Biofortified foods

Building Nutritious Food Baskets

Baseline report on biofortification and thematic areas of Building Nutritious Food Baskets Project in Nigeria

AUGUST 2017

Baseline report on biofortification and thematic areas of Building Nutritious Food Baskets Project, Nigeria

August 2017

Baseline report on biofortification and thematic areasof Building Nutritious Food Baskets Project, Nigeria

ISBN: 978-92-9060-484-6
DOI: 10.4160/9789290604846

International Potato Center
P.O. Box 1558, Lima 12, Peru
cip@cgiar.org • www.cipotato.org
Produced by CIP-Sub-Saharan Africa Regional Office (SSA), Nairobi

Correct citation:
Phorbee, O.; Mulongo, G.; Njoku, N.; Maru, J.; Munyua, H. 2017. *Baseline report on biofortification and thematic areasof Building Nutritious Food Baskets Project, Nigeria*. Nairobi (Kenya). International Potato Center (CIP). ISBN 978-92-9060-484-6. 60 p.

Production Coordinator
Joyce Maru

Copyediting and Layout
Kellen Kebaara

Cover Design
Communications and Knowledge Resources Center

Contents

Contents iii
List of tables iv
List of figures iv
Abbreviations v
Acknowledgements vi
Executive summary vii
Summary of the findings vii
Conclusions and recommendations ix
1. Introduction 1
1.1 Background 1
1.2 Context of the baseline study 2
1.3 BNFB Project: scaling up biofortified crops for nutrition security in Nigeria 3
1.4 Goals and objectives 4
2. Study methodology 5
2.1 Desk review 5
2.2 Field survey 5
2.3 Data analysis 6
2.4 Quality assurance 7
2.5 Ethical considerations 7
3. Main findings on issues and trends in biofortification 7
3.1 Socioeconomic and demographic characteristics of farmers and consumers of biofortified crops and products in Nigeria 7
3.2 Actors and trends in biofortification 10
3.3 Farmers and consumers' knowledge and understanding of biofortification in Nigeria 17
3.4 Production and consumption patterns of biofortified crops and their products 20
3.5 Factors responsible for the slow uptake of biofortification in Nigeria 24
3.6 Barriers preventing disadvantaged groups from accessing and benefiting from biofortification 28
3.7 Relevant institutional frameworks creating an enabling environment for scaling up of biofortification in Nigeria 29
3.8 Levels of investments in biofortification by development partners and the government in Nigeria 30
3.9 Needs and challenges of the key actors in the value chains of biofortified crops 31
3.10 Government policies, strategies and development plans in favor of nutrition and biofortification 34
4. Summary of findings 36
Conclusions and recommendations 38
Annexes 40
Annex 1: Questionnaire for farmers 40
Annex 2: Questionnaire for consumers 46

List of tables

Table 1: Key actors in biofortification of crops in Nigeria 11
Table 2: Number of households reached with biofortified crops in Nigeria and other African countries ('000) 14
Table 3: Release dates for biofortified crops by HarvestPlus 19
Table 4: Frequency of consumption of biofortified crops in the study area 24
Table 5: Factors responsible for the slow uptake of biofortification in the states studied 26
Table 6: Barriers preventing disadvantaged groups from accessing and benefitting from biofortification in the study area 28
Table 7: Constraints and proposed interventions in the yellow cassava value chain 32
Table 8: Constraints and proposed interventions for the OFSP value chain 33
Table 9: Constraints and proposed interventions for the pro-vitamin A maize value chain 34

List of figures

Figure 1: Gender distribution of the respondents in the study 8
Figure 2: Age distribution of farmers and consumers of biofortified crops and products 8
Figure 3: Educational qualifications of farmers and consumers of biofortified crops and products 9
Figure 4: Farmers' land holding sizes 9
Figure 5: Farmers' land holding types 10
Figure 6: Farmers and consumers' awareness on the existence biofortified sweetpotatoes, cassava and maize in Nigeria 18
Figure 7: Farmers and consumers' awareness on the existence of biofortified sweetpotatoes, cassava and maize by state in Nigeria 18
Figure 8: Farmers and consumers' main sources of information on the existence of biofortified sweetpotatoes, cassava and maize in Nigeria 19
Figure 9: Farmers and consumers' understanding of the purpose of biofortification 20
Figure 10: Percentage of farmers cultivating non-biofortified sweetpotatoes, cassava and maize among the sampled population 20
Figure 11: Percentage of farmers planting biofortified varieties of sweetpotatoes, cassava and maize in the sampled states 21
Figure 12: Percentage of farmers planting biofortified varieties of sweetpotatoes, cassava and maize by states 21
Figure 13: Reasons farmers plant biofortified sweetpotato, cassava and maize 22
Figure 14: Portion of land farmers use for planting the biofortified varieties of cassava, sweetpotato and maize 22
Figure 15: Frequency of planting of biofortified 23
Figure 16: Households consuming sweetpotatoes, cassava and maize in the sampled states 23
Figure 17: Types of sweetpotato, cassava and maize consumed 23
Figure 18: Reasons for the consumption of non-white sweetpotato, cassava and maize 24

Abbreviations

ADP	agricultural development program
ATA	Agricultural Transformation Agenda
ARMTI	Agriculture and Rural Management Training Institute
BNFB	Building Nutritious Food Baskets Project
CIP	International Potato Center
CPPA	Centre for Public Policy Alternatives
DFID	Department for International Development
GAIN	Global Alliance for Improved Nutrition
GMOs	genetically modified foods
IITA	International Institute for Tropical Agriculture
NGO	nongovernmental organization
NRCRI	National Root Crops Research Institute, Umudike
OFSP	orange-fleshed sweetpotato
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WHO	World Health Organization

Acknowledgements

We are grateful to the Bill & Melinda Gates Foundation for supporting our project, the Building Nutritious Food Baskets: Scaling up Biofortified Crops for Nutrition Security in Nigeria and Tanzania (BNFB). The BNFB Project greatly appreciates the contributions of all the stakeholders contacted for information in this study. These include the ministries of agriculture, health, education, budgets and national planning, as well as the selected states' agricultural development programs. Worthy of mention as well are the academic and research institutions, namely the Federal University of Agriculture, Abeokuta; the National Root Crops Research Institute, Umudike; the National Cereal Institute, Badeggi; the International Institute of Tropical Agriculture, Ibadan; and HarvestPlus in Nigeria. We appreciate the inputs to this study of development partners and NGOs, specifically the Catholic Relief Services, the Civil Society Scaling-Up Nutrition in Nigeria, Save the Children, etc. Also, we say a big thank you to all the farmers, processors, marketers, consumers and other respondents who gave their unbiased opinions on biofortification and biofortified crops.

We acknowledge the survey team that made the study a reality, specially Dr Chris Ogedengbe and Dr Omoh Omokpedia, who supported Uzoma Chimapam William, Michael Falade and Ibrahim Lawani in data collection, and the project country advocates for reviewing the draft and providing feedback on the findings. Thanks also to Kellen Kebaara for assisting with the editing and layout of this report and to the Communications and Public Awareness Department at CIP–Lima for their support in designing the cover.

Our gratitude goes also to the entire project team in Nigeria for their unwavering dedication and commitment to ensuring the success of this study, and in particular the country coordinator, Dr Olapeju Phorbee, and Isiaka Oyerinde.

We are indebted to Dr Andrew Onwuemele for working on the data, finishing up the study, putting together the report against all odds and developing the advocacy strategy.

Executive summary

About 63% of the women in Nigeria are anemic and 31% are iodine deficient, and close to 30% of under-fives are vitamin A deficient. While the government has instituted several measures to address the micronutrient deficiency challenges, the country continues to report cases of micronutrient deficiency. Biofortification is a strategy for addressing micronutrient malnutrition that can reach the remote rural areas that often are not easily reached by existing initiatives. This justifies the need for biofortification interventions such as the Building Nutritious Food Baskets (BNFB) Project in Nigeria. BNFB is a three-year project (2015–2018) funded by the Bill & Melinda Gates Foundation. It aims to contribute to the reduction of hidden hunger by catalyzing sustainable investments in the utilization of biofortified crops in Nigeria and Tanzania.

This situation analysis employed multiple approaches. Data collection was in two phases. The first stage involved a desk review and content analysis of several documents in which preliminary answers to the specific objectives of the situation analysis were identified. The output from that was a report with preliminary conclusions to be tested during the field visits. The second phase involved field visits and consultations with relevant stakeholders. The main instruments for data collection were questionnaires, a focus group discussion guide and a key informant interview guide. In all, 420 farmers and 735 consumers were systematically and randomly selected to participate in the situation analysis. Qualitative and quantitative techniques were employed in the data analysis. The data collected through the questionnaire were analyzed statistically by relevant descriptive statistics including frequency, percentage, mean, median and cross-tabulation. All data were analyzed with SPSS.

Summary of the findings

Objective 1: Use available data and other information to accurately identify the key actors in the scaling up of biofortified crops and the trends and patterns of consumption of biofortified crops and their products, disaggregated by relevant segments of the country and of the population.

- There were several key actors involved in the scaling up of biofortified crops in Nigeria. These included international partners such as HarvestPlus, the Bill & Melinda Gates Foundation, Catholic Relief Services, Helen Keller International, the International Potato Center (CIP), the United Nations Children's Fund (UNICEF) and the International Institute of Tropical Agriculture (IITA) as well as national partners and research institutes such as the Federal Ministry of Agriculture and Rural Development and the National Root Crops Research Institute.

- The first variety of pro-vitamin A cassava was approved for release in Nigeria in late 2011 and about half a million Nigerian farm households were growing its varieties.

- The level of awareness on biofortification was high among farmers but low among consumers. Over 60% of the farmers surveyed were aware of the existence of biofortified sweetpotatoes, cassava and maize but over 61% of the consumers were not aware of the existence of these crops.

- Among the states, farmers' awareness on biofortification was highest in Benue, at 83.8%, followed by Kaduna, at 79%, Akwa-Ibom, at 70%, Taraba, at 56.9% and Osun, at 56.7%. Among consumers, awareness of the existence of biofortified sweetpotatoes, cassava and maize was high only in Benue state, at 83%.

- The level of farmers' awareness on the biofortified crops was highest for OFSP, at 55.1%, and then cassava, at 39.9%. Only 5% of the respondents were aware of the existence of biofortified maize.

- The main source of information on the existence of biofortified crops was markets, which was the source for 48.2% of the farmers, friends for 24% of the farmers and agricultural development programs (ADPs) for 14.8% of the farmers. The sources of information for consumers included friends for 39.3% of them, markets for 33.1% of them and ADPs for 12.7% of them.

- There was a general low level of awareness among consumers on the benefits of biofortification of crops. Only 25.6% of them accurately identified the benefits of biofortification, compared with 78% of the farmers.

- Some 42.2% of the farmers planted biofortified sweetpotatoes, 33.3% planted biofortified cassava and 15% planted biofortified maize. Overall, only 30.2% of the farmers planted biofortified crops.

- About 61.1% of the farmers planting biofortified crops cultivated them mainly for consumption, while only 30.3% of them cultivated them for sale.

- The predominant types of sweetpotatoes, cassava or maize consumed by the respondents were the white types, which are not biofortified. Fewer than 3% of the respondents consumed the non-white varieties of these crops.

- The consumption of biofortified crops and food products was influenced by the consumers' level of education and location, and the taste and texture of the products.

Objective 2: Identify and analyze the barriers and bottlenecks that prevent disadvantaged groups from accessing and benefiting from biofortification, including the social, political and economic conditions that result in shortfalls in the creation of an enabling environment for the scaling up of biofortification.

- The main barriers disadvantaged groups faced in accessing and benefiting from biofortification included cultural and individual preferences relating to the product attributes; inefficiencies in the credit market, information access, and input and output markets; and their low education levels.

Objective 4: Analyze the extent to which biofortification is prioritized in national policies, law, strategies, plans and budgets.

- There were five key policies in Nigeria that target malnutrition, but only two specifically mentioned biofortification as a strategy for addressing micronutrient deficiency.

- The following gaps were identified with respect to policy support for biofortified foods:
  - The focus of the agriculture policy remained on increasing yields of staple crops;
  - Nutrition policies focused on direct interventions and largely neglected food-based approaches;
  - The policy environment in Nigeria did not overtly promote biofortification.

Objective 5: Analyze government's (and its agencies') policy and funding priorities as far as nutrition and biofortification are concerned.

- The sources of funding for biofortification in Nigeria were internal and external. The internal sources were mainly related to the federal government, while the main external sources were HarvestPlus and the Bill & Melinda Gates Foundation.

- Another source of funding was the New Alliance for Food Security and Nutrition.

Objective 6: Analyze current institutional and structural bottlenecks to address in order to unlock the value chain for the biofortified crops in the country, including the varietal release policies/criteria and the biofortified varieties currently in the pipeline (for release).

- There were nine types of actors in the biofortified crops value chain in Nigeria – farmers, local collectors, national traders, wholesalers, retailers, agroprocessors, home consumers, national agricultural research institutes and the variety release committee.

- The key constraints in the yellow cassava value chain included underutilization of cassava tubers for industrial purposes, weak linkages between the industrial users of cassava products and processors, poor market information, unavailability of inputs, poor finance, and the short shelf life of yellow cassava roots.

- The key constraints in the OFSP value chain included the low uptake of the crop in processing, low productivity of smallholder farmers, poor access to farm inputs, low awareness among consumers on the nutritional value of OFSP, poor linkages among farmers and processors of OFSP, short shelf life of OFSP roots, poor market outlay, and poor multisectoral coordination and collaboration among OFSP stakeholders in Nigeria.

- The key constraints in the maize value chain included insufficient knowledge on good agricultural and postharvest practices; limited knowledge on soil management practices, crop nutrient requirements and other agronomic essentials; aflatoxin contamination; storage pests such as mice, rats and other rodents, which were a source of notable damage to stored maize grain; low yield; and low rates of adoption of the improved technical package by farmers.

- The quantity of food returned after processing was lower for pro-vitamin A cassava than for conventional cassava, and pro-vitamin A cassava products were more expensive than conventional cassava products.

- The poor packaging method used by processors for preserving pro-vitamin A content was one of the major institutional bottlenecks.

- The unavailability of seeds is an important challenge that must be addressed.

- The inadequacy of the laboratory facilities, which are important for research geared towards improving the texture, taste and color of the biofortified crops, was a key institutional problem.

Conclusions and recommendations

This study gives a clear picture of the situation in Nigeria with respect to BNFB objectives and indicators, and also contributes to improving the understanding on the gaps and the actions vital for the scaling up of biofortification in Nigeria. These outcomes will be useful in designing strategic interventions for scaling up biofortified crops for nutrition security in Nigeria. The following recommendations emanate from the findings of the study:

- CIP and HarvestPlus should target more advocacy programs at raising the awareness level on the existence of biofortified crops in Nigeria.

- CIP should aim for the use of media channels such as television and radio for awareness creation and sensitization programs for stakeholders on the existence and importance of biofortified crops for their health.

- HarvestPlus, CIP and other research institutions should focus on improving the yield, maturity period, taste, color and texture of the biofortified crops based on the preferences of farmers and consumers.

- HarvestPlus and CIP should develop an intervention specifically addressing the bottlenecks that prevent disadvantaged groups from accessing and benefitting from biofortified crops.

- HarvestPlus and CIP should advocate for the establishment by the federal government of an institutional framework to support biofortification in Nigeria that is backed by law.

- CIP should carry out advocacy among the partners in the New Alliance for Food Security and Nutrition to ensure that part of their investment in agriculture in Nigeria is directed to biofortification activities.

- CIP and other partners in Nigeria should conduct advocacy programs focused on policy-makers for the mainstreaming of biofortification in agriculture and nutrition policies.

- CIP should create a biofortification innovation platform that incorporates all the stakeholders around the agricultural farming zones in each state, including farmers, researchers, input dealers, processors, marketers, financial institutions and consumers.

- CIP should implement capacity building interventions for key actors in the biofortified crops' value chain as follows:
  - Farmers: on-farm demonstrations on agronomic practices that increase yield and on storage of biofortified crops;
  - OFSP processors: new processing approaches that improve the taste, texture and dry matter content of the roots and processed products;
  - Researchers: techniques to develop new biofortified crops with high yields, resistance to diseases and pests, short maturity period, good taste and high nutritive value.

