



**AgEcon** SEARCH  
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

*The World's Largest Open Access Agricultural & Applied Economics Digital Library*

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

*No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.*



## **Households' demand for fruits and vegetables in Nigeria:**

### **Panel QUAIDS approach**

by Adekemi Obisesan

*Copyright 2021 by Adekemi Obisesan. All rights reserved. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided that this copyright notice appears on all such copies.*

## **Households' demand for fruits and vegetables in Nigeria: Panel QUAIDS approach**

### **Abstract**

The study analyzed households' demand for fruits and vegetables in Nigeria using data from the three waves of Living Standard Measurement Survey-Integrated Survey on Agriculture (LSMS-ISA) namely 2010/11, 2012/13 and 2015/16. The Quadratic Almost Ideal Demand System (QUAIDS) was employed to analyze the demand for bananas, citrus, pineapples, tomatoes, onions, fresh okra and pepper. Nigerian households consumed more vegetables than fruits from 2010-2015. Tomatoes, onions and pepper are important vegetables among Nigerian households across the different zones of the country. High quantity response to movements in relative prices was observed. All the fruits and vegetables were normal goods. Tomatoes, okra, banana, citrus and pineapple were luxury goods while onion and pepper were necessity goods. There is similar fruits and vegetables responsiveness to expenditure increases across sector (rural and urban). All the own-price elasticities (compensated and uncompensated) were negative conforming to demand theory. Nigerian households' response to changes in the prices of fruits and vegetables is more than proportionate. More consideration should be given to intensifying production of fruits and vegetables in technology development and investment to make them available and affordable.

**Keywords:** Food; demand elasticity; healthy diets; income; nutrition security; price; income effect

## **INTRODUCTION**

Food and nutrition insecurity are common challenges across the globe. Regardless of projects and programmes targeted towards increasing food security and nutrition, close to 690 million people in the world remains hungry. Two billion people lack regular access to safe, nutritious and sufficient food in 2019 (Food and Agriculture Organization [FAO], 2020). The burden of malnutrition in all its forms remains a global challenge (World Health Organization [WHO], 2020). Malnutrition contributes significantly to high mortality rate of children worldwide (Luchuo *et al.*, 2013). According to current estimates, 21.3 percent (144.0 million) of children under 5 years of age were stunted, 6.9 percent (47.0 million) wasted and 5.6 percent (38.3 million) overweight in 2019 (World Food Programme [WFP], 2020).

Many African countries are characterized by deteriorating nutrition as 19.1 percent of the population is undernourished (FAO, 2020). In Sub-Saharan African (SSA), over twenty three percent of the total population (two hundred and ten million) are undernourished and poor nutrition is responsible for forty-five percent of death especially in children under five (FAO, 2015). In SSA, more than half of the population cannot afford a healthy diet (WFP, 2020).

Fruits and Vegetables (FV) are vital constituents of a healthy diet. They have health-enhancing properties. According to WHO, there is inverse relationship between increased consumption of FV and increased risks of Non-Communicable Diseases (NCDs) (WHO, 2020). In 2017, 3.9 million deaths were linked to insufficient consumption OF FV (WHO, 2020). Hence, WHO recommends consumption of more than 400g of FV in a day to enhance good health and reduce risks of some NCDs. Findings have further shown that high intake of fruits and vegetables prevents chronic diseases such as heart diseases and certain types of cancer (Key *et al.*, 2002; Hu, 2003), and is associated with an increase in many birth size parameters (Rao *et al.*, 2001; Mikkelsen *et al.*, 2006; Loy *et al.*, 2011).

In spite of the enormous benefits of fruits and vegetables, their consumption in Africa is low compared to the recommended daily intake (Hall *et al.*, 2009). In Sub-Saharan Africa, estimates of fruits and vegetables consumption range from 70 to 312 g per person per day (Ruel *et al.*, 2004). Low income countries (including Nigeria) rely more on staple foods and less on fruits and vegetables compared to high-income countries (FAO *et. al.*, 2020). According to Global Food Policy (2015), Nigeria has the highest number of stunted children in Africa. Therefore, with the growing thrust to improve nutrition by 2030, which is substantiated by the second sustainable development goal (SDG 2), it is of vital importance to examine households' consumption of FV at a disaggregated level in order to ensure nutrition security and healthy diet in Nigeria. This will have implications on the national food policy interventions in the country.

Hence, this study investigates households' demand of selected fruits and vegetables in Nigeria. The study proffers answer to the following research questions:

1. How does the households' demand for fruits and vegetables respond to changes in prices and income?
2. What are the household's demographic factors influencing fruits and vegetables demand in Nigeria?

