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ADOPTION OF IMPROVED VARIETIES OF ROOT AND TUBER CROPS FOR AGRICULTURAL DEVELOPMENT AND FOOD SECURITY IN NIGERIA

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ABSTRACT

There has been relative stagnation in agricultural productivity in recent decades particularly in Africa due to low adoption of technologies by farmers among other factors. This paper was designed o evaluated the adoption of improved varieties of root and tuber crops in relation to agricultural development and food security. Scholarly articles on the subject matter were sought from books, journals, conference proceedings and monographs among others. Areas of interest covered include, Improved Varieties of Root and Tuber Crops, Project and Programmes targeted at dissemination and promotion of improved varieties of root and tuber crops, Adoption of Improved Varieties of Root and Tuber Crops, Factors affecting adoption of improved varieties of root and tuber crops, Concept of Food Production and Food Security; and Impact of Adoption of Improved varieties on Agricultural Development and Livelihood of Farmers. The study disclosed that many improved varieties of root and tuber crops have been developed, released and disseminated to the farmers and other end users. These improved varieties are early maturing, high yielding and disease resistance while some have enriched nutritional values. The development of these improved varieties was achieved through the efforts of international and national institutions notably International Institute of Tropical Agriculture (IITA) Ibadan and National Root Crops Research Institute Umudike. Spatial adoption rates have been recorded across the country, some areas are having high, while some have moderate or low adoption rates. Many factors such as socioeconomics, weak seed and extension systems were attributed to low and differences in adoption rates. Despite these challenges, adoption of improved root and tuber crops have contributed to increased agricultural production and well being of the farmers through income generation and improved nutrition. Re-strategizing agriculture through investment in research and extension will enhance agricultural development and ensure food security. Furthermore, Strengthening the weak seed system and value chains for root and tuber crops will create demand driven opportunities, increase income of farmers and improve the economy of the nation through multiplier effect.

Keywords: *Adoption, Improved Varieties, Root and Tuber Crops, Agricultural Development and Food Security*

INTRODUCTION

The world population is increasing rapidly and it has become difficult to meet the needs of the people in terms of achieving food security by expanding areas under cultivation since fertile land is not increasing overtime. This challenge can be ameliorated through increase in agricultural productivity. This notwithstanding, agricultural productivity and growth will not be easily achieved without proper development and dissemination of technologies that can be adopted by farmers. Agricultural research and technological development are therefore essential in achieving agricultural productivity and thereby reducing poverty (Solomon, 2010 and Solomon *et.al*., 2011)

Adoption is defined as the integration of a new technology into existing practice and is usually proceeded by a period of trying' and some degree of adaptation (Loevinsohn *et. al.,* 2012). It is an individual mental process through which a decision is made to use a technology. It is the acceptance of an innovation developed by researchers. Before a farmer adopts a technology, there are 5 stages needed to undergo: awareness, interest, evaluation, trial and adoption (Ekong, 2010). Awareness involves the farmer coming to know about a technology but have no knowledge of how to use it. This is followed by the farmer showing interest and begins to seek for information about the technology. Then the farmer begins to weigh and compare the technology to what he is using before to know whether it is worth trying based on the inherent advantages. Thereafter the farmer experiments or uses the technology in a small scale for assessment and then finally the farmer decides to adopt or make full use of the technology or innovation. Adoption is influenced by the nature of the individual, factors relating to the innovation or technology, factors from the change agents, social system and socioeconomic factors (Shideed and Mohammed, 2005; Ironkwe *et al*., 2016).

Root and tuber crops most especially play critical roles in the global food system, particularly in the developing countries, where they rank among the top 10 food crops (Nweke 2004). They contribute to the energy, nutrition requirements and constitute an important source of income in rural and marginal areas (Anazodo, 1989; Adewumi *et al.*, 2005). With the oil boom of the 70s and 80s in Nigeria, production of roots and tubers in Nigeria were neglected leading to prolonged use of traditional varieties and production techniques (Ekwere *et al*., 2014). From 1970 to 2022, close to 90 improved varieties of root and tuber crops including cassava, yam, sweetpotato, potato and ginger have been developed, registered and released by international and national research centres in Nigeria. Adoption of these improved varieties of root and tuber crops by farmers is a veritable means of increasing their yields and productivity and thus can help attain food security an important objective of Agricultural Development. For instance,

adoption rate of 60% have been reported for improved cassava varieties in Nigeria (Wossen *et al*., 2017); leading to 82% productivity gain (Manyong, 2017).

