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Awareness of Issues Relating to Bio-fortification of Cassava Crop (*Manihot esculenta*) among Rural Farm Households in Enugu State, Nigeria

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Abstract

This study assessed awareness of issues relating to bio-fortification of cassava crop among rural farm households in Enugu State, Nigeria. Specifically, the study determined extent to which farmers were aware of deficiency of vitamin A; cassava crop fortification with vitamin A; as well as level of adoption of bio-fortified vitamin A cassava crop and constraints to adoption of bio-fortified vitamin A cassava crop in the study area. It was survey design. Population was made up of rural farm households in Enugu State of Nigeria. Data were collected with questionnaire. Data were analysed using mean, frequency and standard deviation. Result shows respondents were aware of four signs of vit A deficiency including, dry skin ($\bar{X}$=3.13), dry eye ($\bar{X}$=2.85), and night blindness ($\bar{X}$=3.71). Results also show that many majority of respondents (76%) were not aware of vitamin A inclusion into cassava crop. Also, few respondents (80%) had fully adopted vitamin A fortified cassava crop. Further results are six constraints to adoption of vitamin A fortified cassava crop. These include poor access to loan ($\bar{X}$=4.56), high cost of VAC planting material ($\bar{X}$=4.36), poor access to VAC planting material ($\bar{X}$=4.61), among others. Based on the findings, the study recommends sensitization on vitamin A cassava crop through extension agents, workshops, seminars and adult education in order to increase their decisions for adoption.

Keywords: Awareness, Rural, Farm, Households, Vitamin A, Cassava, Bio-fortification, Adoptions, Constraints.

Introduction

Cassava (*Manihot esculenta*) is an edible storage roots that serves as a critical staple food for over 180 million Nigerians. Contributes to food security, poverty reduction, and economic growth. Nigeria is the world's largest producer of cassava (Food and Agricultural Organization, 2022). It is a perennial woody shrub extensively cultivated as an annual crop for its edible starchy tuberous root. Cassava is a very important crop to Nigeria, its comparative production advantage over other staples serves to encourage its cultivation even by resource poor farmers (Olasunkanmi, et.al., 2012). Cassava production is currently put at about 34 million metric tons per year with total harvested area of 3.125million per hectares and average yield of 10.83 tons per hectares (Food and Agricultural Organization, 2021). Nigeria cassava production is about third more than production in Brazil and almost double the respective volume of production in Indonesia and Thailand (National Bureau of Statistics, 2021). This made cassava available to every family and easily accessible by the rural dwellers.

In Enugu State, southeast Nigeria, many households largely depend on cassava food products for their daily calorie requirements in the forms of *Garri, Fufu*, flour or chips, and its leaves are used as vegetable and the dry stem as firewood by low-income households (Nimoha et.al., 2018). It produces about 25percent and 40percent more carbohydrates than maize and rice respectively (Theodory et al., 2014). It is used in making starch, glucose, biscuits, ethanol, biofuel, bread, thickeners, custard powders, confectioneries, jelly etc. in industries (Echebiri & Edaba, 2008). It is comparatively more affordable in Nigeria than other staple foods and consumed often on daily basis, and most times more than once per day (Okoye et al., 2021). It forms a considerable chunk of the diet for many and the acceptance of its products by all classes of Nigerians is on its own a production motivator. Its adaptability (as a marginal crop) to poor resource base and climatic conditions has endeared it to most producers than maize, rice and other grains.

Generally, roots of cassava are rich in starch, but low in proteins and micronutrients, including provitamin A carotenoid; thus bio-fortified cultivars with elevated levels of provitamin A are desirable. Vitamin A is a fat soluble vitamin playing an important role in vision, bone growth, reproduction, and in the maintenance of healthy skin, hair, and mucous membrane (Nassar, 2004). Researchers have tried to improve the nutritional value of cassava by crossbreeding wild type varieties. Hybrids showed high protein content compared to typical cassava cultivars.

The concept of bio-fortification involves growing crops to improve their nutritious content by modern biotechnology or traditional selective breeding. Compared to traditional fortification, bio-fortification involves enhancing the nutritional value of plant foods while still growing rather than adding nutrients to the meals after they are processed (Oksana et.al., 2024). Bio-fortification of staple foods with micronutrients is regarded as a sustainable approach to reduce micronutrient malnutrition. It could potentially benefit people in rural and remote areas with

limited access to alternative possible interventions such as supplementation or introducing fortified food products (Okorie, et al, 2021).

