



FARMERS' TRAIT PREFERENCES OF ORANGE-FLESHED SWEET POTATO IN ONDO STATE, NIGERIA

¹Obisesan, A. and ²Omosehin, O.

¹Department of Agricultural & Resource Economics, Federal University of Technology, Akure, Ondo State, Nigeria.

²Department of Agricultural Economics, University of Ibadan, Oyo State, Nigeria

Corresponding Author's Email: kemi_triumph@yahoo.com,

GSM: +2348076673676, **ORCID:** 0000-0003-1433-0118

ABSTRACT

The study analyzed trait preferences of Orange-Fleshed Sweet Potato (OFSP) among farmers in Ondo State, Nigeria. Data were collected through multistage sampling procedure using structured questionnaire. Descriptive statistics, factor analysis, and probit regression model were employed in the data analyses. The mean age of the farmers was 52 years. Most (90%) of the farmers were males with an average household size of 6 persons. The farmers were smallholders with average farm size of 0.62 hectares. The result revealed that majority (76%) of the farmers were aware of the OFSP variety, but only 58% of the respondents were adopters. The result of the probit regression model showed that sex ($P < 0.1$), membership of farmers' association ($P < 0.01$) and credit access ($P < 0.05$) significantly increased adoption while age ($P < 0.05$) had negative influence on adoption of OFSP variety. Early maturity, yield, taste, ability to stay longer in the soil and drought tolerance were the traits considered by the farmers. From the factor analysis, ability to stay longer in the soil had the highest relevance, followed by drought tolerance while early maturity had the least relevance in the model. This revealed that OFSP farmers preferred a variety that has good in-soil storage traits to productivity traits. Therefore, the study recommends the prioritization of the preferred traits in the breeding of improved varieties in order to ensure demand-driven agricultural research and development.

Keywords: Factor, Analysis, Orange-fleshed, Sweet, Potato, Traits.

INTRODUCTION

Malnutrition remains a global phenomenon resulting from the rising pressure to feed the ever-increasing human population by the limited food production resources. It is related to inadequate consumption of both macronutrients and micronutrients. Despite that micronutrients are needed in small quantity in the body system, they are significant in the normal functioning of the human body (World Health Organization (WHO), 2020). One micronutrient that is vital to many physiological processes in human body is vitamin A. It comes from food sources that are either plant or animal-based. Vitamin A is necessary for healthy vision, mental clarity and alertness, bone formation, cell division, and reproduction (Bailey *et al.*, 2015). In many Low- and Middle-Income Countries (LMICs), Vitamin A Deficiency (VAD) is acknowledged as a serious public health risk (Stevens *et al.*, 2015; Song, 2023). This arises from dietary intake of Vitamin A that is insufficient to meet physiological needs. According to WHO (2023), 190 million preschoolers, mostly residing in Africa and South-East Asia are deficient of vitamin A. Furthermore, it has been estimated that 43 million under-five children in sub-Saharan Africa (SSA) lack enough vitamin A (Stathers *et al.*, 2018) and the prevalence of VAD was highest in SSA (WHO, 2020). In Nigeria, 29.5% of the population suffers from VAD. Hence, Nigeria was classified by the WHO as one of the "category one" nations with the highest risk of vitamin A insufficiency (Kuku-Shittu *et al.*, 2016; eHealth Africa, 2016).

Administration of high dose vitamin A supplements periodically has been identified as a low-cost intervention for VAD. However, chronic vitamin A deficiency cannot be addressed through supplementation alone. There is the need for biofortification which involves conventional development of specific crops with higher concentration of vital micronutrients. The biofortification of staple crops is a useful strategy to lessen micronutrient insufficiency (United States Agency for International Development, 2016). Food-based strategies that promote the consumption of foods high in vitamin A,