Various agricultural development programmes and policies aimed at improving the level of agricultural production and ensure self sufficiency in food production, have been developed and executed by successive administrations in Nigeria (Daneji, 2011). Some of these interventions focused on the development of high yielding varieties of seeds that are tolerant to pests and diseases. Cassava has been most favoured among the root and tuber crops for government interventions in Nigeria which include: The Cassava Multiplication Program (CMP) which took off in 1989, the Root and Tuber Expansion Program (RTEP); launched in 2000 and the Presidential Initiative on Cassava (PIC); formed in 2002 (Olusegun *et al*, 2015). Agricultural Transformation Agenda (ATA) was birthed in 2012 and Building an Economically Sustainable Integrated Cassava System (BASICS) established in 2015 among others.

This paper highlights improved varieties of root and tuber crops that have been registered and released in Nigeria and their outstanding qualities, examines their adoption and the impact on agricultural development and food security in the country.

Improved Varieties of Root and Tuber Crops

In the past 5 decades, National Root Crops Research Institute (NRCRI) Umudike and International Institute of Tropical Agriculture(IITA) Ibadan have played leading roles in the development, registration, release and dissemination of over 50 improved varieties of Cassava (Table 1), 19 Yam (Table 2), 9 Sweetpotato, 6 Potato and 2 Ginger varieties (Table 3) in Nigeria. The improved varieties of cassava have enhanced root yields, resistance to major cassava diseases and pests like cassava bacterial blight, cassava anthracnose disease, cassava mosaic disease and green spider mite. In addition, some are early bulking, low in cyanide, non-branching, high in dry matter, root starch content and beta carotene, the precursor of vitamin A. These qualities enable them not only to improve productivity but also to fit different target profiles needed for food and industry. Someone can therefore find the right improved cassava for different purposes including preparation of different food forms (garri, *fufu,* tapioca, starch, *abacha*); starch for textiles and biofuel industry, high quality cassava flour for confectionary, etc.

Improved varieties of yams come with high yields, pests and diseases tolerance, high dry matter, good food qualities (taste, poundability, boiling and frying) and non-oxidizing parenchyma. In a valedictory trial conducted by IITA Aighewi, B., & Maroya, N.

(2020),asserted that the average yam yields of local varieties is less than 25% of the yield of improved released varieties, which range from 30 to 40 tons/ha.

Improved sweetpotato varieties have been developed and selected for different agro-ecological conditions and uses. Sweetpotato varieties differ from each other in many ways, including leaf shape and colour, vine structure, root shapes, root skin colour, flesh colour, taste, texture, dry matter content, yield, resistance to pests and diseases (RAC, 2012).

The "yellow root" cassava and orange fleshed sweetpotato varieties are enriched with beta carotene (pro-vitamin A) and are targeted toward pregnant women, lactating mothers and children who are mostly at risk of vitamin A deficiency. These vitamin A-enriched varieties could provide more vitamin A in the diets of more than 70 million Nigerians who eat these root crops every day (IITA, 2011). Vitamin A deficiency (VAD) is widely prevalent in sub-Saharan Africa, as it afflicts almost 20% of pregnant women and about 30% of children under five in Nigeria (IITA, 2011). VAD can lower immunity and impair vision, which can lead to blindness and even death. Children and women will be the main beneficiaries of the yellow varieties, which could provide up to 25% of their daily vitamin A needs, as asserted by IITA (Ojeleye, 2018).

Potato varieties have enhanced tuber yield, dry matter and taste that make them good for both food and industry. Registered ginger varieties are high yielding with high oleoresin content which makes them ideal for food and industrial use.