Vitamin A is an essential micronutrient and a fat-soluble compound that plays an important role in a wide array of physiologic processes, including vision, immune response, cell differentiation and proliferation, intercellular communication and reproduction. Vitamin A is an essential nutrient lacking in the diets of poor malnourished population (Amanze, et al., 2024). Vitamin A deficiencies retards growth, increase risk of disease and can cause reproductive disorders. Improving cassava production with pro vitamin A could significantly improve nutrition and overall health significantly especially among poor communities.

Vitamin A deficiency (VAD) is a public health problem among young children and pregnant women in low-income countries. Vitamin A is an essential micronutrient for maintaining eye sight, immune function, and growth and development. VAD is caused by low dietary intake of vitamin A in combination with malabsorption and high excretion of vitamin A due to common illnesses (Sommer, et al., 2002). Studies have shown that over 34-69 percent of childhood blindness in Nigeria results mainly from an interplay of vitamin A deficiency, measles and harmful traditional eye practices (Aghaji, et al., 2019). Similarly, in Kenya, the VAD prevalence is classified as severe by WHO with more than 60 percent of preschool children having moderate or severe VAD (WHO, 2009).

Ibitoye and Ogunwande, (2024), asserted that the significant contribution of cassava to food security and economic development of the country, have paved way for the Federal Government of Nigeria to embarked on a number of programmes to boost its production. These include cassava multiplication programmes, root and tuber expansion programmes, and pro-vitamin cassava production technologies, among others. In spite of these diligent efforts by National Root Crops Research Institute (NRCRI), Umudike and International Institute for Tropical Agriculture (IITA), the adoption rate of these Pro-vitamin A varieties by farmers is about 40 percent as at 2014 while at present, the adoption rate seems not known (Oksana et.al., 2024). Nigeria currently has a high Vitamin-A deficiency (VAD) problem; over 20 percent of pregnant women and children under five years are reportedly vitamin-A deficient (Aghaji et al., 2019). Furthermore, Nigeria has a high incidence of impaired vision such as night blindness and xerophthalmia linked to vitamin-A deficiency (Ayinde, 2017).

Despite this, adoption and consumption of bio-fortified pro-vitamin-A cassava variety remains low in Enugu State (Amanze, 2024). The reason for the low adoption to pro-vitamin A cassava variety in the study area is not yet known; whether it was caused by none availability of pro-vitamin A cassava stems or lack of sufficient relevant information for the farmers. More so, factors driving the adoption of this improved variety of cassava remain under-researched in southeast Nigeria, which is a major cassava producing region in the country. Furthermore, previous studies on cassava bio-fortification in Nigeria have focused on various aspects such as determinants and profitability of pro -vitamin a cassava

production in Enugu state, Nigeria (Kaine, et al., 2022), the physicochemical properties and sensory attributes of bio-fortified cassava varieties (Alake et al., 2016), consumer acceptance and demand for bio-fortified cassava varieties (Ayodeji, et al., 2025), adoption pattern and risks associated with bio-fortified pro-vitamin-A cassava adoption (Olatade et al., 2016), expected economic benefits and probable impact of bio-fortified cassava on household expenditure and income (Pablo et al., 2024). Incidentally, there seems to be dearth of research on awareness, adoption constraints and present scenario of issues relating to bio-fortification of cassava crop among rural farm households in Enugu State, Nigeria, hence the necessity for the present study.

Objectives of the study

The general objective of the study was to investigate awareness of issues relating to bio-fortification of cassava crop among rural farm households in Enugu State, Nigeria. Specifically, the study determined:

1. extent to which farmers are aware of deficiency effects of vitamin A in Enugu State
2. farmers awareness of cassava crop fortification with vitamin A in Enugu State
3. level of adoption of bio-fortified vitamin A cassava crop by farmers in Enugu State
4. constraints to adoption of bio-fortified vitamin A cassava crop in the study area.

