Nutritional and health values of indigenous root and tuber crops compared to imported carbohydrate (such as wheat): A case study example from Delta state Nigeria

Bonaventure Onodu , Richard Culas, and Ezekiel Nwose

Charles Sturt University, Australia

Contributed paper prepared for presentation at the 64th AARES Annual Conference, Perth, Western Australia 12-14 February 2020.

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Bonaventure C. Onodu[1 *], Richard J. Culas,[1] Ezekiel U. Nwose[2]

[1]School of Agriculture and Wine Sciences, Charles Sturt University, Orange NSW, Australia

[2]School of Community Health, Charles Sturt University, Orange NSW, Australia

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Perth, Western Australia, 12-14 February 2020

This paper has been published by the Australasian Agricultural and Resource Economics Society (AARES) on the AgEcon Search website at http://ageconsearch.umn.edu/,
University of Minnesota, 1994 Buford Avenue, St Paul MN, USA

Published 2020

*Correspondence: Bonaventure Onodu. School of Agriculture and Wine Sciences, Charles Sturt University, PO Box 883, Orange NSW, Australia. Email: bonodu@csu.edu.au

Abstract

A healthy and productive household can only be achieved by their ability to acquire adequate quality food. Availability of food in sufficient quantity and quality is regarded as the starting point of economic development, social interaction, political stability and security of any nation. Majority of human food sources has been provided by three main crop groups; cereals, legumes and root and tuber crops. Root and tuber crops (RTC) are the main source of carbohydrate in many regions, especially in sub-Saharan Africa where their total calorie consumption could reach up to 50%. Nigeria is the highest producers of the major RTC such as cassava and yams globally, in 2017 Nigeria produced over 59 million metric tons of cassava and 47 million metric tons of yams respectively. Despite the large quantity in RTC production in Nigeria, many consumers' are neglecting its consumption in preference to wheat. Understanding the factors influencing the consumption of RTC in favour of wheat is essential for establishing effective ways to improve nutritional habits of the people in the locality and the entire nation at large. This study analyzed the socioeconomic characteristics influencing RTC consumption in favour of wheat (imported) carbohydrate substitute in Medical Nutrition Therapy (MNT) in Delta State Nigeria. It was identified that age, price of cassava, annual income and household size affect RTC consumption while annual income, household size and cassava price affect wheat consumption in the study area. Conclusion was made that a greater understanding of the relationship between knowledge and dietary intake is important as many evidence support the link between low nutritional knowledge and poor management of chronic diseases. It was recommended that nutritional knowledge programs should be designed and implemented in order to support sound dietary intake within the study area and the entire country at large to reduce the prevalence of non-communicable diseases.

***Keywords*:** Root and tuber crops, wheat, nutritional value, health care, Delta State, Nigeria

1.0: Introduction

Food is regarded as one of the basic necessity of life and also as a key component in measuring fundamental welfare. A healthy and productive life style of any household can be achieved as a result of their ability to have adequate quality food (Titus & Adetokunbo, 2007). Most of the rural households in Africa use at least two third of their consumption budget on food. In low income countries such as Nigeria, food account for the largest share of the household expenditure, but requires a steady production in order to meet consumers' need for consumption (Sanusi & Babatunde, 2017). Fundamental welfare dimensions such as food security, nutrition, health and poverty are all aspects of food. The main determinant of changes in quantity or quality of food a household demand or consume is changes or growth in income, when income increases the household are left with more disposable income thereby resulting in a major shift in demand across different types of food, a shift from inferior foods to more quality and nutritious food of high value (Pingali, 2007).

Availability of food in sufficient quantity and quality is regarded as the starting point of economic development, social interaction, political stability and security of any nation. Households purchase food to maximize utility, or their well-being based on their household collective preferences which are subject to their financial constraints, with an intention that the cost of the food they purchase is less or equal to their entire household sources of income. Consumers eating behavior is an important aspect of life as it can influence their health over a long term, consumption of food with low quality are understood to cause many health problems.

This paper is organized as follows. Section 2 provides review of literature on consumption behavior (demand for RTC) and trends in production of RTC globally and in Nigeria (supply). Data and methods are given in Section 3. Section 4 presents the results. The discussion of the results are given in Section 5, followed by conclusions in Section 6.

2.0 Review of literature

2.1 Consumers' consumption behavior (demand)

The theory of consumer behaviour is based on the assumption of consumer utility and consumer preferences. It looks at how consumption behaviour is influenced to maximize the benefit from the consumption of a product. Consumer consumption behaviour is referred to those actions which are directed towards obtaining, consuming, and disposing of the products. The actions people make for various individual choices affect their environment directly or indirectly (Dzene & Yorulmaz, 2011).

The demand for a commodity can be defined as the quantity of that commodity a consumer is willing and able to purchase at different prices during a particular period of time. There are basic theoretical economic rationalizations behind consumer behaviour towards certain products or commodities. Most variables used for explaining the demand for any good includes; the unit price of the good, the prices of related goods which can be substitutes and the wealth or income status of the consumer (Agwu, Anyanwu, & Udi, 2015). Under the fundamental theory of demand, as prices of commodities rise, consumers substitute by choosing less costly alternative which is as a result of income and demand effect.

2.2 Global root and tuber crops production (supply)

The majority of human food sources has been provided by three main crop groups; cereals, legumes and RTC. The RTC are main source of carbohydrate in many region, especially in sub-Saharan Africa where their total calorie consumption could reach up to 50% (Daryanto, Wang, & Jacinthe, 2017). They are mainly used as staple foods in many developing countries. Majority of the traditional delicacies consumed in several parts of Africa, Asia and Latin America are from RTC. Compared to other staples, RTC produce larger amount of energy and nutrition per unit area of land and time with some contributing essential elements such as iron, zinc, calcium, and vitamins A and C. They serve as functional foods rich in phytochemicals/bioactive, anti-oxidants and probiotic compounds (Saranraj, Behera, & Ray, 2019). These crops require less intensive management systems and are processed into a lot of food varieties, livestock feeds and industrial raw materials (Muimba-Kankolongo, 2018).

The total output from major RTC such as cassava and yam produced globally in 2017 amounted to 292 and 73 million metric tons with Africa producing 61% of the total cassava and 97% of the total yams respectively (FAO, 2019). Despite these achievements in the production of RTC in Africa, Africans food policy over the past has been centered on increasing the production of cereals which do not do well under tropical environment. There are many reasons to increase the production of RTC globally and in Africa in particular these includes; roots and tubers produce more food per unit area of land more than any other crops, many of them like potato and sweet potato have short planting cycle which is 3-4 months before maturity thereby encouraging continuous production, their agro-ecological adaptation and their ability to efficiently convert natural resources to more usable products. They have greater potentials than other crops in terms of water use efficiency (WUE), nutrient content and they also have higher water productivity than cereals, also, they are rated among the most energy productive crops producing 5600 kcal per cubic meter of water (Daryanto, Wang, & Jacinthe, 2016). They are also valuable sources of minerals, vitamins and antioxidants (Bradshaw, 2010).

