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DEMAND TREND FOR GENETICALLY MODIFIED VITAMIN A CASSAVA PRODUCTS IN SOUTH-WESTERN NIGERIA

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Abstract

There is an increasing concern about the prevailing impact of micronutrient deficiencies, which pose serious public health issues, particularly in the world's developing nations. Given the importance of staple foods in the diets of these nations, genetically modified food becomes imperative for reducing the burden of micronutrient deficiencies. The study utilized primary data collected through a household survey in six communities of two Local Government Areas (LGA) within Oyo state. The sampling involved a multi-stage sampling process to investigate the consumption patterns of genetically modified vitamin A cassava products in South-Western Nigeria. The study's conclusions showed that households eat garri (85.8%), lafun (59.2%), and fufu (30.8%) as cassava products. However, non- genetically modified vitamin A cassava

Introduction

Aerobic exercise is physical exercise intended to strengthen the heart and lungs (Oxford Advanced Learners Dictionary 2004: 18). Aerobic exercise is widely used for evaluating maximal or peak aerobic power in children and young adults; they form he important component of physical fitness tests for adolescents and young adult. (Emmanuel, 2009). Satcher (2000) reported that aerobic exercise is a sure route to physical fitness and a significant contributor to good health status. According to Corbin, Paugrazi & Franke (2002), regular exercise that is performed in most days of the week reduces the risk of

Products (62.5%) are consumed at a higher rate than genetically modified vitamin A cassava products (37.5%). The costs of both genetically modified vitamin A cassava products and non-genetically modified vitamin A cassava products, as well as household education level and income, were found to be major determinants of demand for the three cassava products, according to the results of the LA-AIDS model. The genetically modified garri, lafun, and fufu's expenditure elasticity indicated they are both common and upscale foods. The demand for these products was shown to be price elastic based on their own-price elasticity, however their cross-price elasticity in comparison to non-bio-fortified cassava products suggested that the genetically modified vitamin A cassava goods were replacements. It was recommended that governments put plans in place to increase demand from consumers for genetically modified vitamin A cassava products, as doing so will enhance food and nutrition security and open up prospects for earning revenue.

Keywords: Genetically Modified Food, Cassava Foods, Demand Trends, Elasticity, Vitamin A

Introduction

Micronutrient deficiencies are a major public health hazard that are becoming more and more of a worry, especially in the world's poorer countries. According to Lasisi, (2022a), these deficits are linked to a diet high in staple foods that are low in the vitamins and minerals needed for optimal bodily function. Genetically modified food becomes essential for lessening the burden of micronutrient deficiencies since staple foods play such a significant role in the diets of these countries. Prior research conducted in Nigeria has shown that deficits in some micronutrients in particularly those related to iron, zinc, and vitamin A, are widespread serious health issues that require prompt attention (Lundahl and Ndulu, 2022; Lasisi, 2022b).

The consumption of bio-fortified vitamin A staple foods, specifically cassava products, is the main focus of the current study. According to FAO et al. (2019), Nigeria is the world's top producer of cassava, which is also the

nation's second most popular staple food. Therefore, cassava is a good food option that can be bio-fortified throughout the nation to provide vitamin A. The bio-fortification of cassava and maize with vitamin A in Nigeria was given priority by HarvestPlus, an international program that aims to improve the micronutrient components of major staple foods (Abubakar *et al.*, 2017). Three quarters of all harvested bio-fortified roots were reportedly planted as part of the initiative in 2015 (Lundahl and Ndulu, 2022). Regretfully, local markets only sold 10% of the anticipated production from bio-fortified vitamin A cassava roots (Afolami *et al.*, 2020), indicating that bio-fortified foods constitute a relatively small portion of Nigerians' total food intake (Abubakar *et al.*, 2017). It is hard to raise consumer demand and, consequently, supply for these products because of the limited market presence and patronage.

Objective of the Study

Therefore, the purpose of this study was to investigate how South-West Nigerians consume bio-fortified vitamin A cassava products. The consumption pattern can be utilized to predict the prospective market demand for cassava that has been bio-fortified, which can support local economies and open up new business prospects. The spillover effect also includes the potential to increase food and nutrition security (Baker *et al.*, 2022).

