 per cent of the respondents are from households with married heads. This indicates a noteworthy level of household food demand. The north central with the largest number of respondents, has 3 per cent of the respondents attending tertiary institutions unlike the other regions with less than one per cent. This means that the demand for exotic foods will not be much in the study areas given the

Table 1: Socioeconomic Characteristics of Respondents

Socioeconomic Characteristics	North East		North West		North Central		Total
	Number	% of Total	Number	% of Total	Number	% of Total	
Sex of Household Head							
Male	2415	27.8	2723	31.4	3013	34.7	8151
Female	115	1.3	40	0.5	370	4.3	523
Size of Family							
Less than 2	241	2.8	73	0.8	442	5.1	756
2-4	1170	13.5	1273	14.7	1416	16.3	3859
5-9	958	11.0	1273	14.7	1308	15.1	3539
More than 9	161	1.9	144	1.7	217	2.5	522
Sector of Residence							
Urban	314	3.6	232	2.7	748	8.6	1294
Rural	2216	25.5	2531	29.2	2635	30.4	7382
Age of Household Head							
Less than 34	672	7.7	623	7.2	935	10.8	2230
35-44	807	9.3	955	11.0	1004	11.6	2766
45-54	591	6.8	744	8.6	793	9.1	2128
More than 54	460	5.3	441	5.1	651	7.5	1552
Level of Educational Attainment of Household Head							
None	2098	24.2	2600	30.0	2159	24.9	6857
Primary	194	2.2	68	0.8	538	6.2	800
Secondary	169	1.9	79	0.9	449	5.2	697
Tertiary	69	0.8	16	0.2	237	2.7	322
Occupation of Household Head							
Farming	2143	24.7	2539	29.3	2113	24.4	6795
Other Occup.	387	4.5	224	2.6	1270	14.6	1881
Total	2530	29.2	2763	31.8	3383	39.0	8676

Source: Result of Analysis, 2004

relative non-exposure of the survey respondents. Respondents from the north west have the highest percentage of people involved in farming (29%). This means that the region has the potential to be food self sufficient in light of the relatively high percentage of the population currently involved in farming practices.

Food Demand Elasticities of the Households

Income elasticities for all households are as seen in Table 2. The results as presented for the North Central show that garri is an inferior food (-0.10), millet (1.62), yam (1.16) and rice (1.09) are luxury foods and the other foods are essential. Cross price elasticities show the demand for rice (1.01), millet (-1.15), guinea corn (-0.50) and beans (1.08) to be price elastic Maize substitutes for all the other food items; guinea corn complements millet and beans and rice substitutes for garri, beans and maize.

For households in the north east, guinea corn (1.12), beans (1.71) and maize (-1.59) are price elastic. Rice (1.12) and millet (1.44) are the luxury food items in the North East. Other foods are necessities. Cross price relationships show that rice complements guinea corn and yam and substitutes for all other food items. Yam complements rice, guinea corn and garri and substitutes for other food items. Maize is a substitute for all the food items consumed in the north east.In the north west, income elasticity values show yam (3.18) and rice (1.12) to be the luxury foods in the north west and beans (-0.29) and millet (-0.30) inferior foods. Beans (1.27) is the only price elastic food of those consumed in the North West. Cross price relationships for the North West show that yam would substitute for all other food items except beans, maize would complement other food items except rice and yam would substitute all other food items.

Nutritive Value of Foods Consumed in Northern Nigeria

Table 3 shows the nutritive values per kilogramme for selected food items. Yam has the least energy content (1190) of the food items, but the highest moisture content (690). Beans has the highest protein value (225) and yam (19) and garri (10) the least. Yam has the least carbohydrate content (278) and millet the highest calcium content (3970). Guinea corn has the highest phosphorous content (3300) while beans has no iron content. Further details on the nutrient contents of the different foods are as seen in Table 3.

In addition to the unit nutritive value of the study food items, the amount of food consumed is another factor determining the level of nutrients available to consumers. Averages of food consumption over the study period were obtained from the Central Bank of Nigeria, 1998. Maize is the food item consumed in the greatest quantity by Nigerian households and beans is consumed in the least quantity.

In Table 4, combined consumption of maize and garri accounts for more than 80 per cent of all energy consumption. Also, maize is a major source of protein, fat, phosphorous, thiamine, riboflavin and niacin. Garri and millet are the principal sources of calcium and yam accounts for 50 per cent of food moisture. Table 4 presents the source of nutrients and is the first step for obtaining nutrient elasticities for the selected food items.