Methodology

***Area of the study*:** The study area was Enugu State, Southeast Nigeria. Enugu State in Nigeria is located between latitude 6°30′ N and longitude 7°30′ E, and it has a significant agrarian economy. The major crops in the area are cassava, yams, oil palm products, corn and rice. Enugu State. The area is divided into three agricultural zones: Enugu, Nsukka, and Awgu. Majority of the rural dwellers in this state engaged in small-scale farming.

***Population for Study*:** The population for the study was made up of households of registered rural farmers from Enugu state, Nigeria. The respondents were homemakers in the households. There were 8,200 registered rural farm households in Enugu State (Enugu State Fadama Co-ordinating Office in 2023). Rural farm households are people living in rural areas who engage mostly in business of farming operations, which include production, selling, and storage of farm produce, including cassava, among other. They are majorly small scale farmers.

***Sample for the Study*:** A multi-stage sampling technique was used to select respondents for the study. In the first stage, two zones were purposively selected out of the three agricultural zones in the state. In the second stage, three local government area (LGAs) were randomly selected from each of the two Agricultural zones, making a total of six LGAs. In the third stage, four communities were randomly selected from each of the LGA, making a total of 24 communities. Fourth stage, five households were randomly selected from each community making a total of 120 farm households that were sampled. Each household yielded one homemaker. Thus a sample of 120 homemakers was drawn for the study.

Instrument for Data Collection: Questionnaire was used for data

collection. It was developed based on literature review and the specific objectives of the study. Questionnaire section on awareness of signs of vitamin A deficiency had 3-point scale, while the section on costriants to adoption of vitamin A fortified cassava crop had 5-point scale.

The instrument was validated by three university experts in Agricultural Economics. Reliability of the instrument was established using test- re-test method, conducted on 10 farmers in outside the study area. Reliability coefficient of 0.71 was obtained.

***Data Collection Method*:** A total of 120 copies of questionnaire were distributed by hand to the respondents with the help of agricultural extension agents. Questionnaire served as interview schedule for illiterate respondent. Only 100 copies of questionnaire were retrieved and used for this study.

Data Analysis: Data for were analysed using mean, frequency counts, and percentages.

Results

Table 1: Mean Responses and Standard Deviation on Farmers Awareness of signs of Vitamin A Deficiency

S/N	Signs of Vitamin A deficiency	$\bar{X}$	SD	Responses
1	Dry skin	1.75	0.43	A
2	Dry eye	1.76	0.42	A
3	Night blindness	1.68	0.47	A
4	Poor healing of wound	1.69	0.46	A
5	Delayed growth	1.26	0.44	NA

$\bar{X}$ = mean responses; SD = standard deviation; A = aware; NA= not aware

Table1, shows that respondents are aware of the following signs of vitamin A deficiency; dry skin ($\bar{X} = 1.75$), dry eye ($\bar{X} = 1.76$), night blindness ($\bar{X} = 1.68$) and poor healing of wound ($\bar{X} = 1.69$). The standard deviations of the responses range from 0.42 to 0.47, indicating that awareness of signs and symptoms of deficiency effects of Vitamin A are not highly dispersed from the central tendency.

Respondents Awareness of cassava crop fortification with vitamin A in the study area: Data analysis shows that majority (76%) of the respondents in the study area were not aware of cassava crop fortification with vitamin A while some (24%) were aware. This implies that the general knowledge of cassava crop fortification with vitamin A in the study area is still very low.

Level of Adoption of Bio-fortified Vitamin A Cassava Crop among households in the Study Area: Data analysisreveals that very low percentage (8%) of the respondents fully adopted vitamin A cassava crop, yet a lower percentage (6%) partly adopted the cassava crop in the study area. In addition, 10 percent were aware but have not adopted while 76 percent of the respondents were not aware and have not adopted vitamin A fortified cassava in the study area.