Justification

A significant component of agriculture and food markets is consumer demand, which arises from the interaction of social, economic, and environmental elements (Lasisi, 2022b; Ikuemonisan *et al.*, 2020). Due to the complexity of food and its role in satisfying more than just basic human, cultural, and social requirements, food choices made by producers and consumers are diverse and impacted by a wide range of factors (Afolami *et al.*, 2020). Consumer acceptance or adoption of bio-fortified foods, for example, varies based on socioeconomic demographic factors (FAO *et al.*, 2020), sensory evaluation (Reyes *et al.*, 2021), expert information, nutrition knowledge, and benefit consciousness (Afolami *et al.*, 2020).

An essential element of supply and demand is also pricing, including the cost of alternatives. A varied diet is becoming more and more expensive due to the rising costs of non-staple foods (Jogo *et al.*, 2021), while bio-fortified crops are being pushed as an affordable substitute for traditional nutrition strategies (Afolami *et al.*, 2021). Nevertheless, data indicates that buyers are prepared to spend an additional 60–70% for bio-fortified cassava (Lasisi, 2022b). Price affects food security (FAO *et al.*, 2020) and is a crucial factor in consumers' acceptability and adoption (Baker *et al.*, 2022). The increase in the consumption of foods fortified with bio-fortification shouldn't be limited to meeting demand. Policy and demand are impacted by supply, which is crucial (Lundahl and Ndulu, 2022).

The success of commercialisation is determined by a number of elements, including supply, which is known to be complex (Baker *et al.*, 2022). To increase the production of bio-fortification, a deeper comprehension of the factors influencing farmer acceptance is essential. Many factors, including the premium price (Pereira and Oliveira, 2020), price fluctuations and marketing costs (Jogo *et al.*, 2021), farm size (e.g., the average yield of vitamin A cassava varieties is higher than conventional) (Pereira and Oliveira, 2020) and other factors, limit farmers' willingness to adopt bio-fortified crops. Additionally, it is anticipated that attributes associated with farmers—like literacy (Kenny, 2019), knowledge, and attitudes toward technology (Olum *et al.*, 2020)—will impact uptake -, consequently, supply (FAO, 2022). Numerous obstacles challenge small-scale farmers in developing nations, including a lack of proper infrastructure (Onyeneke *et al.*, 2020) and a lack of market awareness (Alarcon *et al.*, 2021; Oteh *et al.*, 2020), which restricts productivity and investment (Oteh *et al.*, 2020; FAO, 2022). Resolving the latter would facilitate improved bio-fortified market access and production stimulation (Lundahl and Ndulu, 2022).

Moreover, it is frequently hypothesized that there are knowledge gaps, inadequate information sharing, and inadequate policies to promote the production and use of bio-fortified foods (Waterlander *et al.*, 2020). Numerous research studies have examined the creation of attitudes and intentional behavior in the context of consumer and farmer research. These studies mostly looked at how various consumer and farmer factors affected the

supply or demand for bio-fortified cassava among consumers. Consumer adoption (Okwuonu *et al.*, 2021), consumption (Afolami *et al.*, 2021), willingness-to-pay (Okwuonu *et al.*, 2021), or preference (Kolapo *et al.*, 2020; Alarcon *et al.*, 2021) are some examples of the measures of consumer demand at the consumer level. Research has focused on the adoption of bio-fortified cassava at the farmer level (HarvestPlus, 202), with particular attention to its productivity difficulties and economic benefits (Okwuonu *et al.*, 2021), Kolapo and colleagues, 2021), or limitations based on gender (Afolami *et al.*, 2021). Although there isn't a "one size fits all" solution for increasing farmer supply and consumer demand, none of these research have looked at supply and demand factors at the same time. As a result, the study's analysis will concentrate on highlighting the supply and demand variables that affect the bio-fortified cassava economic system.

Theoretical Review

The food system's approach, which outlines the many components of our food systems and the trade-offs between them, served as the foundation for our study's theoretical framework (Lasisi, 2022b). For a few reasons, we think this is appropriate for our investigation. First, it depicts the intricate interplay of variables and trade-offs that were centered on the supply and demand for food, or what the economic system refers to as market dynamics. Because they control food pricing as well as production and consumption, supply and demand are fundamental to food systems. Food demand advances food production, value addition, and food security, strengthening ties within the food systems to suit consumer need (Lundahl and Ndulu, 2022).

According to Okwuonu *et al.*, (2021), the food system approach provides direction for controlling the variability of the food supply. In general, a complex web of forces, markets, and systems combine to produce food and agriculture (Okwuonu *et al.*, 2021). Second, improving the food security aspect of the SDGs requires a strong foundation in the food system's approach. Thus, changes in the food system may have an effect on diets and food production (FAO, 2022), which may have an effect on food security (WHO, 2021).