such as Orange-Fleshed Sweet Potatoes (OFSP), have the potential to improve vitamin A status (Laurie *et al.*, 2017). Due to biofortification, the OFSP cultivar has elevated quantities of beta-carotene, which is a precursor to vitamin A (Harvest Plus, 2009; Global Panel, 2015; Maru, 2017). A pre-schooler and a woman who is not nursing can obtain their daily requirements of pro-vitamin A from 125 grams of fresh sweet potato roots, which are mostly orange-fleshed (eHealth Africa, 2016; International Potato Center, 2018). Beyond its ability to combat VAD, OFSP outperforms other sweet potato varieties in terms of taste, storability, fat concentration, dry matter content, and rate of maturation (Okello *et al.*, 2015; eHealth Africa, 2016; USAID, 2016; van Vugt & Franke, 2018; Neela & Fanta, 2019). For vulnerable populations in Nigeria, OFSP, a staple food, can be an affordable and reliable source of vitamin A. According to Low *et al.* (2017), more than forty cultivars of OFSP roots have been brought to Africa. Investigations into Nigerian farmers' awareness, adoption, and traits preference are therefore necessary.

Though, there are studies on adoption of OFSP and the correlates in Nigeria (Adepoju *et al.*, 2017; Chah *et al.*, 2020 & Amos *et al.*, 2022); effect of OFSP adoption on welfare and productivity (Adepoju *et al.*, 2017; Babatunde *et al.*, 2019; Ben-Chukwu *et al.*, 2021); willingness to pay for quality OFSP (Adesina *et al.*, 2017); Technology transfer of OFSP (Nwachukwu & Nwaobiala, 2020); however, there is paucity of studies on OFSP traits preferences among Nigerian farmers. Mourtala *et al.* (2023) addressed preferred traits in sweet potatoes and not the OFSP. Therefore, this study analyzed traits preferences of orange-fleshed sweet potatoes among farmers in Ondo State, Nigeria. Specifically, the study investigated the awareness of orange fleshed sweet potato among farmers, examined adoption of OFSP and the influencing factors and analyzed traits preferences of OFSP in the study area. The study contributes to previous studies on orange-fleshed sweet potatoes by ascertaining if there is improvement in the awareness and adoption of the variety. It further establishes farmers' traits preferences. This will have implications on meeting farmers' needs in crop breeding and improving their welfare.

MATERIALS AND METHODS

Study Area

The study was conducted in Ondo state, one of the six states in Southwest, Nigeria. The state is located between longitudes 5°45' and 8°15' north of the equator and between longitudes 4°30' and 6° east of the Greenwich Meridian. It follows that the state is totally tropical. Most of the population relies on farming, fishing, and trading for a living. The state benefits from the generally lush greenery. While the northern borders are primarily sub-savannah woods, the southern region contains a high forest zone, sometimes known as a rain forest. The climate is tropical, with the rainy season (April to October) and the dry season (November - March). The state is predominantly an agrarian state, although with springing waves of industrialization. The crops commonly grown in the state include cocoa, plantain, banana, yam, potatoes, rice, cassava, maize etc.

Data Sources and Sampling Procedure

Primary data on the socioeconomic characteristics of the respondents, awareness, adoption and trait preferences of the orange-fleshed sweet potato variety were sourced using a well-structured questionnaire. For the selection, a multistage sampling procedure was used. The first stage was the purposive selection of Ifedore and Idanre Local Government Areas (LGAs) due to the predominance of sweet potato farmers in the area. The second stage was the random selection of five communities from each LGA making a total of ten communities. The final stage involved selecting fifteen farmers at random from each community using the list of farmers in the community. This results in a total of 150 respondents who were interviewed for the study. However, only 141 copies of the questionnaire were useful for the study due to incompleteness of few copies.

Analytical Techniques

Descriptive statistics, factor analysis, and probit regression model were used in the data analysis. The socio-economic characteristics of the farmers were described using descriptive statistics. Factor analysis was used to characterize the traits preference among OFSP farmers while probit



regression model was employed to examine the factors affecting farmers' adoption of orange-fleshed sweet potato variety.