Table 2: Mean Responses and Standard Deviation on Constraints to Adoption of Vitamin AFortified Cassava Crop (VAC) by Households in Enugu State

S/N	Constraints to adoption	$\bar{X}$	SD	Responses
1	Poor access to loan	4.56	.89	SA
2	High cost of VAC planting material	4.36	1.35	A
3	Nature and type of soil available in the area does not support the crop	1.56	1.00	SD
4	Poor access to VAC planting materials	4.61	.80	SA
5	Theft/herdsmen conflict	2.56	1.40	D
6	Lack of access to land	1.89	.38	SD
7	Low demand for VAC tubers	2.25	2.74	SD
8	VAC are prone to pest and diseases	1.87	.34	SD
9	VAC has low yield	2.03	0.34	SD
10	VAC is distasteful	2.31	0.91	SD
11	Yellow nature of VAC is not desirable	2.28	0.61	SD
12	VAC is not tasty	1.95	.96	SD
13	VAC does not have much starch	4.06	1.69	A
14	Unavailability of market for VAC	2.23	0.42	SD
15	Lack of training on VAC planting and processing	4.58	.66	SA
16	Difficulty in storing VAC product	1.45	.55	SD
17	Lack of awareness of VAC crop	4.42	.066	SA

SA= strongly agree; A = agree; D = disagree; SD = strongly disagree

Table 2 shows that the respondents strongly agree that the constraints to adoption of Vitamin A cassava among the households in the study area were: Poor access to loan (4.56), Poor access to VAC planting materials (4.61), Lack of training on VAC planting and processing (4.58) and Lack of awareness of VAC crop (4.42). While the respondents strongly disagreed that: Lack of access to land (1.89), VAC are prone to pest and diseases (1.87) and VAC is not tasty (1.95) amongst others were factors that constrain the adoption of Vitamin A Cassava Crop (VAC) among the households in the area. Therefore, it is pertinent to note that to increase the adoption of this cassava crop variety, there is need to increase the farmer's awareness level of vitamin A cassava crop, increase their access to credit, access to land and training of farmers on planting and processing of vitamin A cassava crops.

Discussion

This study assessed awareness of issues relating to bio-fortification of cassava crop among rural farm households in Enugu State, Nigeria. From the result of the study, most of the respondents were male aged 38 years on average. Majorly married with mean household size of 9 persons with average of 14 years of education and average of ₦280,230 annual income per households. Their farm size was average of 1.5 hectares with about average of 19 years of farming experience and majorly sourced their information through radio. Majority of the farmers does not belong to cooperative society this is in line with the findings of Yi Hu, et al., (2022) who found an average farm size of 1.5 hectares among

farm households who adopted new technologies in China.

Farmers awareness of deficiency effects of Vitamin A in the study area: it was observed that the households in the study area observed night blindness, dry skin and dry eyes as symptoms of vitamin A deficiency. Specifically, health risks associated with vitamin A deficiency especially among vulnerable groups in rural areas of sub Saharan Africa are well documented (Ume, et al., 2020). However, studies inferred that pro-vitamin A deficiency is capable of causing impaired vision, reduced immunity, and compromises growth and development leading to death in the most severe cases (Ume, et, al., 2020).

Awareness of fortification of cassava crop with vitamin A. From the findings of the study, it was observed that majority of the respondents are not aware of bio fortified vitamin A cassava. However, households being aware of fortification of cassava crop with vitamin A would have been a great opportunity in fighting against Vitamin A deficiencies in the study area to remedy the area from dry skin, dry eye, night blindness, poor healing of wound and delayed growth as signs of vitamin A deficiencies among households this is in accordance with the findings of (Ayodeji, et al., 2025). The standard deviations ranged from 0.42 to 0.47, indicating that awareness of signs and symptoms of deficiency effects of Vitamin A are not highly dispersed from the central tendency, implying that their responses are tilting towards the mean awareness level which is very low in the study area.

Level of adoption of bio-fortified vitamin A cassava crop among households in the study area: The respondents were grouped into fully adopted, partly adopted, not yet adopted and not aware of it. The fully adopted are farmers who is aware and have started farming this Cassava specie abandoning completely other species they were farming; partly adopted are the farmers who is aware of this cassava specie but still cultivate it in a small portion of their farm (trial or demo farm) while focusing in other cassava species they were used to; not yet adopted are farmers who is aware of this cassava specie but have not started farming it; not aware are farmers who does not know about this type of cassava specie. From the findings of the study, it was observed that about 76% of the respondents does not know about vitamin A cassava crops and about 10% have not yet adopted it. This means that majority of the respondents in the study area is yet to know vitamin A cassava crop. This may be because of lack of advertisement and sensitization of bio-fortified vitamin A cassava crop by extension agents. Increase in awareness level is very necessary for increased adoption of this variety of cassava as it could serve as a sure way of bridging the gap between production and demand due to its high yielding qualities, increasing food security and solving malnutrition issues in the areas (Ume, *et al.*, 2020). Also, its low adoption could also be linked to high cost of the planting materials of this variety compared to other cassava varieties in the market. This is in line with the study of (Ekwe, 2013) who reported cost as reasons for partly adoption of technology. Again, not aware of vitamin A bio fortification of cassava crop could be due to lack of information on availability of vitamin A bio-fortified cassava crop, while partly adoption could be due to