There are previous studies on fruits and vegetables demand in developed and developing countries (Mutuc, *et al.*, 2007; Tey *et al.*, 2009; Bundi *et al.*, 2013) to name a few. Similarly, in Nigeria, Oyekale (2000), Tsegai and Kormawa (2002), Akinleye (2009), Ogundari and Arifalo, (2013), Otunaiya and Shittu (2014) have conducted studies on food demand in Nigeria employing double logarithms function, double hurdle, almost ideal demand system and its variants while Obayelu *et al.*, (2009) Fashogbon and Oni (2013), Khaliukova (2013) and Obisesan (2019) used quadratic almost ideal demand system. However, these studies except

Ogundari & Arifalo (2013), Khaliukova (2013) and Obisesan (2019) considered the whole food basket and treated FV as an aggregate food item in the demand system. Therefore, this study complements previous studies on fruits and vegetables demand in Nigeria by using panel data from 2010 to 2016. It employs Quadratic Almost Ideal Demand System (QUAIDS) within a panel framework to estimate the income and price elasticities of different fruits and vegetables across zones in Nigeria following (Banks *et al.*, 1997). Estimation of demand elasticity of fruits and vegetables at more disaggregated levels is essential in order to have more meaningful analysis of the consumption impacts of domestic food policy interventions (Mutuc *et al.*, 2007).

*Empirical review of Literatures on fruits and vegetables demand in Nigeria*

<b>Previous Studies</b>	<b>Study description</b>	<b>Analytical approach</b>	<b>Results</b>
<b>Mutuc <i>et al.</i>, 2007.</b> <b>Household vegetable demand in Phillipines: is there an urban –rural divide?</b>	Examined price, income, and cross-price elasticities of commonly consumed Philippine vegetables. In addition, effects of socio-demographic factors and urban/rural dummy variables on vegetable food demand were	Three-step estimation method and a Nonlinear Quadratic Almost Ideal Demand System (NQAIDS)	Most of the expenditure and own-price elasticities of the vegetables are near or larger than unitary in both rural and urban areas. Only demand for cabbage and tomatoes in the urban areas tend to be statistically

---

	also explored.		different compared to rural areas.
<b>Bundi <i>et al.</i>, 2013</b>	Described the	Almost Ideal Demand	Kale and tomato were
<b>Urban demand for</b>	consumption patterns	System (AIDS)	important vegetables
<b>smallholder crops:</b>	and assess the		in the diets of
<b>the case of fruits and</b>	responsiveness of		households in
<b>vegetables in</b>	Nairobi households to		Nairobi. The
<b>Nairobi, Kenya.</b>	changes in fruit and		expenditure
	vegetable commodity		elasticities for some
	prices, as well as		vegetables and fruits
	assess the effect of		are high. The
	demographic		expenditure
	characteristics on the		elasticities range
	demand for these		between 0.699 and
	commodities using		1.350. Households'
	dataset of about 760		demographic
	households. Kales,		characteristics
	tomato, cabbage and		influenced the
	onion, banana,		demand for fruits and
	mango, oranges and		vegetables.
	avocado, were		
	selected for the		

---

---

	analysis.		
<b>Otunaiya and Shittu, 2014.</b>	Estimated the price and income (expenditure) elasticities of demand for the commonly consumed vegetables among households in Ogun State, Southwest Nigeria. Data were collected with the use of a well-structured questionnaire administered to one hundred and twenty households that were randomly selected using a multi-stage sampling procedure.	Nonlinear Quadratic Almost Ideal Demand System	Income elasticity of demand for Bitter leave and the Eggplant are elastic, while income elasticity of demand for Tomato to which about one-third of vegetables' expenditure are devoted, is inelastic. Own-price elasticities of demand have the expected negative signs for all the vegetables and are generally inelastic. Estimates of cross price elasticities show the dominance of substitutability among the vegetables with

---



---

**Tey *et al.*, 2009.**

**Demand for  
vegetables in  
Malaysia**

Estimated the price  
and income  
elasticities for the six  
categories of vege-  
tables that are  
commonly found and  
consumed in Malaysia  
using the Household  
Expenditure Survey  
2004/05 data.

Multi-stage demand  
system'

only few cases of  
complementarities.

Income elasticity for  
various vegetable  
categories are  
positive, indicating  
that they are generally  
normal goods.  
Malaysian consumers  
are likely to increase  
their expenditure on  
aggregated vegetables  
and the various  
vegetable categories  
in line with income  
growth.

This, however, may  
not be so certain if  
there are positive  
adjustments in  
vegetable prices as  
suggested by the

---

			estimated own-price elasticities.
<b>Ogundari and Arifalo, 2013.</b>	Investigated separately demand characteristics of fresh fruits and vegetables using the 2003/2004 Nigeria Living Standard Survey (NLSS) data	Double Hurdle	Households in the low and high-income groups considered the demand for fresh fruit to be necessity and luxury-goods, respectively. Fresh vegetables are luxury good. The demand for fruits and vegetables was higher among households with younger members, compared to households with older members. Regional differences in the demand for fruits and vegetables were also evident in the study.