Table1: Cassava Varieties Released and Registered in Nigeria

Original Name	**Variety Name**	**Outstanding Characteristics/ Potential Yields**	**Year of Release**
IITA TMS 130572	NICASS 1	High yielding	1984
IITA TMS 14(2)1425	NICASS 2	High yielding, low cyanide	1986
IITA TMS 190257	NICASS 3	Early bulking, high yielding	1986
IITA TMS 184537	NICASS 4	High yielding	1986
IITA TMS 18200058	NICASS 5	High yielding	1986
IITA TMS 18200661	NICASS 6	High yielding	1986

IITA TMS 18100110	NICASS 7	High yielding	1986
MS 6 (Antiota)	NICASS 8	Non-branching, high yielding, resistant to pest and diseases, low cyanide, good gari and lafun.	1986
MS 3 (Odongbo)	NICASS 9	Non-branching, high dry matter, good for gari, keeps well in the soil. Good for mixed cropping,	1986
	NICASS 10	Moderate yielding	1976
NR 8208	NICASS 11	High yielding	1988
NR 8083	NICASS 12	High yielding >25t/ha	1986
NR 83107	NICASS 13	High resistance to pests and diseases. >25t/ha	1989
NR 8082	NICASS 14	Very high yielding and resistant to pests and diseases. >25t/ha	1986
IITA TMS 150395	NICASS 15	High biomass >25t/ha	1986
NR 8212	NICASS 16	High yielding >25t/ha	1986
NR 41044	NICASS 17	High yielding >25t/ha	1986
IITA TMS 130001	NICASS 18	Moderate yielding	1986
IITA TMS 191934	NICASS 19	High yielding	1986
TME 419	NICASS 20	High yield, resistant to CMD	2005
IITA TMS 1972205	NICASS 21	High yield, resistant to CMD	2005
IITA TMS 1980505	NICASS 22 (FINE FACE)	High yield, resistant to CMD	2005
IITA TMS 1980510	NICASS 23	High yield, resistant to CMD	2005
IITA TMS 1980581	NICASS 24 (DIXON)	High yield, resistant to CMD	2005
NR 87184	NICASS 25	Early maturing, high yielding, suitable for food and industry (34.6t/ha)	2006
IITA TMS 1920057	NICASS 26	Fairly suitable for mixed cropping, high yielding, suitable for food and industry (37.7t/ha)	2006

IITA TMS 1920326	NICASS 27	Early maturing, suitable for mixed cropping, high yielding, suitable for food and industry (39.5t/ha)	2006
IITA TMS 1961632	NICASS 28 (FARMERS PRIDE)	Fairly suitable for mixed cropping, high yielding, suitable for food and industry (43.2t/ha)	2006
IITA TMS 1980002	NICASS 29	Early maturing, fairly suitable for intercropping, high yielding(48.4t/ha	2006
NR 93/0199	NICASS 30	Very suitable for food and industry	2008
IITA TMS 1961089A	NICASS 31	Contains moderate level of beta-carotene, high yielding > 25t/ha, suitable for food and industry	2008
NR 01/0004	UMUCASS 32	Early maturing, high yielding (48.4t/ha), suitable for intercropping, tolerance to drought.	2010
CR 41-10	UMUCASS 33	Very suitable for intercropping, early maturing, high yielding (46.4t/ha), tolerance to acidic soils.	2010
IITA TMS 1010040	UMUCASS 34	Suitable for sole cropping, early maturing, high yielding(51.7t/ha), suitable for food and industry.	2010
IITA TMS 1000203	UMUCASS 35	Suitable for sole cropping, early maturing, high yielding(43.3t/ha), suitable for food and industry.	2010
IITA TMS 1011368	UMUCASS 36	High beta carotene, high yield(46.5t/ha), suitable for gari, fufu and high quality cassava flour.	2011
IITA TMS 1011412	UMUCASS 37	High beta carotene, high yielding(59.1t/ha), suitable for gari and fufu, broad adaptation.	2011
IITA TMS 1011371	UMUCASS 38	High beta carotene, suitable for gari and fufu, suitable for high quality cassava flour. (39.3t/ha)	2011