In the tropical region, RTC are regarded to be contributing significantly in form of sustaining economic development, income generation to numerous farmers who are into their production. The adaptability of RTC to marginal soil, contribution to domestic food security and their ability to be intercropped with other food crops make them very important among the poor farming communities.

Presently, commercial farmers are showing interest in their large scale production due to their tolerance to environmental changes such as climate change (Weerarathne, Marambe, & Chauhan, 2017).

2.3 Root and tuber crops production in Nigeria

Nigeria is the highest producer of the major RTC such as cassava and yams in the world, in 2017 Nigeria produced over 59 million metric tons of cassava and 47 million metric tons of yams respectively (FAO, 2019). These huge quantities harvested annually of the crops can be linked to the growing population, availability and accessibility of high yielding varieties provided by International Institute of Tropical Agriculture (IITA), root crops research institutes as well as the expansion on the land (hectare) allocated for their production. RTC growing belts in Nigeria are located within the agro-ecological zones of the South-South, South-West, South-East, North-Central and North-West regions (Odok, 2018).

In the past, production of RTC was only based on ensuring food security due to government preference on the production of cash crops and cereals, but presently the trend has changed due to numerous uses of roots and tubers ranging from human consumption to industrial use. Often times, especially in Nigeria diabetes patients are misinformed about carbohydrates consumption resulting in patients reducing their intake or total avoidance of starchy staples which are mainly RTC, leading to poor management of diabetes in Nigeria (Udenta, Obizoba, & Oguntibeju, 2014). This misconception has greatly affected both the consumers and producers of RTC. There is an urgent need to investigate the factors affecting the consumption of RTC in the study area. It is essential to integrate local foods within local research and innovation system in relation to the needs of the people.

3. Methods

This section details data collection and the methods involved in the analyses of factors affecting root and tuber crops' consumption, as well as those factors affecting the production of these crops, in the study area. This study was conducted in Ndokwa West Local Government Area of Delta State Nigeria. Delta State is located in the Southern part of Nigeria; it is situated in the region known as the Niger Delta. Ndokwa West Local Government Area of Delta State was created in August 1991 with its head quarter in Kwale. It is located within latitude 6.480E and longitude 5.450N. It has an area of 816m^2 and a population of one hundred and fifty thousand and twenty four (150,024) people (NPC, 2006). This study adopted a multi-stage stratified random sampling procedure.

First stage was a purposive selection of Ndokwa west Local Government Area for the study, the reason was because majority of cassava and yam producers are predominant in the area. The second stage was the stratification of consumers based on major carbohydrate sources consumed by the households. The third stage was the random selection of 80 (40 urban and 40 rural) consumers from the list compiled by the researcher with the assistance of the stakeholders in the Local Government Area, making a total sample size of 80 respondents for the study. After the collection of data only 55 respondents returned their questionnaire and hence, were used in the analysis. The collection of data used for this study lasted for nine months, from December 2017 - August 2018.

The socioeconomic characteristics (SEC) of root and tuber crops (yam and cassava) producers were analyzed. The analysis was performed to create the true picture of the processes involved in production which makes the crop available for consumption in the study area. On assessment of those who produce cassava and/or yam in the study area, 55 responses comprising 43-females and 12-males were received. In the input and output evaluation of producers' i.e. supplies, regression analysis were performed using four functional forms to determine 'lead equation'. Criteria for the determination of the lead equation were a combination of 'least standard error' and highest R^2. On the consumption i.e. demand analysis of root and tuber crops relative to wheat as main carbohydrate food crop in the study area, socioeconomic characteristics as well as other independent variables were analyzed and ascertained on how they impact on urban and rural participants' consumption behavior in the study area.

4.0 Results

4.1 Socioeconomic characteristics (SEC) of producers of root and tuber crops

The SEC of both cassava and yam producers was treated together because majority of the producers in the study area practice mixed cropping, planting both cassava and yam on the same piece of land at the same cropping season.

Table 1: Respondents' SEC distribution

	N	Proportion
Female	43	78%
Male	12	22%
Cassava producers	All	100%
Yam producers	48	87%
Both cassava & yam	48	87%

The distribution of the respondents based on gender and percentages of crop produced were shown in Table 1, the percentage of female producers was 78% while male were 22%, an indication that majority of the producers were female.

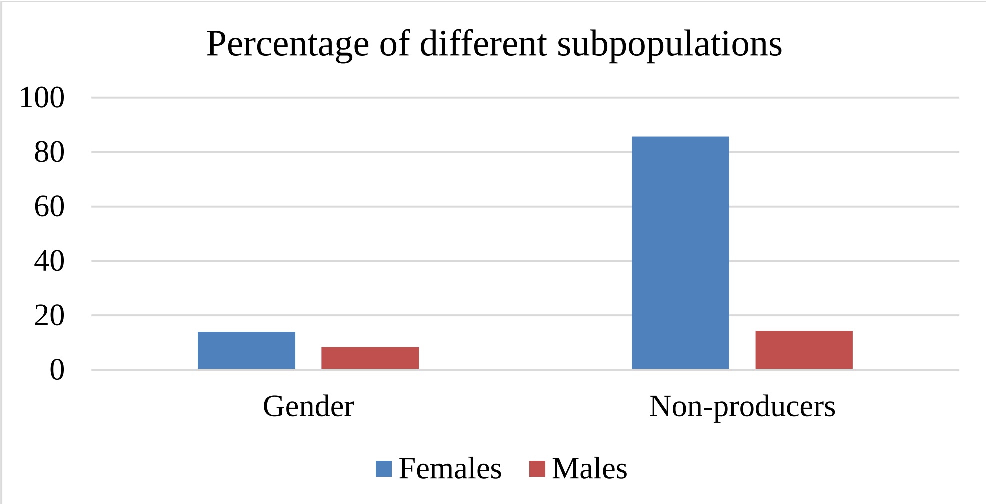

Fig 1: Percentage of men vs. women in yam production

Re-examination about the percentages on male and female producers of yam was shown in Fig 1. illustrating that majority of yam producers were male in the study area.

Table 2: Household size of respondents

HHZ	Single	Married
1-5 persons	7	14
6-10 persons	18	11
11-15 persons	3	2
16-20 persons	0	0
>20 persons	0	0
Total	28	27

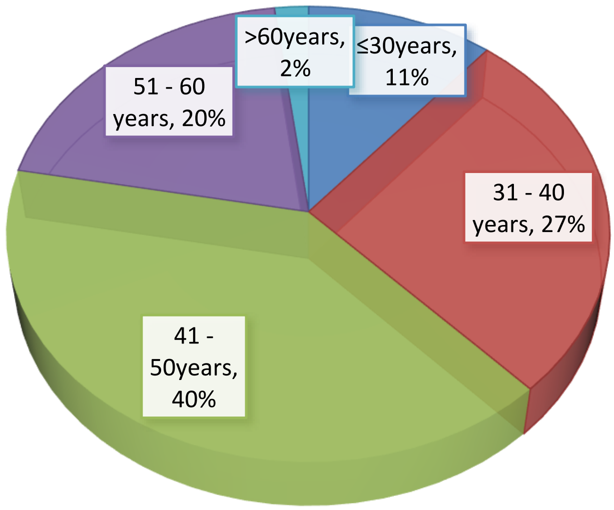

Fig 2: Relative frequencies of stratified age-groups of producers

The socioeconomic characteristics of root and tuber crops producers were explained in Table 1 – Table 4 and Fig. 1, 2 and 3, respectively.