---

---

<b>Khaliukova (2013). Demand analysis for Tomato, Onion, Peppers and fresh Okra in Nigeria</b>	Examined the demand analysis for onion, peppers, fresh okra and tomato in Nigeria using General Household Survey data collected by the World Bank and the Nigeria National Bureau of Statistics in 2010-2011.	Two stage estimation procedure and Linear Approximation Almost Ideal Demand System	Not all of the vegetables are normal goods, okra is an inferior good. Demographic characteristics affect consumption. Marshallian cross price elasticities suggested that the food items are mix of gross substitutes and complements, however, positive values of Hicksian cross-price elasticities indicate that all vegetables are net substitutes
--	---	--	---

---

## **MATERIALS AND METHODS**

### **Data**

The study employed secondary data from the three waves of the Living Standard Measurement Survey-Integrated Survey on Agriculture (LSMS-ISA) namely 2010/11, 2012/13 and 2015/16. Based on the agricultural seasons, each year had two visits (post-planting, September-November, and post-harvest, February-April). Detailed information were collected in the survey on the quantities of household food consumption from own production, purchases, and gifts. The household's weekly expenditure on purchased food items was reported. Prices were derived from transaction data and then used to impute values to own-production and gifts. The data used in this study include household consumption of fruits and vegetables, household food expenditure, prices, age, household size, sex, marital status, educational status. The fruits and vegetables considered as contained in the data set are: bananas, orange/tangerine, pineapples for fruits and; tomatoes, onions, fresh okra and pepper for vegetables. Recall information on food consumption (purchased and auto-consumption) over a week period was collected.

### **The Quadratic Almost Ideal Demand System**

The almost ideal demand system (AIDS) of Deaton and Muellbauer (1980) has been a popular functional form to model demand behavior during the past two decades. The AIDS model has budget shares that are linear functions of log total expenditure. AIDS is a member of the Price-Independent Generalized Logarithmic (PIGLOG) class of demand models (Muellbauer, 1976), which are derived from indirect utility functions that are themselves linear in log total

expenditure. However, there is a body of literature providing evidence on the importance of allowing for non-linearity in the budget share equations (Lewbel, 1991; Banks *et al.*, 1997).

The Quadratic Almost Ideal Demand System can better approximate non-linear Engel curves in empirical analysis than other demand system analysis. Furthermore, the study used a modified routine of Poi (2012) which allows the inclusion of demographic variables to the model using the method of Ray (1983), and compute expenditure and price elasticities. This helps in controlling for factors such as gender, age, education and rural or urban residence which may affect the quantity of fruits and vegetables demanded. The quadratic almost ideal demand system (QUAIDS) model developed by Banks *et al.* (1997), which has budget shares that are quadratic in log total expenditure, is an example of the empirical demand systems that have been developed to allow for this expenditure nonlinearity. The QUAIDS model is a generalization of PIGLOG preferences based on the following indirect utility ( $V$ ) function:

$$\ln V = \left\{ \left[ \frac{\ln x - \ln a(p)}{b(p)} \right]^{-1} + \lambda(p) \right\}^{-1} \dots\dots\dots(1)$$

where  $x$  is total expenditure,  $\mathbf{p}$  is a vector of prices,  $a(\mathbf{p})$  is a function that is homogenous of degree one in prices, and  $b(\mathbf{p})$  and  $\lambda(\mathbf{p})$  are functions that are homogeneous of degree zero in prices. As in the original AIDS model,  $\ln a(\mathbf{p})$  and  $\ln b(\mathbf{p})$  are specified as the translog and Cobb-Douglas equations:

$$\ln a(p) = \alpha_0 + \sum_{i=1}^K \alpha_i \ln p_i + \frac{1}{2} \sum_{i=1}^K \sum_{j=1}^K \gamma_{ij} \ln p_i \ln p_j \dots\dots\dots(2)$$

$$b(p) = \prod_{i=1}^K p_i^{\beta_i} \dots\dots\dots(3)$$

Where  $i=1, \dots\dots\dots K$  denote commodities. The function  $\lambda(p)$  is specified as:

$$\lambda(p) = \sum_{i=1}^K \lambda_i \ln p_i \dots\dots\dots(4)$$

Where,

$$\sum_{i=1}^K \lambda_i = 0$$

Application of Roy's identity to (1) gives the QUAIDS budget share equations. To control for varying preference structures and heterogeneity across households, demographic variables ( $\mathbf{z}$ ) will be incorporated into the QUAIDS model through the linear demographic translating method (Pollak and Wales, 1981). This leads to the following empirical specification of the QUAIDS budget share equations:

$$w_i = \alpha_i + \sum_{j=1}^K \gamma_{ij} \ln p_j + \beta_i \ln \left[ \frac{x}{a(p)} \right] + \frac{\lambda_i}{b(p)} \left\{ \ln \left[ \frac{x}{a(p)} \right] \right\}^2 + \sum_{s=1}^L \delta_{is} z_s \dots\dots(5)$$

where  $\mathbf{z}_s = (z_1, \dots, z_L)$  is a set of demographic variables. Formulas for the QUAIDS expenditure and price elasticities are derived by differentiating the budget share equations with respect to  $\ln x$  and  $\ln p_j$ , respectively.

