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Determinants of urban households' demand for cassava and cassava products in Kaduna, northern Nigeria: The application of AIDS model

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Abstract

Cassava is one of the most important root and tuber crops grown for food in West and Central Africa. It is the chief source of dietary food energy for the majority of the people living in the lowland tropics, and much of the sub-humid tropics of West and Central Africa. The paper examines the most important determinants of the demand for cassava and ascertains the future of cassava in northern Nigeria by estimating and comparing the elasticities of demand for cassava with other root and tuber crops. The analyses were based on data collected by IITA in two rounds, between October 1999 and January 2000. The AIDS (Almost Ideal Demand System) methodology was used to estimate the parameters of the regression, as this model has a functional form, which is consistent with known household budget data and satisfies the requirements of demand theory. Results indicate that cassava is a price inelastic food and the expenditure elasticity is positive, though inelastic. This witnesses that it is fast changing from an inferior food to a necessity. Because of its storability and ease of processing, gari is becoming the most popular form in which cassava is consumed. Cassava tuber, gari, and yam are found to be strong substitutes. Cassava is often regarded as a poor man's food with low nutritional value that is only consumed by subsistence farmers who have little else to eat. Actually, cassava is an excellent source of dietary energy, and it is short sighted to consider cassava solely a subsistence crop.

2. Background and Aim of the Study

In Nigeria, the present understanding of long-term demand structure for crops is limited because few empirical studies are done concerning food demand structure. In order to provide empirical evidence to understand these issues, it is necessary to know the food demand structure and consumption pattern of urban consumers. Appreciation of consumption implications on agricultural production policies is only beginning to evolve. Food production and consumption have their influences on each other. An adequate effective demand for food is needed to sustain the growth in food production, because producers need market for their products. Moreover,

consumption parameters provide necessary information on linkages from food consumption to incentives for agricultural production, through the marketing sector. For instance, the availability of commodity-wise disaggregated food demand parameters are essential in formulating crop diversification policies and programs.

Because of the high costs of production of other food crops (coupled with their high agro-climatic requirements), they are more expensive compared to cassava, and may not be accessible to the urban poor at some periods of the year. Thus, with the growing population in Nigeria and declining real incomes, cassava has the potential to become a highly demanded food crop. Despite the speculations about the growing demand for cassava, however, the demand structure of the crop as a major source of food has not been ascertained. While research efforts (for example, that of IITA) concentrated much on developing high yielding, early maturing and disease resistant varieties, not much was done to study the determinants, elasticities, and the pattern of the demand for cassava. Thus, the specific objectives of the study are as follows:

1. Analyze urban household demand patterns for cassava and cassava products.
2. Estimate household demand elasticity for cassava and its products and other root crops.

3 Research design and analytical method

3.1. Data collection procedure

Within the selected urban centres[1] (Abuja, Kaduna and Kano), three different levels of stratification were used to select respondent households. A combination of cities and income status (inferred from residential area and type of house) formed the first level. Each city was stratified in to low, medium, and high-income areas. This leads to the second level of stratification - the Enumeration Areas (EAs[2]). Within each income stratum, a random sample of EAs (31 from Abuja, 52+ from Kaduna, and 60+ from Kano) was selected from a list of all the EAs. This leads to the third level of stratification – the houses within each EA. A frame of all the houses within each EA was developed. And from this, a random sample of houses was selected. Finally, for each randomly selected house, a frame was developed of all the households within it. From this list, a random sample of one household was selected. This is because of the general assumption that households living in the same house are likely to have similar living standard.

3.2. Data Analyses

To estimate the household demand elasticity, the AIDS methodology, developed by Deaton and Muellbauer (1980) was used. The SAS (Statistical Analysis System) package was used to run the regression. The basis for the AIDS approach comes from the minimisation of cost or expenditure function (Deaton and Muellbauer, 1980). Because household data are used to estimate the model, variables other than income and prices also play important role in shaping consumption patterns. The model aggregates household size, gender of household head, education level of household head and dependency ratio. To incorporate these demographic variables, the AIDS model was specified as follows:

$$W_{it} = \alpha_i + p_{ih}h + p_{id}d + p_{ie}e + p_{ig}g + \beta_i \log (X_t/P_t^*) + \Sigma_j Y_{ij} \log P_{jt} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$i = 1,\ldots, n,\ t = 1 ,\ldots, T$

[1] We analysed the data on Kaduna only.