The Probit Model

The probit model is used in estimating the likelihood of events based on dependent dichotomous variables (Gujarati and Porter, 2009). A dependent variable with a binary choice expects just two values (either zero or one). Consequently, the adoption of orange-fleshed sweet potatoes was met with a dichotomous response from farmers (1 for Yes, 0 for No). The model postulates the probability (P_i) that a farmer will adopt the orange-fleshed sweet potato or not. The probit model is given by: $Pr(Y_i = 1) = \Phi(\beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} \dots \dots \dots + \beta_n X_{ni} + \epsilon_i)$

Where:

Y_i is the binary dependent variable, representing whether or not farmer i has adopted OFSP ($Y_i = 1$ if adopted, $Y_i = 0$ if not adopted).

X_i are the explanatory variable for i^{th} respondent

- X_1 = Sex of household head (female=0, male=1)
- X_2 = Household's head age (years)
- X_3 = Household size (number)
- X_4 = Marital status
- X_5 = Years of education
- X_6 = farmers' association (yes=1, 0 otherwise)
- X_7 = Primary Occupation (farming=1, 0 otherwise)
- X_8 = access to credit (Yes=1, 0 otherwise)
- X_9 = Farm size (hectares)
- X_{10} = farmland acquisition method

β_0 is the intercept term.

β_1 and β_2 are the coefficients for X_{1i} and X_{2i} , and so on respectively, thereby representing the effect of these factors on the probability of adopting OFSP.

ϵ_i is the error term, representing the random variation in the adoption decision that is not explained by the independent variables.

Φ is the cumulative distribution function of the standard normal distribution, which is used to transform the linear combination of variables into a probability between 0 and 1.

Factor Analysis

Following Joreskog (2007) and ten-Holt et al. (2010), the factor model can be expressed as a series of multiple regressions X_i , predicting each of the observable variables from the values of the unobservable common factors, f_i :

$$X_1 = \mu_1 + l_{11}f_1 + l_{12}f_2 + \dots \dots + l_{1m} f_{1m} + \epsilon_1 \dots \dots \dots 1$$

$$X_2 = \mu_2 + l_{21}f_1 + l_{22}f_2 + \dots \dots + l_{2m} f_m + \epsilon_2 \dots \dots \dots 2$$

$$X_p = \mu_p + l_{p1}f_1 + l_{p2}f_2 + \dots \dots + l_{pm}f_m + \epsilon_p \dots \dots \dots 3$$

Where;

- μ_1 = variable,
- μ_p = the intercept terms for the multiple regression models, and ϵ = error term.
- l_{ij} = loading of the i^{th} variable on the j^{th} factors,
- L = Factor Loading.

Then, the factor loadings are given by the matrix L below:

$$L = \begin{pmatrix} l_{11} & l_{12} & l_{1m} \\ l_{21} & l_{22} & l_{2m} \\ l_{p1} & l_{p2} & l_{pm} \end{pmatrix} \dots \dots \dots 4$$

Equation 1-4 can be summarized as:

$$X = \mu + Lf + \epsilon \dots \dots \dots 5$$

Equation 5 led us to the Principal Component Method where we assumed X_i to be a vector of observations for the i^{th} subject which is expressed as:



$$X_i = \begin{cases} X_{i1} \\ X_{i2} \\ \vdots \\ X_{ip} \end{cases} \dots\dots\dots 6$$

The sample variance-covariance matrix S, is expressed as:

$$S = \frac{1}{n-1} \sum_{i=1}^n \{X_i - \bar{x}\} \{X_j - \bar{x}\}' \dots\dots\dots 7$$

The *p* eigenvalues for this variance-covariance matrix as well as corresponding eigenvectors for this matrix.