Table 3: Distribution of respondents by education and years of farming

Educational level	N	Years of experience in farming				
		1-5 yrs	6-10 yrs	11-15 yrs	16-20 yrs	>20 yrs
Primary or none	13	0	0	1	2	10
Secondary	15	0	3	3	4	5
Tertiary	27	12	2	1	1	11

Table 4: Absolute and relative frequencies of respondents

	Units of measure	Absolute Hz	Relative Hz %)
Output	≤ 20 baskets	2	3.9%
	21-30 baskets	4	7.9%
	31-40 baskets	2	3.9%
	41-50 baskets	8	15.7%
	≥ 51 baskets	35	68.6%
Farm size	< 1 hectare	23	41.8%
	1-1.5 hectare	24	43.6%
	1.6-2 hectare	4	7.3%
	> 2hectar	4	7.3%
Cassava variety	local	36	65.5%
	improved	11	20.0%
	both	7	12.7%
	others	1	1.8%

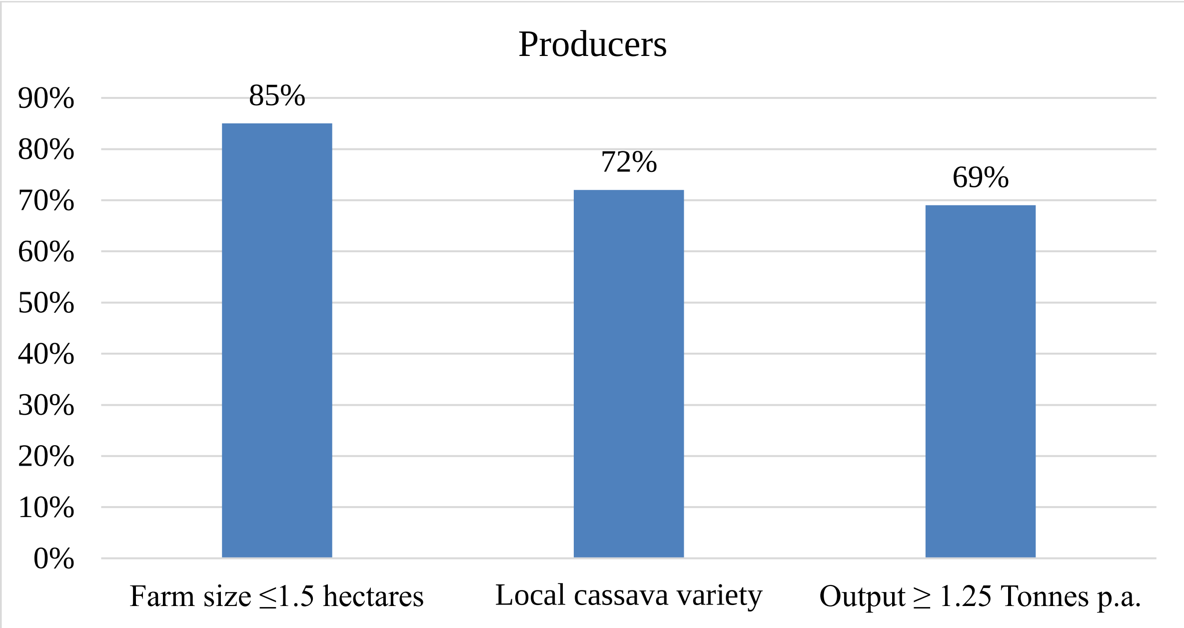

Fig 3: Absolute and relative frequencies of respondents based of farm, variety and output

The below sections (sections 4.2 and 4.3) present the results of the regression analyses conducted in the study area in relation to production and consumption of RTC. The descriptions of the variables used in the regression analyses are given in the Appendix.

4.2. Relationships between inputs and outputs of 'root and tuber' production in study area

4.2.1 Cassava

The four functional forms estimations regarding input and output relationships in cassava production are shown in Table 5. The double-log functional form was chosen as the lead equation because it was the functional form with the least standard error (0.182), having the second highest coefficient of multiple determination R^2 (0.862 or 86.2%), it is the form with the second highest f-value (8.04), it has the second highest number of statistical significant exogenous variables and its significant exogenous variables conform with a priori expectations.

Table 5: Inputs and outputs of cassava production

Variables	Linear	Double Log	Semi-Log	Exponential
Dependent variable: Cassava produced				
Constant	35.945 (0.134)	-1.647 (0.591)	-67.103 (0.442)	2.676 (0.019)*
Age	2.067 (0.009)*	0.191 (0.006)*	3.872 (0.038)*	0.081 (0.021)*
Gender	-0.001 (0.895)	-0.104 (0.733)	-1.314 (-0.971)	-8.793 (0.816)
Marital Status	0.185 (0.622)	-0.008 (0.937)	1.235 (0.658)	0.002 (0.891)
H.H. Size	0.138 (0.330)	0.104 (0.299)	1.229 (0.660)	0.009 (0.185)
Level of education	1.866 (0.027)*	0.075 (0.055)*	2.394 (0.032)*	0.055 (0.138)
Farming experience	0.000 (0.000)*	0.626 (0.000)*	15.667 (0.000)*	1.317 (0.000)*
Farm size	0.001 (0.052)*	2.232 (0.387)	0.001 (0.106)**	1.927 (0.482)

Qty of stem	-2.977 (0.202)	-0.665 (0.388)	-35.198 (0.115)	0.006 (0.957)
Price of stem	-0.008 (0.776)	0.093 (0.159)	2.233 (0.227)	-0.001 (0.337)
Land prep.	0.000 (0.865)	-0.90 (0.068)	-1.809 (0.185)	4.885 (0.399)
Planting	0.000 (0.480)	-2.181 (0.372)	-5.819 (0.399)	1.842 (0.892)
Weeding	6.066 (0.986)	0.036 (0.622)	-0.450 (0.828)	0.000 (0.363)
Fertilizer appli.	2.005 (0.066)*	0.084 (0.057)*	1.892 (-0.122)	0.101 (0.043)*
Harvesting	-0.440 (0.809)	0.120 (0.567)	4.612 (0.439)	-0.092 (0.271)
R^2	0.867	0.862	0.809	0.843
Standard error	4.289	0.182	5.139	0.194
F-Value	8.391	8.037	5.456	6.889

*1%; **5%; and ***10% significant levels

4.2.2 Yam

The exponential functional form was selected as the lead equation for yam production in the study area, this is because it is the form with the least standard error of estimation 0.313, having the second highest coefficient of multiple determinations 0.580 or 58%, having the highest number of significance of independent variables, having second to highest of F-value and also the significant independent variables conforms with a priori expectations as shown in Table 6.