Table 2: Income and Price Elasticities for Households in Northern Nigeria

Food Items	Income Elasticities	Price Elasticities						
		Rice	Millet	G. Corn	Yam	Garri	Beans	Maize
Households in the North Central								
Rice	1.09	1.01	-0.14	0.29	-0.69	0.89	0.61	0.18
Millet	1.62	-0.09	-1.15	-0.01	-0.04	-0.56	-0.40	0.22
G. Corn	0.25	-0.11	-0.5	-2.20	0.58	0.56	0.22	0.72
Yam	1.16	-0.16	0.37	0.07	0.76	-0.02	-0.03	-0.03
Garri	-0.10	0.70	-0.18	0.08	0.07	0.31	0.48	0.03
Beans	0.06	0.85	0.52	-0.14	-0.84	0.79	1.08	1.11
Maize	0.04	0.09	0.57	0.70	-0.51	0.37	0.68	0.93
Households in the North East								
Rice	1.12	0.05	0.32	0.14	-0.88	0.22	0.11	0.72
Millet	1.44	0.49	-0.82	-0.10	0.19	0.21	-0.02	0.08
G. Corn	0.23	-0.28	0.96	1.12	-0.08	-0.50	0.01	0.12
Yam	0.31	-0.02	-0.46	0.23	-0.10	0.23	0.03	0.13
Garri	0.31	0.38	-0.15	0.02	-0.59	0.62	-0.01	0.39
Beans	0.11	2.22	-0.50	-0.48	0.98	1.71	3.29	0.48
Maize	0.36	0.06	0.29	0.12	0.68	-0.01	0.04	-1.59
Households in the North West								
Rice	1.12	0.21	-0.19	-0.13	0.09	0.02	0.11	0.08
Millet	-0.30	-0.29	-0.90	0.68	0.44	0.07	-0.16	-0.47
G. Corn	0.14	0.28	0.42	-0.13	1.61	0.27	-0.11	-0.07
Yam	3.18	0.67	-0.58	0.66	0.97	1.02	-0.48	-1.77
Garri	0.41	-1.08	0.43	0.66	0.04	0.28	0.76	-0.07
Beans	-0.29	0.27	0.70	0.87	-0.13	0.45	1.27	-0.11
Maize	0.16	0.68	0.27	-0.37	0.23	0.40	0.61	0.94

Source: Result of Analysis, 2004

Table 3: Nutritive Value of Food per Kilogramme and Average Food Consumption

Nutrients	Rice	Millet	G. Corn	Yam	Garri	Beans	Maize
Energy (cal)	3630	3290	3450	1190	3510	3380	3570
Moisture (%)	120	109	101	690	126	114	116
Protein (g)	70	74	107	19	10	225	94
Fat (g)	5	13	32	2	11	14	42
Carbohydrate (g)	799	777	741	278	842	610	736
Calcium (mg)	90	3970	260	520	450	1040	160
Phosphorous (mg)	1270	2440	3300	610	790	4160	2200
Iron (mg)	17	171	106	8	16	-	36
Thiamine (mg)	1	1.8	3.4	1.1	0.8	0.8	3.3
Riboflavin (mg)	0.3	1.1	1.5	0.2	0.3	0.9	1
Niacin (mg)	28	8	33	3	10	40	22
Food(Kg)	35.89	69.83	88.38	274.59	394.56	21.74	1009.09

Source: Central Bank of Nigeria, 1998
Food and Agricultural Organisation, 1968

Table 4: Food Share of Nutrients Based on Average Food Consumption

Nutrients	Rice	Millet	G. Corn	Yam	Garri	Beans	Maize	Total
	Percentages							
Energy	2.15	3.80	5.04	5.40	22.88	1.21	59.5	100
Moisture	1.13	2.01	2.35	49.92	13.10	0.65	30.84	100
Protein	1.99	4.10	7.50	4.14	3.13	3.88	75.25	100
Fat	0.35	1.76	5.49	1.07	8.43	0.59	82.31	100
Carbohydrate	0.02	4.13	4.99	5.81	25.30	1.01	56.57	100
Calcium	0.40	34.32	2.84	17.68	21.99	2.80	19.99	100
Phosphorous	1.38	5.17	8.85	5.08	9.45	2.74	67.33	100
Iron	0.91	17.89	14.03	3.29	9.46	0.00	54.42	100
Thiamine	0.81	2.84	6.79	6.82	7.13	0.39	75.22	100
Riboflavin	0.76	5.40	9.32	3.86	8.32	1.38	70.96	100
Niacin	3.11	1.73	9.02	2.55	12.21	2.69	68.89	100

Source: Result of Analysis, 2004

Table 5: Nutrient Elasticities for Foods Consumed by Households in Northern Nigeria

