



## Economic Analysis of Pro-Vitamin A Cassava Variety: Atipof Health benefits Among Consumers

<sup>1</sup>Udemezue, J.C.\*, <sup>2</sup>Ekwuye, B.M. & <sup>3</sup>Nweke, J.O.

<sup>1</sup>National Root Crops Research Institute Umudike, PMB, 7006 Umuahia Abia State, Nigeria.

<sup>2</sup>Department of Finance and Operations Unit, Christian Aid United Kingdom/DRC 034 Bougainvillea, Goma, Nord Kivu Democratic Republic of Congo.

<sup>3</sup>Diagnostic Laboratory Unit, Medical Centre, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

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\*Corresponding author: **Udemezue, J.C.**

National Root Crops Research Institute Umudike, PMB, 7006 Umuahia Abia State, Nigeria.

### Abstract

*Hunger and malnutrition have not been able to be successfully addressed for a number of years in Africa, and these led to poor diet, which is the foremost among the causes of micronutrient deficiencies in the continent. Vitamin A deficiency is an important micronutrient deficiency prevailing in Asia and Sub-Saharan Africa; this imposed threats to children and pregnant women in the continents as well. As a result of this, efforts have been made to develop and distribute vitamin-A-enriched cassava varieties across continents through a process known as biofortification. Biofortification is an innovative process of enhancing the micronutrient composition of food crops to caution against the effects of micronutrient deficiencies. Bio-fortified cassava is, therefore, not just a food crop but as a major source of health benefits and cash income for producers in comparison with other staple crops. It contributes positively to poverty alleviation by generating income for the vast number of households. Industrial applications for cassava include the production of starch, high-quality cassava flour, ethanol, cassava chips, and dried pellets. Cassava leaves are nutritious vegetables and can be used as animal feed. Pro-vitamin A cassava varieties have a high potential to reduce poverty and malnutrition among the smallholder farm households in Nigeria. In light of the above, this paper used available literature to look into the following: analysis of pro-vitamin A cassava enterprise: implications to health benefits, diffusion and consumption update of pro-vitamin A cassava varieties released in Nigeria, and challenges of delivering pro-vitamin A cassava to the end users.*

**Keywords:** *Cassava, bio-fortification, health implications, income generation, customers' preference.*

### Introduction

Cassava is an essential root crop that is widely grown by both male and female farmers in Nigeria (Effiong, Effiong, and Udo, 2015). It is a resistant crop that is able to withstand disease, drought, and pests. Nigeria is currently the largest producer of cassava in the world, with an annual output of over 63 million tons of tuberous roots (FAO, 2020; Udemezue *et al.*, 2024). According to Onyeneke *et al.* (2020), the majority of rural women of childbearing age and children whose diets are mostly of cassava and cassava by-products are possibly at the risk of vitamin-A deficiency. This has led to the efforts being made to develop and distribute vitamin-A-enriched cassava varieties across Nigeria through a process known as biofortification (De Moura *et al.*, 2015; Onyeneke *et al.*, 2020). Biofortification is an innovative process of enhancing the micronutrient composition of food crops (Olatade *et al.*, 2016; Saltzman *et al.*, 2016). Nigeria is currently facing a significant issue of vitamin A deficiency (VAD). According to studies by Aghaji *et al.* (2019) and Ayinde&Adewumi (2016), it has been reported that over 20% of pregnant women and children under five years old in Nigeria are lacking vitamin A. According to findings, Nigeria has a high occurrence of vision impairments, such as night blindness and xerophthalmia, which are linked to vitamin A deficiency (Ayinde&Adewumi, 2016; Aghaji *et al.*, 2019).

Provitamin-A-enriched biofortified cassava varieties were introduced in Nigeria in two waves. The first wave in 2011 had a 50% provitamin-A target level, while the second wave in 2014 increased to a 70% provitamin-A target level (Oparinde et al., 2016). Presently, several varieties of biofortified vitamin-A cassava varieties are in existence in Nigeria today. These include UMUCASS (36, 37, 38, 42, and 43 varieties), NR 0220, TMS 1371, TMS 0593, and TMS 0539 (Ayinde, 2016; Eyinlaet al., 2019). Biofortification can reduce the prevalence of vitamin A deficiency, thereby providing an essential role of nutrients in the diets of rural households (Oparinde et al., 2016; Garg et al., 2018; Onyenekeet al., 2020).