NR 03/0211	UMUCASS 39	Early maturing, high yielding, high starch yield, suitable for high quality cassava flour. (42.5t/ha)	2011
NR 03/0155	UMUCASS 40	Early maturing, high yielding(53.7t/ha), suitable for gari and fufu, tolerance to drought.	2011
CR 36-5	UMUCASS 41 (AYAYA)	High starch, dry matter, suitable for intercropping and suitable for gari and fufu. (42t/ha)	2012
IITA TMS 1982132	UMUCASS 42	High root yield, high dry matter and moderate carotene content. (49.5t/ha)	2012
IITA TMS 1011206	UMUCASS 43	High root yield(53t/ha), dry matter and starch content, and suitable for high quality cassava flour	2012
NR 07/0220	UMUCASS 44	High beta carotene content and high yielding. (36t/ha)	2014
IITA TMS 1070593	UMUCASS 45 (SUNSHINE)	High carotene content and high yielding. (34t/ha)	2014
IITA TMS 1070539	UMUCASS 46	High carotene content and high yielding. (32t/ha)	2014
TMS 13F1160P004	UMUCASS 47 (GAME CHANGER)	High starch, dry matter content and high fresh root yield (39.2 t/ha)	2020
TMS 13F1343P0022	UMUCASS 48 (OBASANJO-2)	High starch, dry matter content and high fresh root yield (38.7 t/ha) and good for flour.	2020
NR 130124	UMUCASS 49 (HOPE)	High fresh root yield (40.1 t/ha). Excellent gari and fufu quantity and quality	2020
IITA-TMS-IBA 00070	UMUCASS 50 (BABA-70)	High fresh root yields. Excellent gari and fufu quality (37.5 t/ha)	2020
TME B693	UMUCASS 51 (POUNDABLE)	Poundable, mealy, low cyanogenic potential and high dry matter (26 t/ha)	2020
IBA 154810	UMUCASS 52 (HEADMASTER)	High dry matter, (high yielding 51.67t/ha) ,best for garri and suitable for fufu and high quality flour	2022

IKN 130010	UMUCASS 53 (SECURITY-2)	High dry matter and high total carotenoid content. high yielding (44t/ha) ,best for garri and suitable for fufu and high quality flour	2022
IBA 164773	UMUCASS 54 (NO-HUNGER)	High yielding (45.80t/ha) ,suitable for garri and high quality flour	2022

Source: Catalogue of Released and Registered Varieties in Nigeria. NACGRAB Moore Plantation Ibadan

Table 2: Yam varieties released and registered in Nigeria

Variety Name	Outstanding Characteristics/ Potential Yields	Year of Release
TDR 89/02677	Stable yield, very good cooking and pounding qualities, cream tuber parenchyma, 25% tuber dry matter content.	2001
TDR 89/02565	Stable yield, very good cooking and pounding qualities, cream non oxidizing parenchyma, 35% tuber dry matter.	2001
TDR 89/02461	Stable yield, very good cooking and pounding qualities, cream parenchyma, 26.7% tuber dry matter.	2001
TDr 89/02665 (Asiedu)	Stable yield, very good cooking and pounding qualities, cream non-oxidizing parenchyma, 35.3% tuber dry matter.	2003
TDR 95/01924	Stable yield, very good cooking and pounding qualities, white non-oxidizing parenchyma, tuber dry matter = 32.8%	2003
DRN 200/4/2	High yielding, pests and diseases tolerant, very good for fufu, frying and boiling. (35t/ha)	2008
TDa98/01176 (Swaswa)	High yielding, pests and diseases tolerant, good for pounded yam, frying and boiling, suitable for both rainy and dry seasons yam production. (26-30t/ha)	2008
TDa98/01168	High yielding, pests and diseases tolerant, good for pounded yam frying and boiling. (24-28t/ha)	2008
TDa98/01166	High yielding, pests and diseases tolerant, good for pounded yam, frying and boiling, suitable for both rainy and dry seasons yam production. (26-30t/ha)	2008
TDr 95/19158	High yielding, pests and diseases tolerant, very good for yam, fufu, frying and boiling. (29.4t/ha)	2009