Eigen value of S is given as $\lambda_1, \lambda_2, \lambda_p$, while the Eigen vectors is given as: e_1, e_2, e_3

Eigen decomposition of S is simplified as:

$$S = L\lambda'e \dots\dots\dots 8$$

Percentage of Variance explained by each Principal Component is now given as:

$$\frac{\lambda_i}{\sum_{j=1}^p \lambda_j} \times 100 \dots\dots\dots 9$$

RESULTS AND DISCUSSION

Socio-economic Characteristics of the Respondents

The descriptive statistics of the socio-economic characteristics of the respondents is presented in Table 1. The results revealed that the mean age of the respondents was 52.29 years, this indicates that farmers in the study area are aging and the youth are not engaging in farming. This supports Obisesan (2021) that posited low engagement of youth in Nigerian agriculture with farmers’ mean age of 53.01 years. Most of the farmers (90%) were males while the average household size was 6 persons. This implies that males still dominate crop production. Furthermore, the results showed that the farmers were smallholders with average farm size of 0.62 hectares. There was low access to credit with only 19% of the farmers having access to formal credit. It has been observed that access to credit remains a constraint to agriculture especially among smallholders. The average year of schooling was 8.1 years. This indicates that most of the farmers had low level of education. However, more than half of the farmers had access to extension services. This could be an indication of improvement in extension services in Nigeria.

Table 1: Socio-economic Characteristics of the Respondents

Variable	Frequency	Percentage
Age ≤ 30	11	7.80
31-40	32	22.70
41-50	33	23.40
51-60	45	31.91
61-70	16	11.35
70 above	4	2.84
Mean 52.29		
Sex Male	127	90.00
Female	14	10.00
Years of education No formal	25	17.73
1-6	40	28.37
7-12	67	47.52
13-18	8	5.67
>18	1	0.71
Mean 8.10		
Household size 1-5	58	41.13
6-10	70	49.65
11-15	13	9.22
Mean 6.30		
Farm size 1-5	120	85.11
6-10	19	13.48
>10	2	1.41
Mean 0.62		
Credit access Yes	27	19.14
No	114	80.86
Farmers association Yes	86	61.00
No	55	39.00
Access to extension services Yes	79	56.03
No	62	43.97
Years spent in the village 1-5	4	2.84
6-10	28	19.86
11-15	37	26.24
16-20	49	34.75
>20	23	16.31
Mean 18.97		

Source: Authors' computation, 2023

Awareness and Adoption of OFSP Variety

Awareness of orange fleshed potato is reasonably high among the respondents as most (74%) of the farmers were aware of the variety. This is in line with Nwachukwu & Nwaobiala (2020) and Kaphaika *et al.* (2023) which reported high awareness of OFSP in Nigeria and Malawi, respectively. However, from the study, not all the farmers who were aware of the variety adopted it. From the results of the study, only 58% of the farmers adopted the variety. This corroborates Babatunde *et al.* (2019) and Chah *et al.* (2020) who stated that though farmers were aware of the OFSP varieties yet there is low adoption of the variety in Kwara and Abia states of Nigeria, respectively. Hence, this study ascertains improvement in awareness of OFSP but adoption of OFSP is low among farmers.



Table 2: Distribution of Respondents based on Awareness and Adoption of OFSP

Variable	Frequency	Percentage
Awareness	107	76
Yes		
No	34	24
Adoption		
Yes	82	58
No	59	42

Source: Authors' computation, 2023

Determinants of Adoption of OFSP Variety

The results of the probit model on the factors influencing the adoption of OFSP variety is as shown in Table 3. The Prob > chi² is 0.0011, indicates that the overall model is statistically significant at a 1% level. The Pseudo R² value of 0.3679 indicates that the model explains 36.79% of the variation in the dependent variable. The results showed that sex, membership of farmers' association and credit access significantly increased probability of adoption while age had negative influence on adoption of OFSP variety. From the result, being a male increases likelihood of adoption statistically (P< 0.1) by 0.21. This is in congruence with Adepoju *et al.* (2017) which posited that being a male farmer increased probability of adoption of OFSP in Osun State, Nigeria. In the country, production of root and tuber crops is predominantly male activity. Furthermore, males generally dominate intra-household agricultural production decision making (Ajewole *et al.*, 2015, Ednah & Sichilima, 2016 & Obisesan and Akinola, 2021). The age of the farmer significantly (P<0.05) but negatively influenced probability of OFSP variety adoption. The results show that a unit increase in the age of the household head will reduce the likelihood of adopting OFSP variety by 0.03. Older farmers tend to be risk averse and are less likely to have children between 1-5 years of age that need Vitamin A in their households. This is consistent with Babatunde *et al.* (2019) which recorded that age of the farmer had negative influence on intensity of adoption of OFSP in Kwara state, Nigeria. Furthermore, belonging to farmers' association increases likelihood of adoption significantly at 1% level by 0.89. In the same vein, access to credit has a positive and significant effect on adoption of OFSP. From the result, an increase in credit access will increase the probability of OFSP variety adoption by 0.78 units significantly at 5% level. Access to credit enhances the financial status of farmers and gives them opportunity to invest in new technology.