[2] The EAs were already designated by the National Population Commission (NPC).

Where

α_i represents the average value of the budget share in the absence of price, income and other demographic factors, W_{it} is the budget share of the i^{th} commodity in period t, P_{jt} is the price of the j^{th} commodity in period t, X_t is total expenditure on the commodities under study, h is household size, d is the dependency ratio in the household, e is education level of household head (number of years), g is gender of household head (1 = man), p_{ih}, p_{id}, p_{ie}, p_{ig}, β, and y_{ij} are parameters to be estimated, and P_t^* is a price index defined by:

$\log P^*_t = \Sigma_j w_j \log P_{jt}$ …… (2)

In this study, the *homogeneity* condition is tested. The *adding-up* condition is imposed by the model and so is not testable (Deaton and Muellbauer, 1980b). In the context of the AIDS, testing or imposing the *symmetry* restriction is valid only when the theoretical price index, which is non linear, is used, not when an approximation index (Stone's index: equation 2) is used (Deaton and Muellbauer, 1980a in Savadago and Brandt, 1988). Since the theoretical price index is not used in this study, symmetry restrictions are neither tested nor imposed.

4. Results and discussion

4.1. Household and Expenditure Characteristics[3]

Table 1 presents relevant statistics by per *capita expenditure quartiles*[4] to allow comparison of expenditures of poorer and richer households. Total food and nonfood expenditures in the survey area amount to about 38000 Naira or equivalently $348[5] US per capita per year (Table 1). This level is reassuring to note that average per capita expenditures are close to per capita income levels for Nigeria, which are estimated at $310 US (World Bank, 1999). In here, we observe that per capita expenditures of the survey households are above the average per capita income for Nigeria. This may be on account of the fact that Kaduna is one of the major cities of Nigeria and it is expected that the households have incomes above the average per capita of the country.

Table 1. Household and expenditure characteristics, by per capita expenditure quartile[6]

Characteristics	Quartile				
	1	**2**	**3**	**4**	**All**
Household size	8.1	7.4	6.7	4.1	6.65
Dependency ratio	0.87	0.82	0.79	0.67	0.79
% of male headed households	90.0	94.4	94.4	93.3	93.1
Monthly food expenditure per capita	529.9	1021.3	1579.0	2381.7	1212.7
Monthly non-food expenditures per capita	613.2	1124.5	2019.8	6439.4	1981.3
% share of food in total expenditure	46.4	47.6	43.9	27.0	37.6
% of non-food in total expenditure	53.7	52.4	56.1	73.0	62.4
% of cassava in total food expenditure.	6.48	6.19	3.61	3.54	4.93

Source: 1999/2000 IITA Survey on Food Demand in Nigeria

[3] Household consumption expenditures are used in the analysis as a proxy for income. This is because data on expenditures are generally more reliable than income data as questions of income are sensitive and it is expected that households underestimate their income. Due to this reason, expenditures are used as proxy for income in the study.

[4] It is computed by dividing the total expenditure of the household by the respective household size.

[5] $1US = 110 Naira (official exchange rate in March 2001)

[6] Expenditure quartile 1 represents the lowest and 4 the highest income groups.

On average, richer households have smaller families (4.1 members) compared to poorer households (8.1 members). Though the trend is as expected, it is only surprising to see this unusual big difference in household size. We can attach no reason for this. The dependency ratio, defined as the number of elderly (> 65) and children (≤ 15) per number of adults ($15 \leq x \leq 65$), is greater for the lower quartile (0.87) than for the upper quartile (0.67). The interpretation is those 87 children and elderly depend up on 100 adults in the lower quartile, while 67 to 100 is the proportion in the upper quartile. Ten per cent of the households in the lower quartile are female headed as compared to 7 per cent in the upper quartile. The level of food and nonfood expenditure is, by definition, higher in the upper quartile.