Cassava is not just a food crop but a major source of cash income for producers; in comparison with other staple crops, it contributes positively to poverty alleviation by generating income for a vast number of households (Aroke, 2014). Vitamin A is an essential nutrient lacking in the diets of poor, malnourished populations. Its deficiency retards growth, increases risk of disease, and can cause reproductive disorders, but providing cassava production with Pro-Vitamin A (biofortification) could significantly improve nutrition and overall health, specifically among poor communities (Effiong, Effiong, and Udo, 2015). By implementing biofortification, the prevalence of vitamin A deficiency can be reduced, seeing the vital roles of cassava in the diets of rural households in Nigeria (Oparinde et al., 2016; Garg et al., 2018). Therefore, it is crucial to invest in pro-vitamin A cassava farming in order to ward off vitamin A deficiency in our communities. In light of this, the paper used an analytical method to review the economic analysis of pro-vitamin a cassava variety: the tips of health benefits among consumers.

### **Analysis of Pro-Vitamin A Cassava Enterprise: Implications to Health Benefits**

Globally, hunger and undernutrition have not been able to successfully address for decades (Food and Agriculture Organization, 2018), and this led to poor diet, which is the foremost among the causes of micronutrient deficiencies. The majority of people in the developing world consume an insufficient amount of the fruits, vegetables, and animal products that provide the micronutrients essential for good health. They don't have access to adequate quantities of nutritious and balanced diets required for optimum growth and development, and this remains a major impediment to their health and well-being (Govender, Pillay, Siwela, Modi, & Mabhaudhi, 2017).

Vitamin A deficiency is an important micronutrient deficiency prevailing in Asia and Sub-Saharan Africa, and this imposed threats to children and pregnant women in the continent (Udemezue et al., 2021). In the Democratic Republic of Congo (DRC) and Nigeria, their malnutrition and infant mortality are among the highest in the world. According to a national survey carried out in 2003, the prevalence of vitamin A deficiency among children under five was about 60%, of which provitamin A cassava has the potential for providing substantially increased amounts of vitamin A diets with beta-carotene concentrations between  $<1 \mu\text{g}$  and more than  $15 \mu\text{g}$ . Cassava with high beta-carotene can be visibly distinguished from normal cassava by its yellowish color.

Global demand for cassava products such as flour, starch, ethanol, chips, and pellets run into billions of dollars in transaction value, with China leading the demand pack at 60% of total imports (Business a.m., 2019). Other cassava import destinations could be found in North America, Europe, and so on. The local demand value for cassava is forecast to hit over \$8 billion in 2022, while the global value for exports was put at \$51 billion as of 2013 (Business a.m., 2019). Cassava has both traditional and industrial applications; traditionally, it is consumed as food in the form of fufu or processed into garri for consumption. The industrial application for cassava includes the production of starch, high-quality cassava flour, ethanol, cassava chips, and dried pellets. Cassava leaves are nutritious vegetables and can be used as animal feed. The stem can be sold as seed material. We also have a large importation of processed starch, which is sold by various supermarkets, and other cassava derivatives into Nigeria. These are the opportunities for local investments. Therefore, the cassava production sector provided the basis for the agro-industrial development and contributed significantly to the commercialization, monetization, and integration of the rural sector (Kuye, 2015; Oruonye, Ahmed, and Joseph, 2021).