Table 3: Factors Influencing the Adoption of OFSP

Variables	Coefficient	Std. Err.	z	P> z	Marginal effect (dy/dx)
Sex	1.42*	0.85	1.67	0.095	0.2112
Age	-0.04**	0.02	-2.01	0.035	0.0251
Marital Status	0.28	0.39	0.70	0.483	0.0227
Household Size	0.09	0.07	1.26	0.207	0.0116
Years of Education	0.04	0.30	-0.12	0.903	0.1093
Primary occupation	0.31	0.22	1.41	0.158	0.1454
Membership of farmers' association	1.29***	0.40	3.23	0.001	0.8913
Farmland acquisition	0.17	0.14	1.19	0.233	0.135
Farm Size	-0.64	0.47	-1.36	0.178	0.0028
Access to Credit	1.30**	0.51	2.54	0.011	0.777
Constant	0.17	1.98	0.09	0.93	
LR chi2(11)	30.99				
Prob > chi ²	0.0011				
Pseudo R ²	0.3679				
Log likelihood	-42.35				

Source: Authors' Computation, 2023

Factorization of Farmers' Trait Preference

Factorization was performed on the preferred traits mentioned by the farmers namely: early maturity, yield, taste, ability to stay longer in the soil and drought tolerance using principal component factor (Table 4). An eigenvalue is the variance of the factor. In the initial factor solution, the first factor accounted for the highest variance, followed by the second factor. The proportion informs the relative weight of each factor in the total variance. From the results, the first factor explained 51.84% of the total variance while factor 1 and factor 2 accounted for 69.75% of the total variance. The decision rule according to Kaiser criterion is to retain factors with eigenvalues equal to or greater than 1. Based on this, only the first factor was retained because the eigenvalue associated with other factors were less than one. However, the first factor tends to describe the farmers' average position on OFSP traits because it affected all the responses positively as shown in the factor loading (Table 5).

Furthermore, the factor loadings which are the weight and correlation between the factor and each variable showed that ability to stay longer in the soil, drought tolerance, taste and yield seems to describe factor 1 in order of magnitude. These show that these traits are important to OFSP farmers in the study area. This further suggests that the features included in Factor 1, such as yield, taste, and ability to withstand drought, have a significant impact on how farmers perceive different crops. Furthermore, Table 5 shows the uniqueness of each trait. The term uniqueness represents the variance that is unique to the variable and not shared with other variables. In other words, it is equal to 1-communality (variance that is shared with other variables). Hence, the lower the uniqueness, the higher the relevance of the variable in the factor model.

From the study, ability to stay longer in the soil had the least variance not accounted for by other variables (31.49%). Therefore, it has the highest relevance in the factor model, followed by drought tolerance while early maturity had the least relevance in the model. This reveals that OFSP farmers preferred a variety that has good in-soil storage traits than productivity traits. The results further suggested that farmers are not interested in productivity attributes only but multiple varietal traits when making adoption decisions. This corroborates Acheampong *et al.* (2018) which posits that cassava farmers do not consider only single traits but also some important non-tradable traits such as root longevity in soil after maturity when making their seed selection decisions.