1. Introduction

1.1 Background

Globally, malnutrition and nutrition-related diseases continue to be problems of great public health importance. In 2015, 159 million children under the age of five were chronically malnourished or stunted, presenting massive global health and economic development challenges.[1] This scenario is abysmal in Africa. According to the Hunger and Nutrition Commitment Index for Africa for 2016, that year 58 million children under the age of five were stunted, 13 million were wasted and 10.3 million were obese. Additionally, an estimated 220 million Africans were calorie deficient. The hunger and malnutrition situation in Africa is evidently reflected in Nigeria. Nigeria has the highest number of stunted children under age five in sub-Saharan Africa and the second highest in the world, with 37% of all children of that age classified as stunted and 19% as severely stunted.[2]

Malnutrition can take several forms including hunger, undernutrition, overnutrition and micronutrient deficiency. Micronutrient deficiency, often referred to as hidden hunger, is a serious problem in sub-Saharan Africa. The most prevalent micronutrient disorders on the continent are vitamin A and iron deficiencies. An estimated 163 million children and women of reproductive age are anemic, while about 44 million of pre-school children in Africa are vitamin A deficient. About 24% of all child deaths are attributable to vitamin A deficiency.[3]

In Nigeria, about 63% of the women are anemic and 31% are iodine deficient, and close to 30% of under-fives are vitamin A deficient and 20% are zinc deficient.[4] While the government has instituted several measures to address micronutrient deficiency challenges, micronutrient deficiency continues to be manifested in several segments of the population.

The current efforts to address micronutrient malnutrition include supplementation programs that provide iron and vitamin A capsules to women of reproductive age and children under the age of five through the health sector. Even where supplementation coverage through these programs is high, it only targets the most vulnerable groups, yet micronutrient deficiencies are of public health significance and the entire population needs to have access to adequate micronutrients. Food-based approaches for addressing micronutrient malnutrition have so far largely been limited to commercial food fortification of salt with iodine; cooking oil, sugar and margarine with vitamin A; and wheat flour and maize meal with iron and B vitamins. The promotion of dietary diversification and nutrition-sensitive food production, and nutrition education have not received the focus and sustained attention necessary to effect sustainable behavior change.[5] Biofortification provides an additional strategy for addressing micronutrient malnutrition to reach the remote rural areas often not easily reached by the other existing initiatives.

Nutrition evidence shows that added nutrients bred into staple foods under controlled conditions become bioavailable when the food is consumed and are absorbed at sufficient levels to improve micronutrient status. A study in South Africa evaluated the impact on liver reserves of vitamin A of in

[1] UNICEF, WHO and World Bank. (2015). Joint child malnutrition estimates: levels and trends. Global database on child growth and malnutrition. (http://www.who.int/nutgrowthdb/estimates2014/en/, accessed May 2017).

[2] Nigeria health sector component of national food and nutrition policy: national strategic plan of action for nutrition (2014–2019).

[3] Tagwireyi, J. (2017). A situational analysis of regional investment, policies, legislations and advocacy efforts of food based approaches to combating macronutrient deficiency in Sub-Saharan Africa: focus on bio-fortification.

[4] Micronutrient Initiative. (2013). Nigeria Country Profile (http://www.micronutrient.org/english/view.asp?x=596).

[5] Tagwireyi, J. (2017). A situational analysis of regional investment, policies, legislations and advocacy efforts of food based approaches to combating macronutrient deficiency in Sub-Saharan Africa: focus on bio-fortification.

children fed sweetpotato for five months during the school year and found that those who ate orange-fleshed sweetpotato (OFSP) had a positive change in liver reserves of vitamin A compared with those who ate white sweetpotatoes, measured using the modified relative dose response test,[6] which is a semi-quantitative method to evaluate liver reserves.[7] In more recent work among Bangladeshi women, [8] consumption of OFSP 6 days a week over 10 weeks did not show a net gain in the total body reserves of vitamin A over the negative controls but it did contribute to the rise in circulating serum beta-carotene concentrations. With respect to yellow cassava, in vitro studies with cassava showed that beta-carotene content was proportional to the volume consumed and that the genotype did not have an influence on the level of beta-carotene currently available in the germplasm.[9] In studies conducted on animals, the bioconversion factor was found to be 3.7 µg beta-carotene to 1 µg retinol despite the fact that the cis-β-carotene composition in processed cassava is 48%.[10] This justifies the need for new interventions for addressing micronutrient deficiency problems in Nigeria, such as the Building Nutritious Food Baskets (BNFB) Project.

1.2 Context of the baseline study

Although Nigeria recorded a decline in under-five stunting from 41% in 2008 to 37% in 2013,[11] the country still accounted for 11 million out of the world's 60 million stunted children in 2012.[12] The Nigeria demographic and health survey data[13] showed that the nutritional status trend worsened from 24% in 2003 to 23% in 2008, the underweight status from 29% in 2003 to 11% in 2013 and the wasting status from 14% in 2008 to 18% in 2013. There is abundant evidence suggesting that malnutrition is prevalent in Nigeria in general and in northwest Nigeria in particular, where the basic needs of life of food, shelter and clothing often are not within the reach of the majority of the poor. Data for 2013 show that more than half of the children aged under five years from the North West region were chronically malnourished while 36% were severely stunted.[14] Zamfara is one of the states in the region with appalling malnutrition among under-fives, and 34% of the children there were severely malnourished while 56% were chronically malnourished.[15]

The October 2016 Cadre Harmonisé[16] analysis on Nigeria showed that some 8 million people in the northeast were facing acute food insecurity. While the government has geared up its support and humanitarian access to the northeastern states, the situation remained particularly worrisome in the

[6] van Jaarsveld, P.J., Faber, M., Tanumihardjo, S.A. et al. (2005). β-Carotene-rich orange-fleshed sweet potato improves the vitamin A status of primary school children assessed with the modified-relative-dose-response test. *Am J Clin Nutr*., 81:1080–1087.

[7] Tanumihardjo, S.A. (2011). Vitamin A: biomarkers of nutrition for development. Am J Clin Nutr., 94:658S–65S.

[8] Jamil, K.M., Brown, K.H., Jamil, M., Peerson, J.M., Keenan, A.H., Newman, J.W., Haskell, M.J. (2012). Daily consumption of orange-fleshed sweet potato for 60 days increased plasma β-carotene concentration but did not increase total body vitamin A pool size in Bangladeshi women. J Nutr., 142:1896–1902.

[9] Thakkar, S.K., Maziya-Dixon, B., Dixon, A.G., Failla, M.L. (2007). β-carotene micellarization during in vitro digestion and uptake by Caco-2 cells is directly proportional to b-carotene content in different genotypes of cassava. *J Nutr.,* 137:2229–2233.

[10] Howe, J.A., Valentine, A.R., Hull, A.K., Tanumihardjo, S.A. 2009. C natural abundance in serumretinol acts as a biomarker for increases in dietary pro-vitamin A. *Exp Biol Med*., 234:140–147.

[11] NPC, ICF International. (2014). Nigeria 2013 Demographic and Health Survey. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF International..

[12] Ehikioya, A., Adanikin, O. (2012). The report: 11 million Nigerian children are malnourished. (http://www.A life free from hungerinternational.org/url.cfm, accessed 13 May 2017).

[13] NPC, ICF International. (2014). Nigeria 2013 Demographic and Health Survey. Abuja, Nigeria, and Rockville, Maryland, USA: NPC and ICF International.

[14] ibid

[15] Ibid

[16] Cadre Harmonisé is an internationally recognized tool used in West African to analysis and identify areas and people at risk of food and nutrition insecurity.

state of Borno, where nearly 60% (3.3 million people) of the population was facing acute food insecurity, including 55,000 who were threatened by famine.[17]

The initiative to control and reduce micronutrient deficiency disorders in Nigeria goes back to 2002, when the government adopted as a new strategy fortification of staple foods with vitamin A so that children could easily consume vitamin A in their food. The Ministry of Industry, through the Standards Organization of Nigeria, published mandatory standards for vitamin A fortification for flour, sugar and vegetable oil that year. By 2004, 70% of the sugar, 100% of the wheat flour and 55% of the vegetable oil in the market were fortified with vitamin A. Nigeria is also fortifying wheat flour with iron, thereby helping to protect children and mothers' physical and mental health.[18] In 2004, the Federal Government of Nigeria initiated the Home-Grown School Feeding Programme through the Universal Basic Education Act. That legislation stipulated that at a minimum all state primary schools must provide one meal a day to each student. The school feeding program aimed at improving the nutritional intake of at least 25 million children of school age. As part of the efforts to address the dire nutrition situation of Nigeria, a National Strategic Plan of Action for Nutrition was devised that built on other strategic documents such as Vision 20:2020 and the National Strategic Health Development Plan for 2009 to 2015.

Food-based approaches for addressing micronutrient malnutrition in Nigeria have so far largely been limited to commercial food fortification of salt with iodine; cooking oil, sugar and margarine with vitamin A; and flour and maize meal with iron and B vitamins. Many rural communities have limited access to commercially processed and fortified foods, and often locally processed and unfortified foods are more readily available to them and cheaper.[19] Biofortification – the enhancement of micronutrient levels of staple crops through biological processes such as plant breeding and genetic engineering[20] – provides an additional strategy for addressing micronutrient malnutrition in Nigeria. Biofortification has multiple advantages, including the fact that it capitalizes on the regular daily intake of a consistent amount of a staple food by all the family members and it has the potential to reach the remote rural areas that are not easily reached by the existing initiatives. These advantages were the triggers for the initiation of BNFB in Nigeria.

BNFB was initiated to contribute to tackling the health and other challenges posed by micronutrient deficiency in Nigeria. As a best practice, the implementation of any development intervention program is usually accompanied by systematic efforts to measure its effectiveness and understand its broad impact on its beneficiaries. That approach demands proper knowledge of the existing situation in order to be able to establish the counterfactual of the program. It is in that context that the baseline survey of the BNFB Project was commissioned.

1.3 BNFB Project: scaling up biofortified crops for nutrition security in Nigeria

BNFB is a three-year project running from 2015 to 2018 and funded by the Bill & Melinda Gates Foundation. It aims to contribute to the reduction of hidden hunger by catalyzing sustainable investments in the utilization of biofortified crops at scale in the Nigeria and Tanzania. The project adopts a multi-crop food basket approach, advocates for increased investment in the integration of biofortified food crops in food systems and contributes to the sustainable solutions for addressing

[17] RCPA. (2016). 32nd Annual Meeting of Food and Nutrition Insecurity In North-East Nigeria (https://www.oecd.org/countries/nigeria/Food-nutrition-insecurity-Nigeria_EN.pdf, accessed 13 May 2017).

[18] UNICEF. (2006). Information Sheet Nutrition(https://www.unicef.org/wcaro/WCARO_Nigeria_Factsheets_Nutrition.pdf).

[19] Tagwireyi, J. (2017). A situational analysis of regional investment, policies, legislations and advocacy efforts of food based approaches to combating macronutrient deficiency in Sub-Saharan Africa: focus on bio-fortification.

[20] Bouis, H.E. (2002). Plant breeding: A new tool for fighting micronutrient malnutrition. *Journal of Nutrition,* 132:491–494.

micronutrient malnutrition, especially in the vulnerable groups of young children and women. The project builds on lessons learnt from and achievements of the Reaching Agents of Change (RAC) Project (2011–2015), which was spearheaded by the International Potato Center (CIP) and Helen Keller International, to scale up the adoption of biofortified crops. The crops BNFB is promoting are high iron beans, pro-vitamin A maize (orange maize), orange-fleshed sweetpotatoes (OFSP) and yellow cassava. BNFB is led by CIP, which along with the International Center for Tropical Agriculture (CIAT), the International Maize and Wheat Improvement Center (CIMMYT), the International Institute of Tropical Agriculture (IITA), HarvestPlus and the Forum for Agricultural Research in Africa (FARA), forms the consortium of six core partners implementing the project, working together with national partners. The project has two specific objectives:

- Strengthen the enabling environment for increased investments in biofortified crops;
- Strengthen institutional and community capacities to produce and consume biofortified crops.

The primary aim of the situation analysis was to gather analytical data and information that establish the baseline status of the key thematic components of BNFB and the key actors responsible for realizing the objectives of the BNFB Project.

1.4 Goals and objectives

The general objectives of conducting the situation analysis were to:

- Improve the understanding of decision-makers, partners and all other stakeholders working in biofortification in the country;
- Identify the causes of the slow uptake of biofortification, as the basis for recommending actions;
- Identify the mechanisms to support national and decentralized planning and development processes, including influencing policies, strategies, budgets and national policies to contribute towards creating an enabling environment for scaling up biofortification;
- Identify the current levels of funding and/investments in biofortification by development partners and the government;
- Strengthen the knowledge base on the current consumption patterns for biofortified crops and their products;
- Map out the key actors, the needs of the population and communities, and the bottlenecks and gaps to be addressed in order to unlock the value chains of the biofortified crops in the country and prioritize interventions that need to be implemented (advocacy, promotion, seed systems, and institutional and individual capacity building and training);
- Identify the major policies, strategies and plans in place that favor biofortification and the areas for further policy engagement.

The specific objectives of situation analysis were to:

- Use available data and other information to accurately identify the key actors in scaling up biofortified crops and the trends and patterns of consumption of biofortified crops and their products, disaggregated by relevant segments of the country and of the population;
- Identify and analyze the barriers and bottlenecks that prevent disadvantaged groups from accessing and benefiting from biofortification, including the social, political and economic conditions that result in shortfalls in the creation of an enabling environment for the scaling up of biofortification;
- Assess the current investment pattern in biofortification and the main donors to approach to unlock increased investments in biofortification;
- Analyze the extent to which biofortification is prioritized in national policies, law, strategies, plans and budgets;

- Analyze the government's (and its agencies') policy and funding priorities as far as nutrition and biofortification are concerned;
- Analyze the current institutional and structural bottlenecks to address in order to unlock the value chain for the biofortified crops in the country, including the varietal release policies and criteria and the biofortified varieties currently in the pipeline (for release);
- Assess the needs of the population and communities, bottlenecks and gaps to be addressed and prioritize the interventions that need to be implemented (advocacy, promotion, seed systems, and institutional and individual capacity building and training opportunities).

2. Study methodology

Mixed methods were employed in conducting the situation analysis, which was in two phases: a desk review involving a content analysis of literature pertinent to the objectives of BNFB, and a field survey with field visits and consultations with stakeholders.

2.1 Desk review

The first stage was a desk review during which preliminary answers to the specific objectives of the situation analysis were identified through a content analysis of several documents, including key reports, policy documents, published studies, research and survey reports and relevant grey literature. It also involved a content analysis of available legislation, social policy, budget allocation and expenditure documents in conformity with the objectives of BNFB. The product from this stage was a report with preliminary conclusions to be verified during the field visits.

2.2 Field survey

2.2.1 Research design

The survey research design was adopted for the study. Generally survey research draws samples from a large population and the conclusions reached from the sample are generalized to the entire population. This design was suitable for the situation analysis, as it was not possible to cover all the states in Nigeria due to cost and time considerations. The design also allowed us to elicit information about attitudes and perceptions, which might have been difficult to obtain using other designs.

2.2.2 Sample size determination and sampling technique

The total population of farmers in Nigeria and of those involved in the planting of biofortified crops are unknown. Consequently, the sampling design adopted for the situation analysis was purposive. However, efforts were made to ensure that the study covered all the geopolitical zones in Nigeria.

The seven states of Akwa-Ibom, Benue, Enugu, Kwara, Kaduna, Osun and Taraba were purposively selected from each of the six geopolitical zones of Nigeria for the situation analysis study. Each of these states was divided into farming zones following a geographical categorization based on the crop types and share of production. With the assistance of the agricultural development programs (ADPs), two farming zones were purposively selected in each state using their cultivation of sweetpotato, maize and cassava as the main criterion for selection. In each of the farming zones, a list of farmers was obtained from the ADP. That list served as the sampling frame from which 60 farmers were randomly selected in each of the selected states. Also, in each of the selected states 105 consumers of at least one of sweetpotato, cassava and maize crops were purposively selected. A total of 420 farmers and 735 consumers participated in the study.