A probit regression analysis is done in order to estimate the probability that a given household consumes the individual fruit and vegetable in question. This regression is then used to yield the Inverse Mills Ratio (IMR) for each household in order to correct the possible bias created by the presence of zero consumption (Heien and Wessels, 1990).

$$w_i = \alpha_i + \sum_{j=1}^K \gamma_{ij} \ln p_j + \beta_i \ln \left[ \frac{x}{a(p)} \right] + \frac{\lambda_i}{b(p)} \left\{ \ln \left[ \frac{x}{a(p)} \right] \right\}^2 + \sum_{s=1}^L \delta_{is} z_s \dots\dots + IMR_i(6)$$

Following Banks *et al.* (1997), the expressions for the elasticity formulas is simplified by using the intermediate results:

$$\mu_i \equiv \frac{\partial w_i}{\partial \ln x} = \beta_i + \frac{2\lambda_i}{b(p)} \left\{ \ln \left[ \frac{x}{a(p)} \right] \right\} \dots\dots\dots(7)$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial \ln p_j} = \gamma_{ij} - \mu_i \left( \alpha_j + \sum_{l=1}^K \gamma_{jl} \ln p_l \right) - \frac{\lambda_i \beta_j}{b(p)} \left\{ \ln \left[ \frac{x}{a(p)} \right] \right\}^2 \dots\dots\dots(8)$$

In terms of the  $\mu_i$ , the formula for expenditure elasticities can be written as:

$$e_i = 1 + \frac{\mu_i}{w_i} \dots\dots\dots(9)$$

The expression for the Marshallian or uncompensated price elasticities can be written as:

$$e_i = \frac{\mu_{ij}}{w_i} - \delta_{ij} \dots\dots\dots(10)$$

Where  $\delta_{ij}$  is the Kronecker delta. The Hicksian or compensated price elasticities are obtained from the Slutsky equation:

$$e_{ij}^c = e_{ij}^u + w_j e_i \dots\dots\dots(11)$$

*Variables definition*

The independent variables included in the model are prices of tomatoes, pepper, onion, okra, banana, pineapples and citrus; household's expenditure on fruits and vegetables. Sex (male-1, female-0) and age of the household head (years), household size (number), educational status of the household head (educated=1, 0 otherwise), sector (urban=1, 0-others).

## RESULTS AND DISCUSSION

### Fruits and Vegetables Consumption in Nigeria

Over 90% of the households had at least one type of FV included in their weekly food consumption in the survey period. The proportion of households consuming FV increased from 85.8 in 2010 to 97.8 in 2015 (Table 1). Consumption of fruits and vegetables was more in the urban than rural Nigeria. Urban residents might have better knowledge about the health benefits of FV.

Nigerian households consumed more vegetables than fruits from 2010-2015 (Table 2). From the results, on the average, 74.9% of Nigerian households consumed onions with average quantity of 0.92kg, pepper was consumed by 70.7% households with average quantity of 0.65kg, 69.0% households consumed tomatoes with mean quantity of 1.60kg, okra was consumed by 40.6% with an average quantity of 0.68kg while 19.0%, 15.5% and 5.24% consumed citrus (2.01kg), banana (1.64 kg) and pineapple (2.6kg) respectively from 2010-2015. Furthermore, Table 2 reveals that households consuming the fruits and vegetables considered in the study (except okra) was higher in the urban sector than rural irrespective of the fact that their production is more concentrated in the rural areas.

**Table 1.** Share of households consuming fruits and vegetables in Nigeria

Year	All	URBAN	RURAL
2010	85.8	89.6	84.2
2012	96.2	97.7	95.5
2015	97.8	98.7	97.3

Source: Author's estimations from the LSMS-ISA 2010, 2012 and 2015 data.

The shares reported are only of households consuming fruits and vegetables in a 7 days period. Households can consume more than one type of fruits and vegetables.



**Table 2.** Households consuming fruits and vegetables in Nigeria by FV Type(%)

<b>Year</b>	<b>Tomatoes</b>	<b>Pepper</b>	<b>Onion</b>	<b>Okra</b>	<b>Banana</b>	<b>Citrus</b>	<b>Pineapple</b>
<b>2010 All</b>	69.3	73.5	76.4	39.7	14.8	12.9	6.07
<b>RURAL</b>	63.6	70.6	74.9	32.8	12.9	10.6	4.8
<b>URBAN</b>	80.3	79.3	79.2	53.2	18.5	17.7	9.9
<b>2012 All</b>	66.9	69.3	85.9	44.6	14.1	20.8	4.9
<b>RURAL</b>	60.6	64.5	89.1	45.9	12.3	17.9	3.7
<b>URBAN</b>	80.8	79.9	84.5	41.7	18.2	27.4	7.7
<b>2015 All</b>	75.3	69.4	92.5	47.5	20.3	26.2	5.2
<b>RURAL</b>	69.7	63.6	91.5	45.2	24.7	23.7	4.0
<b>URBAN</b>	87.1	81.4	93.9	48.6	18.3	31.5	7.7

Source: Author's estimations from the LSMS-ISA 2010, 2012 and 2015 data.

The shares reported are only of households consuming fruits and vegetables. The shares reported are only of households consuming fruits and vegetables in a 7 days period. Households can consume more than one type of fruits and vegetables.