Table 6: Inputs and outputs of yam production

Variables	Linear	Double Log	Semi-Log	Exponential
Dependent variable: Yam produced				
Constant	1.434 (0.983)	-2.406 (0.698)	-167.703 (0.444)	2.453 (0.212)
Age	0.541 (0.097)*	-0.115 (0.230)	-3.703 (0.270)	0.014 (0.136)
Gender	18.144 (0.014)*	0.216 (0.389)	8.977 (0.311)	0.014 (0.029)*

Marital Status	3.775 (0.667)*	0.049 (0.792)	3.218 (0.620)	0.098 (0.096)**
H.H. Size	-1.581 (0.139)	0.093 (0.588)	3.478 (0.562)	-0.046 (0.139)
Level of education	6.016 (0.052)*	0.148 (0.438)	4.711 (0.483)	0.174 (0.052)*
Farming experience	-3.853 (0.063)*	-0.102 (0.476)	-2.746 (0.582)	-0.122 (0.043)*
Farm size	0.008 (0.695)	0.518 (0.410)	19.380 (0.381)	0.000 (0.721)
Qty of seed yam	2.449 (0.019)*	0.315 (0.125)	11.174 (0.122)	0.071 (0.019)*
Land prep.	0.413 (0.202)	0.346 (0.099)**	12.480 (0.091)**	0.013 (0.173)
Planting	-5.149 (0.033)*	-0.065 (0.759)	-2.304 (0.757)	-0.143 (0.040)*
Weeding	1.537 (0.925)	-0.050 (0.865)	-2.875 (0.778)	9.993 (0.832)
Fertilizer application	0.001 (0.737)	0.190 (0.488)	7.297 (0.448)	1.941 (0.738)
Harvesting	-2.105 (0.765)	0.024 (0.989)	-3.771 (0.951)	-0.043 (0.833)
R^2	0.593	0.367	0.368	0.580
Standard error	10.824	0.384	13.490	0.313
F-Value	2.128	0.848	0.849	2.015

*1%; **5%; and ***10% significant levels

4.3 Consumption determinants of RTC with respect to wheat in the study area – rural vs. urban comparison

Appropriate intake of food has been realized to have a major influence on public health. The major determinant of food choices is hunger, but when many options are available to choose from, what consumers choose is not determined solely by physiological or nutritional needs but consumers' socioeconomic characteristics and also personal, social, cultural, economic and emotional factors (Oti, 2018). The socioeconomic characteristics and resource of individual household have been identified as among the basic factors influencing the food security status of households. As the world economy becomes more integrated and the barriers in communication solved by technology, diet transition would have been inevitable.

Urbanization has been identified as one of the crucial determinants of dietary transition resulting in accelerated shift in diets (Cockx, Colen, & De Weerdt, 2017). The differences in the pattern of food consumption among rural and urban dwellers may be attributed to location, while rural based households may be restricted to only the food produced in their locality, their urban counterparts may have access to a wider variety of food items produced outside their area. The differences in urban and rural food demand and consumption with regards to RTC relative to wheat was statistically analyzed and is discussed below.

4.3.1 Cassava consumption urban vs. rural in the study area

The statistical analysis of urban cassava consumption revealed that among the eight independent variables regressed using all the four functional forms, it was only age, income and cassava price that were statistically significant based on the lead equation taken. The reason for choosing exponential functional form as the lead equation was because it is the form that has the least standard error, the highest coefficient and the variables that are significant agreed to a priori expectation as shown in Table 7.

Table 7: Urban cassava consumption

Variables	Linear	Double Log	Semi-Log	Exponential
Dependent variable: Cassava consumed (urban)				
Constant	-2305.81 (0.964)	-2.412 (0.582)	-972955 (0.032)*	9.802 (0.00)*
Age	-15.587 (0.166)	0.061 (0.909)	60458.08 (0.267)	-0.001 (0.000)*
Level of education	37.718 (0.081)*	0.592 (0.043)*	39750.43 (0.168)	0.000 (0.683)

H.H Size	458.839 (0.004)*	0.289 (0.066)*	22674.56 (0.146)	0.004 (0.113)
Health Value	1.755 (0.200)	-0.127 (0.327)	-4242.51 (0.743)	1.312 (0.542)
Annual income	-1.077 (0.088)*	0.885 (0.006)	22339.91 (0.464)	2.664 (0.010)*
Cass. price	-2.288 (0.510)	0.165 (0.482)	43635.32 (0.069)*	0.000 (0.000)*
Yam price	-4829.97 (0.217)	-0.390 (0.248)	-45941.5 (0.176)	-0.093 (0.138)
Wheat price	5250.485 (0.108)	0.509 (0.205)	106116.7 (0.011)*	-0.089 (0.089)
R^2	0.929	0.914	0.688	0.950
Standard error	30814.37	0.644	64471.27	0.489
F-Value	50.421	41.202	8.528	74.176

* 1%, ** 5%, and *** 10%, significance levels

The analysis of the variables that affect the quantity of cassava consumption among rural respondents revealed that household size and annual income of the respondents has some impact in the quantity of cassava products they consume. The double-log functional form was chosen because it is the form with the least error of estimation and the function with the highest coefficient of multiple determinations (R2) of 0.770 (77%) as shown in Table 8.

Table 8: Rural cassava consumption

Variables	Linear	Double Log	Semi-Log	Exponential
Dependent variable: Cassava consumed (rural)				
Constant	-906.792 (0.160)	-1.290 (0.785)	-7726.22 (0.012)*	4.456 (0.00)*
Age	-0.002 (0.000)*	0.025 (0.894)	-144.286 (0.210)	3.608 (0.000)*
Level of education	0.006 (0.027)**	0.231 (0.103)	211.457 (0.018)*	8.575 (0.070)***
H.H Size	-0.003 (0.040)**	0.686 (0.005)*	509.218 (0.001)*	-2.812 (0.292)
Health Value	94.962 (0.041)**	0.491 (0.265)	593.613 (0.033)*	0.072 (0.357)
Annual income	237.335 (0.276)	0.482 (0.099)***	346.801 (0.055)**	0.288 (0.443)

Cass. price	121.719 (0.339)	0.140 (0.445)	70.594 (0.531)	0.269 (0.223)
Yam price	-88.545 (0.153)	0.073 (0.577)	-68.214 (0.399)	-0.007 (0.950)
Wheat price	0.352 (0.600)	-0.674 (0.326)	82.222 (0.844)	0.000 (0.733)
R^2	0.639	0.770	0.762	0.606
Standard error	483.341	0.639	392.1012	0.836
F-Value	6.860	12.997	12.430	5.972

*1%; **5%; and ***10% significant levels

4.3.2 Yam consumption urban vs. rural in the study area

In urban yam consumption out of the eight exogenous variables fitted in the consumption model only three variables were significant at different levels of significance, they are Age, Household size and cassava price. Exponential functional form was chosen as the lead equation because; it is the equation with the least standard error of 0.272, has the highest coefficient of multiple determination of 0.652 (65%) and has the highest f-statistic of 7.272 as shown in Table 9.