As expected, the share of food in total expenditures declines from 46.4 per cent for poorer households to 27 per cent for the richer ones. This agrees with the concept of "Engel's Law", which says: "*The proportion of personal expenditure devoted to necessities decreases as income rises*". Comparison of crop food and animal food expenditures shows that crop food expenditure outweighs that of animal food across all the quartiles. So, households of Kaduna eat more of crops and less of animal products.

4.2. The chi-square test

Cassava (and its products) expenditure share in total food expenditure was presented in Table 1. From the table, it is made apparent that as we go from lower to higher income groups, the share of cassava in total food expenditure declines. Therefore, we want to observe if there is any relationship between income level of a household and this share. The null hypothesis was that the household expenditure share of cassava and cassava products in total food expenditure is the same in all income groups. To test this hypothesis, a chi-square test is used.

Table 2. Cassava shares in total food expenditure and X^2calculations*

Given		**X^2 calculations**			
Income groups	Observed share of cassava in total food expenditure (in %)* 0	Probability (if Ho true) π	Expected share (in %) $E = s\pi$	Deviation $0 - E$	Deviation squared and weighted $(0-E)^2/E$
1	6.48	0.25	4.955	1.525	2.33
2	6.19	0.25	4.955	1.235	1.53
3	3.61	0.25	4.955	-1.345	1.81
4	3.54	0.25	4.955	-1.415	2.00
	s = 19.82	1.00	19.82	0	$X^2 = 7.67$

* Computed from table 1

Interpretation: The null hypothesis is rejected. So the cassava expenditure share in total food expenditure is not the same in the different income groups. This implies that the trend shown in the sample did not simply come by chance. Cassava's share to total food expenditure is relatively high in the low-income group than in the high-income group. The outcome in the sample holds true in the population as well.

4.3. Model Output

4.3.1. Cassava Demand Determinants: Demographic factors

In table 3, each coefficient represents the effects on the dependent variables of a 1 per cent change in the explanatory variable. Since the dependent variables are budget shares (the budget in our case

is the total expenditure on the items under study), the estimated parameters are occasionally very small. To allow for easier interpretation are, therefore, the original coefficients multiplied by 100 (see Deaton and Muellbauer, 1980). The coefficients in table 3 thus represent 100 times the effects on budget shares of a 1 per cent change in the independent variables.

Table 3 shows that there is a positive relationship between household size and budget share of cassava tuber and *gari*. One more household member in the family increases budget share of cassava tuber by 0.3 per cent and that of *gari* by 0.9 per cent. This positive relationship applies to the rest crops too. This is because the more members of the household are, the more food is needed to feed each person.

An increase in the dependency ratio increases the budget share of cassava tuber and *gari*, because as dependency ratio increases more members are dependent on the limited adults and therefore the lesser the income available to feed each person. The probable reason for this may be because cassava tuber and *gari* are relatively cheaper commodities. When we observe the yam expenditure, it decreases with the increase in dependency ratio. Yam is the most expensive and preferable crop from the other tuber and root crops.