Pro-vitamin A cassava varieties have a high potential to reduce poverty and malnutrition among the smallholder farm households in Nigeria. Bio-fortification, a process whereby certain crops are bred/fortified with essential micronutrients, is increasingly becoming common in addressing the menace of hidden hunger (Bouis, Saltzman, Low, Ball & Covic, 2017; Olayinka et al., 2020). Cassava is one of the crops targeted for biofortification because it is consumed daily by millions of poor households who rely on it for their daily energy needs. Pro-vitamin A cassava variety holds promise for improving the nutritional status and health of poor populations in Nigeria (Odoemelam & Anyim, 2019). The crop has zero tolerance for hunger and poverty in the newly enunciated Sustainable Development Goals (SDGs). Therefore, popularization and adoption of the pro-vitamin A cassava variety is very essential to effectively combat hidden hunger and poverty among the rural populace. It is also essential to attaining the SDGs in the major areas of achieving food security and improved nutrition (Olayinka et al., 2020).

Addressing the problem of hidden hunger through provision, dissemination, and popularization of bio-fortified varieties of provitamin A cassava will go a long way to enhance the socioeconomic well-being of the peasant farmers; this is more so given the popular belief that when hunger is addressed in a poverty situation, poverty is deemed overcome. So, with Nigeria presently as the world's largest producer of cassava, with production estimated at 64 million metric tons (Sen Nag, 2017), combined with the multifarious uses of cassava in Nigeria, the crop, no doubt, has a special capacity to bridge the gap in food insecurity and poverty alleviation among Nigeria's farmers (Akaa, Amonjenu&Akaa, 2016; Olayinka *et al.*, 2020).

Provitamin A can repair the immune system and vision that could cause blindness. Cassava is a staple food crop with worldwide distribution and serves as a fundamental energy source and food security for about 80 million people worldwide. Because of the significant contribution of cassava to food security and economic development of the country, the Federal Government of Nigeria embarked upon a number of programs to boost its production (Effong, Effongu, and Udo, 2015). These include cassava multiplication programs, root and tuber expansion programs, and pro-vitamin A cassava production technologies, amongst others. Considering the importance of cassava as a traditional staple food in Nigeria, its productivity can be increased and sustained through efficient utilization of existing resources.

### **Diffusion and Consumption Update of Pro-vitamin A Cassava Varieties released in Nigeria**

In 2016, Harvest Plus and its partners (scientists of IITA and NRCRI) successfully developed and distributed pro-vitamin vitamin A cassava varieties to more than one million farming households in Nigeria and the Democratic Republic of Congo (DRC) (Ilona *et al.*, 2017). The organization (Harvest Plus) was of the view that vitamin A cassava varieties can be developed without compromising yield qualities, and the varieties will be widely accepted. At the end of the delivery program, it has shown that farmers are willing to grow vitamin A cassava varieties, and consumers are also willing to buy and eat vitamin A cassava products (Ilona *et al.*, 2017). This proves that an innovation cannot be complete until it gets to the final stage of adoption. This new set of pro-vitamin A cassava varieties has increased beta-carotene levels as well as matching agronomic characteristics as an incentive for better farmers' adoption.

Bio-fortified cassava is a component of enough vitamin A that improves nutritional status and reduces vitamin A deficiency. Consuming vitamin A cassava increases children's vitamin A intake and status. According to Godwin Atser (2014), IITA and the National Root Crops Research Institute (NRCRI) in Umudike have developed three newly improved vitamin A cassava varieties with yellow roots, and the efforts were to tackle the problem of vitamin A deficiency, especially among women and children in the country. The three varieties are UMUCASS 44, UMUCASS 45, and UMUCASS 46. The second in the series of provitamin A varieties released in the country are NR07/0220, IITA-TMS-IBA070593, and IITA-TMS-IBA070539. The new varieties have a pro-vitamin A content that contains 10 parts per million (ppm) based on fresh roots when compared to the first series (UMUCASS 36, UMUCASS 37, and UMUCASS 38, commonly known as IITA-TMS-IBA011368, IITA-TMS-IBA1371, and IITA-TMS-IBA011412) that were released three years ago with a pro-vitamin A content of between 6 and 8 ppm (Godwin Atser, 2014). Vitamin A deficiency causes stunting in children, predisposes them to sicknesses such as diarrhea and measles, and even premature death. In pregnant women, vitamin A deficiency results in night blindness and increases the risk of mortality.