2.2.3 Key data sources

In order to achieve the objectives of the situation analysis, both qualitative and quantitative data were gathered from primary and secondary sources. Primary data were obtained from farmers and consumers of sweetpotato, cassava and maize. Secondary data were collected from published and unpublished materials such a key reports, policy documents, published studies, research and survey reports, and social policy, budget allocation and expenditure documents. Some of the secondary sources of data were Tagwireyi (2017),[21] UNICEF, WHO & World Bank (2015),[22] HarvestPlus (2016),[23] the Nigeria Health Sector Component of National Food and Nutrition Policy, and the National Strategic Plan of Action for Nutrition (2014–2019), among others.

2.2.4 Methods of primary data collection

The main instruments used in collecting data for the situation analysis were questionnaires, an in-depth interview guide and focus group discussion (FGD) guide.

- **Questionnaire administration:** Two sets of questionnaires were designed for the situation analysis. The first questionnaire was for farmers (see Annex 1). The questions sought information on the farmers' demographics, farming practices, awareness on the non-white cassava, sweetpotato and maize, production patterns and challenges etc. The second questionnaire was administered to consumers (see Annex 2) and the questions bordered on demographics, frequency and pattern of consumption of sweetpotatoes, cassava and maize crops and their products, awareness on non-white cassava, sweetpotatoes and maize, among other issues.

- **Focus group discussions:** One focus group discussion was conducted for farmers in each state to establish their awareness on and knowledge about OFSP, vitamin A maize and yellow cassava, how they sourced seeds, how and to whom they sold their produce, and motivation for growing the crops of interest and their challenges. Each focus group consisted of a maximum of eight farmers. Farmers who were growers of at least one of sweetpotato, cassava or maize were recruited through their state ADPs at least two days before the engagement.

- **In-depth interviews:** The respondents for the in-depth interviews included processors; input suppliers for vines, stems and seed; ADP staff; nutritionists; representatives of research and training institutes; aggregators and marketers of biofortified crops.

2.3 Data analysis

Qualitative and quantitative techniques of data analysis were employed for both the descriptive and inferential analyses of the study. Content analysis was undertaken on data collected through the in-depth interviews and FGDs. The data collected through the questionnaire were analyzed using relevant descriptive statistics including frequency, percentage, mean, median and cross-tabulation. All data collected were analyzed with the SPSS.

[21] Tagwireyi, J. (2017). A situational analysis of regional investment, policies, legislations and advocacy efforts of food based approaches to combating macronutrient deficiency in Sub-Saharan Africa: focus on bio-fortification.

[22] UNICEF, WHO and World Bank. (2015). Joint child malnutrition estimates: levels and trends. Global Database on Child Growth and Malnutrition (http://www.who.int/nutgrowthdb/estimates2014/en/, accessed May 2017).

[23] HarvestPlus. (2016). Biofortification in Africa: evidence of success and vision for scaling up. ReSAKSS 2016 Conference Side Event, 18 October 2016, Accra, Ghana.

2.4 Quality assurance

Quality assurance is critical in a survey of this nature, so, in all the stages of the survey adequate measures were taken to enhance the credibility of the exercise and the quality of the data collected.

The design of the data collection instruments was tailored to the scope of the study, taking cognizance of the broad goals and the specific objectives as stated in the terms of reference. These helped determine the variables that were included in the data collection instruments. In addition, the decision to design four data collection instruments, i.e. two questionnaires, an FGD guide and an in-depth interview guide, was to ensure that adequate data were collected from the different sources in a complementary manner. This facilitated data triangulation and improved the internal validity and reliability of the instruments as well as the quality of the data. Furthermore, the two questionnaires were pilot tested and, along with the other two research instruments, were thoroughly reviewed and revised several times based on the views and comments of experts in this field. Check questions were incorporated in the instruments to ensure that inconsistencies on the part of the respondents and enumerators in the field were detected during data cleaning and analysis.

2.5 Ethical considerations

The research design included measures to preempt the occurrence of ethical issues in the study. In this regard each questionnaire was accompanied with a short consent form that was read to the respondents, and it is only after agreeing to the content of the form that they were allowed to participate in the research.

To ensure maximum confidentiality of the research participants, the analysis and presentation of data from the interviews and the FGDs, and the questionnaire administration observed the principle of non-attribution.[24]

3. Main findings on issues and trends in biofortification

This section presents the main findings of the situation analysis for BNFB. It first deals with the demographic and socioeconomic characteristics of the respondents to the questionnaire interviews, who mainly were farmers and consumers in the sampled states.

3.1 Socioeconomic and demographic characteristics of farmers and consumers of biofortified crops and products in Nigeria

Basic sociodemographic characteristics of farmers and consumers are important variables in determining their social and economic behavior. Figure 1 presents the gender distribution of the respondents in the study. More male farmers (73.5%) and male consumers (61.7%) participated in the study.

[24] That means that while all the participants' contributions were taken into account in the study, specific statements cannot be traced back to them.

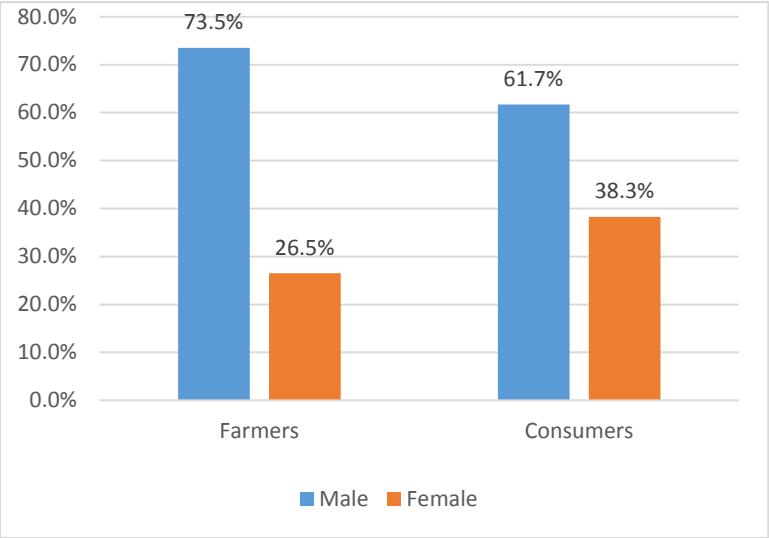

Figure 1: Gender distribution of the respondents in the study

Figure 2 indicates that 51.3% of the farmers in the study were between the ages of 31 and 50 years, while about 72.3 % of the consumers were between 21 and 40 years old.

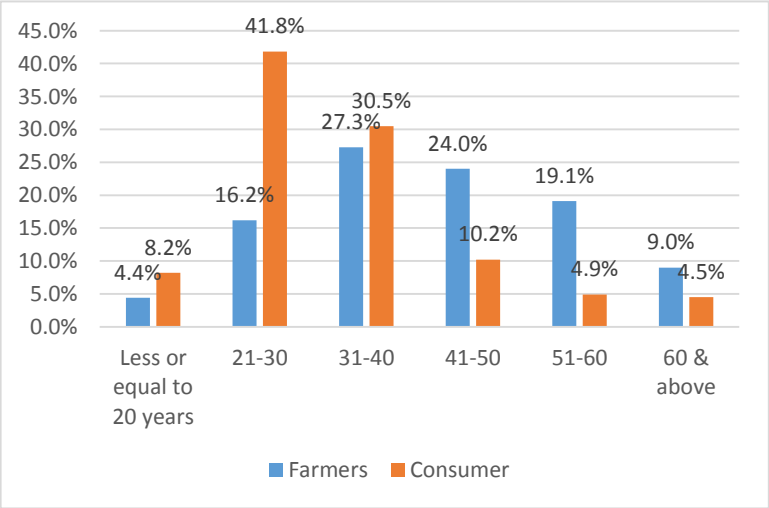

Figure 2: Age distribution of farmers and consumers of biofortified crops and products

Figure 3 indicates that the consumers of biofortified crops were mainly individuals with relatively high educational qualifications, as over 78% of them had secondary or tertiary education as their highest educational level. The low consumption of the crops among the less educated might be attributed to their low nutritional knowledge, and it agrees with Mogendi et al. (2016)[25] who found that nutritional knowledge was relatively lower among households with low education than among those with better educated respondents. Another explanation is that most of the sensitization and awareness programs for biofortification were conducted in urban areas among educated people. This calls for more outreach to the grassroots communities to increase their knowledge on the value of biofortified crops.

[25]Mogendi, J.B., De Steur, H., Gellynck, X. and Makokha, K. 2016. Modelling protection behaviour towards micronutrient deficiencies: case of iodine biofortified vegetable legumes as health intervention for school-going children. Journal List Nutr Res Practv.10(1):

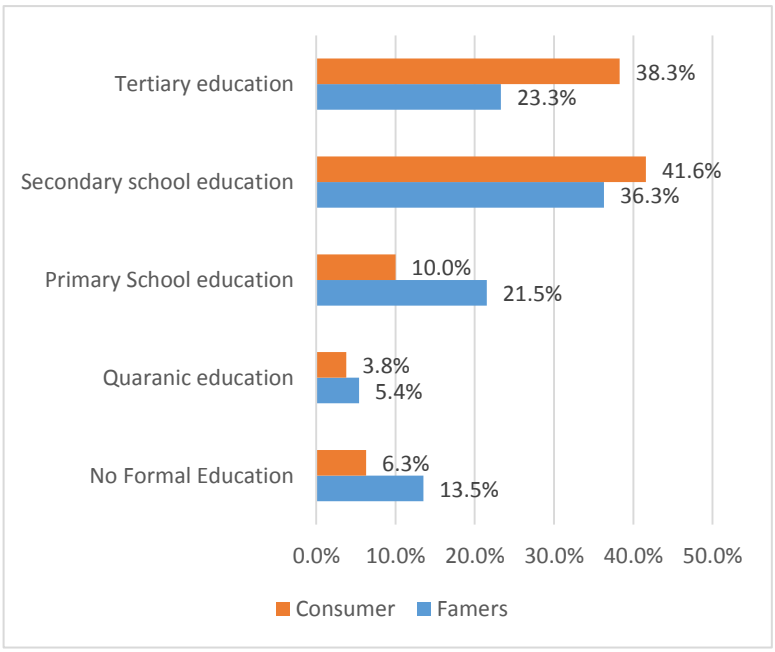

Figure 3: Educational qualifications of farmers and consumers of biofortified crops and products

Among the farmers, 89.4% had farmed for at least five years, 52.3% processed their crops for both family consumption and basic income generation, and 47.7% restricted their livelihood activities to farming. Some 52.1% of the farmers were members of farmers' associations and cooperatives, while the others did not belong any farming association.

Figure 4 shows farmers' land holding sizes, and most of them had more than 5 acres. Almost 60% of the farmers farmed in lowlands, or fadama[26] land (Figure 5).

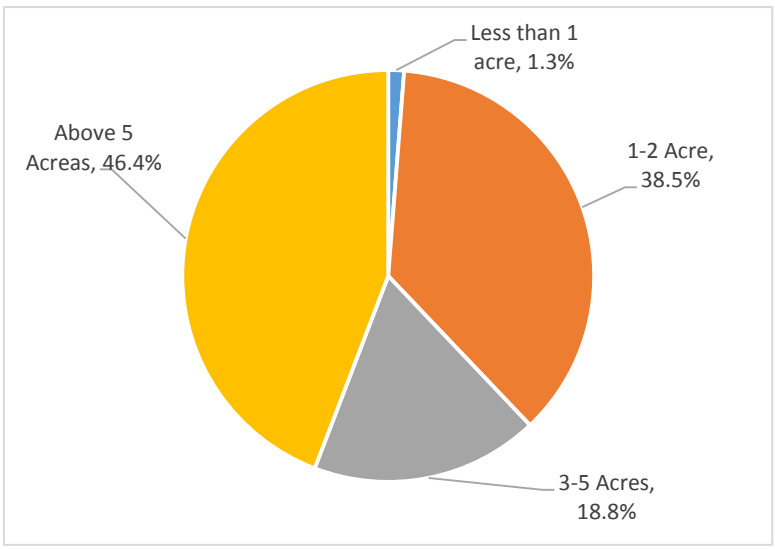

Figure 4: Farmers' land holding sizes

[26] 'Fadama' is a Hausa name for irrigable land, usually low-lying plains underlain by shallow aquifers, found along major river systems.

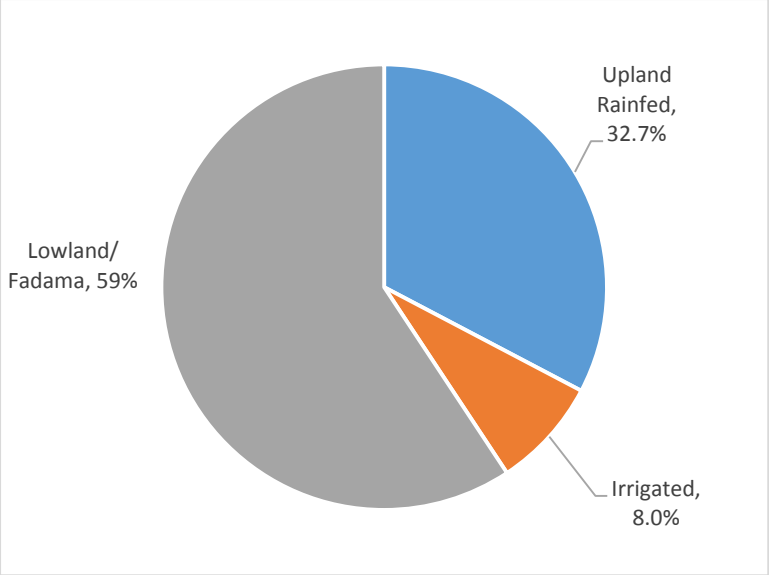

Figure 5: Farmers' land holding types

3.2 Actors and trends in biofortification

A stakeholder analysis was carried out aimed at identifying the key actors in biofortification processes and activities in Nigeria. These stakeholders were later grouped into the categories of international actors and donors, national political actors (legislators, governors), government ministries, universities and research institutes, NGOs and civil society organizations, producers, processors, input dealers, marketers and consumers. Table 1 shows the key actors in biofortification activities. The main actors involved in supporting and promoting biofortification activities in Nigeria included HarvestPlus, Catholic Relief Services, Helen Keller International, CIP, UNICEF, IITA, the Federal Ministry of Agriculture and Rural Development and the National Root Crops Research Institute (NRCRI). Others were input dealers, producers, processors, marketers and consumers of biofortified products in Nigeria. The activities of each of these actors in support and promotion of biofortification are highlighted in Table 1.

2.2.1 Institutional and structural bottlenecks to address in order to unlock the value chain of biofortified crops

The key actors in the biofortification of crops were asked to name the institutional and structural bottlenecks to be addressed in order to unlock the value chain of the biofortified crops in Nigeria. Their answers are summarized in Table 1. With regard to the crops themselves, the actors observed that (1) the quantity of food returned after processing pro-vitamin A cassava was low compared with the conventional cassava, and was a reason that consumers preferred the conventional type, (2) the prices of vitamin A cassava products were higher than those for conventional cassava products, (3) there was a misconception that biofortified crop products were GMO products, (4) awareness about OFSP and its products was low, and (5) OFSP's texture and low dry matter content were challenges in its uptake.

In terms of structural and institutional bottlenecks, the key actors regarded investment in the agricultural extension program as low, and the packaging method for preserving pro-vitamin A content during processing was seen as poor. This calls for capacity building for processors to unlock the value chain of biofortified crops. Availability of funds is also a challenge for all the actors and for all the activities necessary to unlock the value chain of the biofortified crops.

Some of the key actors also noted that in some states the farmers' adoption of biofortified crops was high, and increasing numbers of them were looking for the seeds of the crops. Unavailability of seeds has become a major challenge that must be addressed. Furthermore, there was the problem of recycling of seeds by farmers using traditional methods rather than getting seeds from seed companies. This practice has hindered the scaling up of biofortified crops.

The inadequacy of the laboratory facilities at NRCRI is a major institutional problem. Such facilities are important for research geared towards analyzing and improving the physico-chemical and sensory properties of the biofortified crops.