Table 3. The parameter estimates and tests of homogeneity*

	α	P_{ih}	P_{id}	P_{ie}	P_{ig}	β_i	Y_{i1}	Y_{i2}	Y_{i3}	Y_{i4}	Y_{i5}	ΣY_{ij}
Cassava tuber	2.3	0.3	0.4	-0.3	-1.8	1.9	1.6	0.2	0.6	-1.2	-2.4	-7.6
(1)	(0.78)	(2.50)[b]	(1.14)	(-4.86)[a]	(1.75)[c]	(4.93)[a]	(-1.86)[c]	(1.78)[c]	(2.35)[b]	(-1.19)	(-2.65)[b]	(-1.89)[c]
Gari	56.2	0.9	0.2	+0.00	0.7	2.2	10.3	12.7	8.0	-10.8	-0.1	-35.0
(2)	(7.71)[a]	(3.72)[a]	(1.83)[c]	(2.15)[b]	(0.20)	(13.24)[a]	(1.72)[c]	(2.38)	(3.08)[a]	(-1.58)[c]	(-0.02)	(-2.94)[b]
Yam	47.5	0.4	-2.4	0.8	3.4	16.2	55.1	47.9	23.7	8.4	25.2	32.9
(3)	(5.08)[a]	(1.83)[c]	(-1.92)[c]	(3.54)[a]	(1.21)	(5.72)[a]	(0.20)	(2.59)[b]	(0.31)	(0.90)	(3.36)[a]	(1.87)[c]
Potato	3.5	0.2	-0.8	-0.5	-0.8	9.0	-8.4	10.0	17.3	0.4	-5.2	9.5
(4)	(0.47)	(1.63)[c]	(-0.78)	(-2.65)[b]	(-1.23)	(1.37)	(-1.39)	(1.03)	(2.36)[b]	(1.76)[c]	(-3.29)[a]	(0.69)
Cocoyam	9.3	0.2	14.8	-0.1	1.8	1.6	2.9	2.7	3.6	4.9	35.0	-1.1
(5)	(2.17)[b]	(1.10)	(2.61)[b]	(-0.65)	(0.90)	(4.90)[a]	(1.40)	(0.48)	(1.86)[c]	(0.86)	(3.23)[a]	(-0.12)

Source: 1999/2000 IITA Survey on Food Demand in Nigeria

The numbers in parentheses are t values

[#] Dependent variables are presented as budget shares
[a] significant at 1 percent level
[b] significant at 5 percent level
[c] significant at 10 percent level

P_{ih} = Household size
P_{id} = Dependency ratio
P_{ie} = Education of household head (in years)
P_{ig} = Gender of household head (Male =1)

Female-headed households show a 1.8 per cent more expenditure share on cassava tuber than male headed while it is 0.7 and 3.4 per cent less for *gari* and yam, ceteris paribus. One year increase in the education of household head, decreases the share of cassava tuber by 3.5 per cent, while that of *gari* and yam increase by a smaller percentage, other things being equal. Regarding potato and cocoyam, households are shown to decrease their expenditure share with the increase in education.

Table 3 further shows in the column headed ΣY_{ij}, the row sums of the unconstrained Y_{ij} matrix; this number shows 10^2 times the absolute effect on each value share of a 1 per cent increase in all prices and total expenditure. Under homogeneity, this should be zero and the bracketed numbers given are t-tests of the significance of the deviation from zero. Hence, a proportional increase in prices and expenditure will decrease expenditure on cassava tuber and *gari*, and increase expenditure on yam. Therefore, the homogeneity condition is rejected for tuber, *gari* and yam. The test result suggests that the homogeneity condition in the estimated demand system hold only for

potato and cocoyam. These results indicate that available data for the other commodities may be inconsistent with demand theory, and money illusion may be present among the consumers. The results, however, do not imply that consumer theory is rejected on the basis of these findings. Several other empirical studies, including that of Deaton and Muellbauer, find that homogeneity condition does not hold for many commodities (See Deaton and Muellbauer, 1980).

4.3.2. Elasticities

4.3.2.1. Expenditure elasticity

The expenditure elasticities for the root and tuber crops show that when income increases, households will consume relatively more *gari* (1.104) and yam (1.303). On the other hand, households consume relatively less cassava tuber (0.321), potato (0.452) and cocoyam (0.755). The interpretation is that when income increases by 10 per cent, cassava expenditure increases by 3.21 per cent. So, cassava tuber is an income inelastic food and is a necessity for Kaduna households. This shows that it is fast changing from an inferior food to a necessity in Kaduna. There can be two reasons for this change: the increase in economic importance of cassava and, on the other hand, the decrease of the living standard of households (due to the growing population in Nigeria and declining real incomes).

4.3.2.2. Uncompensated own and cross-price elasticities

The uncompensated price elasticities for the root and tuber crops are shown in table 4. Cassava tuber shows an own-price elasticity of -0.46 meaning that an increase of the cassava price by 10 per cent would decrease cassava consumption by 4.6 per cent. To compensate for such a price increase and lowered consumption, households would increase *gari* and yam consumption by 2.12 and 1.38 per cent respectively as shown by their magnitude of their respective cross-price elasticities (table 4). So cassava tuber is a price inelastic food crop, which reflects its growing importance in the households of Kaduna. The own-price elasticity of *gari* is equal to –0.407, meaning that an increase in the price of *gari* by 10 percent would decrease *gari* consumption by 4.07 per cent. To compensate for such lowered consumption, households would increase cassava tuber and yam consumption by 5.37 and 3.29 per cent respectively.