Table 4: Traits Preference of the Respondents

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	2.59175	1.69578	0.5184	0.5184
Factor 2	0.89597	0.24330	0.1792	0.6975
Factor 3	0.65267	0.11957	0.1305	0.8281
Factor 4	0.53310	0.20659	0.1066	0.9347
Factor 5	0.32651		0.0653	1.0000

Source: Authors' Computation, 2023

Table 5: Factor Loadings and Unique Variance

Variables	Factor 1	Uniqueness
Early maturity	0.5495	0.6980
Yield	0.6532	0.5733
Taste	0.7495	0.4383
Ability to stay longer in soil	0.8277	0.3149
Drought tolerance	0.7850	0.3837

Source: Authors' Computation, 2023

CONCLUSION AND RECOMMENDATION

The study examined farmers' awareness, adoption of orange fleshed sweet potato and their traits preferences in Ondo state, Southwest Nigeria. Despite high awareness of the orange-fleshed sweet potato variety among the respondents, adoption of the variety is low. The likelihood of adoption was higher among male and young farmers. Membership of farmers association and credit access are also significant factors increasing the probability of orange-fleshed sweet potato adoption. Furthermore, the OFSP farmers take into consideration many traits in their adoption decisions. In-soil storage and drought tolerance are more preferred than productivity traits among the farmers. Therefore, the study recommends that agricultural research and development should satisfy farmers' demand by prioritizing in-soil storage and drought tolerance traits in the breeding of improved variety.

REFERENCES

- Acheampong, P. P., Owusu, V. and Nurah, G. (2018). How does farmer preference matter in crop variety adoption? The case of improved cassava varieties' adoption in Ghana. *Open Agriculture*, **3**: 466-477.
- Adepoju, A. A., Raufu, M. O., Sanusi, W. O. and Onabamiji, O. A. (2017). The effect of bio-fortified orange fleshed sweet potato adoption on farming household welfare in Osun State, Nigeria. *International Journal of Political Science and Development*, **5**(4): 145-155. DOI:10.14882/ijpsd2017.080.
- Adesina, B. A., Abdurrasheed, M. D., Okoye, A. C., Ekah, E. O., Anedo, E. O., & Afuape, S. (2017). Farmers' willingness to pay for quality orange-fleshed sweet potato (OFSP) vines in North Central Nigeria: A case of Benue and Nasarawa States. *Nigeria Agricultural journal*, **48**(1): 110-121.
- Ajewole, O., Ayinde, O.E., Ojehomon, V., Agboh-Noameshie, R., & Diagne, A. (2015). Gender Analysis of agricultural innovation and decision making among rice farming household in Nigeria. *Journal of Agricultural Informatics*, **6**(2):72-82. (ISSN2061-862X).
- Amos, E. D., Olasore, A., Mohammed, A., Asagba, A., Adams, S. A., Yakubu, S. & Omonayin, M. A. (2022). Factors influencing adoption of orange fleshed sweet potato (ofsp) production among smallholder farmers in Kwara State, Nigeria. *International Journal of Research and Innovation in Social Science (IJRISS)*, **6**(3): 101- 115. ISSN 2454-6186.
- Babatunde, R. O., Omoniwa, A. E., & Adeniyi, A. E. (2019). Orange fleshed sweet potatoes (OFSP) and productivity: the case of smallholders in Kwara State, Nigeria. *Agricultura Tropica et Subtropica*, **52**(3-4): 105-111.