Table 9: Urban yam consumption

Variables	Linear	Double Log	Semi-Log	Exponential
Dependent variable: Yam consumed (urban)				
Constant	-91.399 (0.415)	-62.273 (0.387)	-1096.30 (0.338)	-3.712 (0.595)
Age	-0.374 (0.000)*	-0.885 (0.000)*	-12.621 (0.000)*	-0.26 (0.000)*
Level of education	-1.015 (0.518)	0.058 (0.735)	1.518 (0.575)	-0.095 (0.338)
H.H Size	1.693 (0.017)*	0.350 (0.006)*	5.022 (0.013)*	0.112 (0.012)*
Health Value	0.051 (0.897)	-0.008 (0.946)	0.295 (0.873)	4.193 (0.999)
Annual income	1.119 (0.340)	-0.006 (0.917)	0.095 (0.918)	6.497 (0.375)
Cass. price	-0.011 (0.033)**	-4.201 (0.089)***	-66.813 (0.088)**	-0.001 (0.029)*

Yam price	0.003 (0.619)	2.132 (0.725)	39.682 (0.680)	0.000 (0.658)
Wheat price	0.000 (0.890)	0.997 (0.736)	17.642 (0.707)	-1.485 (0.909)
R^2	0.608	0.597	0.554	0.652
Standard error	4.353	0.293	4.645	0.272
F-Value	6.021	5.743	4.815	7.272

*1%; **5%; and ***10% significant levels

Double-log functional form was chosen as the lead equation for rural yam consumption in the study area, the reason was because it is the functional form with standard error of estimation 0.264, the highest coefficient of multiple determination of 0.700 (70%) and highest f-statistics of 9.06 as shown in Table 10.

Table 10: Rural yam consumption

Variables	Linear	Double Log	Semi-Log	Exponential
Dependent variable: Yam consumed (rural)				
Constant	-9.132 (0.383)	-0.432 (0.828)	-44.668 (0.388)	1.488 (0.003)**
Age	4.237 (0.000)*	0.347 (0.000)*	6.485 (0.000)*	0.207 (0.000)*
Level of education	0.013 (0.144)	0.261 (0.324)	7.444 (0.277)	0.001 (0.176)
H.H Size	0.180 (0.235)	0.198 (0.046)*	3.244 (0.199)	0.010 (0.134)
Health Value	0.009 (0.986)	-0.055 (0.646)	-2.032 (0.516)	0.010 (0.670)
Annual income	0.706 (0.055)**	0.252 (0.031)**	2.739 (0.350)	0.031 (0.060)***
Cass. price	3.970 (0.434)	0.054 (0.192)	0.483 (0.646)	2.625 (0.254)
Yam price	0.035 (0.716)	0.003 (0.955)	-1.040 (0.503)	0.002 (0.597)
Wheat price	8.502 (0.904)	0.017 (0.793)	1.098 (0.503)	-5.895 (0.852)
R^2	0.575	0.700	0.544	0.621
Standard error	6.591	0.264	6.833	0.297
F-Value	5.249	9.059	4.614	6.361

*1%; **5%; and ***10% significant levels

4.3.3 Wheat consumption urban vs. rural in the study area

Wheat has become one of the most imported agricultural commodities, as at 2015, Nigeria imported about 4.3 million metric tons of wheat at a cost in excess of $3 billion. Wheat is consumed in various forms in Nigeria ranging from biscuits, bread, spaghetti and other items virtually in every home (Falola, Achem, Oloyede, & Olawuyi, 2017). The continuous increase in wheat demand can be attributed to increasing urbanization and population growth. This study analyzed the various factors that influence the consumption of wheat in the study area.

The analysis of urban wheat consumption shows that among the eight variables fitted in the consumption model only three exogenous variables were statistically significant at different levels of significance as shown in Table 11, the variables are household size, annual income and cassava price, all the statistically significant variables have positive relationship with the explanatory variable. The functional form that was chosen as the lead of equation is double-log functional form, the reason for selecting it was because; it has the least standard error of estimation of 0.203, has the highest coefficient of multiple determination (R^2) of 0.515. This implies that variations in the explanatory variables explained only 51.5% of the total variation in quantity of wheat consumed in the study area.

Table 11: Urban wheat consumption

Variables	Linear	Double Log	Semi-Log	Exponential
Dependent variable: Wheat consumed (urban)				
Constant	-260.012 (0.055)**	-105.924 (0.043)**	-2541.51 (0.052)**	-8.985 (0.094)***
Age	0.018 (0.826)	0.004 (0.977)	-0.027 0.994)	0.001 (0.797)
Level of education	-1.711 (0.345)	-0.100 (0.462)	-2.964 (0.388)	-0.058 (0.426)
H.H Size	1.157 (0.164)	0.157 (0.077)**	3.328 (0.131)	0.054 (0.107)
Health Value	-0.104 (0.815)	0.030 (0.717)	0.218 (0.916)	0.001 (0.966)

Annual income	5.319 (0.036)**	0.198 (0.071)	5.439 (0.048)**	1.977 (0.050)**
Cass. price	0.022 (0.001)*	6.959 (0.000)*	165.577 (0.001)*	0.001 (0.000)*
Yam price	0.007 (0.352)	3.930 (0.351)	92.696 (0.380)	0.000 (0.324)
Wheat price	0.001 (0.779)	0.693 (0.762)	13.662 (0.811)	3.606 (0.735)
R^2	0.478	0.515	0.490	0.502
Standard error	5.150	0.203	5.092	0.206
F-Value	3.551	4.119	3.721	3.908

*1%; **5%; and ***10% significant levels

Exponential functional form was chosen as the lead equation for rural wheat consumption, the reason was because; it is the function with the least standard error of estimation 0.509, it has second highest coefficient of multiple determination of 0.418 as shown in Table 12.