Table 1: Key actors in biofortification of crops in Nigeria

Category	Partners	Reasons for inclusion as partners	Institutional and structural bottlenecks to address to unlock the value chain of biofortified crops
International agencies and donors	HarvestPlus	• HarvestPlus supports NRCRI to breed, test and release vitamin A cassava developed through a partnership with IITA • Creative public awareness campaigns leveraging the power of the mass media, including Nollywood, in educating Nigerians on micronutrient deficiencies and the benefits of vitamin A cassava • Creating and strengthening demand by supporting commercial processing of vitamin A cassava into popularly consumed products such as gari and fufu	• The net food returned from pro-vitamin A cassava is low • Vitamin A products are more expensive than those of non-vitamin A varieties • The misconception that biofortified crops are GMO crops • Mistakes in the distribution by farmers of other varieties of cassava as vitamin A cassava
	IITA	• Worked in close partnership with HarvestPlus for the release of pro-vitamin A maize and cassava. A total of 6 varieties have been released in Nigeria with approval from the National Centre for Genetic Resources and Biotechnology	• Low investment in the agricultural extension program • Poor packaging and method of preserving pro-vitamin A content during processing • Acceptability
	G8 New Alliance for Food Security and Nutrition	• G8 members made multiyear technical and funding commitments to support agricultural program implementation	• Inability of partners to meet their financial commitments to the alliance
	CIP	CIP is a not-for-profit international agricultural research for development organization with a focus on potato, sweetpotatoes and other Andean roots and tubers. BNFB is led by CIP and is implemented by a consortium of six core partners. CIP implemented the RAC, Rainbow and the Jumpstarting Biofortification projects in Nigeria	• Farmers' low adoption of the biofortified varieties. The few farmers planting the crops are not courageous enough to drive the market. They are waiting for CIP to come and mop up the produce. • Policy-makers are slow in buying into biofortification • Misconception that biofortification is genetic modification • Relatively low dry matter in the biofortified crops compared with the non-biofortified varieties, resulting in their low adoption by farmers • Weak intersectoral collaboration since some sectors find it difficult to mainstream biofortification in their

Category	Partners	Reasons for inclusion as partners	Institutional and structural bottlenecks to address to unlock the value chain of biofortified crops
			activities • Limited funding to drive biofortification across the value chain, especially for processing and product development • Government inconsistency in funding and supporting biofortification • Farmers want to have a ready-made market and demand before planting and committing to the crops. They are not willing to take the risk of producing without an assured market, but consumers have to see the crops in market to buy
National and political office holders	National assembly	Law making in respect of biofortification	
Ministries	Federal Ministry of Agriculture and Rural Development	Responsible for developing policies to guide nutrition and nutrition development in Nigeria	• Funding • Office space
	Federal Ministry of Health	Prepared a strategic plan of action that sets priorities for improving the nutritional status especially of mothers, infants and young children	• Funding
Universities and research institutes	Agricultural Research Council of Nigeria	Might be of relevance to BNFB in developing storage systems and infrastructure, which are currently absent for OFSP	
	Agriculture and Rural Management Training Institute	ARMTI was actively involved in the Rainbow Project with responsibilities to build capacity across the OFSP value chain	• Limited advocacy programs to engage communities and farmers on the biofortified crops • Limited access to modern technology to meet training needs • Limited access to funds sometimes deters some would-be trainees from participating in training and agencies from nominating their staff
	National Root Crops Research Institute (NRCRI)	NRCRI is a partner in the development of pro-vitamin A cassava and OFSP, mostly in analysis. It worked collaboratively with HarvestPlus to introduce the variety as well as monitor field performance of the biofortified crop. NRCRI also partners with CIP and the Alliance for a Green Revolution in Africa in the development and release of OFSP.	• At the onset issues relating to GMOs were a challenge. • Standards are usually not met by farmers. Improper planting, processing and packaging techniques are a constant challenge, and the pro-vitamin A content of the crop lost to poor postharvest handling is rising • Access to advanced scientific laboratory equipment has been a challenge • Limited availability of funds • Older scientists are forced to work in the laboratory as since younger scientists have inadequate experience

Category	Partners	Reasons for inclusion as partners	Institutional and structural bottlenecks to address to unlock the value chain of biofortified crops
	Institute of Agriculture Research and Training	IART is an institute of the Obafemi Awolowo University and one of four university-based agricultural research institutes. The institute undertakes genetic improvement of maize, kenaf and jute and has partnered with IITA to release hybrid varieties of pro-vitamin A maize in the Nigerian market	• Low participation of young people in agriculture • Training associated with the introduction of new crop and new technology • Training of older farmers in rural locations • Adoption pro-vitamin A maize by farmers is high and the numbers of farmers looking for seeds is growing. Therefore, availability of seeds is a challenge.
NGOs/civil societies	Coalition of Smallholder Women Farmers in Nigeria	Supporting farmer groups in six geopolitical zones	
	Fahimta Women and Youth Development Initiatives	Supporting farmer groups in six geopolitical zones	
Producers	Farmers	Cultivating biofortified crops	
Processors	Processors	Processing of biofortified crops for consumption	
Input dealers	Marketers	Selling farm inputs	
Marketers	Marketers	Selling finished biofortified products	
Consumers	Individuals/ households	Purchasing and consuming biofortified products	

3.2.1 Trends in biofortification support and promotion in Nigeria

Yellow cassava and orange maize

The first variety of pro-vitamin A cassava was approved for release in Nigeria in late 2011, eight years after the crop's development activities were initiated in 2003 at CIAT and IITA with funding from HarvestPlus. By 2015, five years after the release of pro-vitamin A cassava, an estimated half a million Nigerian farm households were growing its varieties, [27] which contain significant amounts of pro-vitamin A even after processing (Table 2). Yellow cassava now represents an additional source of vitamin A in Nigerian diets. The biofortified food basket in Nigeria includes six varieties of vitamin A cassava, six varieties of vitamin A maize, two varieties of high iron and zinc sorghum and millet, and two varieties of OFSP. The release dates for pro-vitamin A cassava, OFSP and vitamin A maize in Nigeria were 2011, 2012 and 2014, respectively. These biofortified varieties were conventionally bred and are as high yielding as other varieties commonly grown by farmers.[28] Table.2 shows the number of households in Nigeria and other African countries reached with biofortified crops.

[28]Ilona, P., Bouis, H.E, Palenberg, M., Moursi, M. and Oparinde, A. (2017). Vitamin A cassava in Nigeria: crop development and delivery. *African Journal of Food, Agriculture and Nutrition*, 27(2):34–44.

Table 2: Number of households reached with biofortified crops in Nigeria and other African countries ('000)

Crop/country	2012	2013	2014	2015
Vitamin A cassava, Nigeria	0	106	360	520
Vitamin A OSP, Uganda	33	76	107	132
Iron beans, Uganda	29	69	43	37
Iron beans, Rwanda	105	609	332	480
Iron beans, DR Congo	60	241	128	175
Vitamin A cassava, DR Congo	0	25	75	180
Vitamin A maize, Zambia	0	11	104	110
Total	227	1,137	1,149	1,634

Source: HarvestPlus (2016)[29]

HarvestPlus (2016) presents a summary of key trends and developments in biofortification of crops in Nigeria as follows:

- 1.2 million farmers are planting biofortified varieties of cassava, maize and sweetpotatoes across 24 states;
- About or over 500 farmers are investing in community-based commercial seed production targeting vitamin A cassava and/or OFSP;
- Five seed companies are producing vitamin A maize and distributing it through 100 agrochemical dealers;
- Twenty-five food products of biofortified crops were developed and 10 were commercialized;
- Three hundred small and medium enterprises are engaged in processing vitamin A cassava into gari, fufu and flour;
- Five hundred small-scale enterprises are producing and marketing vitamin A cassava confectioneries and complimentary foods for children;
- Biofortification is included in the micronutrient deficiency control guidelines by the Federal Ministry of Health;
- Twenty public and private sector partners are engaged in product delivery.

OFSP

According to the Nigeria national coordinator of CIP, since 2011 CIP has implemented several OFSP activities. These are described below.

Reaching Agents of Change Project

RAC ran over four years and was implemented by CIP and Helen Keller International in Tanzania, Mozambique and Nigeria, as the principal countries, and Ghana and Burkina Faso, as the secondary countries. The main focus was on increasing awareness about vitamin A deficiency and strengthening both the technical and advocacy capacity for the successful utilization of OFSP in nutrition interventions. The project advocated for increased investment in OFSP to combat vitamin A deficiency among young children and women of reproductive age, and also built the institutional capacity to design and implement gender-sensitive projects to ensure wide access and utilization of OFSP in selected African countries.

In Nigeria, RAC generated USD 1,262,479.42, which supported vine multiplication, dissemination, production and processing, and the conduct of a gender study on sweetpotato production systems. The project supported advocacy work and capacity development for 16 national advocates to

[29] HarvestPlus. (2016). Biofortification in Africa: evidence of success and vision for scaling up. ReSAKSS 2016 Conference Side Event, 18 October 2016, Accra, Ghana.

engage and influence policy and 79 technical experts to deliver the training-of-trainers course on 'Everything you ever wanted to know about sweetpotato'. RAC developed two toolkits on a range of topics related to OFSP, advocacy materials, and OFSP investment guide products targeting investors, implementers and policy-makers. The project strengthened the capacity of the Agricultural and Rural Management Training Institute (ARMTI) to host and run annual courses on sweetpotato. After the project ended ARMTI continued to offer the sweetpotato course on its own on a fee basis. Under seed systems activities, RAC facilitated the production of clean planting materials of OFSP vines for widespread distribution by decentralized vine multipliers and fast tracked the release of two OFSP varieties in Nigeria, King J and Mothers Delight. The project worked with NRCRI to develop a seed multiplication plan for the production of foundation OFSP seed to supply large quantities of clean vine cuttings in Benue, Kaduna, Kwara, Nasarawa and Abuja Federal Capital Territory states. RAC established 6.3 ha of disease-free primary and 4.2 ha of disease-free secondary materials. In addition, it developed a monitoring and evaluation plan and system, systematically documented the process of the project implementation and produced a booklet on the lessons learned, which it shared widely.

Sweetpotato for Health and Wealth in Nigeria (Rainbow Project)

According to Rainbow Project's technical advisor/project manager, the project, supported by the Federal Ministry of Agriculture and Rural Development, was started in 2014 as an offshoot of the investment raised by the first phase of RAC. The aim of the Rainbow Project was to build a community of practice that would effectively contribute to the reduction of food insecurity, malnutrition and poverty in Nigeria through leveraging the unexploited potential of OFSP and improving the market opportunities for all types of sweetpotato. The project was implemented in the seven states of Osun, Kwara, Kaduna, Benue, Nasarawa, Federal Capital Territory and Ebonyi.

Between April 2014 and December 2015, which is when the project was implemented actively,

- About 50 vine multipliers were identified, selected and empowered to produce OFSP vines for farmers' uptake;

- All the ADP extension staff in all the project states and a few others from outside the ADPs participated in the training-of-trainers' 10-day course on 'Everything you ever wanted to know about sweetpotato' at ARMTI, Ilorin. Almost all of them were further equipped to step down the training to others in their states or locations.

- Over 35,000 households with children under the age of five years were reached with at least one bundle of OFSP with 100 cuttings of vines to encourage them to start home gardens and to give them access to the nutritious crop.

- The Rainbow Project collaborated with Helen Keller International on the SPRING Project, where almost 1000 infant and young children's feeding support groups in Benue and Federal Capital Territory were reached with OFSP vines and equipped to plant, process and use OFSP as a complementary food for their babies.

- In creating an institutional demand for OFSP root, the Rainbow Project successfully advocated for inclusion of OFSP in the Osun State school feeding program, which was accepted by the O-Meal School Feeding Program, began with a pilot of 8 schools, and gradually scaled up to 17 schools before the project ended. Fortunately, the Jumpstarting Project of CIP continued with the OFSP school program. As at December 2016, OFSP pottage was on the menu of not less than 174 public schools in Osun state, consuming about 10 t of the crop weekly and creating a market for OFSP farmers, vendors and other stakeholders. About four private schools in the state also were serving the pottage.

- The Osun state government has helped to equip the youth with skills related to the OFSP value chain, under the Osun Youth Empowerment Scheme.

- OFSP bread, made using then puree, was introduced to bakers and it has now moved from home consumption to commercialization. It was also included in the school menu of Oriade LGA in Osun state.

- Sensitization activities were carried out among strategically targeted groups, institutions, organizations etc. to create awareness on OFSP for its adoption. Such targets included antenatal clinics, developmental organizations, agricultural shows, market and road shows, eateries, food-based associations, etc. Commemorations of national and international days related to nutrition also were used to sensitize the public on the crop, especially in Abuja, where most of the events were concentrated.

- Some development organizations were already using OFSP for their programs, disseminating the vines to beneficiaries as part of their nutrition-sensitive agriculture. Such organizations included the Catholic Relief Services under its SMILE Project that is in five states of Nigeria.

- Some indigenous foods were being enriched with OFSP for household dietary diversity and income generation. OFSP was used in foods such as pap, gari, pastries, edible flours for meals consumed as 'swallows' with soups and sauces, local beverages (kunu and juice), and bread. The leaves were cooked and consumed as conventional leafy vegetables.

Jumpstarting Orange-fleshed Sweetpotato through Diversified Markets

The Jumpstarting Orange-fleshed Sweetpotato through Diversified Markets Project is a three-year project that began in April 2014 and that seeks to develop OFSP production and markets in Osun and Kwara states. The main activity on the production side has been strengthening the seed system's capacity through the identification and development of a system of decentralized vine multipliers able to provide planting material of high quality and to knowledgeably serve as marketers of their product to promote the crop as well. The primary market identified and promoted in Osun state is the school feeding program, and sweetpotato was successfully integrated into the school menu and is served to students in an expanding number of schools, starting with 8 schools and growing to 174 by December 2016. In Kwara state the focus was more on fresh root market sale and promotion of processed products, emphasizing both the nutritional value and the profitability of the crop. In Kwara the project sponsored a number of participants to the 'Everything you ever wanted to know about sweetpotato' training-of-trainers' course run by ARMTI. In all its areas of engagement, CIP's approach has been to work closely with federal and state institutions, including the O-Meal School Feeding Program of Osun State, the ADPs in Kwara and Osun states, and a host of other public and private sector partners.

Sweetpotato Action for Security and Health in Africa

The Sweetpotato Action for Security and Health in Africa (SASHA) Project is a 10-year research project designed to improve the food security and health of poor families in sub-Saharan Africa by exploiting the untapped potential of sweetpotato. SASHA is part of the continent-wide Sweetpotato for Profit and Health Initiative (SPHI) co-led by CIP and FARA that aims to reach 10 million households across Africa by 2020. Since July 2015 the SASHA Project has collaborated with NRCRI, Umudike, to develop and test a model for sustainable pre-basic seed production for the timely availability of quality sweetpotato planting materials. Activities are implemented at the two stations of NRCRI in Abia and Osun states and in Kano and Kaduna states. These are important sweetpotato producing areas, and seed production activities are being linked with institutional markets for roots. The specific objectives are to:

- Ensure increased capacity for the production of high quality sweetpotato planting materials by the public and private sectors;
- Enhance the awareness and commercialization of high quality sweetpotato planting material among stakeholders;
- Establish a quality assurance system for sweetpotato pre-basic seed and quality declared seed.

SASHA's achievements to date include infrastructure improvement, training in tissue culture micropropagation and screen house management, production of 75,000 pre-basic cuttings, and drafting of seed standards for sweetpotato quality-declared planting material.

SASHA has collaborated with the Nigerian government, particularly NRCRI, to provide backstopping for breeding efforts at NRCRI through provision of germplasm and supporting multilocational trials, leading to the official release of the first OFSP variety for Nigeria, Mother's Delight. Further, breeders at NRCRI and other institutions have participated in regional and continental communities of practice, strengthening the national capacity and the regional integration of sweetpotato breeding efforts.

BNFB

BNFB is a three-year project running from November 2015 to October 2018 and is funded by the Bill & Melinda Gates Foundation. It seeks to reduce hidden hunger by catalyzing sustainable investment for the utilization at scale of the biofortified crops vitamin A cassava, vitamin A maize, vitamin A sweetpotato and iron rich beans. The project is being implemented in Nigeria and Tanzania to demonstrate how multiple biofortified crops can be scaled up together at the country level. The project is led by CIP, which along with CIAT, CIMMYT, CIP, IITA, HarvestPlus and FARA, forms the consortium of six core partners implementing the project. These work together with national implementing partners on advocacy, policy development, nutrition education, and behavior change communication for demand creation, capacity strengthening and institutional learning to support the scaling up of multiple biofortified crops. The project has two specific objectives: to strengthen the enabling environment for investments in biofortified crops and to strengthen institutional and community capabilities to produce and consume biofortified crops.