Before the release, participatory varietal trials involving farmers were carried out across ten states in Nigeria, and this cut across the different agro-ecological zones in the country. It was observed that the varieties have the ability to yield 32–36 tons per hectare, and this speeds up the adoption rate of yellow cassava varieties. Sequel to this, Nigerians ranked first among countries in Africa in consumption of provitamin A cassava products such as *fufu*, *gari*, *tapioca*, flakes, and the value-added products, and these efforts will ultimately satisfy the increasing need for more healthy and nutritious food produced in environmentally sustainable ways. Therefore, the rate of consumption of provitamin A cassava in Nigeria is a result of its potentials in terms of nutritional value, health benefits, marketability, high yield, and quality of the products (Amadiet *al.*, 2019; Amadi, Nzeakor, and Chimaraoke, 2020).

To ensure proper diffusion of provitamin A cassava, Harvest Plus, in collaboration with IITA and NRCRI, designed a delivery strategy. This employed existing extension pathways designed for other cassava projects funded by foreign donors like the World Bank and the International Fund for Agricultural Development in Nigeria. As to provide technical assistance to strengthening the different value chain operators, the delivery strategy empowers the downstream population where hidden hunger is a challenge to production and processing of vitamin A cassava. This effort is to meet both food and income needs for sustainable development. As a result of this, four states (Oyo West, Imo East, Akwa Ibom South, and Benue North) were initially targeted and also used as hubs to reach all other states (Godwin Atser, 2014).

**Seed Multiplication:** in order to ensure adequate seed multiplication in the country, Harvest Plus, with its partners, works with farmers, stem traders, cooperatives, government extension, and nongovernmental organization (NGO) partners to multiply stems. In 2013, over 650 hectares of released vitamin A cassava varieties were multiplied in 272

villages. In 2014, over 1,000 hectares were also multiplied, and private sector engagement was increased from 5 percent in 2012 to 32 percent in 2013. This was expected to account for over 70 percent of total stem production and trade by 2018. Using improved agronomic practices, average stem yield on multiplication farms increased from 200 to 500 bundles on-farm and to 1,000 on-stations. At a stage, the trajectory of seed multiplication seemed to be stagnant as a result of the adoption behaviors of the end users.

**Seed Delivery:** In 2013, over 106,000 farmers received and planted pro-vitamin A cassava stems in four target and ten expansion states. This number expanded threefold in 2014 and exceeded 350,000 farmers as more partners were engaged in stem dissemination to vulnerable households. Women represented 45 percent of the recipients of stems in 2013 but afterwards accounted for over 60 percent by 2016.

**Value Addition:** Twenty-five traditional meal and confectionery food products have been developed using vitamin A cassava and are highly consumed by Nigerians. Ten other innovative foods and beverages have been evaluated for commercial processing and marketing for consumption. This has already created and diversified markets for vitamin A cassava for sustainable adoption.

**Consumption and Marketing:** Estimation shows that over 30 million Nigerians have already received information on biofortification with an emphasis on vitamin A cassava. On average, rural farmers consume 40 percent and sell 60 percent of their pro-vitamin A cassava. In 2013, almost 90 percent of the estimated 7,000 tons of vitamin A cassava roots harvested from multiplication farms was consumed, while only 10 percent was sold. As farmers adopt and increase the production of vitamin A cassava on their farms, it is expected that the ratio of products sold will progressively increase to its maximum depending on the market. Owing to the increasing market presence, Harvest Plus has initiated demand creation for yellow cassava tubers and its products such as garri and fufu. Groups of processors with business focus have singled out in each of the target states to process fresh yellow roots into garri and fufu for sale. This is as a result of the growing demand for vitamin A garri by Nigerians in the Diaspora and other private food companies in Nigeria. To make the consumption rate of provitamin A cassava more successful, Harvest Plus employed stakeholders in its information dissemination circle.