- Bailey, R. L., West, K. P., Jr, Black, R. E. (2015). The epidemiology of global micronutrient deficiencies. *Ann Nutr Metab.*, **66**: 22-33. 10.1159/000371618 [PubMed]
- Ben-Chukwu, M. A., Amadi, P. A., Mgbebu, E. S., Nwankwo, I. I. and Afuape, S. O. (2021). Effects of adoption of orange-fleshed sweet potato varieties on farm income and output among growing households in Ebonyi and Abia states, Nigeria. *Nigeria Agricultural Journal*, **52**(2): 377-383.
- Chah, J. M., Anugwa, I. Q., & Nwafor, I. M. (2020). Factors driving adoption and constraining the non-adoption of biofortified orange-fleshed sweet potatoes (OFSP) among farmers in Abia State, Nigeria. *Journal of Agriculture and Rural Development in the Tropics and Subtropics (JARTS)*, **121**(2): 173-183.
- Ednah, N., & Sichilima, T. (2016). Gender and decision making in agriculture. A case study of the smallholder groundnut sector in Zambia. Retrieved November 10, 2018, from https://beamexchange.org/uploads/filer_public/67/70/677053c0-8171-4067-a55f-54ff476d189/gender_study_groundnuts_sector.pdf.
- eHealth Africa (2016). Sweet potatoes: a realistic answer for Nigeria's nutrition crisis. Retrieved from <http://www.ehealthafrica.org/latest/2016/4/21/sweetpotatos-a-realistic-answer-for-Nigerias-nutrition-crisis>.
- Global Panel (2015). Biofortification: An agricultural investment for nutrition. Policy Brief No.1, Global Panel on Agriculture and Food Systems for Nutrition, London, UK.
- Harvest Plus (2009). Pro-vitamin A sweetpotato. A handbook by the International Potatoes Centre on Breeding Crops for better Nutrition accessible online via http://www.harvestplus sweet potato_strategy.pdf.
- Gujarati, D.N. & Porter, D.C. (2009). Basic Econometrics. 5th Edition, McGraw Hill Inc., New York.
- Harvest Plus (2009). Pro-vitamin A Sweetpotato: A handbook by the International Potatoes Centre on Breeding Crops for better Nutrition accessible online via http://www.harvestplus sweet_potato_strategy.pdf.
- International Potato Center (2018). Annual Report 2018. Retrieved April 19, 2022 from <https://cipotato.org/annualreport2018>.
- Jöreskog, K. G. (2007). Factor analysis and its extensions. In R. Cudeck & R. C. MacCallum (Eds.), *Factor analysis at 100: Historical developments and future directions*: pp. 47–77. Lawrence Erlbaum Associates Publishers.
- Kaphaika, C. S., Katengenza, C. P., Pangapanga-Phiri, I., & Chambukira, M.H. (2023). More interventions, low adoption: to what extent are the existing seed sources to blame? the case of orange fleshed sweet potato in central and Northern Malawi. *Sustainability*, **15**(19): 14390; <https://doi.org/10.3390/su151914390>.
- Kuku-Shittu, O., Onabanjo, O., Fadare, O., & Oyeyemi, M. (2016). Child malnutrition in Nigeria: evidence from Kwara State (Vol. 33). International Food Policy Research Institute.
- Laurie, F. M., Faber, M., & Claasen, N. (2017). Incorporating Orange-fleshed Sweet Potato Into The Food System As a Strategy for Improved Nutrition: the Context of South Africa. *Food Research International*, **104**(3). DOI:10.1016/j.foodres.2017.09.016.
- Low, J. W., Mwanga, R. O. M., Andrade, M., Carey, E., Ball, A. M. (2017). Tackling vitamin A deficiency with biofortified sweetpotato in sub-Saharan Africa. *Glob Food Sec.* **14**: 23-30. doi:10.1016/j.gfs.2017.01.004.
- Maru, J. (2017). Newly launched orange flesh sweet potato (OFSP) platform to fight hidden hunger in Nigeria. Retrieved from: <https://cipotato.org/blog/newlylaunched-orange-fleshed-sweetpotato-ofsp-platform-tofight-hidden-hunger-in-nigeria>.
- Mourtala, I.Z.M, Nwankwo, M. I., Dan-Jimo, B. & Oselebe, H. O. (2023). Sweetpotato Breeding Priority and Preferred Traits to Increasing its Utilisation in Niger and Nigeria. *African Journal of Agricultural Research*, **19**(5): 516-529. DOI:10.5897/AJAR2023.16336.
- Neela, S. & Fanta, S. W. (2019). Review on Nutritional Composition of Orange-fleshed Sweet Potato and its Role in Management of Vitamin A. Deficiency. *Food Science & Nutrition*, **7**(6): 1920-1945. <https://doi.org/10.1002/fsn3.1063>.