### **Estimated parameters of the QUAIDS model**

Some households in the LSMS-ISA data used in the study recorded zero expenditure in the survey. According to literature, three main factors could be responsible for zero expenditures in household level data: it is possible for households that they never consume the commodity of

interest; limited survey periods can record zero consumption of the commodity among some households while some households may fail to report consuming the commodity due to the fact that it is not an optimal decision at a particular time subject to the set of prices they face and income (Meyerhoefer *et al.*, 2005; Tafere *et al.*, 2011). This problem was solved using a two stage estimation procedure. In the first stage, a probit regression was estimated to represent a decision by household (h) to demand the particular commodity (i) or not. The estimate of the maximum likelihood was later used to construct the Inverse Mills Ratio (IMR) for each household. The IMR was used in the second stage as an explanatory variable to incorporate the censoring latent variable in the regression (Heins and Wessels, 1990; Bundi *et al.*, 2013) see eq. 6.

The estimated parameters of the QUAIDS model are presented in Table 3. Seventeen out of the 28 price effects are significant, reflecting high quantity response to movements in relative prices among Nigerian households. This might be due to the disaggregation of the fruits and vegetables which gives better understanding of households' sensitivity to price changes than when aggregated.

The expenditure coefficients (LNEXP and LNEXP<sup>2</sup>) which are the Beta and Lambda ( $\lambda$ s) components of the equation show the linear nature of the demand (since AIDS is nested in QUAIDS (eq. 6). The LNEXP<sup>2</sup> are the quadratic terms, thus testing if all  $\lambda$ s equal zero in the model. This tests whether the AIDS model fits the data better than the QUAIDS. From the results, the coefficients of ( $\lambda$ ) for the different fruits and vegetables considered are significant suggesting that the QUAIDS model fits the data better than the AIDS. The implication is that, the response of the demand for all the fruits and vegetables to increase in total expenditure is non-

linear, strongly supports the rejection of the hypothesis that the quadratic expenditure term is zero. This reveals the suitability of the QUAIDS model over the traditional AIDS model.

Furthermore, Table 3 revealed the effects of demographic factors on the household demand of the different fruits and vegetables. More than half (thirty out of forty-two) of the demographic variables are statistically different from zero. Age of the household head has positive and significant influence on the demand for onion ( $p < 0.01$ ), citrus ( $p < 0.1$ ) and pineapple ( $p < 0.1$ ) while it has negative effect on tomatoes ( $p < 0.05$ ) as well as banana and okra at 5% and 10% significant level respectively. Larger households consume more tomatoes and pepper while those with small sizes consume more fruits. This is due to the fact that almost all the other food groups are consumed with pepper and tomatoes stew in Nigeria. However, this is not in tandem with Khaliukova (2013) who opined that the more the household size, the less the consumption of tomatoes and pepper in Nigeria. The low consumption of fruits by households with large size could be regarded to as economic non-consumption that is, due to economic recession/ high poverty rate in Nigeria. This authenticates the fact that economic downturns undermine nutrition security in Nigeria.

Educational status has positive and significant influence on the demand for almost all the items. Education enhances the understanding of the nutritional benefits of fruits and vegetables. The results show that being educated increases the consumption of tomatoes ( $p < 0.01$ ), pepper ( $p < 0.01$ ), onions ( $p < 0.05$ ), banana ( $p < 0.01$ ), okra ( $p < 0.01$ ) and citrus ( $p < 0.05$ ) by 0.0019, 0.0018, 0.0015, 0.0023, 0.0021, and 0.0007 respectively. Furthermore, urban households demand more fruits and vegetables than their rural counterparts. This might be due to higher poverty rate in rural Nigeria.

**Table 3.** Estimated parameters of the QUAIDS model

<b>Variables</b>	<b>Tomatoes</b>	<b>Pepper</b>	<b>Onion</b>	<b>Banana</b>	<b>Okra</b>	<b>Citrus</b>	<b>Pineapple</b>
<b>Constant</b>	-0.3362*	-0.0110	0.5097*	0.3046*	-0.1241*	0.3915*	0.2656*
	(0.3319)	(0.0451)	(0.0350)	(0.0309)	(0.0387)	(0.0295)	(0.1894)
<b>PTOMA</b>	0.1138*						
	(0.0125)						
<b>PPEPR</b>	0.0303*	0.0008					
	(0.0079)	(0.0057)					
<b>PONION</b>	-0.1166*	-0.0132*	0.1001*				
	(0.0080)	(0.0068)	(0.0089)				
<b>PBANA</b>	-0.0036	-0.0128*	0.0063	-0.0084*			
	(0.0059)	(0.0030)	(0.0047)	(0.0038)			
<b>POKRA</b>	0.0608*	0.00078	-0.0508*	0.0008	0.1183**		
	(0.0067)	(0.0034)	(0.0060)	(0.0031)	(0.0051)		
<b>PCITRU</b>	-0.0507*	-0.0048	0.0450*	0.1834*	-0.0113*	0.0028	
	(0.0059)	(0.0039)	(0.0045)	(0.0032)	(0.0036)	(0.0061)	
<b>PPINE</b>	-0.0340*	-0.0010	0.0291*	-0.0006	-0.0121*	0.0062	0.0123**
	(0.0038)	(0.0026)	(0.0030)	(0.0025)	(0.0024)	(0.0047)	(0.0049)
<b>LNEXP</b>	-0.1642*	-0.0425	0.1467*	0.0218	-0.0689	0.0613	0.0464*
	(0.0077)	(0.0101)	(0.0073)	(0.0070)	(0.0088)	(0.0067)	(0.0044)
<b>LNEXP<sup>2</sup></b>	-0.0142*	-0.0030*	0.0152*	0.0004*	-0.0033*	0.0029*	0.0020*
	(0.0005)	(0.0006)	(0.0004)	(0.0003)	(0.0005)	(0.0004)	(0.0002)
<b>Age</b>	-0.0003**	0.0002	0.0004***	-0.0001**	-0.0006*	0.0004*	0.0002*