In light of the framework, we propose that a system-based approach—which offers insights into the production of food, what shapes consumer demand, and how to scale up supply—is essential to connecting the dots between the availability of food, food demand, and attaining adequate nutrition (Kolapo *et al.*, 2021). Since demand and supply interact to create a financial system that benefits the market and customers alike, this study assume it is essential to comprehend the variables that cause shifts in the deeper levels of supply and demand (Foley *et al.*, 2021). Market forces are most effective because of their implications for the agricultural market and prices.

This method makes it possible to see trade-offs and correlations between the variables that affect producer supply and consumer demand, especially the price intervening component, which points to the possibility of a structural equation model. Food systems and their effects on food security are reflected in price fluctuations, which are a crucial endogenous element in food choice that influences both the production and consumption of food (FAO, 2022)

This study assumes Two-Stage Least Square (2SLS) constitutes the optimum structural equation estimation for accurately estimating supply and demand (Lasisi, 2022a). This approach is required to account for missing variables and resolve the endogeneity issue brought on by simultaneity and measurement mistakes. Thus, our hypothesis is that the bio-fortified cassava market system in Nigeria is not impacted by price. We think that as additional elements come together, producers and consumers may be more willing to supply and demand bio-fortified cassava.

Methodology

The study was carried out in the southwest Nigerian state of Oyo. The state is located between latitudes 7° and 8° N and longitudes 3° and 5° E. The National Population Commission (2006) reported that 5,580,894 people lived in the state. Primary data from household surveys conducted in six (6) garri processing centers located in five (5) local government areas (LGAs) in the state—Ibarapa East (New Eruwa and Aderomu Village); Iseyin (Otiri Farm); Egbeda LGA (Kulodi); Onireke LGA (Dugbe Market); and Oyo North (Mokola Market)—were used in the study. Twenty (20) households that consume cassava products were chosen at random from each of the villages that were chosen.

The chosen homes were profiled based on their socioeconomic attributes using descriptive data. By estimating the percentage of household income allotted to the consumption of bio-fortified cassava products relative to total household expenditures, the Linear Approximate Almost Ideal Demand System (LA-AIDS) model was utilized to ascertain the consumption behavior of the selected households for bio-fortified cassava products (Okwuonu *et al.*, 2021).

The LA-AIDS model was used to calculate expenditure elasticity, own-price elasticity, and cross-price elasticity—three types of Marshallian uncompensated elasticity—in order to forecast the kind of demand for bio-fortified cassava products (Okwuonu *et al.*, 2021). The LAAIDS model can be expressed using the demand system created by Deaton and Muellbauer (1980) as follows:

$$\omega_i = \alpha_i + \sum^{n}_{j=1} \gamma_{ij} + \ln \rho_i + \beta_i \ \ln\left(\frac{X}{\rho}\right) + \lambda_{ij} z_j + \varepsilon 1$$

.....Equation (1)

where n is the number of cassava products and ωi is the budget share of the ith food item.

pi is the cost of that particular food item.

p is the price index, and X is the total amount spent on food items in the system.

The chosen socioeconomic characteristics of the households are represented by zj.

To be estimated are the parameters ai, γij, λij, and βi.

The disturbance term is εi.

The Marshallian uncompensated measures of expenditure, own-price, and cross-price elasticity (Foley *et al.*, 2021) can be derived using the parameter estimations of the LA-AIDS model as follows:

$$\delta_i = 1 + \left(\frac{\beta_i}{\omega_i}\right) \varepsilon_{ii} = -1 + \left(\frac{\gamma_{ii}}{\omega_i}\right) - \beta_i \ \varepsilon_{ij} = \left(\frac{\gamma_{ii}}{\omega_i}\right) - \beta_i \left(\frac{\omega_j}{\omega_i}\right)$$

.....Equation (2)

where δi, ii, and ij stand for the own-price, cross-price, and Marshallian expenditure elasticity, respectively.

Result and Discussion

Respondents' socioeconomic characteristics

The socioeconomic details of the households in the sample are shown in Table 1. With an average age of 42, men make up the bulk (63.3%) of household heads. This result is consistent with the 2003 Demographic and Health Survey study, which found that men lead the majority of Nigerian families (83%). The majority of households (56.7%) had fewer than five individuals, with an average size of four.

When it comes to education, the highest level obtained by 74.1% of household heads is secondary and tertiary education combined. Farming accounts for the most prevalent primary occupation (37.5%) among the families. Prior research has demonstrated that agriculture serves as a major source of food and income, especially for Nigerian rural households (Foley *et al.*, 2021). The average monthly income of the households is approximately ₦30,000, suggesting that the average household in the research area is not well off.