Table 12: Rural wheat consumption

Variables	Linear	Double Log	Semi-Log	Exponential
Dependent variable: Wheat consumed (rural)				
Constant	-116.947 (0.212)	-125.138 0.272	-1425.49 (0.160)	-9.937 (0.363)
Age	0.133 (0.024)*	0.217 (0.137)	1.938 (0.133)	0.014 (0.044)**
Level of education	-0.506 (0.761)	0.328 (0.447)	-0.504 (0.894)	0.115 (0.557)
H.H Size	1.149 (0.005)*	0.364 (0.017)	4.342 (0.002)*	0.093 (0.043)**
Health Value	0.633 (0.394)	0.075 (0.675)	1.037 (0.510)	0.047 (0.589)
Annual income	4.809 (0.807)	-0.046 (0.798)	0.286 (0.856)	-3.313 (0.886)
Cass. price	0.000 (0.937)	-1.781 0.694)	-24.200 (0.546)	9.227 (0.878)
Yam price	0.002 (0.706)	5.931 (0.545)	76.402 (0.380)	0.000 (0.825)
Wheat price	0.004 (0.063)***	8.537 0.126	90.374 (0.069)*	0.000 (0.123)
R^2	0.515	0.351	0.418	0.418

Standard error	4.334	0.537	4.750	0.509
F-Value	4.118	2.095	2.783	2.780

*1%; **5%; and ***10% significant levels

5. Discussion

5.1 Socioeconomic characters (SEC): Root and tuber crops (RTC) producers

Results indicate that all (100%) respondents are cassava producers, only 87% of them produce yam. This also implies 87% being producers of both cassava and yam (Table 1). Further evaluation to determine the proportion of the yam producers (i.e. men relative to women) indicate that most of the non-producers of yam are females and this constitute 14% of the female sub-population compared to 8% of the male sub-population; or 86% of the non-producers being women relative to men constituting 14% (Fig 1). The above statement is an indication that farmers in the study area who are yam producers were predominantly male, this agrees with the earlier research carried out indicating that yam is a male crop (Ajieh, 2012; Ekunwe, Orewa, & Emokaro, 2008).

In this study, marital status was dichotomous married or single. The single group included those who have been unmarried, divorced, widows and widowers. The marital status analysis of respondents indicate that 27 (49%) of the producers are married. Further evaluation considering household size shows that a vast majority of the singles have large household size of six to ten persons (Table 2). Age distribution of the producers shows that none of the respondents was below 20years old (Fig 2), an indication that majority of the producers are mature and can make their own decisions without the consent of their parents.

The analysis of educational status and years of experience in farming shows that majority of the respondents' attained high institutions and have up to 20 years farming experience an indication that the farmers will have the capacity to adopt any cropping innovation introduced to them (Table 3). Cassava variety, farm size, and output analysis on respondents' information based on their previous farming season were also analyzed (Table 4). Further critical review of the data show that most of the farmers have farm size ≤1.5 hectares, use local varieties and produce ≥1.25 tons per annum (Fig 3). The use of local verities of planting materials, less than 2 hectares of land was the reason for the low output recorded in the area.

5.2 Input and output: the relationship between inputs and outputs in RTC production

5.2.1 Cassava

Out of the 14 independent variables that were fitted into the cassava production model, five were found to be statistically significant at different levels of significance. The variables are; age, level of education, years of experience in farming, amount spent on fertilizer application and investment or expenses on farm land preparation. With the exception of land preparation, all the exogenous variables have a direct or positive relationship with the quantity of cassava produced in kilogram being the dependent variable.

Age: The t-statistic of age is 3.126 and significant at 0.01(1%) level of significant, with a coefficient of 0.191. this implies that as the age of cassava producers increases, the output of cassava produced from their farm also increases and vice versa. This relationship is as expected because increase in age has a correlation with increased life experience generally, when life experience is wholly or partly invested into production, it will result into increased output as experienced among the cassava producers in the study area. The coefficient of 0.191 recorded by cassava producers implies that as the age of an average farmer increases by one year, the quantity of cassava produced will also increase by 0.191 kg, this is in agreement with (Onubuogu, Esiobu, Nwosu, & Okereke, 2014; Onubuogu & Onyeneke, 2012) indicating that an increased experience in any venture enhances output performance.

Level of education: The t-statistic level of education is 2.050 and significant at 0.05 (5%), having a coefficient of 0.075. Implying that as the level of education of producers' increases, the quantity of cassava produced by them also increases. This conforms to the initial expectation because education instills in individuals the knowledge and skills to make proper planning and better management decisions which in turn will increase their productivity. This is in line with the discovery which confirms that education and training enhances farmers' productivity (Onubuogu & Onyeneke, 2012). Level of education having a coefficient of 0.075 implies that an additional level of education acquired by cassava producers will increase their cassava output by 0.075kg.

Farming experience: With t-statistic of 4.903 and significant at 0.01 (1%) with a coefficient of 0.626. Increased life experience generally enables people to get exposed to many things such as more skills and knowledge. The case of cassava farmers in the study area will not be different. Accordingly, farming experience has a direct relationship with the quantity of cassava produced. The coefficient of 0.626 implies that any additional year in farming experience will increase their cassava output by 0.626kg.

Land preparation: The t-statistic of land preparation is -1.945 with a coefficient of -0.090 and significant at 0.05 (5%) level of significance. Land preparation has an inverse relationship with cassava output produced in the study area. The implication of this is that as more money is spent on land preparation in the study area, the quantity of cassava produced declines and vice versa. The plausible explanation to this scenario is that in the study area cassava is not grown as a sole crop but is grown in combination with other crops. Incidentally, the expenditure on land preparation is not shared among these various crops but is borne by cassava (as in this case) hence the inverse relationship. The coefficient of -0.090 is an implication that any money (Naira) increase in land preparation will result in a reduction in cassava output produced by 0.090kg.

Fertilizer application: The t-statistic of fertilizer application is 2.032 while its coefficient is 0.084 and is significant at 0.05 (5%) level of significance. Generally, fertilizer application when used in optimum level under normal condition is expected to increase output of crops. The result conforms to a priori expectation and shows that an increase use of fertilizer will increase cassava output among respondents in the study area. The coefficient of 0.084 implies that any additional money (Naira) spent on fertilizer application will increase cassava output by 0.084kg.

5.2.2 Yam

The analysis shows that out of the 13 independent variables fitted into the production model, five were strongly significant at 5%, they are; gender, level of education, farm experience, quantity of seed yam planted and the expenditure for planting while marital status was significant at 10%. With the exception of farming experience and expenditure on planting/sowing which have a negative relationship with quantity of yam produced the rest have positive relationship with the dependent variable (quantity of yam produced in kg) this is because they have positive coefficients.

Gender: With a coefficient of 0.460 and is significant at 0.029 (3%) level of significance, with a t-statistic of 2.369. Yam being a male dominated crop in the study area, this implies that as the number of male who engage in yam production increases by one in the study area, the quantity of yam produced will also increases by 0.460 kg.

Level of Education: The t-statistic is 2.077, significant at 0.05 (5%) level with a coefficient of 0.174. The implication of the above values is that as the level of education increases, the quantity of yam produced in the study area also increases. Higher level of education can be linked with high quality skills of farmers, making them to be well informed and able to adopt new farming technology and innovations faster. This is in agreement with (Onubuogu et al., 2014) which concluded that higher level of education determines the quality of skills of farmers, their allocative abilities, their efficiency and how well informed they are about innovations and technologies around them. What this means is that in the study area any additional years in education will increase yam output by 0.174kg.