	(0.0002)	(0.0001)	(0.0002)	(8.67e <sup>-04</sup> )	0.0001	(8.74e <sup>-04</sup> )	(5.61e <sup>-04</sup> )
<b>Sex</b>	-0.0004	-0.0004	0.0001	-0.0001	0.0008***	0.0002	-0.0002
	(0.0007)	(0.0006)	(0.0008)	(0.0004)	(0.0005)	(0.0003)	(0.0002)
<b>Household</b>	0.0002**	0.0004*	-0.0002**	-0.0001	-0.0003	-0.0001*	4.99e <sup>-06</sup>
<b>size</b>	(8.33e <sup>-05</sup> )	(7.4e <sup>-05</sup> )	(0.0001)	(4.43e <sup>-05</sup> )	(5.38e <sup>-05</sup> )	(4.19e <sup>-05</sup> )	(2.67e <sup>-05</sup> )
<b>Educational</b>	0.0019*	0.0018*	0.0015**	0.0023*	0.0021*	0.0007**	0.0001
<b>status</b>	(0.0006)	(0.0005)	(0.0007)	(0.0003)	(0.0004)	(0.0003)	(0.0002)
<b>Sector</b>	0.0052*	0.0005	0.0047*	-0.0038*	-0.0035*	-0.0020*	-0.0011*
	(0.0008)	(0.0007)	(0.0009)	(0.0004)	(0.0006)	(0.0005)	(0.0004)
<b>Zone</b>	-0.0003	-0.0057*	0.0082*	-0.0011*	-0.0008**	0.0011*	-0.0014*
	(0.0006)	(0.0005)	(0.0006)	(0.0003)	(0.0004)	(0.0003)	(0.00018)

Source: Author's estimations from the LSMS-ISA 2010, 2012 and 2015 data.

\*,\*\*,\*\*\* indicate level of significance at 1%,5% and 10%, respectively. Standard errors are in parenthesis. All prices are in logarithms, PTOMA=price of tomatoes, PPEPR=price of pepper, PONION= price of onion, PBANA=price of banana, POKRA=price of okra, PCITRU= price of citrus, PPINE= price of pineapple. LNEXP= logarithm of total food expenditure, LNEXP<sup>2</sup>= square of logarithm of total food expenditure

### Expenditure Elasticities of demand

The expenditure elasticities for the different fruits and vegetables are reported in Table 4. All elasticities are positive indicating that all the FV are normal goods. This finding is consistent with Fashogbon and Oni (2013) and Obisesan (2019) that fruits and vegetables are normal goods in Ondo state, Nigeria and urban Nigeria respectively. The expenditure elasticities are greater than unity for tomatoes, okra, banana, citrus and pineapple while they are less than unity for onions and pepper. The results indicate that onions and pepper are expenditure inelastic while others are expenditure elastic. Ten percent increase in income will increase demand for banana

and citrus by 17.0% and 14.9% respectively. The high expenditure elasticity for pineapple (2.09) shows that it is a more desired form of fruits.

**Table 4.** Expenditure elasticities

<b>FV items</b>	<b>Elasticities</b>
<b>Tomatoes</b>	1.14
<b>Pepper</b>	0.98
<b>Onion</b>	0.61
<b>Banana</b>	1.70
<b>Okra</b>	1.01
<b>Citrus</b>	1.49
<b>Pineapple</b>	2.09

---

### **Own- and cross-price elasticities of fruits and vegetables in Nigeria**

The study further examines the own and cross price elasticities of fruits and vegetables. Estimates of the Marshallian (uncompensated) expenditure elasticities and Hicksian (compensated) expenditure elasticities are presented in Tables 5 & 6 respectively. The estimates

on the diagonal are the own price elasticities of the different fruits and vegetables. The compensated and uncompensated own-price elasticities are negative. This shows they follow the demand theory. The uncompensated price elasticity estimates reveal that the demand for all the fruits and vegetables except pineapple are own-price elastic. From the results, a one percent increase in the prices of tomatoes, pepper and onion will lead to 1.20, 1.05 and 1.04 decrease in the quantity demanded, respectively. The compensated own-price elasticities are smaller in their absolute value than the uncompensated (Table 6). There is a significant income effect in the responsiveness of all the fruits and vegetables demand to changes in their prices.

A mix of complementary and substitution relationship was observed among the fruits and vegetables from the Marshallian cross price elasticities. For instance, pepper has a complementary relationship with tomatoes (-0.74), that is, 1% increase in the price of tomatoes will decrease the quantity of pepper demanded by 0.74.