TDr 89/02602	High yielding, pests and diseases tolerant, very good for yam, fufu, frying and boiling. (31.5t/ha)	2009
TDa 00/00194	High yielding, pests and diseases tolerant, good for pounded yam, frying and boiling. (37.5t/ha)	2009
TDa 00/00104	High yielding, pests and diseases tolerant, good for pounded yam, frying and boiling. (30t/ha)	2009
UMUDa-4	High yielding, good for Amala, pounded yam, frying and boiling. (33.3t/ha)	2010
UMUDr-17	High yielding under dry season yam cropping system. (30t/ha)	2010
UMUDr-18	High yielding, pests and diseases tolerant, very good for yam fufu, frying and boiling. (31t/ha)	2010
UMUDr-20	High yielding. (39.8t/ha)	2016
UMUDr-21	High yielding. (43.9t/ha)	2016
FAVOURITE		2022

Source: Catalogue of Released and Registered Varieties in Nigeria. NACGRAB Moore Plantation Ibadan

Table 3: Some of the Sweetpotato, Potato and Ginger varieties released and registered in Nigeria

Crop	**Variety Name**	**Outstanding Characteristics**	**Year of Release**
SweetPotato	TIS-87/0087	Widely adapted, highly dependable as under any adverse condition produces economic yield. Good for fries and chips, high tolerance to sweet potato weevil.	1992
SweetPotato	TIS-87/0087	Very high root yields. The top is highly cherished by livestock and fishes.	1992
SweetPotato	TIS2532.OP.1.13	Tuberous roots are very large with white flesh.	1992
SweetPotato	TIS-8164	Very high root yields. Vines cherished by livestock and fishes. Good for starch production.	1992
SweetPotato	UMUSP 1	High beta carotene, high dry matter, high root yield and resistant to SPVD. (63.63t/ha)	2012

SweetPotato	UMUSP 2	White-fleshed sweetpotato with high dry matter, high yield and high resistance to sweetpotato virus disease. (44t/ha)	2012
SweetPotato	UMUSP 3	High carotene content and high yield. (56.4t/ha)	2013
SweetPotato	UMUSPO/4 Solo-Gold	High root carotenoid content, high root yield, resistant to sweetpotato virus disease and high dry matter content. (26.8t/ha)	2018
Potato	VC 785-2	High and stable yield with moderate branching habit.	1976
Potato	VC 801-4	High and stable yield, Large tubers with few branches.	1980
Potato	BR63-18	Early maturing, short dormancy excellent culinary qualities. High dry matter.	2003
Potato	Marabel	Extra early maturity, high yield, high number of marketable tubers and high dry matter content. (23t/ha)	2014
Potato	Rumba	Large tuber size (≥ 50mm), high tuber yield, and high dry matter content (20%). (20t/ha)	2016
Potato	Jelly	High tuber yield, high dry matter content and early maturity. (18t/ha)	2016
Ginger	UMUGIN 1	High yield (39 t/ha), light yellow rhizome skin and flesh, tolerant to yellow leaf spot	2022
Ginger	UMUGIN 2	High yield (30t/ha), Smooth rhizome skin, Pale yellowish grey rhizome flesh, tolerant to yellow leaf spot. High oleoresin content	2022

Source: Catalogue of Released and Registered Varieties in Nigeria. NACGRAB Moore Plantation Ibadan

Project and Programmes targeted at dissemination and promotion of improved varieties of root and tuber crops

Several projects and programmes by Nigeria government and International Research organizations have tried to disseminate improved varieties of root and tuber crops in order to improve production and ensure food security. These programmes include National Accelerated Food Production Programme (NAFPP); Cassava Multiplication Project (CMP); Presidential Initiative Cassava (PIC); Root and Tuber Expansion Project (RTEP), Agricultural

Transformation Agenda (ATA) and Building an Economically Sustainable Integrated Cassava System (BASICS) among others.

NAFPP was perhaps the earliest post independence programmes designed in the early 60s by both the Federal and state governments to accelerate the production of grains (maize, rice, guinea corn, millet, wheat, and cowpeas) and root and tubers especially cassava. It targeted major staple foods crops of Nigerians for accelerated production through the introduction of high yielding varieties, use of appropriate fertilizers, agrochemicals, good storage and processing facilities, provision of credit as well as marketing outlets. In addition, several research institutes were mandated to develop improved crop varieties which were disseminated through extension agents and popularized through the use of mass media (Daneji, 2011).