3.3 Farmers and consumers' knowledge and understanding of biofortification in Nigeria

Farmers and consumers' knowledge and understanding of biofortification play important roles in two main respects. They help farmers in the adoption of biofortified crops for production and consumption at the family level and they help consumers understand the nutritional and health benefits of biofortified crops and, hence, the importance of consuming them at the household level. Figure 5.6 shows farmers and consumers' awareness levels on the existence of biofortified sweetpotato, cassava and maize in Nigeria.

The study found awareness on biofortification to be high among farmers but low among consumers. Figure 6 indicates that 61% of the surveyed farmers were aware of the existence of at least one biofortified crop in the study area, while 62% of the consumers were not aware of the existence of any of the biofortified sweetpotato, cassava or maize in Nigeria. This finding has implications for the work to increase the levels of consumption of these crops. Behavior change communication and social marketing, tailored to the specific biofortified products and market contexts, can be used to increase awareness and overcome this limitation.

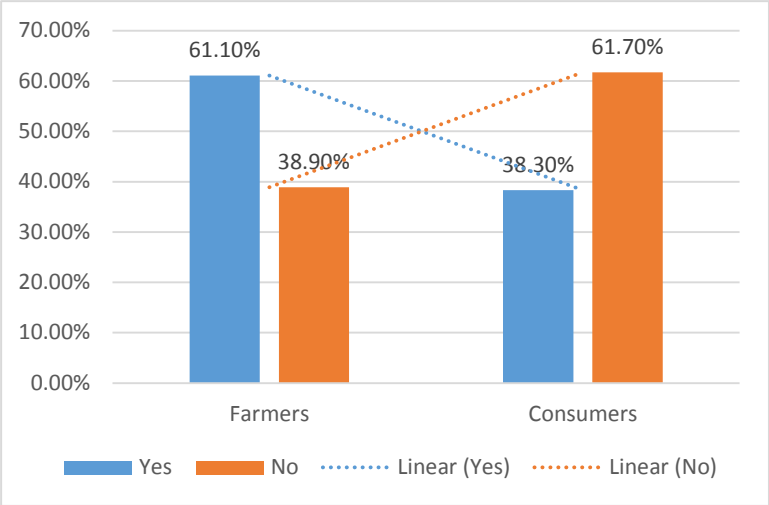

Figure 6: Farmers and consumers' awareness on the existence biofortified sweetpotatoes, cassava and maize in Nigeria

At the state level, awareness on the biofortified crops among farmers was highest in Benue, at 83.8%, followed by Kaduna, at 79%, Akwa-Ibom at, 70% and Taraba and Osun, at 56.7% (Figure 7). Awareness on the biofortified crops among farmers was lowest in Enugu and then Kwara. With respect to consumers, awareness on biofortified sweetpotatoes, cassava and maize in Nigeria was high only in Benue, where more than 83% of the consumers indicated that they were familiar with biofortified crops. In the rest of states, less than half of the consumers were aware of the existence of biofortified sweetpotatoes, cassava or maize.

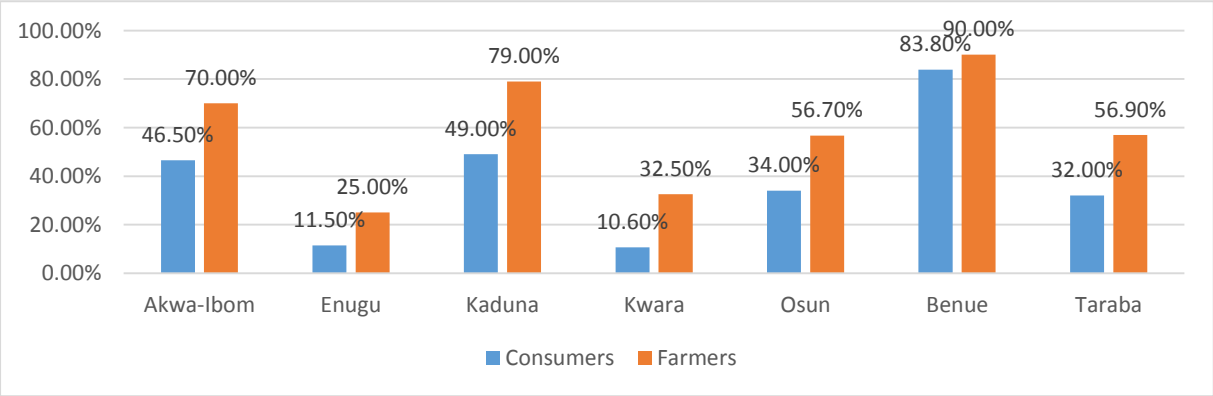

Figure 7: Farmers and consumers' awareness on the existence of biofortified sweetpotatoes, cassava and maize by state in Nigeria

The level of awareness among farmers on the individual crops was highest for sweetpotatoes, with 55.1% of the farmers claiming awareness of it, followed by cassava, with 39.9% of the farmers. Only 5% of the farmers were aware of the existence of biofortified maize. The low awareness on biofortified maize may be attributed to the fact that it was introduced to famers later than the other two crops (see Table 3). OFSP and cassava were released in December 2012 and 2011, respectively, while orange maize was released in 2014.

Table 3: Release dates for biofortified crops by HarvestPlus

Crop	Nutrient	Country	Year	Year released in Nigeria
Sweetpotatoes	Vitamin A	Uganda, Mozambique	2007	2012
Cassava	Vitamin A	DR Congo, Nigeria	2011	2011
Bean	Iron	DR Congo	2012	
Pearl millet	Iron	India	2012	
Maize	Vitamin A	Nigeria	2014	2014
Rice	Zinc	Bangladesh, India	2013	
Wheat	Zinc	India, Pakistan	2013	

Source: Levit (2011)[30]

The study also sought to determine what farmers and consumers' sources of information were with respect to awareness and knowledge on the existence of the biofortified sweetpotatoes, cassava and maize. Figure 8 shows that for the farmers the sources of information were mainly markets, friends and ADPs, while for the consumers friends were the most important source, then markets, followed by community events. For the purpose of advocacy and sensitization on the existence and importance of biofortified crops there is need for the integration of radio and television channels, as studies have proven their effectiveness in information dissemination, particularly for low income farmers in rural Nigeria.

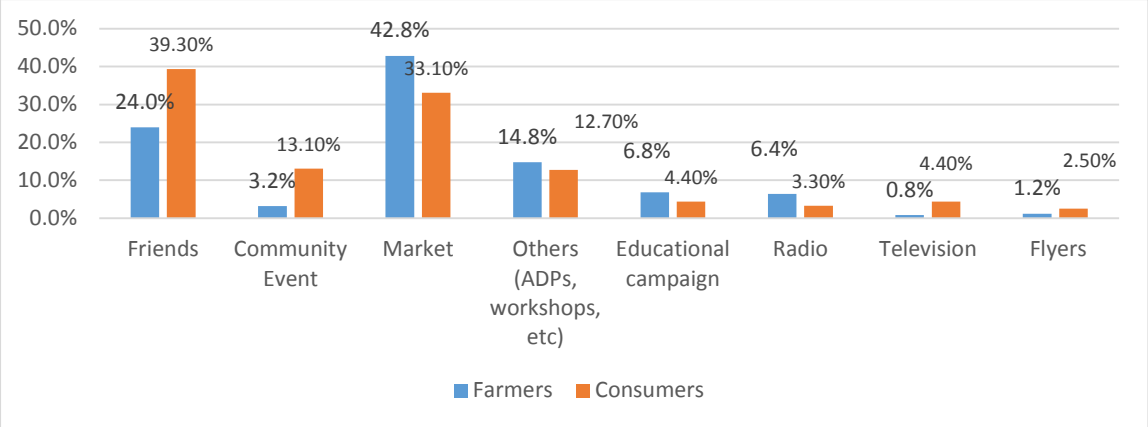

Figure 8: Farmers and consumers' main sources of information on the existence of biofortified sweetpotatoes, cassava and maize in Nigeria

Although farmers and consumer's knowledge on the existence of biofortified crops is vitally important, their understanding of the rationale behind the introduction of biofortified crops is more crucial as it has implications for farmers' adoption and production of the crops, as well as consumers' preferences and consumption of the crops. There was a generally a low level of knowledge among consumers on the benefits of biofortification of crops, and only 25.6% of them accurately named those benefits, compared with 78% of farmers (Figure 9). This calls for more targeted advocacy and awareness campaigns focusing on nutrition education among consumers throughout the country.

[30]Levitt, T, (2011). Can GM-free biofortified crops succeed after golden rice controversy? http://www.theecologist.org/News/news_analysis/1159571/can_gmfree_biofortified_crops_succeed_after_golden_rice_controversy.html. Accessed 18/05/17

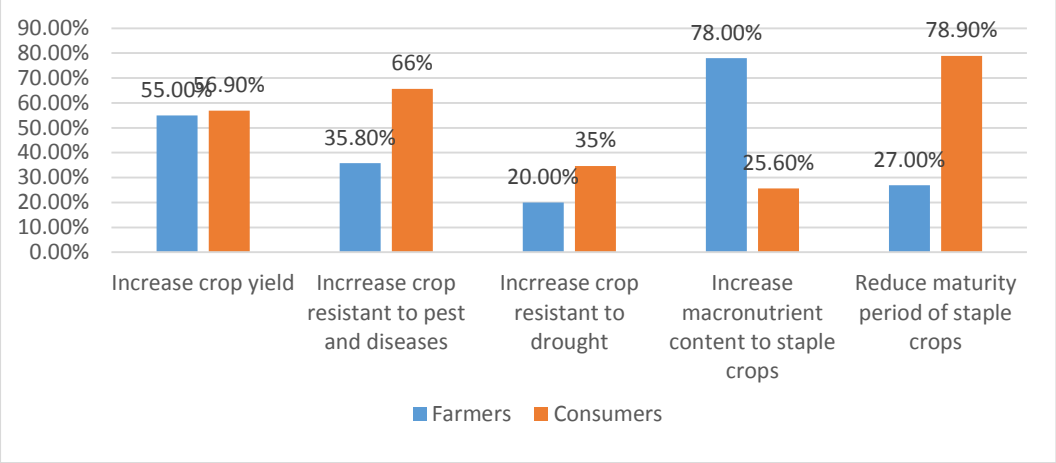

Figure 9: Farmers and consumers' understanding of the purpose of biofortification

3.4 Production and consumption patterns of biofortified crops and their products

Production of biofortified crops is one of the necessary conditions for their consumption. Hence, it is germane to determine the existing production level for the biofortified crops in Nigeria. At the same time, the consumption of biofortified crops and their products is of utmost importance in the effort to reduce micronutrient deficiency among poor households. This section examines the extant production and consumption patterns of biofortified crops and their products in Nigeria.

3.4.1 Farmers' involvement in planting biofortified crops

It was important to establish the proportion of farmers cultivating conventional varieties of sweetpotatoes, cassava and maize among the sampled population. Figure 10 indicates that 51.8% of the farmers cultivated sweetpotatoes, 78.9% cultivated cassava and 92% cultivated maize. Cassava and maize were consumed as staple foods across the length and breadth of Nigeria and this may explain the high numbers of farmers planting them.

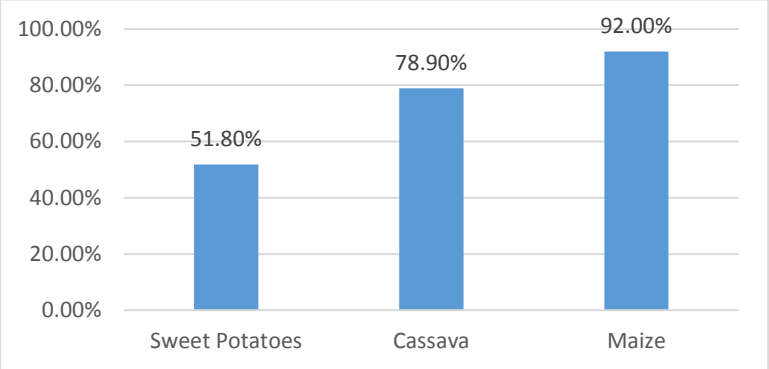

Figure 10: Farmers cultivating non-biofortified sweetpotatoes, cassava and maize among the sampled population

The study sought to find out whether farmers planted the biofortified varieties and for what purpose. While 42.2% of the farmers planted biofortified sweetpotatoes, only 33.3% and 15% of the farmers farmed biofortified cassava and maize, respectively. This is despite the fact that cassava and maize are the staple crops in the survey states (Figure 11). Overall, only 30.2% of the farmers were

planting biofortified crops. The late introduction of orange maize to farmers relative to sweetpotatoes is factor in its low adoption.

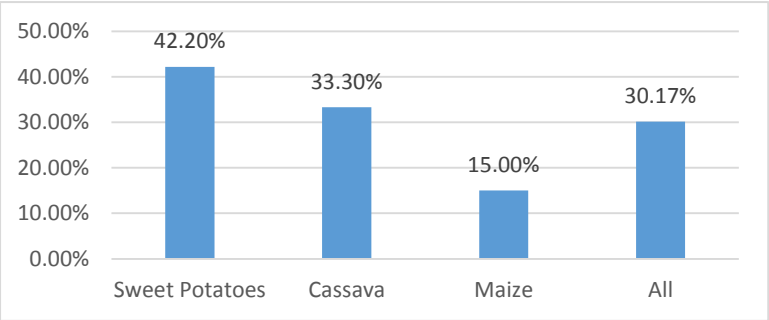

Figure 11: Farmers planting biofortified varieties of sweetpotatoes, cassava and maize in the sampled states

Figure 12 shows that the dominantly cultivated biofortified crop varied by state. Yellow cassava was dominant in Benue, Osun and Akwa-Ibom states and was planted by 89.1%, 67% and 53.7% of the farmers, respectively. OFSP was popular in Kwara, Kaduna and Taraba and was cultivated by 70%, 61.9% and 55.7% of the farmers, respectively. There was no state among those in the survey where biofortified maize was the most cultivated among the three crops. This calls for more advocacy, sensitization campaigns and awareness creation among farmers across the states in Nigeria on the availability of biofortified maize. The staple food preferences in the states may account for the variations in the numbers of farmers planting the biofortified crops. Cassava is the common staple food in Akwa-Ibom, Enugu, Osun and Benue, while sweetpotato is a common staple food in Taraba, Kwara and Kaduna states.

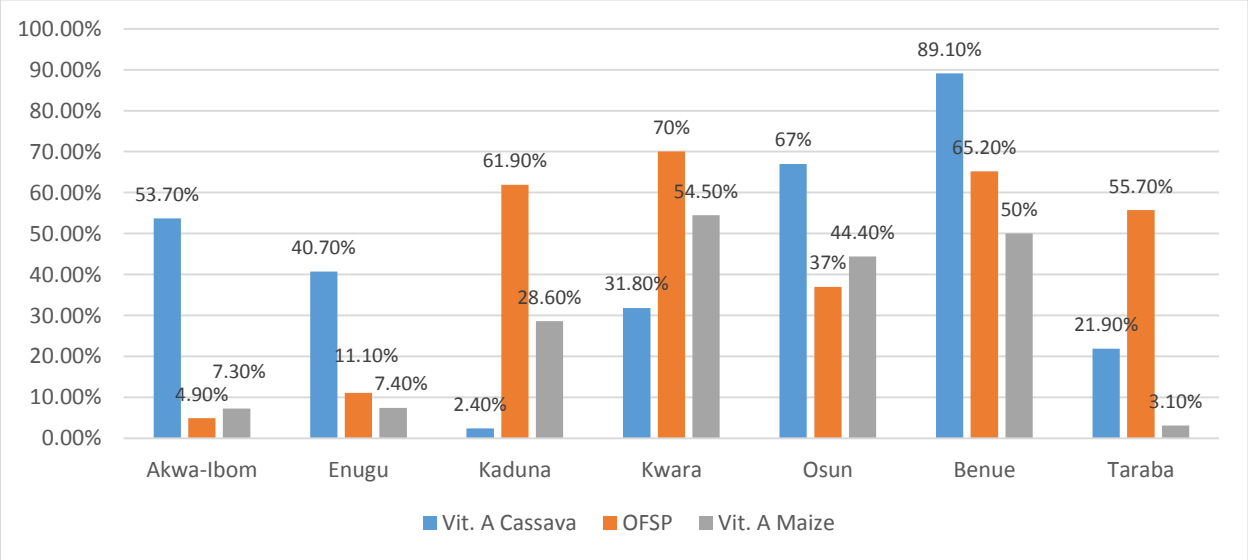

Figure 12: Farmers planting biofortified varieties of sweetpotatoes, cassava and maize by state

3.4.2 Reasons for planting the biofortified crops

For the majority the farmers, cultivation of biofortified crops was mainly for local consumption, and only 30.3% of the respondents cultivated the crops for sale (Figure 13). The low proportion of famers cultivating the crops for commercial purposes has implications for the quantity of biofortified crops in the market and the volumes available for consumers to purchase. It is also an indication of the level of awareness on the existence of biofortified crops among farmers.