**Table 5.** The Marshallian / uncompensated elasticity of demand

<b>FV</b>	<b>Tomatoes</b>	<b>Pepper</b>	<b>Onion</b>	<b>Banana</b>	<b>Okro</b>	<b>Citrus</b>	<b>Pineapple</b>
<b>Tomatoes</b>	<b>-1.20</b>	-0.74	0.33	0.05	0.04	-0.01	0.01
<b>Pepper</b>	-0.05	<b>-1.05</b>	-0.09	-0.02	-0.05	0.05	0.04
<b>Onion</b>	-0.21	-0.16	<b>-1.04</b>	0.01	-0.02	0.05	0.02
<b>Banana</b>	0.23	-0.27	-0.27	<b>-1.43</b>	0.14	0.13	-0.23
<b>Okro</b>	0.18	-0.12	-0.17	0.08	<b>-1.01</b>	0.04	-0.02
<b>Citrus</b>	-0.17	0.16	0.14	0.14	0.05	<b>-1.60</b>	0.21
<b>Pineapple</b>	-0.29	0.53	0.14	0.74	-0.24	0.68	<b>-0.82</b>

Source: Author's estimations from the LSMS-ISA 2010, 2012 and 2015 data

**Table 6.** Hicksian /compensated elasticities of demand

<b>FV</b>	<b>Tomatoes</b>	<b>Pepper</b>	<b>Onion</b>	<b>Banana</b>	<b>Okro</b>	<b>Citrus</b>	<b>Pineapple</b>
<b>Tomatoes</b>	<b>-0.84</b>	0.19	0.35	0.10	0.15	0.04	0.02
<b>Pepper</b>	0.25	<b>-0.83</b>	0.36	0.02	0.05	0.09	0.06
<b>Onion</b>	0.40	0.30	<b>-0.87</b>	0.03	0.04	0.08	0.03
<b>Banana</b>	0.76	0.11	0.20	<b>-1.36</b>	0.30	0.20	-0.20
<b>Okra</b>	0.49	0.11	0.11	0.13	<b>-0.91</b>	0.08	-0.004
<b>Citrus</b>	0.29	0.50	0.54	0.20	0.19	<b>-1.54</b>	-0.19
<b>Pineapple</b>	0.36	1.00	0.71	-0.65	-0.03	-0.59	<b>-0.80</b>

Source: Author's estimations from the LSMS-ISA 2010, 2012 and 2015 data

## **CONCLUSION AND RECOMMENDATIONS**

The study employed QUAIDS in analyzing households' fruits and vegetables demand in Nigeria using data from the three waves of LSMS-ISA namely 2010/11, 2012/13 and 2015/16. The fruits and vegetables considered are: bananas, citrus, pineapples, tomatoes, onions, fresh okra and pepper. There is high quantity response to movements in relative prices. All the fruits and vegetables considered are normal goods. Tomatoes, okra, banana, citrus and pineapple are luxury items while onion and pepper are necessity items in the households. Households' demographic factors affect demand for fruits and vegetables in Nigeria. All the own-price



elasticities (compensated and uncompensated) are negative, hence, conforming to the demand theory. Nigerian households respond more than proportionately to changes in the prices of the fruits and vegetables. A mix of complementary and substitution relationship exist among the fruits and vegetables. There is a significant income effect in the responsiveness of all the fruits and vegetables demand to changing fruits and vegetable prices. The study recommends interventions that stabilize prices and boost income in Nigeria. Consumption of fruits should be included in the school feeding programme. The study further suggests more attention on nutrition- sensitive food system that can promote and sustain healthy and diverse diets.

#### **REFERENCES**

- Banks J., Blundell R., Lewbel A. (1997): Quadratic Engel curves and consumer demand. *The Review of Economics and Statistics*, 79: 527–539.
- Chastre D, Duffield A, Kindness H, LeJeune S. and Taylor A.(2000): *The Minimum Cost of a Healthy Diet: Findings from Piloting a New Methodology in Four Study Locations. Save the Children. London UK; 2000.*
- Deaton A.S., Muellbauer J. (1980): An almost ideal demand system. *American Economic Review*, 70: 312–326.
- Fashogbon A.E., Oni, O.A (2013): Heterogeneity in Rural Household Food Demand and Its Determinants in Ondo State, Nigeria: An Application of Quadratic Almost Ideal Demand System. *Journal of Agricultural Science*; 5 ( 2):169-177. ISSN 1916-9752 E-ISSN 1916-9760

Food and Agriculture Organization, International Fund for Agricultural Development, World Food Program (2014): The State of Food Insecurity in the World 2014. Strengthening the enabling environment for food security and nutrition.” Rome: FAO, 2015 Available at <http://www.fao.org/3/a4ef2d16-70a7-460a-a9ac-2a65a533269a/i4646e.pdf> Accessed August 16, 2016.

Food and Agriculture Organization (2020): The State of Food Security and Nutrition in The World 2020. <https://www.fao.org/publications/sofi/2020>.

FAO, IFAD, UNICEF, WFP & WHO (2020): The State of Food Security and Nutrition in the World 2020. Transforming Food Systems for Affordable Healthy Diets, Rome FAO. <https://doi.org/10.4060/ca9692en>.