Farming experience: With a coefficient of -0.122, significant at 0.04 (4%) level of significant and t-statistic of -2.166, implying that the quantity of yam produced in the study area has an inverse relationship with farming experience; this is against what was expected because much experience can lead to making good decisions regarding farming skills and technologies to increase productivity. What it means is that any additional year in farm experience will decrease the quantity of yam produced by 0.122kg in the study area.

Quantity of seed yam: The statistical analysis shows that t-statistic of quantity of seed yam used in production was 2.554, which is significant at 0.01 (1%) with a positive coefficient of 0.174. This implies that as the quantity of seed yams used in production in the study area increases the output also increases, these conforms with the a priori expectation, indicating that higher seed yams rate would result in higher yam population which will be transformed into higher yield except where there is overcrowding leading to competition of available nutrients leading to eventual yield reduction.

The relationship of quantity of seed yams and the output of yam produced are very positive implying that any additional increase in quantity of seed yam used in production will lead to an increase in the output by 0.174kg; this is in agreement with an earlier investigation conducted in Benue state Nigeria, they concluded increase in the quantity of seed yams cultivated will result in an increase in output (Shehu, Iyortyer, Mshelia, & Jongur, 2010).

Planting/sowing: When the cost of planting is increasing, it will in turn reflect in the outcome of the output in its decrease 'ceteris paribus'. The coefficient of planting and sowing cost in the study area was found to be negative showing that it has an inverse relationship with the quantity of output produced. When the cost of planting or sowing increases it will lead to producers not increasing their farm size thereby limiting their scale of production, but when producers accept new innovations in terms of technology and skills which will reduce their planting cost, it will go a long way in increasing the quantity of their output. This is implying that any technology or skill or innovation that will reduce the planting/sowing cost by 0.143 will in turn increase quantity of yam produced by 4% in the study area.

Marital status: The coefficient of marital status was positive 0.098 and statistically significant at 10% level of probability, what this implies is that marital status as a variable has the effect of increasing output in the study area. In the study area majority of the household head with large household size were unmarried, widowed or divorced and all were regarded as unmarried. Large household size is a source of family or unpaid labour for most farm operations at the rural areas. More adults among the large household size mean more labour availability being channeled into yam production thereby resulting to an increase in quantity of yam produced.

5.3 Consumption determinants rural versus urban comparison

5.3.1 Cassava

Urban consumption: The variables fitted in the equation were able to explain 95% in variation in quantity of cassava consumed among the respondents in the study area. The statistical analysis revealed that age affects consumption of cassava in the urban areas, this agrees to a priori expectation because older people are discouraged from consuming root and tuber crops with the intention it could expose them or escalate their diabetes conditions due to misinformation. Since age has an inverse relationship to quantity of cassava consumed in the urban location of the study area, its significant is that as the age of the respondents increases, the quantity of cassava they consumed decreases and vice versa.

Also, annual income was also significant. The t-statistic of annual income is 2.740 and significant at 1% level of significance. With positive coefficient of 2.664, the implication is that as the annual income increases the quantity of cassava consumed also increases indicating that cassava is a normal good to the urban respondents. The t-statistics of cassava price is -3.984 with a positive coefficient implying that as the price of cassava increases, the quantity of cassava demanded also increases. This was not in agreement with our expectation because the basic law of demand states that as the price of good increases the demand for the good will decrease. The reason may be because even if the price of cassava increases it will still make cassava cheaper than its other substitute food crops in the study area.

Rural consumption: Out of the eight variables fitted in the yam consumption model for rural communities four were statistically significant at different levels of significance. The t-statistic of household size is 3.056 and significant at 1% level of significance, with a coefficient of 0.686 the implication of this is that as the number of people in the household increases, the quantity of cassava consumed also increases and vice versa. This agrees with the a priori expectation because increase in household size means making more people for cassava consumption. The t-statistic of annual income is 1.703 and is significant at 10% level of significance. The coefficient of annual income is 0.482 implying that any additional increase in annual income by a Naira will also increase the quantity of cassava consumed by 0.482kg in the study area.

5.3.2 Yam

Urban consumption: Apart from household size that has a positive relationship with quantity of yam consumed in the urban location the remaining two has an inverse relationship with the dependent variable. The t-statistic of age is -6.135 while its coefficient is -0.026 and is significant at 1% level of significance. The analysis shows that as the age of household heads in the urban location in the study area increases, the quantity of yam consumed decreases and vice versa. The coefficient of -0.026 implies that an additional year increase in the household of urban yam consumption will reduce the quantity of yam consumed by 0.026kg.

The t-statistic of household size is 2.675 with a positive coefficient of 0.112 which is significant at 1% level of significance. Since the coefficient is positive the implication is that as the number of people in the household increases, the quantity of yam consumed also increase and vice versa. With a coefficient of 0.112 the implication is that as the number of household size of urban yam consumption increases by one person, the quantity of yam consumed will increase by 0.112kg.

Cassava price being significant at 5% level of significance, with a t-statistic of -2.293 and coefficient of -0.001. Since the coefficient is negative mean that it has an inverse relationship with the quantity of yam consumed by urban population implying that any increase in cassava price will in turn also increase the price of yam as a close substitute and hence, reduce the quantity of yam consumed. With a coefficient of -0.001 the implication to urban yam consumption is that any increase in the price of cassava by a Naira will lead to a decrease in the consumption of yam by 0.001kg.

Rural consumption: Age, household size, annual income and price of cassava are the significant variables. All the significant variables have positive coefficients implying they have positive relationship with the quantity of yam consumed. The t-statistic of age is 6.656 with coefficient of 0.347 and significant at 1% level of significance. The result shows that as the age of the head of yam consuming household in the area increases, the quantity of yam consumed also increases. It also implies that any increase in age by one year will increase yam consumption by 0.347kg in the rural community. Household size has t-statistic of 2.074, coefficient of 0.198 and significant at 5% level of significance. Revealing that as the household size number increases, the quantity of yam consumed also increases, indicating that any one person addition or increase in the household will increase yam quantity consumed by 0.198kg. The t-statistic of annual income is 2.258 with a coefficient of 0.252 and significant at 5% level of significance.

The implication of the result is that as the annual income of the sampled respondents' increases, the quantity of yam they consume also increases and vice versa. The coefficient of 0.252 implies that a Naira increase in the annual income of an average respondent will lead to an increase in the quantity of yam they consume by 0.252kg. Price of cassava has a coefficient of 0.054 and significant at 10% level of significance. The result shows that as the price of cassava (the main staple crop in the locality) increases, all things being equal, and the quantity of yam (a close substitute for cassava) consumed by household in the area also increases. With the coefficient of 0.054 implying that a Naira increase in the price of cassava will lead to an increase in quantity of yam consumed by 0.054kg.