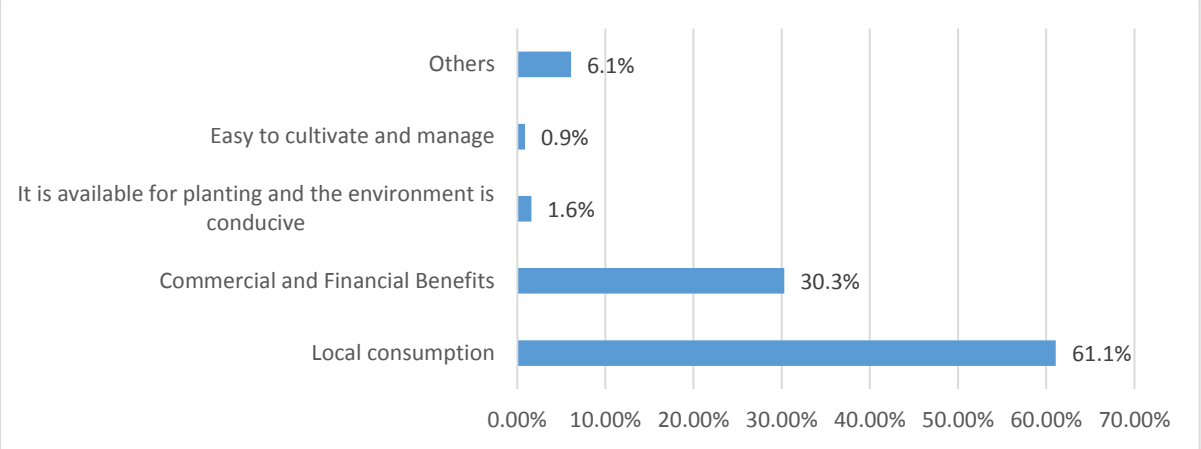

Figure 13: Reasons farmers planted biofortified sweetpotato, cassava and maize

3.4.3 Size of land farmers were willing to allocate to biofortified crops

The study found that most of the farmers had 1–2 ha for planting biofortified crops and only 6.9% of the farmers had allocated more than 5 ha to biofortified crops (Figure 14). The small size of land that farmers were willing to put aside for biofortified crops has implications for the quantity of the crops produced and the quantity made available to consumers for purchase.

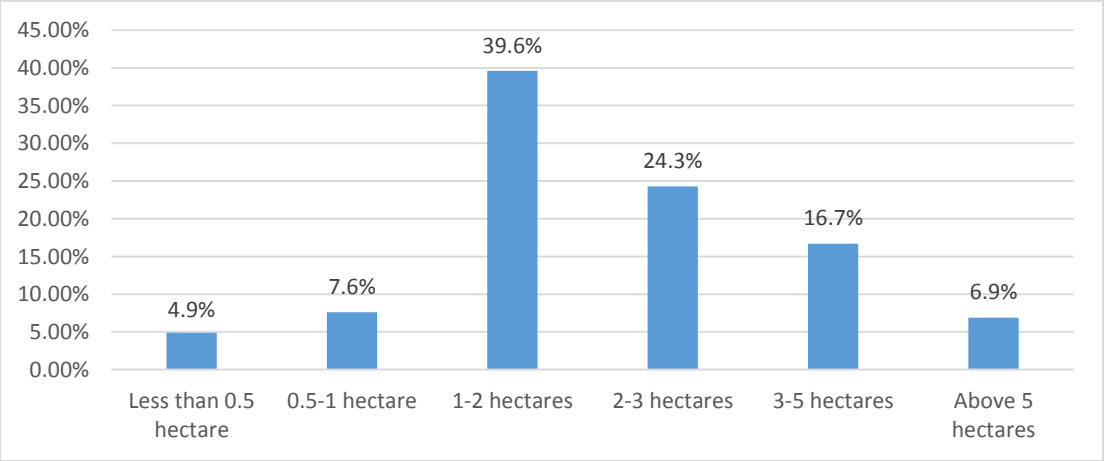

Figure 14: Portion of land farmers use for planting the biofortified varieties of cassava, sweetpotato and maize

Although it is possible to plant three crop cycles of OFSP in a year, most farmers planted only one (Figure 15).

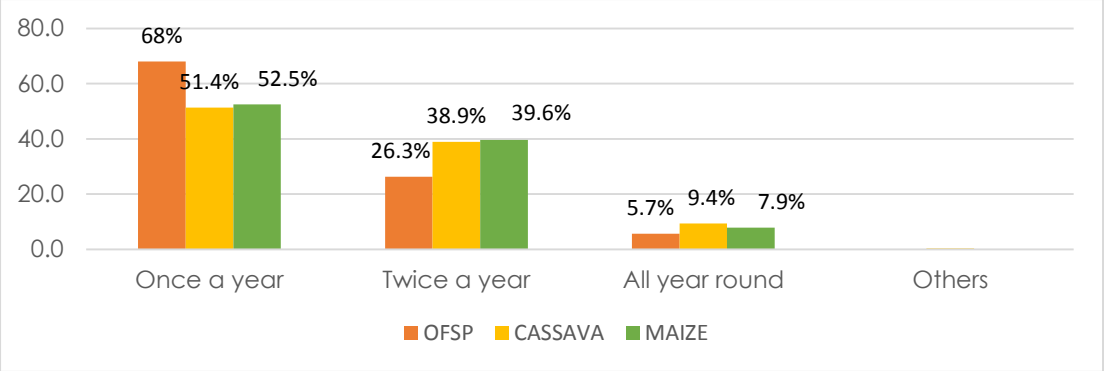

Figure 15: Farmers' frequency of planting biofortified crops

3.4.3 Consumption patterns for biofortified crops

The level of consumption of sweetpotato, cassava and maize and their products was of interest to the study. Figure 16 shows that almost all the respondents consumed all the three crops.

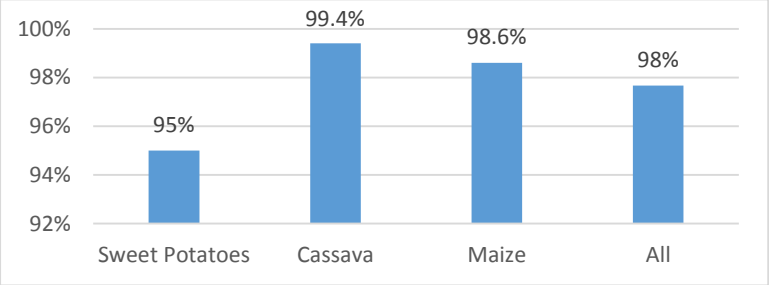

Figure 16: Households consuming sweetpotatoes, cassava and maize in the sampled states

The predominant types of sweetpotato, cassava and maize consumed by the respondents were the white types, which are not biofortified (Figure 17). Incidentally, fewer than 3% of the respondents indicated consuming biofortified sweetpotato, cassava or maize.

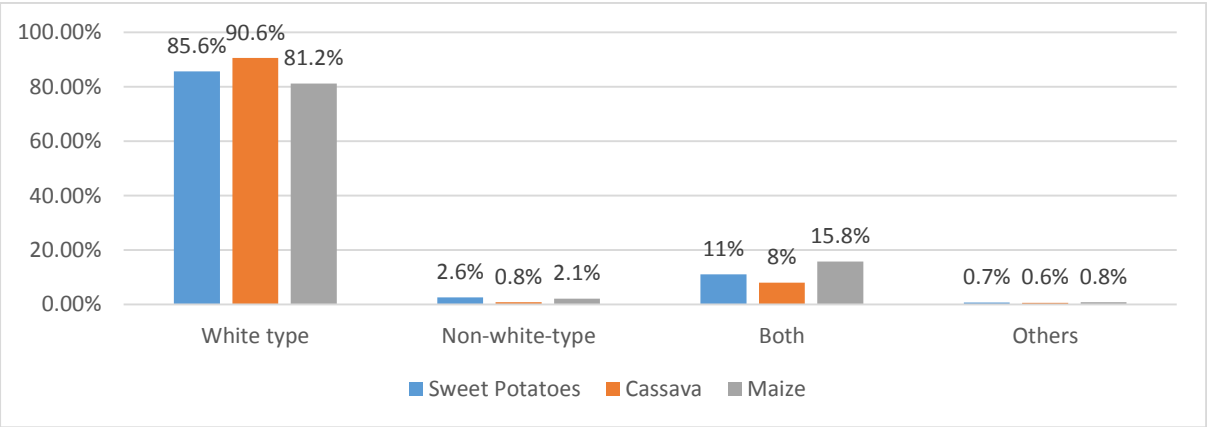

Figure 17: Types of sweetpotato, cassava and maize consumed

The main reason the non-white sweetpotato, cassava and maize were consumed was their availability (Figure 18). For sweetpotato, however, slightly more households consumed it for its nutritional value than its availability.

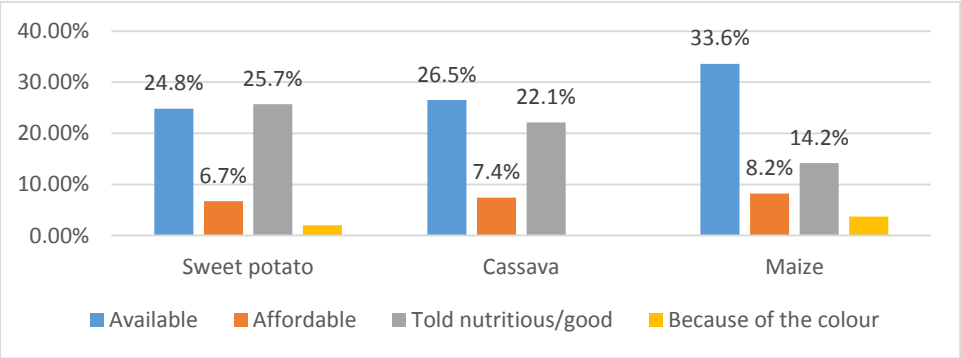

Figure 18: Reasons for the consumption of non-white sweetpotato, cassava and maize

Consumption of biofortified crops and food products appeared to be influenced by the educational attainment of the consumers. For instance, 82% of OFSP consumers, 77.4% of the yellow cassava consumers and 87.5% of orange maize consumers had at least a minimum of secondary school level education. Consumer location also was an important factor in the consumption patterns for the biofortified crops, with OFSP and maize having more urban consumers, at 41.8% and 53.2%, respectively, than rural consumers, who were at 39.6% for OFSP and 33.6% for maize. Yellow cassava, however, had more rural than urban consumers, who were at 35.8% and 29.1%, respectively.

Household consumption of biofortified crops as staples was influenced also by the taste and texture of the produce or by-products. The majority of OFSP consumers preferred to fry or consume it raw just as they would eat a carrot, because its taste was poor when boiled. In northern Nigeria maize is consumed mostly as 'tuwo', a local staple. Consumers of tuwo prefer white maize because of its superior texture compared to vitamin A maize. This is the reason many farmers who grow maize commercially prefer to grow the white type.

Mostly, biofortified food crops were consumed only occasionally and depended on whether their consumers came across them while shopping (Table 4). The main factors considered in the purchase of the products included texture, appearance, taste and serving options.

Table 4: Frequency of consumption of biofortified crops in the study area

Frequency	OFSP (n = 113)	Vitamin A cassava (n = 95)	Vitamin A maize (n = 113)
	%	%	%
Occasionally	58.4	60.0	71.0
Weekly	22.1	26.3	8.4
Monthly	3.5	3.2	3.3
When in season	15.9	10.6	17.3

3.5 Factors responsible for the slow uptake of biofortification in Nigeria

The findings demonstrate that there is a slow uptake of biofortified crops and products among farmers and consumers in Nigeria. The factors responsible for that in regard the three crops of

sweetpotato, cassava and maize in the study states are summarized in Table 5 and discussed in the following paragraphs.

3.5.1 Akwa-Ibom state

The main factors affecting the scaling up of biofortified sweetpotatoes included poor access to vines, low awareness on the crop and pest infestation problems. In the case of cassava, the lower starch content of the biofortified cassava compared with the white types, oversupply of the crop and the absence of collaboration among agricultural stakeholders in the state were the main issues. With respect to biofortified maize, the texture was perceived by farmers and consumers as too hard.

3.5.2 Enugu state

The main factors hindering the expansion of biofortified sweetpotatoes included pest infestation when the roots stayed too long in the ground after maturity, and the poor access to vines. In the case of biofortified cassava, the problems cited were the lack of collaboration between the state's agricultural associations and the agricultural development program, the unavailability of stems even when farmers were willing to pay for them, and the activities of Fulani herders that destroyed the first planting for many farmers. The main factor identified for maize was the low awareness on its existence among the farmers in the state.

3.5.3 Kaduna state

The scaling up of biofortified sweetpotato was hampered by its low demand, the absence of accessible markets in which to sell the roots, pest infestation if the roots stayed too long in the ground after maturity, cracking of the roots, and the high moisture content of the roots. Biofortified cassava's expansion was affected by its lower starch content compared with local types, its low awareness among consumers, its poor patronage even in the local markets, and spoilage. The main challenge for biofortified maize was the high preference of consumers for white maize over pro-vitamin A maize.

3.5.4 Kwara state

The main difficulties for biofortified sweetpotatoes included its poor awareness, the low demand expected by the growers, and pest infestation if the roots stayed too long in the ground after maturity. In the case of cassava, the constant destruction of the crop by cattle brought by herders to graze, its low awareness among consumers and poor patronage in the local markets were the main difficulties. Other factors included spoilage and poor access to affordable farm equipment for mechanized farming. The main challenge for maize was the farmers' inability to differentiate between biofortified and conventional maize.

3.5.5 Osun state

The slow uptake of biofortified sweetpotato was influenced by farmers' poor access to markets to sell the roots and pest infestation of the roots. In the case of cassava, the factors were several. First, large-scale buyers and processors wanted the cassava tubers to be freshly harvested, a condition that many of the farmers complained was not feasible, as they needed about two days to harvest and transport the crop. Also, the prices offered by the factories were too low to meet the production costs and profit expectations of farmers. These are major constraints to the commercial farmers, who are forced to sell their harvest to small-scale buyers and to reduce their production. There are also the problems of low starch and high moisture content of the yellow cassava. The uptake of yellow maize is hampered by the poor access to land and to subsidized agricultural inputs and materials.

3.5.6 Benue state

The factors responsible for the slow uptake of biofortified sweetpotato included problems of pest infestation, cracking of the tubers, and the poor taste of the OFSP relative to the conventional varieties. In the case of cassava, the issues included (1) low awareness among consumers on the crop and its products, (2) general perception that it was meant for only sick people, (3) marketing challenges, which had forced some farmers to lower their production, (4) low starch content, which is a major detriment since a high starch content is a key requirement for consumers, and (5) poor access to the stems. The main hindrances for biofortified maize included its low awareness among consumers, the lack of markets in which to sell it and pest infestation.