unavailability of cassava stem, high cost of stem among others while some reasons for not yet adopted could be low level of starch as some of the respondents reported low starch in vitamin A bio-fortified cassava crop. Partly adopted could also be because of some socio-economic characteristics of the population understudy such as age.

These findings are in line with the study of Ume, et al; (2020) who opined that aged people are usually conservative to technology adoption for fear of failure as farming is full of risks and uncertainties. Low level of education could also be a factor for not yet adopted of vitamin A bio-fortified cassava crop since increase in education is expected to increase awareness level and risk taking on the side of the farmers. Farm size and household size could also be another factor for partly adoption of Vitamin A bio fortified cassava crop as farmers with large farm size are likely to devote a section of their farm for new technology and farmers with large household size may likely adopt new technology due to availability of farm labour. Increase in income and higher years of farming experience is also likely to increase adoption of new technology. This is similar to the findings of Okorie, et al, (2021) who linked farming experience with adoption of innovation.

The result on constraints to adoption of bio-fortified vitamin A cassava crop among the households in the area showed that the farmers strongly agreed to: poor access to loan (4.56), high cost of vitamin A cassava crop planting material (4.61), Lack of training on VAC planting and processing (4.58) and Lack of awareness of VAC crop (4.42). The also considered High cost of VAC planting material (4.36) and VAC does not have much starch (4.06) as strong factors. While the respondents strongly disagree to: Low demand for VAC tubers (2.25), VAC is distasteful (2.31), Unavailability of market for VAC (2.23) and Yellow nature of VAC is not desirable (2.28) as a strong factor that inhibits adoption of VAC in the study area. While the respondents were undecided about difficulty in storing of VAC product (1.45) since may be many have not tried it; they produce and sell or consume. However, each of the constraints appears to be dispersed from the central tendency. This implies that to increase farmers adoption of vitamin A cassava crop, the government has to increase their access to loan to enable them buy the cassava stem, train the farmers on the health benefits of consuming such cassava, protect the farmers farm against theft and increase their access to land for such production. This is in line with the study of Idowu (2021) who found economic, social and institutional factors to inhibit Farmers' Adoption of Agricultural Technology in Kebbi State Nigeria.

The standard deviations of the responses range from 0.34 to 2.74, indicating that the adoption of vitamin A cassava crop (VAC) among the households in the area vary to differing extents.

Conclusion

The findings of the study reveal that majority of the respondents in the study area were not aware of vitamin A inclusion in cassava crops. Some were aware of symptoms of vitamin A deficiency but never knew it could be sourced from cassava crop. Again, the study further revealed that very few of the respondents fully adopted vitamin A cassava in the

study area. From the findings of the study, some constraints impeded access to bio-fortified cassava crops such as: Poor access to loan; High cost of Vitamin A cassava crop planting material; Poor access to Vitamin. A. cassava planting materials; Lack of awareness of Vitamin A cassava crop among others.

Recommendations

Based on the findings, the study recommends that:

1. The Government should partner with farmers to multiply this cassava stems to reduce cost of access to bio-fortified cassava stem.
2. The study also recommends sensitization on vitamin A cassava crop through extension agents, workshops, seminars and adult education in order to increase their decisions for adoption.
3. The health sector should sensitize the rural farmers on deficiency effects of vitamin A nutrient and how it can be remedied with consumption of vitamin A bio-fortified cassava
4. Government should provide input subsidies inform of cassava planting material to increase farmers access to vitamin A bio-fortified cassava planting materials
5. Farmers should be encouraged to form or join cooperatives for the gains of capacity building and cross breeding of ideas in order to facilitate decision to adopt the technology.