Hall, J.N, Moore, S. and Lynch, J.W. (2009): Global variability in fruit and vegetable consumption. *American Journal of Preventive Medicine*, 36(5):402-409.

Heien, D. and C. Wessells. (1990): Demand systems estimation with microdata: a censored regression approach. *Journal of Business & Economic Statistics*, 8(3): 365-371.

Johns T.(2002): Plant genetic diversity and malnutrition. *African Journal of Food and Nutrition Sciences*. 2(2).

Jing, X., Mittelhammer, R., & Heckeley, T. (2004): A Quads Model of Japanese Meat Demand. Selected Paper American Agricultural Economics Association Denver. Colorado, U.S.A.

Khaliukova, O. (2013). Demand Analysis for Tomato, Onion, Peppers, and Fresh Okra in Nigeria. University of Tennessee, Knoxville Trace: Tennessee Research and Creative Exchange

- Luchuo, E.B., Paschal, K.A., Nga, G., Njam, P.K., Yelene, S., Nsah, B. Ajue, T.T. (2013): Malnutrition in Sub-Saharan Africa: Burden, Causes and Prospects. *Pan Afr. Med. Journal*. doi:10.11604/pamj.2013.15.120.2535.
- Meyerhoefer, C. D., Ranney, C. K., Sahn, D. E., (2005): Consistent estimation of censored demand systems using panel data, *American Journal of Agricultural Economics*, 87, 660-672.
- Muellbauer, J. (1976): Community preferences and the representative consumer. *Econometrica: Journal of the Econometric Society*, 979-999.
- Mutuc M.E.M., Pan S., Rejesus R.M. (2007): Household Vegetable Demand in the Philippines. Is there an urban-rural divide? *Agribusiness*, 23: 511–527.
- Obayelu A.E, Okoruwa V.O., Ajani O.I.Y. (2009): Cross-sectional analysis of food demand in the North Central, Nigeria: The quadratic almost ideal demand system (QUAIDS) approach. *China Agricultural Economic Review*, 1: 173–193.
- Obisesan, A.A. (2019): Households' demand for fruits and vegetables in Urban Nigeria. *Pacific Journal of Science and Technology*, 20(1): 171-183.
- Ogundari, K., Arifalo, S.F. (2013): Determinants of Household Demand for Fresh Fruit and Vegetable in Nigeria: A Double Hurdle Approach. *Quarterly Journal of International Agriculture*, 52 (3): 199-216.
- Otunaiya, A.O. ,Shittu, A.M. (2014): Complete Household Demand System of Vegetables in Ogun State, Nigeria. *Agric. Econ. – Czech*, 60 (11): 509–516.
- Oyekale, A. S. (2000): An Application of Almost Ideal demand systems (AIDS) to Food Demand in Nigeria. *Nigerian Agricultural Development Studies*, 1(2).
- Poi, B. P. (2012): Easy demand-system estimation with quaid. *The Stata Journal*, 433-446.

Ray, R. (1984): A Dynamic Generalisation of the Almost Ideal Demand System. *Economics Letters* 14: 235-239.

Ruel, M.T., Minot, N. and Smith, L. (2004): Patterns and determinants of fruit and vegetables in sub-saharan Africa: Multicountry comparison. A paper presented at Joint FAO/WHO Workshop on fruits and vegetables for health, 1-3 September, 2004, Kobe, Japan. 14. USDA (2009). Why is it important to eat fruit? <http://www.mypyramid.gov>. Accessed 01/08/2012.

Tafere, K., Taffesse, S. Tamiru, S. Tefera, N, Paulos (2010): Food demand Elasticities in Ethiopia: Estimates using Household Income Consumption Expenditure (HICE) survey data. Ethiopia Strategy Support Program II Working paper No. 011. IFPRI, Washington, D.C.

Tsegai D.W., Kormawa P.M (2009): The determinants of urban households' demand for cassava and cassava products in Kaduna, Northern Nigeria: An application of the AIDS model. *European Journal of Development Research*, 21: 435–447.

World Food Programme 2020: Global report of Food Crises. <https://www.wfp.org/publications/2020>.

World Health Organization (WHO) and Food and Agriculture Organization of United Nations (FAO). (2003): Diet, Nutrition and the Prevention of Chronic Diseases. Report of a Joint WHO/FAO Expert Consultation. WHO Technical Report Series no. 916. Geneva, Switzerland.

WHO (2003): Diet, nutrition and the prevention of chronic diseases. Report of a Joint FAO/WHO Workshop on fruits and vegetables for health, 1-3 September, 2004, Kobe, Japan.

WHO (2020): Double Burden of Malnutrition. <https://www.who.int/nutrition/double-burden-malnutrition/en/>.

## **ACKNOWLEDGEMENT**

The author would like to thank her mentors, Prof. Derek Byelee and Dr Tewoja Mogue for their immense contributions to this work under the AAEA Africa Early Career Scholarship mentoring programme. She equally appreciates the support in terms of the data from a faculty at Michigan State University through the project called “Feed the Future Nigeria Agricultural Policy Project”. She appreciates Dr Saweda Liverpool-Tasie who initiated the AAEA Africa Early Career Scholarship mentoring programme.