Nutrients	Income	Rice	Millet	G. Corn	Yam	Garri	Beans	Maize
Nutrient Elasticities for Foods Consumed by Households in the North Central								
Energy	16.1881	22.8106	25.2328	33.1865	-24.3681	32.5636	53.4875	62.0543
Moisture	62.9452	5.2128	30.3845	21.177	23.0847	16.183	26.8659	30.6357
Protein	18.4183	12.415	37.1349	36.7081	-35.4583	35.4703	57.9625	80.9192
Fat	8.3312	13.2304	41.284	46.2896	-38.1981	35.913	61.3396	81.827
Carbohydrate	14.4929	21.8298	23.1185	30.8748	-20.7973	29.955	50.9861	58.8209
Calcium	76.0218	13.7461	-25.5103	10.1226	2.4276	-1.2012	13.7828	31.4952
Phosphorous	19.8975	14.1459	29.4178	28.7375	-28.1436	33.1936	53.848	73.5472
Iron	38.5284	8.7591	2.818	8.3001	-17.7977	21.6505	37.9334	64.9969
Thiamine	17.4116	10.8167	37.5438	38.9157	-29.7418	33.1463	55.6405	76.0562
Riboflavin	18.4732	12.0222	30.119	30.077	-29.1676	32.719	53.975	75.6936
Niacin	13.1015	18.6188	32.4769	30.0423	-31.5843	38.1988	58.7242	74.7782
Nutrient Elasticities for Foods Consumed by Households in the North East								
Energy	39.3591	15.4009	13.1444	13.8246	26.0334	15.6527	6.505	-81.9422
Moisture	35.4106	7.6564	-15.3402	17.7216	8.0867	19.9024	4.8463	-35.8686
Protein	39.6283	14.2437	21.9834	16.451	51.1395	6.3239	16.08	-113.365
Fat	36.8306	8.7731	25.7574	16.0305	51.0555	3.3601	5.2395	-126.111
Carbohydrate	37.2377	15.7617	10.8429	13.3245	24.3173	16.5604	5.4765	-77.8956
Calcium	70.3241	31.4596	-32.3222	5.3658	7.5367	28.1635	9.7081	-16.1912
Phosphorous	40.0704	13.7363	19.0996	17.71	41.446	8.0038	11.9026	-98.9244
Iron	53.5514	11.6774	11.9396	21.5283	32.5711	3.0198	2.0635	-78.6407
Thiamine	38.0051	7.4829	21.8609	17.9846	45.9267	3.2835	4.5254	-114.12
Riboflavin	40.244	10.48	21.6272	18.9118	43.922	4.3376	7.48	-106.32
Niacin	37.7209	13.1716	23.8644	18.1711	38.8928	8.6052	11.9578	-99.6905
Nutrient Elasticities for Foods Consumed by Households in the North West								
Energy	37.6955	20.455	21.9067	-0.6482	29.6608	37.9287	51.7026	42.6705
Moisture	169.8541	40.7575	-15.5755	31.6623	60.7247	68.0127	5.1765	-61.3761
Protein	27.4121	52.9399	21.0601	-18.1144	35.0022	39.297	49.9596	60.4685
Fat	20.49	48.8429	26.2963	-23.2338	29.8745	38.2538	56.0046	73.639
Carbohydrate	37.0891	15.5127	21.8651	2.6375	29.3804	37.7295	51.0221	38.7212
Calcium	58.1743	-6.628	-23.2126	44.1383	41.9721	36.624	18.2163	-30.6475
Phosphorous	31.2407	40.9903	20.016	-10.7528	37.0828	38.7716	47.6458	50.3967
Iron	20.6644	27.9245	6.4717	-1.4974	46.6281	32.8312	34.501	35.3517
Thiamine	37.5388	49.3716	19.8346	-17.3419	36.4049	41.2646	47.4125	56.3481
Riboflavin	27.1754	43.4292	20.374	-14.6542	37.668	38.1814	47.703	56.0064
Niacin	27.5844	38.7702	25.8951	-13.8079	34.0202	37.405	52.5679	57.8968

Nutrient Elasticities of Foods Consumed in Northern Nigeria

Table 5 presents the nutrient elasticities for food items consumed in the north central region. A one per cent increase in the price of millet (holding other prices and income constant) would positively affect carbohydrate availability by 23 per cent and increase protein and thiamine contents in the diet of the study respondents by 37 per cent. A change in the price of yam by one percent would lead to a reduction in the availability of almost all food nutrients except calcium and moisture.

Increasing income by one percentage point would result in an increase of more than 70 per cent calcium availability to residents of the north east. A similar increase in the price of maize would however have very serious implications on the well being of residents of the north east as the unit availability of all food nutrients would reduce. Conversely, increasing the price of garri would lead to an enhancing nutrient availability to the respondents.

The food items that would have the greatest negative effects on overall nutrient availability to residents of the northwest are millet and guinea corn. Percentage increase in income would improve overall health (through improved nutrition) of the respondents. Increasing the price of beans will enhance the availability of almost all nutrients by approximately 50 per cent.

CONCLUSION

There is an increasing realisation that food demand studies should go beyond the realm of being mere academic exercises to having an impact on the livelihood of people who consume the foods. This study has attempted to do this by examining the changes in nutrient availability arising from price and income changes in Northern Nigerian households.

Using demand elasticities from traditional demand studies, the study was able to show the intervening relationship between nutrient changes arising from changes in economic factors. The major policy implications of the study are that it provides a means to derive a nexus between economic planning and the (nutritional) well being of the citizens of the nation. With this tool, therefore, it is possible to predict the remote effects of (1) food policies and pricing (2) import restrictions (3) farm subsidies (4) income distribution and (5) associated government legislation on food nutrient status.

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