References

Aghaji, A.E., Duke R. and Ugochukwu C. W. (2019). Inequitable coverage of vitamin A supplementation in Nigeria and implications for childhood blindness BMC Public Health 19:282. https://doi.org/10.1186/s12889-019-6413-1.

Amanze, A.N, Oparaojiaku, J.O, Enwerem A.V., Orji, J.O., Ikeh, A.O., Nwokorie, U.M., Osuagwu, C.O. (2024). Preferential Adoption of Bio-fortified Pro-Vitamin A Yellow cassava varieties as Smart Feeding for Rural Farmers in Southeast Nigeria. Proceedings of the Annual Conference of the Agricultural Extension Society of Nigeria.

Ayinde, O.E. (2017). Risk analysis in innovation system: a case study of production of vitamin A cassava variety among farmers in Oyo state, Nigeria, *J. Agric. Faculty Gaziosmanpasa Univ. JAFAG 34 (3) 263–270.*

Ayodeji O., Olude, D., Ayodeji K., Tanimonure, V., Wongnaa,C.A., Oluseyi A. (2025). Impact of credit constraints on adoption of biofortified food crop among farming households in Nigeria, Sustainable Futures, 9(1) 1-8. https:// doi.org/10.1016/j.sftr.2024.100421.

Echebiri, R.N. & Edaba, M.E.I. (2008) Productionand utilization of cassava in Nigeria: Prospectsfor food security and infant nutrition. PatnsukJournal 4(1), 38 – 52. Retrieved from http://www.patnsuk journal.net/Vol4No1/p5.pdf.

Ekwe, K. C. (2013). *"Pro-vitamin A" Cassava:* Hope Rise for Nigerian Children. Roots: Quarterly Newsletter of National Root Crops Research Institute, Umudike. January to March, 1(1): 26 - 33.

FAO, IFAD, WFP, (2015). The State of Food Insecurity in the World, FAO, Rome,

FAOSTAT (2021). Food and Agriculture Data. http://www.fao.org/faostat/en/#data/

FAOSTAT (2022). Food and Agriculture Data. http://www.fao.org/faostat/en/#data/

Government of Nigeria (2013). National Strategic Plan of Action for Nutrition (2014-2018), Abuja, Nigeria,

Ibitoye, O., & Ogunwande, I. O. (2024). The Effect of Bio-fortified Vitamin A Cassava on Poverty Status of Farming Households in Nigeria, Evidence from Oyo State. *Gadau Journal of Pure and Allied Sciences*, 3(1), 30–40. https://doi.org/10.54117/gjpas.v3i1.121

Idowu A.C., (2021). Constraints to Farmers' Adoption of Agricultural Technology: A Case of Sawah Eco-technology among Farming Households in Kebbi State Nigeria. Dutse International Journal of Social and Economic Research, 6(1), 119-127

Ihuoma C. O, Narayanan N. N., Chiedozie N. E, Nige J. T (2021). Opportunities and challenges for biofortification of cassava to address ironand zinc deficiency in Nigeria. Global Food Security journal, 28, 1-9

International Fund for Agricultural Development (IFAD), (2007). Exploring gender issues in our work: main findings from a questionnaire survey, Paper Presented at Looking for New Directions: Gender Mainstreaming and Women's Empowerment Workshop, Rome, pp. 16–17.

International Institute of Tropical Agriculture (IITA) (2015). News-2014 archive: Nigeria releases more cassava with higher pro-vitamin A to fight micronutrient deficiency.

Latham, M.C., (2011). Vitamin A supplements and morbidity in children – a conundrum unanswered, Bull. Nutr. Found. India 32 (1) 5–7.

Mariana S.S. M., Cristina M.M. A., (2024). Structural, functional, nutritional and clinical aspects of vitamin A: A review, Pharma Nutrition, Volume 27.