- Nwachukwu, C. C. (2020). Analysis of Technology Transfer of the Orange Fleshed Sweet Potato Varieties to Farmers in Abia State, Nigeria. *Nigeria Agricultural Journal*, **51**(3): 72-80.
- Obisesan, A. A. & Akinola, M. O. (2021). Women's Involvement in Intra-Household Decision Making on Agricultural production: What Factors Matter? *Revista Espinhaco*, **10**(2): ISSN-e:2317-0611.
- Obisesan, A. A. (2021). What Drives Youth Participation and Labour Demand in Agriculture? Evidence from Rural Nigeria. *Revista Espinhaco*, **10**(1): 231-237.
- Okello, J. J., Shikuku, K. M., Sindi, K. & Low, J. (2015). Farmers' Perception of Orange-fleshed Sweet Potato: Do Common Beliefs about Sweet Potato Production and Consumption Really Matter? *African Journal of Food, Agriculture, Nutrition and Development*, **15**(4): 345-352.
- Song, P., Adeloye, D., Li, S., Zhao, D., Ye, X., Pan, Q., Qui, Y., Zhang, R., Rudan, I. (2023). The Prevalence of Vitamin A Deficiency and its Public Health Significance in Children in Low- and Middle-Income Countries: A Systematic Review and Modelling Analysis. *Journal of Global Health*, **13**: 04084. Doi: 10.7189/jogh.13.04084.
- Stathers, T., Low, J., Mwanga, R., McEwan, M., David, S., Gibson, R., Namanda, S. McEwan, M., Malinga, J., Ackatia Armah, R., Benjamin, M., Katcher, H., Blakenship, J., Andrade, M., Agili, S., Njoku, J., Sindi, K., Mulongo, G., Tumwegamire, S., Njoku, A., Abidin, E., Mbabu, A., Mkumbira, J., Ogero, K., Rajendran, S., Okello, J., Becho, A., Ndyetabula, D., Grant, F., Maru, J., Munyua, H., Mudege, N., Muzhingiri, T. (2018). Everything you ever wanted to know about sweet potato: Reaching Agents of Change TOT Manual, 12, 664. International Potato Center, Lima, Peru. Retrieved from: <https://hdl.handle.net/10568/98334>.
- Stevens, G. A., Bennett, J. E., Hennocq, Q., Lu, Y., De-Regil, L. M., Rogers, L., et al. (2015). Trends and Mortality effects of Vitamin A Deficiency in Children in 138 low-income and middle-income countries between 1991 and 2013: a pooled analysis of population-based surveys. *Lancet Glob Health*, **3**: 528-536. 10.1016/S2214-109X(15)00039-X.
- ten Holt, J. C., van Duijn, M. A., & Boomsma, A. (2010). Scale construction and evaluation in practice. A review of factor analysis versus item response theory applications. *Psychological Test and Assessment Modeling*, **52**(3): 272-297.
- United State Agency for International Development (2016). Orange-fleshed sweet potatoes: Improving lives in Uganda. Retrieved 23 Nov 2022 from <https://www.usaid.gov/results-data/success-stories/orangefleshed-sweet-potatoes-improving-lives-uganda>.
- Van Vugt, D. & Franke, A. C. (2018). Exploring the yield gap of orange-fleshed sweet Potato varieties on smallholder farmers' fields in Malawi. *Field Crops Research*, **221**: 245-256. <https://doi.org/10.1016/j.fcr.2017.11.028>
- World Health Organization (WHO) (2020). Micronutrients Survey Manual. Retrieved March 23, 2021 from <https://www.who.int/publications/i/item/9789240012691>.
- WHO (2023). WHO e-Library of Evidence for Nutrition Actions (eLENA). Nutrients. Vitamin A. (<http://www.who.int/elena/nutrient/en/#vitamina>).