**Stakeholders:** Partnerships are very essential to the delivery efforts in Nigeria. Harvest Plus works in collaboration with the ministries of Agriculture and Health, the International Institute of Tropical Agriculture (IITA), the National Root Crops Research Institute (NRCRI), NGOs, universities, and food companies. The Federal Ministry of Agriculture and Rural Development helps to provide both political and financial support for the development and dissemination of biofortified food crops, which are fully integrated into the Agricultural Transformation Agenda (ATA) of the Federal Government. The Ministry of Health also provided help by including bio-fortified cassava, maize, sweet potato, and pearl millet in the new Micronutrient Deficiency Control Guidelines that were approved by the National Health Council in August 2013 (Godwin Atser, 2014).

### Challenges of delivering provitamin A cassava to end users

Inadequate number of national breeders focus on cassava; this may be a constraint in the future. The government should ensure that national breeders are supported, as to increase their capacities, strengthened, and updated to respond to advances in breeding for high nutrient levels in crops.

Literacy levels of farmers in particular make them shy away from opportunities provided by the IITA and NRCRI.

Increasing trends in disease and pest pressures, climate change, and soil degradation may limit the supply of vitamin A cassava, depending on how current varieties respond to the changing environment. This suggests that more robust varieties need to be continuously developed in the years ahead.

Inability of the stem cuttings to meet its targeted population of farmers' participation. The shortage of the stems among the farmers makes some not interested in vitamin A cassava production.

Inadequate funding of research work: Lack of funds in carrying out research work on cassava inhibits the findings of solutions to the problems faced by farmers.

The delivery process assumes to be cost-effective at the initial stage; therefore, governments at all levels are advised to invest in the development and dissemination of nutritious crops.

### Conclusion

Production of pro-vitamin A cassava is essential for nation-building because the crop has zero tolerance for hunger and poverty, and this can bring about Sustainable Development Goals (SDGs) in the developing nations. Therefore, popularization and adoption of the pro-vitamin A cassava variety is very essential to effectively combat hidden hunger and poverty among the rural populace. In light of this, the paper reviewed an analysis of pro-vitamin A cassava



enterprise: implications to health benefits, diffusion and consumption update of pro-vitamin A cassava varieties released in Nigeria, and the challenges of delivering pro-vitamin A cassava to end users.

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#### ABOUT THE AUTHORS



**Udemezue, Joseph Chidozie** holds a Ph.D. in Agricultural Extension (Communication/Journalism) from Chukwuemeka Odumegwu Ojukwu University, Anambra State, Nigeria, M.Sc. and B.Agric. in Agricultural Extension (University of Nigeria, Nsukka). He is a seasoned research officer at the National Root Crops Research Institute, Umudike, Nigeria. His research interest for the past years spans issues on agricultural extension, information communication technologies (ICTs), climate change studies, farm broadcasting, public relations/advertisements on agricultural firms, food security, farm management, agricultural marketing, gender studies, rural development, adoption studies, and editing of agricultural papers.



**Ben Madu Ekwuye** is the Head of Finance & Operations (Country Finance & Admin Team Lead)-Christian Aid UK/DRC Country Program. Before his current position, he was the Head of Finance/Finance Team Lead, CAID UK/Nigeria Country Program (2020-Dec 2021), Senior Finance Coordinator, Northeast Humanitarian Crises, CAID UK/Nigeria Country Program (2018-2021), State Finance and Admin Lead, Society for Family Health (SFH) Owerri Office (2015-2018), Senior Finance Officer at SFH, Owerri Office (2012-2015), among others.

He holds an MBA in Business Administration (University of Nigeria Nsukka), an MBA in Human Resources (ESAE University, Benin Republic), an M.Sc. in Accountancy (Imo State University, Nigeria), and a B.Sc. in Accountancy (Chukwuemeka Odumegwu Ojukwu University, Nigeria).



**Johnson Okwudili Nweke** is a senior medical laboratory scientist working at the Diagnostic Laboratory Unit, Medical Centre, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria. He completed an undergraduate program in medical laboratory science from Nnamdi Azikiwe University, Awka, Nigeria. Johnson has a penchant for public health, healthcare logistics operations, sustainable supply chain, cancer, and infectious diseases research.