Usage patterns of cassava products in homes

The consumption patterns of households for cassava products are displayed in Table 2. Most of the households (60%) reported that their main source of carbohydrates was cassava. This data validates the claim made by FAO et al. (2019) that cassava ranks as Nigeria's second most popular staple food. Households consume a percentage of 85.8, 59.2, and 30.8% of cassava products as fufu, flour (lafun), and flake (garri), respectively. Products made from non-bio-fortified vitamin A cassava are consumed at a higher rate (62.5%) than those made from bio-fortified vitamin A cassava (37.5%).

Table 1: Socioeconomic Characteristics of Respondents

		Frequency	Percent	Mean
Age of household head	≤30	18	15.0	42
	31 – 40	39	32.5	
	41 – 50	41	34.2	
	51 – 60	18	15.0	

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	>60	4	3.3	
	Total	**120**	**100**	
Gender of household head	Male	76	63.3	
	Female	44	36.7	
	Total	**120**	**100**	
Household size	≤5	68	56.7	4
	6 – 10	35	29.2	
	>10	17	14.2	
	Total	**120**	**100**	
Educational attainment	No formal education	3	2.5	
	Primary education	28	23.3	
	Secondary education	55	45.8	
	Tertiary education	44	28.3	
	Total	**120**	**100**	
Primary occupation	Farming	45	37.5	
	Salaried employment	32	26.7	
	Trading	22	18.3	
	Artisans	19	15.8	
	Pensioners	2	1.7	
	Total	**120**	**100**	
Household monthly income (₦)	<10000	3	2.5	30,042
	10000 – 19999	21	17.5	
	20000 – 29999	37	30.8	
	30000 – 39999	42	35.0	
	40000 – 49999	11	9.2	
	≥50000	6	5.0	
	Total	**120**	**100**	

Source: Data Analysis, 2023

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Table 2: Household cassava products consumption practices

	Frequency	Percent
Cassava as major source of carbohydrate		
Yes	72	60.0
No	48	40.0
Forms of consumption		
Cassava flakes (garri)	103	85.8
Cassava flour (lafun)	71	59.2
Fufu	37	37.0
Type of cassava consumed		
Bio-fortified vitamin A	45	37.5
Non-bio-fortified vitaminA	75	62.5
Totals	**120**	**100**

Source: Data Analysis, 2023

Factors affecting the market for products made from bio-fortified vitamin A cassava

Estimates for the LA-AIDS analysis of the variables influencing the market for products containing bio-fortified vitamin A cassava are shown in Table 3. The dependent variables, which are the expenditure shares on bio-fortified vitamin A garri, bio-fortified vitamin A lafun, and bio-fortified vitamin A fufu, are represented by the expenditure share of the bio-fortified vitamin A cassava products. Natural logarithms of the prices of different cassava products, such as bio-fortified vitamin A garri, bio-fortified vitamin A lafun, bio-fortified vitamin A fufu, and non-bio-fortified vitamin A garri, non-bio-fortified vitamin A lafun, and non-bio-fortified vitamin A fufu, were included in the explanatory variables. The household's socioeconomic characteristics were also included as explanatory variables.

The variation in the expenditure share on bio-fortified vitamin A lafun, garri, and fufu was shown by the value of the coefficients of determination, or R2, which ranged from 0.5162 to 0.3664. The outcome shows that the prices of both bio-fortified and non-bio-fortified vitamin A products, as well as the age, gender, education, and income of the household head, are significant

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factors influencing the demand (expenditure share) for bio-fortified cassava products. The cost portion of the bio-fortified cassava products is negatively impacted by the individual product prices.

The demand for bio-fortified cassava products is positively impacted by the prices of non-bio-fortified cassava products. This could be the case since the items are equivalents; so, if the cost of the non-bio-fortified cassava products rises in comparison to the cost of the bio-fortified cassava products, the household's expenditure share on the bio-fortified vitamin A cassava products could also rise. The data also showed a positive correlation between household income and the percentage of money spent by households on the three bio-fortified cassava products. This implies that households' expenditure share on bio-fortified cassava products may rise in tandem with household income.