The CMP and the PIC mainly focused on improving production and facilitating the building of domestic productive capacity to efficiently, profitably and sustainably satisfy the market demand with the quality and quantity required (PIC, 2003).

According to the RTEP implementation manual (PIM, 2001 and NADP, 2003), the programme focuses on available low-cost technologies that can be easily adopted by poor farmers, a combination of improved cassava, yam, direct potatoes and cocoa yam varieties, given the high cost of inputs and the restricted access to credit by small scale farmers. Hence, RTEP aims at exposing farmers to improved root and tubers crops production and processing

Cassava and Ginger were the two root and tuber crops that were amongst the target crops of ATA. Planting materials of improved varieties cassava and landraces of ginger were massively multiplied and distributed to farmers in order to boost production.

Between 2002 and 2010, IITA implemented a research for development (R4D) project called Integrated Cassava Project (ICP) to support the presidential initiative (PI) for cassava launched in 2002, to boost cassava production and processing. Through this project, IITA successfully introduced and promoted cassava varieties via the National Agricultural Research Services (NARs) and Agricultural Development Programs (ADPs). Furthermore, in a research spanning 12 years, the IITA, in partnership with the NRCRI, developed three pro-vitamin cassava varieties which were released by the Federal Government in December, 2011, using traditional breeding method in a Harvest Plus-funded project (IITA, 2011).

Building an Economically Sustainable, Integrated Cassava System (BASICS) was established in 2015 and anchored by IITA Ibadan, with the aim of developing a sustainable cassava seed value chain in Nigeria. The seed value chain serves as a vehicle to deliver better quality and more productive planting material, and enable more efficient dissemination and adoption of

new cassava varieties to improve productivity, food security and increase income of cassava seed entrepreneurs (CSEs)(www.iita.org)

Adoption of Improved Varieties of Root and Tuber Crops

Root and tuber crops including cassava, sweetpotato, potato and yam are the most important food crops for direct human consumption in Africa. These four crops (Cassava, Yam, Sweetpotato and Potato) are grown in varied agro-ecologies and production systems contributing to more than 240 million tons annually, covering around 23 million hectares (Sanginga, 2015). Adoption of Improved varieties of root and tuber crops is critical to increase yield per unit area as their inherent genetic resilience enables them to withstand diseases and vagaries of climatic change. Solomon (2010); Solomon *et al*. (2011) asserted that adoption of improved varieties is the most important factor in increasing agricultural productivity and reduction of poverty in the long-term. In addition to improving productivity, adoption of improved varieties of root and tuber crops has the potential of relieving gender in-equality within African agricultural systems since Women play a critical role in the production of these crops (Sanginga, 2015).

Improved varieties of root and tuber crops which are multiple disease and pest resistant, early maturing, and high yielding have been developed by research institutions. These varieties are high yielding with good levels of multiple disease and pest resistance as well as of acceptable quality for food, feed and industrial uses in Nigeria. While the combination of these new varieties and better agronomic practices could increase yields per unit area by at least 40%, the rate of adoption by smallholder farmers has been low. The dissemination of these varieties has often suffered a setback due unreliable seed distribution system caused by weak extension system. The extension agent – farmer ratio is so wide, currently between 1:5000-1:10,000 across the states in Nigeria (Davis *et.al*., 2019). This has compelled farmers to continue to grow local, low yielding and disease infested varieties that are not "true to type".

Table 4: Levels of adoption of some selected root and tuber crops technologies in Anambra state

	0	**1**	**2**	**3**	**4**	**5**	**6**	**Total**	**Mean**
Yam									
White yam	10.53	21.64	5.26	0	17.54	45.03	0	360	2.11
Yellow yam	23.98	45.61	0	0	1.17	16.96	0	231	1.35
Aerial yam	56.14	33.92	0	0	0	9.94	0	143	0.84