3.5.7 Taraba state

The main challenges for biofortified sweetpotato included the incessant pest infestation and the low awareness among farmers and consumers on the crop. Biofortified cassava upscaling was hindered by its low awareness in the states and marketing problems. The main factors considered by the farmers to affect biofortified maize expansion included its low awareness among consumers, poor access to markets and pest infestation

Table 5: Factors responsible for the slow uptake of biofortification in the states studied

State	Factors influencing the slow uptake		
	Orange-fleshed sweetpotatoes	Vitamin A cassava	PVA maize
Akwa-Ibom	• Poor access to vines • Low awareness • Pest infestation problems	• The yellow cassava has a lower starch content than conventional cassava types, and many consumers prefer a starchy staple • Absence of markets to sell the yellow tuber and its products such as fufu and gari • There is a large supply of the crop so farmers are forced to sell their produce for prices lower than their production cost. They lack a good road network, storage facilities, etc. that would permit moving the produce to other markets or storing it to sell when prices improve • Poor collaboration between agricultural associations of farmers, aggregators, processors, etc., the presence of which would increase the level of awareness on the crop among farmers and consumers	• The vitamin A maize was introduced in 2014 but is not cultivated in many parts of Akwa-Ibom. Farmers and consumers consider it to have a poor texture when compared with white maize
Enugu	• Pest infestation if the tubers stay too long in the ground after maturity • Poor access to vines	• Lack of collaboration between the state's agricultural associations and the agricultural development program • In some farming communities in Enugu seedling stems' unavailability even when farmers are willing to pay for them is a problem • The activities of the Fulani herders destroy the first planting for many farmers	• Vitamin A maize was introduced for large-scale farming in August 2016, so it is not very popular among farmers in Enugu, who are smallholders

State	Factors influencing the slow uptake		
	Orange-fleshed sweetpotatoes	Vitamin A cassava	PVA maize
Kaduna	• Overall, the demand for OFSP is low among consumers and even farmers. Many of the farmers do not know that OFSP can be processed into multiple products • Absence of accessible markets to sell the tubers • Pest infestation, and this is very common with the Mothers Delight variety • Cracking of the tubers, especially the King J variety • High moisture content and high likelihood to spoil – the farmers complained that OFSP had a shorter shelf life than the conventional varieties	• Yellow cassava has lower starch content than the white variety, but many consumers prefer a starchy staple • Poor awareness among consumers and poor patronage even in the local markets • Spoilage	• For large commercial production of maize, the white variety is a preferred choice for many farmers
Kwara	• Poorer awareness and demand than the growers expect • Pest infestation if the tubers stay too long in the ground after maturity	• Constant destruction of the crops by herders whose cattle graze on the cassava • Poor awareness among consumers and poor patronage in the local markets • Spoilage • No access to affordable farm equipment to mechanize cropping	• Many farmers either do not cultivate it or do not know about it because many of them mix up its seed with that of the conventional yellow maize, making their differentiation during harvest difficult
Osun	• Low awareness among consumers and the lack of a market to sell the tubers • Pest infestation of the tubers	• Large-scale buyers and processors request for freshly harvested cassava tubers, a condition that many of the farmers regarded as not feasible, as they would need about two days to harvest and transport the tubers • The price per heap or bag that factories wanted to pay was too low considering the production costs and farmers' profit expectations. These are major constraints to commercial farmers, who are now forced to sell to small-scale buyers and to lower their production • Buyers complain about the low starch and high moisture content of the yellow cassava	• Pest infestation was a common problem in 2016. Other major problems with maize cultivation in Osun State included lack of access to land adjacent to dams for irrigated farming and to subsidized agricultural inputs and materials
Benue	• All the farmers complained that OFSP was prone to pest attack • All the farmers complained that OFSP cracked sometimes after maturity and this affected its quality and market value • The farmers complained that OFSP was not as sweet as the conventional sweetpotato, especially when boiled. But this may be due to the preparation	• Low awareness among consumers on the crops or their products. The general perception was that yellow cassava was meant for only sick people • Marketing is a major challenge and has forced some farmers to reduce their yellow cassava production • The low starch content is disliked; a starchy texture is major requirement for consumers	• Low awareness among consumers and lack of markets to sell the tubers • Pest infestation of the tubers

State	Factors influencing the slow uptake		
	Orange-fleshed sweetpotatoes	Vitamin A cassava	PVA maize
	method, as many of the farmers said that they boiled it in a lot of water	• After processing yellow cassava products have a lower weight than those from white cassava of the same weight • Poor access to stems	
Taraba	• Incessant pest infestation • Low awareness among consumers	• Low awareness among consumers on the crop or its products. The general perception was that it was meant for only sick people • Marketing is a major challenge and has forced some farmers to reduce their production	• Low awareness among consumers and lack of markets to sell the tubers • Pest infestation of the tubers

3.6 Barriers preventing disadvantaged groups from accessing and benefiting from biofortification

There has not been a conclusive definition of the term disadvantaged group because the definitions out there are based on the respective scholar's perspective. So terms such as poor group, vulnerable group and weak competition rival[31] are commonly used interchangeably for disadvantaged groups. But they have one point in common: the main feature of disadvantaged groups is that they comprise people in a disfavored position in the society who are poor in their material life owing to barriers they cannot overcome or to the lack of economic, political or social opportunities. In this report, the concept of disadvantaged groups refers to clusters of people or individuals in those circumstances. Such groups include the poor male and female farmers in rural communities in Nigeria with limited access to the basic necessities of life. In the situation analysis the respondents were asked to identify the barriers that prevented such individuals from accessing and benefitting from biofortification in Nigeria. Table 6 shows those barriers.

Table 6: Barriers preventing disadvantaged groups from accessing and benefitting from biofortification in the study area

Barriers	Respondents	Percentage
Cultural/individual preferences around product attributes	215	55.4
Credit market inefficiencies	324	83.5
Informational inefficiencies	300	77.3
Input and output market inefficiencies	279	71.9
Land market inefficiencies	123	31.7
Low educational qualifications	345	88.9
Risk market inefficiencies	231	59.5

Cultural and individual preferences around some crops and their products were important bottlenecks for disadvantaged groups in accessing and benefitting from biofortified crops according to 55.4% of the respondents (Table 6). Individual preferences related to product attributes included taste and ease of preparation and cooking. Literature supports this finding, specifically the fact that low income consumers in developing countries are willing to trade off substantial caloric intake for preferred foods.[32]

[31]Chen Chengwen. (2000). *On socially disadvantaged*. Beijing, Shishi Publishing House, Issue No. 1, p.1.
[32]Atkin, D. (2012). Trade, tastes and nutrition in India. Yale Economics Department Working Paper.

Credit market inefficiency was another major bottleneck for disadvantaged groups in accessing and benefiting from biofortification, as indicated by over 83% of the respondents. Disadvantaged groups have poor access to credit facilities, occasioned by the imperfect rural financial markets. Their inability to provide the needed collateral prevents them from borrowing to invest in crops such as biofortified crops and from insuring crops against the risk associated with experimenting with new crop varieties. This finding agrees with Croppenstedt et al.'s (2003) [33] study, which found that credit constraints significantly interfere with fertilizer adoption.

Some 77.3% of the respondents considered informational inefficiencies as a barrier for disadvantaged groups. Biofortified crops, which are particularly beneficial to disadvantaged groups, will not be taken up without information about their value or about how to correctly use them. Studies have shown that the way information is presented can be as important as the content of the information itself. Certain groups may face larger information barriers if information is less accessible to them, such as women in the north.

For 71.9% of the respondents input and output market inefficiencies were a bottleneck for the disadvantaged groups in accessing and benefiting from biofortified crops (Table 6). The high prices of fertilizer and other inputs were primary barriers in this regard. Many disadvantaged farmers are poor and are unable to access or pay for the inputs required for biofortified crops. They often have to deal with inadequate infrastructure, missing supply chains or unprofitably high prices. Their poverty status also prevents them from accessing information, which is a sine qua non for the adoption of any technology.

Other barriers identified included land market inefficiencies and risk market inefficiencies, as well as low educational qualifications of the disadvantaged groups, which limited their capacity to access new knowledge (Table 6).

3.7 Relevant institutional frameworks creating an enabling environment for scaling up of biofortification in Nigeria

According to North (1990),[34] institutions are composed of formal rules created by human beings such as statute law, common law and regulations; informal constraints such as conventions, norms of behavior and self-imposed codes of conduct; and the enforcement characteristics of both. Institutions play important roles in the effective and efficient performance of any system. For biofortification to gain the required adoption and to scale up in Nigeria, it requires an enabling institution. A review of the institutions that work in food and nutrition in Nigeria was undertaken to identify those that support the promotion of biofortification. The content of policy documents, policy implementation guidelines and presentations by the Federal Government of Nigeria relevant to agriculture, nutrition and food was analyzed. The study found that there was no specific governmental institution with biofortification promotion as its sole mandate. Although some research institutions such NRCRI were involved in biofortification research, that was not their core responsibility. In 1990 the Federal Government of Nigeria created the National Committee on Food and Nutrition to coordinate and provide leadership in the drawing up and articulation of a comprehensive policy and actions that would considerably reduce malnutrition or eliminate it altogether in the country. That committee at first was domiciled in the Federal Ministry of Science and Technology, but was moved to the Federal Ministry of Health in 1993. Now it is in the Ministry of Budget and National Planning.

[33] Croppenstedt, A., Goldstein, M. and Rosas, N. (2013). Gender and agriculture: inefficiencies, segregation, and low productivity traps. *The World Bank Research Observer,* 28(1):79–109.

[34] North, D.C. (1990). Institutions, Institutional Change and Economic Performance. Cambridge University Press: New York.

The National Committee on Food and Nutrition prepared the National Food and Nutrition Policy in 1995, which the federal government approved in 1998 and launched in November 2002. That policy set specific targets, which included the reduction of severe and moderate malnutrition among children under the age of five by 30% by 2010 and the reduction of micronutrient deficiencies, principally in vitamin A, iodine and iron, by 50% by 2010. The efforts to achieve these goals included the fortification of staple foods with vitamin A so that children would naturally consume vitamin A in their food. This resulted in vitamin A fortification of 70% of sugar, 100% of wheat flour and 55% of the vegetable oil on the market. The federal government also launched the Home-Grown School Feeding and Health Programme in September 2005 under the coordination of the Federal Ministry of Education. That program aimed to provide one nutritionally adequate meal during the school day. Nigeria has recently embarked on the management of severe acute malnutrition and currently has over 495 community sites across northern Nigeria for the management of acute malnutrition.[35]

The Nutrition Division, which is located in the Ministry of Budgets and National Planning, currently serves as the convening government body responsible for scaling up nutrition. It is responsible for bringing together various government ministries and departments including the ministries of health, education, agriculture, women affairs, finance, information, science and technology, and water resources, and the planning commission. All relevant ministries also are engaged through the Nutrition Partners Forum, which meets at least four times annually with its partners, including national and international NGOs, United Nations agencies, donors, businesses and the media, to work on strategy development and take decisions relating to funding and nutrition emergencies. The absence of a specific institution whose key mandate is promoting and supporting biofortification activities is a major drawback in the effort to reduce micronutrient deficiencies in Nigeria.

3.8 Levels of investments in biofortification by development partners and the government in Nigeria

As evidence in favor of biofortification builds up stakeholders are increasingly interested in investing in it to reduce micronutrient deficiency. Investment in biofortification is rated as cost-effective. Hoddinott et al. (2013)[36] estimate that every dollar invested in programs to reduce stunting would generate between USD 24.40 and USD 26.60 in economic returns. According to the World Bank[37] investing in nutrition can increase a country's gross domestic product by at least 3% annually. A recent study by HarvestPlus[38] that used country-level data to rank countries according to their suitability for investment in biofortification interventions identified Nigeria as a top priority country for benefiting from biofortification. The projected total cost of scaling up biofortification of only yellow cassava in Nigeria was USD 25 million. This value is obtained from the ex-ante assessment of biofortification in Nigeria.[39]

Funding for biofortification in Nigeria comes from internal and external sources. The internal sources are mainly the federal government and its agencies. However, biofortification funding is limited by the absence of a supportive institutional framework backed by law. In 2014 the federal government, through the Ministry of Agriculture and Rural Development, provided 130 million naira (USD 833,333.30) to CIP in support of biofortification.

[35] Health Sector Component of National Food And Nutrition Policy national strategic plan of action for Nutrition (2014–2019).

[36] Hoddinott, J., Alderman, H., Behrman, J.R., Haddad, L. and Horton, S. (2013). The economic rationale for investing in stunting reduction. *Maternal and Child Nutrition*, 9(Suppl. 2):69–82.

[37] World Bank. (2010). Scaling up nutrition: what will it cost? Washington, DC: World Bank.

[38] Asare-Marfo, D., Birol, E., Gonzalez, C., Moursi, M., Perez, S., Schwarz, J. and Zeller, M. (2013). Prioritizing countries for biofortification interventions using country-level data. HarvestPlus Working Paper No. 11 (October 2013). Washington, DC: HarvestPlus.

[39] Fiedler, J. (2010). The cost of micronutrient interventions. Washington, DC: HarvestPlus.

Although there are multiple external sources of investment in the agriculture sector in Nigeria, the sole nongovernmental source of funding for biofortification in Nigeria was HarvestPlus. The Department for International Development of the United Kingdom provided £30 million of core funding to HarvestPlus over 2012–2015 to enable the scaling up of biofortified food crops through the delivery of at least 6 new crop varieties to 3 million farming households in 7 countries in Africa, including Nigeria, and Asia. In addition, biofortification falls into the areas of interest of the Bill & Melinda Gates Foundation under nutrition, especially nutrition-sensitive agriculture. The foundation supports the CIP and HarvestPlus biofortification projects. For CIP, its support has gone to the RAC Project, which ran from 2011 to 2014; the Jumpstarting OFSP for Diversified Markets in West Africa Project, which was implemented 2014–2017 in Nigeria, Ghana and Burkina Faso; the SASHA Project; and the BNFB Project in Nigeria and Tanzania.

A source of funding that may be relevant to investment in biofortification in Nigeria is the New Alliance for Food Security and Nutrition. This is a collaboration of governments, the private sector and development partners that is focusing on the actions needed to promote agricultural investment and consequently food and nutrition security. It is an initiative that is being promoted by the African Union, is supported by key global development partners, and its goals are in line with the principles of the Comprehensive Africa Agriculture Development Programme.[40] Nigeria joined the New Alliance for Food Security and Nutrition in 2013. That year 30 companies in the alliance committed to invest USD 3.8 billion in the agriculture sector in 10 years. The investment in agriculture accounted for about 40% of the alliance's investment commitments in Africa in 2014. The Nigerian government made 13 broad and 27 specific commitments to be fulfilled between November 2013 and December 2016, while development partners committed to providing the equivalent of about USD 500 million in funding for Nigeria's agriculture sector in the 2013–2016 period. The commitment of the private sector has increased by 20% to USD 4.5 billion. In terms of funds invested, the private sector committed to invest about USD 4.5 billion over a period of about 10 years and had made investments of about USD 1.1 billion by June 2015.[41] The private companies in Nigeria that have joined the alliance include AGCO, Agro-Allied Syrups, Dansa Holdings Ltd, Unilever, and Umza International Farms Ltd.[42]

3.9 Needs and challenges of the key actors in the value chains of biofortified crops

There are nine types of actors in the biofortified crops' value chains in Nigeria: farmers, local collectors, national traders, wholesalers, retailers, agroprocessors, home consumers, national agricultural research institutes and the variety release committee. National level traders are the pivotal actors in the national market as they collect the produce from farmers or local collectors in the various states and transport it to the markets in the big cities using hired trailers. From there, wholesalers distribute the produce to retailers to be sold to agroprocessors. Farmers often sell their produce directly to agroprocessors or consumers to improve their profit margin, though they may also sell it to the local collectors or retailers for lower prices. Like the rest of Nigeria's agriculture, OFSP, yellow cassava and orange maize production is entirely dependent on smallholder farmers. But farmers are constrained by factors related to input availability and supply, financing, reliability of markets, marketing logistics, and technical and business knowledge. Without exception, the value chains of the biofortified crops are currently weak and suffer from inadequacies in human and financial resources, institutional structures and infrastructure. In addition to their almost negligible scale in farming, compared to other crops biofortified crops' value chains are plagued with limited production and marketing knowledge and capacity; underdeveloped infrastructure; poor access to

[40] Nigeria New Alliance Grow Africa Report.
[41] ibid
[42] https://new-alliance.org/resource/summary-new-alliance-letters-intent-2012-2013

finance; an absence of backward investment, especially in processing; and weak to nonexistent linkages between processors and farmers.