5.3.3 Wheat

Urban consumption: The statistical analysis revealed that among the eight independent variables fitted in the wheat urban consumption model, three was found to be statistically significant at different levels of significance. The significant variables are age, household size and wheat price. The t-statistic of household size is 1.823, with a coefficient of 0.157 and is significant at 10% level of significance. An indication that as the household size of the urban respondents' increases, the quantity of wheat consumed also increases. With the coefficient of 0.157, it implies that one person increase in the respondents' household will increase the average household wheat consumption by 0.157kg.

The t-statistic of Annual income is 1.871 with a coefficient of 0.198 and is significant at 10% level of significance. The result shows that as the annual income of the sampled respondents' increases, the quantity of wheat they consume also increases. The coefficient of 0.198 implies that any one Naira increase in annual income will have a resultant effect in quantity of wheat consumed by an increase of 0.198kg. Cassava price with t-statistic of 4.060, with a coefficient of 6.959 and is statistical significance at 1% level of significance. This implies that as the price of cassava increases, the quantity of wheat which could serve as a substitute for cassava also increases and vice versa. With a coefficient of 6.959 it implies that a Naira increase in price of cassava will result in an increase in quantity of wheat consumed by 6.959 kg.

Rural consumption: All the significant variables fitted in wheat rural consumption model have positive coefficients meaning that they have positive relationship with the dependent variable (quantity of wheat consumed). Age of household heads with t-statistic of 2.098, coefficient of 0.014 and significant at 5% level of significance. This implies that as the age of the respondents' increases, the quantity of wheat consumed in their respective households also increases. With a coefficient of 0.014 what it shows is that any additional age by one year in the age of household heads will increase wheat consumption by 0.014kg all things being equal.

The coefficient of household size is 0.093 and significant at 5% level of significance. Implying that household size has a positive relationship with the dependent variable quantity of wheat consumed, this agrees with a priori expectations because more household number means more people to feed which will result in an increase in consumption of their food. With a coefficient of 0.093 what it means is that any additional person in the household will increase the quantity of wheat consumed by 0.093kg.

Wheat price is with t-statistic of 1.587, which is significant at 10% level of significance. This shows that as wheat price increases in the rural community the quantity of wheat consumed also increases, this conforms with what was expected because it has been confirmed that residents are informed or advised to abandon locally produced staple crops which is mainly root and tuber crops in favour of wheat thereby exposing residents to a lot of harsh or unfavourable conditions in their effort to meet up with their consumption requirements.

6. Conclusions

A healthy and productive lifestyle of household can be achieved due to their ability to access quality food. Humans require food for life's sustenance, prevention of sickness and provision of energy for the normal functions of the body. Recently, many clinical and experimental researches have suggested that diet plays a crucial role in the pathogenesis of many chronic diseases such as cardiovascular diseases, hypertension, obesity, cancer and diabetes. In the past, the burden of non-communicable diseases was regarded as a problem of developed countries, recently evidence has shown that the menace is now affecting developing countries more. This study analyzed the socioeconomic characteristics influencing root and tuber crops in favour of imported carbohydrate substitute wheat. It was identified that age, annual income, price of cassava and household size affects the consumptions of RTC in the study area. An earlier study confirmed that processed root and tuber crops are rich in fibre (Onodu, Culas, & Nwose, 2017).

Fibre is readily available in Nigerian local staple food sources yet it is not routinely included in the diet prescription for diabetes. Many diabetic patients in Nigeria are misinformed about the consumption of carbohydrate foods and how it is associated with hyperglycemia, resulting in total avoidance or reduction in their carbohydrate intake. The government should control the importation of wheat into the country while encouraging the increase in consumption of local high-fibre low fat carbohydrates foods among the people living with diabetes and also control the escalation of fast food eateries that are exposing people to the consumption of high energy density and high fat meals.

Increasing the production of RTC in the study area will go a long way in alleviating the problem of food security. Making available to the farmers any modern technology that will reduce the cost incurred by producers during planting and sowing of their products will hence increase their production. In the case of Yam, since Yam has been confirmed to be male/men dominated crop, encouraging more male/men to go into its production will assist in increasing its output in the study area. Teaching the farmers the appropriate technique in fertilizer application, subsidizing its price and making it available at all time for the farmers will assist in boosting their output in RTC. Lastly, government should provide extension service programs for the farmers, these are the people that will carry new innovations from research institutes to the farmers by increasing their technical knowhow as way of agronomic practices to the production of RTC and increasing the farm output.

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Appendix

1. The multiple regression model for RTC production is as follows;

Y = f(X1, X2, X3, X4, X5, …, X14, e) ……………………… (1)

Where,

X1 = Age of respondents (Yrs)

X2 = Gender (male 1, female 0)

X3 = Mariral status (married 1, single 0)

X4 = Household size (No)

X5 = Level of education (Yrs)

X6 = Farming experience (Yrs)

X7 = Farm size (Ha)

X8 = Quantity of planting materials (Kg)

X9 = Price of planting materials (₦)

X10 = Land preparation (₦)

X11 = Planting cost (₦)

X12 = Weeding cost (₦)

X13 = Fertilizer application cost (₦)

X14 = Harvesting cost (₦)

e = Error term

The fuctional forms are expressed explicitly as;

Linear:

Y = b0 + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + …, …+ b14X14 + e

Double log:

Log Y = Log b0+ b1LogX1 + b2LogX2 + b3LogX3 + b4LogX4 + …, + b14LogX14 + e

Semi-log:

Y = Logb0 + b1LogX1 +b2LogX2 + b3LogX3 + b4LogX4 + b5LogX5 + …+ b14LogX14 + e

Exponential:

LogY = b0 + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + ...,…. + b14X14 + e

Where,

b0 = constant

b1 – b14 are estimated coefficients

X1 – X14 are as defined in equation (1)

2. Implicitly, the multiple regresson model for consumption is as follows;

Y = f(X1, X2, X3, X4, X5, X6, X7, X8, e)……………………(2)

Where,

$X1$ = Age of respondents (Yrs)

$X2$ = Level of education (Yrs)

$X3$ = Household size (No)

$X4$ = Health value (health value 1, otherwise 0)

$X5$ = Annual income (₦)

$X6$ = Cassava price (₦)

$X7$ = Yam price (₦)

$X8$ = Wheat price (₦)

e = error term

The fuctional forms are expressed explicitly as;

Linear:

$$Y = b0 + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + b7X7 + b8X8 + e$$

Double log:

$$Log\ Y = Log\ b0+ b1LogX1 + b2LogX2 + b3LogX3 + b4LogX4 + \ldots\ldots\ldots\ldots.. + b8LogX8 + e$$

Semi-log:

$$Y = Logb0 + b1LogX1 +b2LogX2 + b3LogX3 + b4LogX4 + b5LogX5 + \ldots\ldots\ldots. + b8LogX8 + e$$

Exponential:

$$LogY = b0 + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + b6X6 + b7X7 + b8X8 + e$$

Where,

b0 = constant

b1 – b8 estimated coefficients

X1 – X8 are as defined in equation (2)