Chinese yam	73.68	11.70	0	0	0	14.62	0	145	0.85
Cocoyam									
Ede Ofe	7.02	17.54	0	1.75	0	66.67	0	609	3.56
Ede Uko	14.04	17.54	0	0	0	46.78	0	430	2.52
Ede buji	19.30	33.92	0	0	5.85	14.62	0	223	1.30
Sweet Potato									
TIS. 8441	53.22	14.04	8.18	0	1.75	2.92	1.17	101	0.59
Ex. Igbariam	70.17	21.64	0	1.17	2.92	0	0	70	0.41

Adapted from Ironkwe, A. G., Ezebuiro, N. C. and Ewuziem, J. E. (2016), 0. None, 2. Awareness, 2. Interest, 3. Evaluation, 4. Trial, 5. Adoption, 6. Discontinued

The average adoption rate of improved cassava varieties at country and regional levels may vary. Wossen *et al*., (2017) reported average adoption rate of improved cassava varieties in Nigeria to be about 60%. Adoption rates also showed a large spatial heterogeneity. In particular, adoption rates reach as high as 79% in the Southwest region of the country while it was only about 31% in the Southeast region of the country. The north and south-south had 59% and 69% adoption rates respectively. The distribution of adoption by gender reveals that the adoption rate among men headed households is about 61.5% while the adoption rate among female headed households is relatively low (about 48.6%). In Ghana, Acheampong *et al*,. (2017), reported awareness level of 50% and overall adoption rate of 6% of improved yam varieties and also observed large spatial heterogeneity in their awareness and adoption.

Factors affecting adoption of improved varieties of root and tuber crops

Factors that impede the adoption of improved varieties include unavailability of improved planting material (Acheampong *et al*,. 2017; Adeola *et al,* 2019), high cost of improved varieties (Okeke and Mbah, 2021), weak seed production and dissemination system, low productivity in poor soils and under low input, poor storage of harvested roots and tubers and consumer preferences (Sanginga, 2017). The lack of research funding, limited research capacity and poor infrastructure (for research and on-farm) greatly diminishes the development of a competitive agricultural sector in Africa, and particularly for root and tuber crops

Ojeleye, (2018) found that adoption of recommended practices for improved cassava varieties were significantly determined by socioeconomic characteristics such as age, gender, educational level, levels of income, years of farming experience and extension contact, as significant relationships were found between these factors and the adoption of recommended

practices for the two improved varieties studied. Adeola *et al,* (2019) reported that availability of vines of improved varieties, high yield potential, early maturity, resistant to pests and diseases and market availability were the technology-specific attributes that influenced both the adoption of improved sweetpotato varieties and its use intensity. Results reported by Kapalasa *et.al.*, (2019) show that the variety characteristics that were significant in influencing adoption of improved potato varieties included high yield, early maturity and larger tuber size that were preferred variety characteristics. Furthermore, the rate of adoption of a new technology is subject to its profitability, degree of risk associated with it, capital requirements, agricultural policies and socioeconomic characteristics of farmers (Shideed and Mohammed 2005).Anyaegbunam *et.al.,*(2009) indicated that educational level, credit availability and farm size were the factors influencing the adoption of yam mini sett technology

Concept of Food Production and Food Security

According to Gebrehiwot (2009), food security was understood as adequacy of food supply at global and national levels until the mid 1970's. This view favored merely food production oriented variables and overlooked the multiple forces which in many ways affect food access. Evidences show that during the last two decades, food production has been increasing in some countries of the world. However, large amount of food at global level does not guarantee food security at national level. Moreover, availability of enough food at national level does not necessarily ensure household food security. But, during the same period, more than 100 million people were affected by famine and more than a quarter of the world's population was short of enough food. Although food production has been increasing from time to time, food insecurity, malnutrition and hunger and much more serious problems would remain the main agenda in the globe today (Barrett. 2002).