Table 4. Expenditure and uncompensated (Marshallian) price elasticities

	Budget share	Expenditure elasticities	Cassava tuber	*Gari*	Yam tuber	Potato	Cocoyam
Cassava tuber	0.028	0.321	-0.456	0.212	0.138	-0.211	-0.890
Gari	0.207	1.104	0.537	-0.407	0.329	-0.289	0.088
Yam	0.534	1.303	1.024	0.835	-0.718	0.107	0.451
Potato	0.165	0.452	-0.514	-0.568	0.951	-1.006	-1.187
Cocoyam	0.066	0.755	0.398	0.215	0.438	-0.330	-0.670

Source: 1999/2000 IITA Survey on Food Demand in Nigeria

Price changes of cassava tuber has less impact on the quantities consumed, may be because cassava is a necessity in the households of Kaduna and has to be bought, no matter the price. The cassava-to-yam, the cassava-to-*gari* and the *gari*-to-yam cross price elasticities are positive showing that they are strong substitute goods. The own-price elasticities of all the food commodities under study show a negative sign (as expected), which is consistent with the theory (or law) of demand.

4.3.2.3. Elasticities by Income Group

It has been observed in previous studies that low-income households often respond to price changes in a manner that differs from that of the general population. To observe his in the context of Kaduna households, demand elasticities of the root and tuber crops were re-estimated for all the survey households and for the first and fourth expenditure quartile, reflecting the poorest and the richest households.

Table 5. Expenditure and uncompensated own-price elasticities, by income group

	Uncompensated own-price elasticity			Expenditure elasticity		
	Income group			Income group		
	Low	High	All	Low	High	All
Cassava tuber	-0.96	-0.13	-0.46	0.73	0.26	0.32
Gari	-0.44	-0.35	-0.41	1.16	0.92	1.10
Yam	-0.21	-0.78	-0.72	1.21	1.56	1.30
Potato	-1.18	-0.46	-1.01	0.66	0.14	0.45
Cocoyam	-0.72	-0.24	-0.67	1.05	0.60	0.76

Source: 1999/2000 IITA Survey on Food Demand in Nigeria

With the exception of yam, low-income households seem to be highly responsive to changes in prices than high-income households. In the case of cassava tuber, its demand by the rich is less sensitive to its market price, probably because the share of cassava to total food expenditure is lower and therefore it is not as important as for the poor. Yam is a relatively luxury commodity with expenditure elasticity of 1.30. Due to this reason, the price and income responsiveness is higher for richer households reflecting its importance for the rich.

5. Conclusion and recommendation

The results of the chi-square test confirm that the budget share of cassava and cassava products in total food expenditure is higher among the poor. Therefore, cassava and cassava products are more important among the poor than the rich. The estimates in this study found cassava tuber to be price and income inelastic food item. This indicates that cassava tuber is a necessity for the poor households. Cassava tuber is believed to be a traditional and poor man's crop. From this study, though we notice that the expenditure share is relatively higher among the poor than the rich, its consumption by the rich has also increased. With processing and post-harvest technology, cassava has the potential to be more demanded by the urban households of Kaduna. A typical example of this can be *gari*. The high expenditure elasticity of *gari* indicates that the popularity of cassava products is increasing among the rich too. *Gari* is highly consumed among the households than tuber, flour and chips. This is due to its applicability to be eaten in a wide variety of forms and its storability without any damage for up to three months.

The market potential of cassava depends on transformation. The development of appropriate and cost effective farm-level processing technologies is critical for expanding the market for cassava in future. The estimates of compensated cross-price elasticities indicate that the substitution effects of price changes are quite strong. Therefore, government price interventions may lead to considerable price repercussions in the economy.

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