The expenditure share of households on the three bio-fortified cassava products is positively influenced by the educational attainment of the household head as well. This suggests that if the household head is more educated or has completed higher education, then the expenditure share of households on the bio-fortified products may be higher. Lasisi, (2022a) assert that education is necessary for the acceptance of ideas and the availability of information that will facilitate adoption. Because of this, educated household heads are more likely than their uneducated counterparts to be aware of the nutritional value of the bio-fortified vitamin A cassava products, which could encourage them to spend more money on the bio-fortified goods. This outcome is consistent with Onyeneke *et al.*, (2020) findings, which show that a household head's increased educational attainment increases the likelihood that they will be able to afford bio-fortified vitamin A garri.

Table 3: Estimates of the LA-AIDS analysis of demand for vitamin A bio-fortified cassava products

	E_BVAG	E_BVAL	E_BVAF
Constant	–2.302	5.057	1.411
LnPBG	–0.693**	0.326	0.074
LnPBL	–0.051	–0.175**	0.372

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LnPBF	–0.164	–0.047	–0.231
LnPNG	0.429*	0.236	0.291
LnPNL	0.378	0.077***	0.175
LnPNF	0.094	0.113	0.153**
Age	–0.103***	0.064***	0.078**
Gender	0.062	0.228**	0.435*
Household size	–0.022	0.041	0.083
Education	0.277***	0.136**	0.184**
Income	0.185**	0.181***	0.122***
R2	0.4218	0.5162	0.3664

Source: Data Analysis, 2023

Remarkably, the significant level at 10%, 5%, and 1% are indicated by the symbols *, **, and ***. The expenditure share for bio-fortified vitamin A garri, bio-fortified vitamin A lafun, and bio-fortified vitamin Afufu is represented by the variables E_BVAG, E_BVAL, and E_BVAF, respectively. The costs of bio-fortified vitamin A garri, bio-fortified vitamin A lafun, and bio-fortified vitamin A fufu are represented by the natural logarithms LnPBG, LnPBL, and LnPBF, respectively. The natural logarithms of the pricing for non-bio-fortified vitamin A garri, non-bio-fortified vitamin A lafun, and non-bio-fortified vitamin A fufu are represented by the symbols LnPNG, LnPNL, and LnPNF, respectively.

Table 4: Own-price elasticity and Marshallian spending for goods containing bio-fortified vitamin A cassava

	Expenditure elasticity	Own-price elasticity
Bio-fortified vitamin A garri	1.42	–1.12
Bio-fortified vitamin A lafun	1.12	–2.21
Bio-fortified vitamin A fufu	1.05	–1.98

Source: Data Analysis, 2023

The Marshallian cross-price elasticity between vitamin A-fortified and non-bio-fortified cassava products is displayed in Table 5. The findings demonstrate that the majority of the elasticity values are positive, suggesting that these are replacement items. The few negative numbers show that the products are complementary to one another. Non-bio-fortified vitamin A garri, for

example, can be used in place of bio-fortified vitamin A garri and fufu, but it can also be used as a complementary food item with bio-fortified vitamin A lafun (Lasisi, 2022a). Similarly, nonbio-fortified vitamin A lafun and fufu are complementary food items to bio-fortified vitamin A garri but can be substituted for bio-fortified vitamin A lafun and fufu.

Table 5: Cross-price elasticity of Marshallians for vitamin A cassava products, both bio-fortified and non-bio-fortified

	Bioft vit.A garri	Bioft vit.A lafun	Bioft vit.A fufu
Non-bio-fortified vitamin A garri	1.28	−1.71	0.93
Non-bio-fortified vitamin A lafun	−0.88	1.35	1.21
Non-bio-fortified vitamin A fufu	−1.04	1.17	1.44

Source: Data Analysis, 2023

Elasticity for Cassava Products Bio-fortified with Vitamin A

The values for the own-price elasticity and Marshallian spending for bio-fortified vitamin A cassava products are displayed in Table 4. The outcome demonstrates that bio-fortified garri, lafun, and fufu have positive expenditure elasticity that is more than one, showing that they are both typical and upscale foods. The demand for the three most popular bio-fortified cassava products is price elastic since their individual price elasticity is negative and greater than one. The bio-fortified goods compared to their illiterate peers. This outcome is consistent with Lasisi, (2022a) findings, which show that a household head's increased educational attainment increases the likelihood that they will be able to afford bio-fortified vitamin A garri.

Conclusion

The study offers specific indicators that can be used to create frameworks for policy that will increase nutrition security and boost the economy. According

to the study's findings, there is less of a market for vitamin A cassava products that have been bio-fortified than there is for those that have not.

Recommendation

It is advised that going forward, policymakers put plans into place to increase demand for the bio-fortified cassava product, as this will enhance the security of food and nutrition while also generating prospects for income.

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