As the occurrence of hunger, famine, and malnutrition are increasing from time to time in developing countries, the conceptual framework of food security has also progressively developed and expanded. The idea of food security attained wider attention since the 1980s after the debate on 'access' to food and the focus of the unit shifted from global and national levels to household and individual levels (Debebe and Tesfaye, 1995). This paradigm came with new concept and definition of food security and it led to two additional major shifts in thinking; from a first food approach to a livelihood perspective and from objective indicators to subjective perceptions The most commonly accepted definition of Food security is "access by all people at all times to enough food for an active and healthy life" (World Bank. 1986). Food insecurity is a situation in which individuals have neither physical nor economical access to the nourishment they need. A household is said to be food insecure when its consumption

falls to less than 80% of the daily minimum recommended allowance of caloric intake for an individual to be active and healthy. In particular, food insecurity includes low food intake, variable access to food, and vulnerability- a livelihood strategy that generates adequate food in good times but is not resilient against shocks (Devereux. 2000). During the debates that preceded the World Food Summit (WFS) held in Rome in 1996, it was established that "There is food security when all people at all times have sufficient physical and economic access to safe and nutritious food to meet their dietary needs including food preferences, in order to live a healthy and active life"{ USAID, 2008). When an individual or population lacks or is potentially vulnerable due to the absence of one or more factors outlined above, then it suffers from, or is at risk of food insecurity.

Based on the WFS (1996), the definition focuses on three distinct but interrelated elements, all three of which are essential to achieving food security:

1. Food availability: having sufficient quantities of food from household production, other domestic output, commercial imports or food assistance.
2. Food access: having adequate resource to obtain appropriate foods for a nutritious diet, this depends on available income, distribution of income in the household, food prices and market access
3. Food utilization: proper biological use of food, requiring a diet with sufficient energy and essential nutrients, potable water and adequate sanitation, as well as knowledge of food storage, processing, basic nutrition and child care and illness management

Impact of Adoption of Improved varieties on Agricultural Development and Livelihood of Farmers

The general goal of developmental initiatives is total transformation in the quality of the life of the people or target beneficiaries of development programmes (Daneji, 2011). Agriculture is reputed as the backbone of rural development as over 70% of Nigerian population including women, youths and children reside and earn their living in rural areas mostly involved in agriculture and agriculture related enterprises (Yahaya, 2000). Agricultural development can be viewed as improvement in the principles, and practice of agriculture given both human and material resources that will result in maximum output from a combination of minimum inputs (Olawoye and Ogunfiditimi, 1989).

Adoption of improved varieties is an important means of maximizing output with minimum inputs. It ensures the production of a resilient crop with high yielding ability coupled with resistance to pests and diseases thereby ensuring optimal returns from the effort of our farmers.

Increased food production as a result of adoption of improved varieties not only lead to agricultural development but also to increased food production and abundance thereby helping to put hunger and related food crisis to check. Improved production as a result of adoption of improved varieties of root and tuner crops also impacts positively on the economics and livelihood of farmers and stakeholders. They are able to earn more cash, improve their overall wellbeing including training of their children and healthcare. An early adopter of YIIFSWA-promoted improved yam varieties enjoys "fantastic" yield of 32.6 t/ha (Asiedu), 30.0 t/ha (Kpamyo), and 37.5 t/ha (Swaswa) which he used among other things to present to his son's bride in order to fulfil and essential requirement for traditional marriage (IITA News, downloaded from https://www.iita.org/news-item/early-adopter-of-yiifswa.. 30/01/2022). In a similar study on the effect of improved cassava production on the income of household farmers, over 90% of the respondents indicated increased income from adoption of cassava technology (Anyaegbunam *et.al*.,2017). Consumption of nutrient enriched varieties help in the nutritional security. The orange-fleshed variety has been used in Africa to combat widespread vitamin A deficiency that results in blindness and even death in children and Pro-vitamin A cassava varieties also provide 25% of daily recommended vitamin A (Ojeleye,2018)

CONCLUSION

Improved varieties of root and tuber crops have been and are still being churned out by both international and national agricultural research systems. Dissemination and adoption of these improved varieties have the potential to improve productivity significantly thus contributing to agricultural development and food Security. Strategic investment in research, extension, and improved seed system would ensure effective varietal development and adoption to accelerate impact of technology advances on the populace. Furthermore, understanding the importance of promoting new varieties with enhanced nutritional properties will be acquired by building on previous investments in orange-flesh sweetpotato and pro-vitamin A cassava. Improved value chains for root and tuber crops will create new opportunities and increase income potential for all stakeholders.

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