Nassar, N.; Alves, J.; De Souza, E. (2004). An interesting interspecific cassava hybrid. Revista Ceres, 51, 495–9

National Bureau of Statistics, Nigeria. (2021). National Population Statistics, National Bureau of Statistics Abuja, Nigeria

Nimoha G., Godfred O. A, Ismael T, and Anaman R, (2018). Consumers' Willingness to Consume Cassava Leaves as a Leafy Vegetable in the Kumasi Metropolis, International Journal of Food Studies IJFS 7, 38–50

Okorie, O.J.; Okon, U.E.; & Enete, A.A. (2021), "Profit Efficiency Analysis of Cassava Production in Enugu State, Nigeria" (2021). *Journal for the Advancement of Developing Economies*. 10(1), 37-51

Okoye, F.U., Okoye, A.C. & Umeh, S.I. (2021) Consumption behaviour analyses of cassavaproducts among rural household in EbonyiState, Nigeria. Agro-Science 20(2), 14 – 19.https://dx.doi.org/10.4314/as.v20i2.3

Oksana M., Krishnamoorthi A., Abhishek S., Ravinder K., Kalaiselvi P., Nageshwar F., Utkarsh T & Munmun M. (2024), Biofortification: Enhancing Nutritional Content in Crops through Biotechnology and Fighting Climate Change. Journal of Advances in Biology & Biotechnology. 27(2):186-210. DOI: 10.9734/jabb/2024/v27i2710

Olasunkanmi, M.B, Afolabi, M. & Fisayo,D.(2012). Enterprise Combinations in Cassava Based Food Crop Farming System in Nigeria: Evidence from Ogun State, Greener Journal of Agricultural Sciences, 2(1), 13-20.

Olatade, K.O., O.O. Olugbire, A.A. Adepoju, F.J. Aremu, P.B. Oyedele (2016). *How does farmers' characteristics affect their willingness to adopt agricultural innovation*? The case of biofortified cassava in Oyo state, Nigeria, *International Journal Science and Technology 5 (2): 61.*

Oparinde, A. A. Banerji, E. Birol, P. Ilona, (2014). Information and consumer willingness to pay for biofortified yellow cassava: evidence from experimental auctions in Nigeria, HarvestPlus Working Paper No. 13, *International Food Policy Research Institute*, Washington, DC, USA,

Oteh, O.U., Mbanasor, J.A., Agwu, N. M, K. Hefferon, K, Onwusiribe C. N and De Steur H., (2023). Cogent Food & Agriculture (2023), 9: 2263972https://doi.org/10.1080/23311932.2023.226397

Pablo, A.M., Noé, A.R., Isaac, M.M., José, L.D.A., Gloria I.B.L. & Otto, R.L.O (2024). Cassava cultivation; current and potential use of agroindustrial co–products. *AIMS Environmental Science*, 11(2): 248–278. DOI: 10.3934/environsci.2024012.

SAHEL (2016) Sahel Capital Agribusiness Managers, Vol. 13. 1-5

Theodory, M., Honi, B. & Sewando, P. (2014) Consumer preference for cassava productsversus different processing technologies. Int.J. Innov. Sci. Res. 2(1), 143 –151. Retrievedfromhttp://www.ijisr.issr-journals.org /abstract.php?article=IJISR-14-105-02.

Ume S.I., Uloh, EV, Onyeke, AC and Nwose, D I (2020) Technical inefficiency of pro vitamin A cassava varieties farmers in South East, Nigeria (using normalized trans-log production frontier function model); bridging agriculture and nutritional divide in rural areas of Sub-Saharan Africa. International Journal of Science & Healthcare Research. 2020; 5(3): 529-540.

Ume, S I, Ezeano, C I, Onunka, B N and T. C. Nwaneri (2016). Socio-economic determinant factors to the adoption of cocoyam production technologies by smallholder farmers in South East Nigeria. Indo - Asian Journal of Multidisciplinary Research (IAJMR) 2; (5); 760 – 769. Available online awww.jpsscientific publications.com

Ume, S I, Okoye, F U, Onwujiariri, U.J and Achebe, U (2020). Analysis of Intensity of Adoption of odourless fufu processing technology by Pro vitamin A cassava variety processors in Anambra State of Nigeria; An Implication to Health and Nutritional Food Security International Journal of Science and Healthcare Research; (5)3:

World Health Organization (WHO), (2009). *Global Prevalence of Vitamin a Deficiency in Populations at Risk 1995–2005*, WHO Global Database on Vitamin A Deficiency, Geneva.

Yi Hu, Binbin Li, Zhenghe Zhang, Jian Wang, (2022) Farm size and agricultural technology progress: Evidence from *China, Journal of Rural Studies*, 93 (9), 417-429, https://doi.org/10.1016/j.jrurstud.2019.0