Tables 7–9 present the constraints and proposed interventions in the value chains of the three targeted biofortified crops in Nigeria.

Table 7: Constraints and proposed interventions in the yellow cassava value chain

Constraints	Proposed interventions
Underutilization of cassava roots in the improved food and industrial products' channels of the cassava value chain	• Organize an innovative and learning platform that is mutually beneficial to all stakeholders
Weak linkages between industrial users of cassava products and cassava processors	• Advocate for the restructuring of the management of the processing mills to operate as business enterprises and adopt diversification strategies • Strengthen linkages of industrial users of cassava products and cassava processors, e.g. for the use of cassava starch in textiles and pharmaceutical firms
Weak market information – meaning that farmers do not know where their produce is sold and for how much or which are the best links for disposing of produce	• Facilitate the establishment of a market information system for cassava and other related commodities • Establish a private sector-led cassava marketing innovation or shared learning platform
Low rate of adoption of yellow cassava by farmers	• Capacity building and awareness creation for farmers on the nutritional value of yellow cassava
Unavailability of inputs (fertilizers, pesticides and herbicides) for farmers when and where needed	• Facilitate access to affordable and available fertilizers, herbicides, pesticides, etc. by farmers when and where needed
Lack of finance by many farmers for cassava production and by processors to purchase processing equipment and vehicles for collection of roots and onward transportation of finished products	• Devise friendly strategies for farmers and microprocessors to access funds • Explore the use of associations or cooperatives providing funds for members in order to reduce the cost of servicing individual loans
Inability of many farmers to deliver cassava to industrial processors within 24 hours of harvesting	• Promote the use of appropriate technologies for harvesting, e.g. a lifter. Processors could introduce the use of mobile peelers by farmers' cooperatives or outgrowers
There is little differentiation between the pro-vitamin A cassava and other varieties of cassava, which poses the risk of the cassava being used for other purposes including animal feed	• Capacity building and awareness creation for farmers on the identity characteristics of yellow cassava
Inadequate knowledge, expertise and technology for cassava processing	• Capacity building for cassava processors on the most cost-effective strategies for cassava processing
Extension services tend to be inadequate, inefficient and ineffective	• There is need for the engagement of more extension workers to increase farmers' access to inputs, processors and markets
The perishability of fresh cassava makes even minor delays in its transport very costly. Infrastructure is inadequate and postharvest technology needs to improve	• Cassava farmers should be organized into clusters, and transportation or processing infrastructure should be provided for such clusters to reduce transport costs and perishability of cassava

Table 8 contains the key constraints in the OFSP value chain and the proposed areas of intervention for each. The issues of capacity building and awareness creation are paramount for farmers, processors, consumers and policy-makers. Improving and strengthening the linkages among producers, processors, manufacturers and marketers are germane in increasing the adoption and consumption levels of OFSP and are among the preconditions for strengthening the OFSP value chain in Nigeria.

Table 8: Constraints and proposed interventions for the OFSP value chain

Constraints	Proposed interventions
Comparatively low awareness and low uptake for processing	• Awareness creation and sensitization campaigns for producers, processors and consumers on the nutritional value of OFSP
Lack of integration and coordination among producers, processors, manufacturers and marketers. Most value chain activity is at the production level and distribution is mostly restricted to local markets	• Strengthen linkages among producers, processors, manufacturers and marketers
Low productivity of smallholders owing to the small size of the land holdings used for cultivating the crop	• Increase farmers' access to land for cultivation of OFSP through collaboration with state ADPs and state governments
Poor storage conditions owing to the lack appropriate information or technology, and lack of infrastructure	• Develop appropriate storage facilities to reduce postharvest losses
Poor access to farm inputs such as fertilizers and pesticides	• Make planting material available to farmers • Multiply and sell OFSP varieties via existing seed suppliers
Low awareness among farmers, consumers and policy-makers on the nutritional and economic value of OFSP	• Awareness campaigns on the nutritional value of OFSP should be carried out on a sustained basis
Poor linkages among farmers and buyers of OFSP	• Link producers with collectors for direct collection of the crop • Establish local collection centers
Low adoption of OFSP	• Awareness campaigns on the nutritional value of OFSP should be carried out on a sustained basis
The low dry matter content in OFSP makes it much softer than the conventional sweetpotato	• Facilitate the breeding and release of varieties with high dry matter. The three or so varieties in the release pipeline that are reported to be high in dry matter content should be fast tracked for release and made available to farmers
At the policy level, there is poor multisectoral coordination and collaboration among stakeholders	• Development of an effective coordination mechanism among line ministries

Table 9 shows the key constraints in the pro-vitamin A maize value chain and the suggested interventions to address them.

Table 9: Constraints and proposed interventions for the pro-vitamin A maize value chain

Constraints	Proposed interventions
Insufficient knowledge on good agricultural and postharvest practices	• Awareness creation and capacity building for farmers on good agricultural and postharvest practices for orange maize
Limited knowledge among farmers on soil management practices, crop nutrient requirements and other key agronomic insights	• Awareness creation and capacity building for farmers on soil management practices and crop nutrient requirements for orange maize
Aflatoxin contamination in maize produced in Nigeria is a major constraint	• Sensitization on strategies to reduce aflatoxin in orange maize production • Development of orange maize varieties that are resistant to stress, insects and fungi
Storage pests such as mice, rats and other rodents are notable sources of damage for stored maize grain	• Sensitization and awareness creation on best practices for storage of orange maize to reduce postharvest losses
Low yield is a major limitation to the development of the value chain	• Awareness creation and capacity building for farmers on soil management practices and nutrient requirements for orange maize • Increase sustainable access of fertilizers to farmers
Poor access to finance	• Develop farmers' cooperatives and build capacity on the use of the available sources of funding for agriculture
Low rate of adoption of the improved technical package by farmers in Nigeria	• Awareness creation and sensitization campaigns on the nutritional value of orange maize for producers, processors and consumers

3.10 Government policies, strategies and development plans in favor of nutrition and biofortification

Many countries have seen rapid acceptance of biofortification by government entities, and national governments have proactively integrated it into their agriculture and nutrition policies. Panama and Colombia were among the first countries to include biofortification in their national food security plans. Biofortification has been included in national nutrition strategies in Rwanda, Ethiopia and Zambia.[43] While Nigeria has a complex and multisectoral policy landscape in the areas of food and nutrition, the integration of biofortification in the agriculture and nutrition policies has received little attention from the government. In this section we map out the government policies, strategies and plans that target the promotion of biofortification.

3.10.1 Agriculture policy

The Federal Ministry of Agriculture and Rural Development is the custodian of the agriculture policy launched in 2001. The policy promotes import substitution and private sector investment in agriculture. The key objectives of the policy are to achieve domestic self-sufficiency in the major food crops, improve the number of value-added products and increase Nigeria's agricultural exports. The Nigeria Agricultural Transformation Agenda's (ATA) Food Security and Nutrition Strategy for 2015–2020 was developed in 2016. It targets undernutrition, specifically stunting, underweight, wasting and micronutrient deficiencies, as well as overweight and obesity, utilizing nutrition-sensitive agriculture as the point of entry. The Food Security and Nutrition Strategy was designed so that its goals aligned with the national policy provisions on agriculture, food and nutrition, and the

[43] Bouis, H.E., Saltzman, A., Low, J., Ball, A. and Covic, N. (2017). The way forward. *African Journal of Food, Agriculture, Nutrition and Development,* 17(2):12130–12141.

need to urgently reduce the high level of malnutrition in Nigeria. The strategy provides for the use of biofortification as a micronutrient deficiency control strategy and aims to promote biofortified staples such as rice and maize in addition to pro-vitamin A cassava and OFSP.

3.10.2 Food and nutrition policy

The food and nutrition policy was published in 2014. It focuses on addressing the scourge of malnutrition in Nigeria. The policy provides the framework for addressing the problems of food and nutrition insecurity at the individual, household, community and national levels. It provides guidelines for the identification, design and implementation of interventions across the different relevant sectors. The primary focus of the policy is on direct interventions that focus on increasing production and improving processing of agricultural produce. The strategies proposed for addressing vitamin A deficiency include supplementation, fortification and dietary diversification.[44]

3.10.3 National guidelines on micronutrients' deficiencies control in Nigeria

The national guidelines on micronutrients' deficiencies control in Nigeria were published by the Ministry of Health in 2013. These guidelines are one of the main policy documents in Nigeria that recognize biofortification as a viable long-term strategy for the prevention and control of vitamin A deficiency.

3.10.4 National science, technology and innovation policy

The policy on science, technology and innovation launched by the Ministry of Science and Technology in 2012 has as its core mission the evolution of a new Nigeria that harnesses, develops and utilizes science, technology and innovation to build a large, strong, diversified, sustainable and competitive economy that guarantees a high standard of living and quality of life to its citizens. While there are no nutrition considerations in this policy, it has provisions for biotechnology research.

3.10.5 National school health policy

The nutrition component of the 2006 school health policy of the Ministry of Education is the school feeding program, which aims to provide one adequate meal a day to all children enrolled in schools nationwide. The policy builds upon the government's current National Home-Grown School Feeding and Health Programme, which aims to contribute to the realization of the national and international development goals.

So far, there are five policies in Nigeria that target malnutrition as an area of intervention but only two of them mention biofortification specifically as a strategy for addressing micronutrient deficiency. Several gaps can be identified with respect to policy support for biofortified foods:

- The focus of the agriculture policy remains on increasing yields for staple crops such as rice, cassava, maize, sorghum etc. and is silent on biofortified crops even though they are nutrient dense.
- Nutrition policies focus on direct interventions and largely neglect food-based nutrition approaches. An exception to this is the mandatory fortification of selected food items.
- The policies focusing on food supplementation are being implemented by the health sector, especially vitamin A distribution. Implementation of policies on mandatory food fortification has had varying levels of success.[45]

[44] Adeyinka,O. (2015). Situation analysis Report on Building Nutritious Food Baskets (BNFB): Scaling up Bio-fortified Crops for Nutrition Security in Nigeria.

[45] Ibid

Overall, the current policy environment in Nigeria does not promote biofortification overtly. Apart from the agriculture policy and the national guidelines on micronutrients' deficiencies control in Nigeria, no other government policy document targets biofortification as a strategy for addressing micronutrient deficiency. The absence of an institutional framework with the sole mandate of promoting biofortification may account for this. However, some initiatives in the national guidelines on micronutrients' deficiencies control and the agriculture policy that are relevant to the BNFB mandate can be leveraged to facilitate the scaling up of biofortification.

4. Summary of findings

This report presents the findings of the situation analysis that was aimed at gathering analytical data and information that establishes the baseline status of the key thematic components of the project and key actors responsible for realizing the objectives of the BNFB Project in Nigeria. The following are the main findings from the empirical analyses with respect to the seven general objectives of the situation analysis, the conclusions and key areas of interventions necessary for scale up of biofortification, and recommendations.

Objective 1: Use available data and other information to accurately identify the key actors in the scaling up of biofortified crops and the trends and patterns of consumption of biofortified crops and their products, disaggregated by relevant segments of the country and of the population.

- There were several key actors involved in the scaling up of biofortified crops in Nigeria. These included international partners such as HarvestPlus, the Bill & Melinda Gates Foundation, Catholic Relief Services, Helen Keller International, CIP, UNICEF and IITA as well as national partners and research institutes such as the Federal Ministry of Agriculture and Rural Development and NRCRI.

- The first variety of pro-vitamin A cassava was approved for release in Nigeria in late 2011 and about half a million Nigerian farm households were growing its varieties.

- The level of awareness on biofortification was high among farmers but low among consumers. Over 60% of the farmers surveyed were aware of the existence of biofortified sweetpotatoes, cassava and maize but over 61% of the consumers were not aware of the existence of these crops.

- Among the states, farmers' awareness on biofortification was highest in Benue, at 83.8%, followed by Kaduna, at 79%, Akwa-Ibom, at 70%, Taraba, at 56.9% and Osun, at 56.7%. Among consumers, awareness of the existence of biofortified sweetpotatoes, cassava and maize was high only in Benue state, at 83%.

- The level of farmers' awareness on the biofortified crops was highest for OFSP, at 55.1%, and then cassava, at 39.9%. Only 5% of the respondents were aware of the existence of biofortified maize.

- The main source of information on the existence of biofortified crops was markets, which was the source for 48.2% of the farmers, friends for 24% of the farmers and ADPs for 14.8% of the farmers. The sources of information for consumers included friends for 39.3% of them, markets for 33.1% of them and ADPs for 12.7% of them.

- There was a general low level of awareness among consumers on the benefits of biofortification of crops. Only 25.6% of them accurately identified the benefits of biofortification, compared with 78% of the farmers.

- Some 42.2% of the farmers planted biofortified sweetpotatoes, 33.3% planted biofortified cassava and 15% planted biofortified maize. Overall, only 30.2% of the farmers planted biofortified crops.

- About 61.1% of the farmers planting biofortified crops cultivated them mainly for consumption, while only 30.3% of them cultivated them for sale.

- The predominant types of sweetpotatoes, cassava or maize consumed by the respondents were the white types, which are not biofortified. Fewer than 3% of the respondents consumed the non-white varieties of these crops.

- The consumption of biofortified crops and food products was influenced by the consumers' level of education and location, and the taste and texture of the products.

Objective 2: Identify and analyze the barriers and bottlenecks that prevent disadvantaged groups from accessing and benefiting from biofortification, including the social, political and economic conditions that result in shortfalls in the creation of an enabling environment for the scaling up of biofortification.

- The main barriers disadvantaged groups faced in accessing and benefiting from biofortification included cultural and individual preferences relating to the product attributes; inefficiencies in the credit market, information access, and input and output markets; and their low education levels.

Objective 4: Analyze the extent to which biofortification is prioritized in national policies, law, strategies, plans and budgets.

- There were five key policies in Nigeria that target malnutrition, but only two specifically mentioned biofortification as a strategy for addressing micronutrient deficiency.

- The following gaps were identified with respect to policy support for biofortified foods:
  - The focus of the agriculture policy remained on increasing yields of staple crops;
  - Nutrition policies focused on direct interventions and largely neglected food-based approaches;
  - The policy environment in Nigeria did not overtly promote biofortification.

Objective 5: Analyze government's (and its agencies') policy and funding priorities as far as nutrition and biofortification are concerned.

- The sources of funding for biofortification in Nigeria were internal and external. The internal sources were mainly related to the federal government, while the main external sources were HarvestPlus and the Bill & Melinda Gates Foundation.

- Another source of funding was the New Alliance for Food Security and Nutrition.

Objective 6: Analyze current institutional and structural bottlenecks to address in order to unlock the value chain for the biofortified crops in the country, including the varietal release policies/criteria and the biofortified varieties currently in the pipeline (for release).

- There were nine types of actors in the biofortified crops value chain in Nigeria – farmers, local collectors, national traders, wholesalers, retailers, agroprocessors, home consumers, national agricultural research institutes and the variety release committee.

- The key constraints in the yellow cassava value chain included underutilization of cassava tubers for industrial purposes, weak linkages between the industrial users of cassava products and processors, poor market information, unavailability of inputs, poor finance, and the short shelf life of yellow cassava roots.

- The key constraints in the OFSP value chain included the low uptake of the crop in processing, low productivity of smallholder farmers, poor access to farm inputs, low awareness among consumers on the nutritional value of OFSP, poor linkages among farmers and processors of OFSP, short shelf life of OFSP roots, poor market outlay, and poor multisectoral coordination and collaboration among OFSP stakeholders in Nigeria.

- The key constraints in the maize value chain included insufficient knowledge on good agricultural and postharvest practices; limited knowledge on soil management practices, crop nutrient requirements and other agronomic essentials; aflatoxin contamination; storage pests such as mice, rats and other rodents, which were a source of notable damage to stored maize grain; low yield; and low rates of adoption of the improved technical package by farmers.

- The quantity of food returned after processing was lower for pro-vitamin A cassava than for conventional cassava, and pro-vitamin A cassava products were more expensive than conventional cassava products.

- The poor packaging method used by processors for preserving pro-vitamin A content was one of the major institutional bottlenecks.

- The unavailability of seeds is an important challenge that must be addressed.

- The inadequacy of the laboratory facilities, which are important for research geared towards improving the texture, taste and color of the biofortified crops, was a key institutional problem.

Conclusions and recommendations

This study gives a clear picture of the situation in Nigeria with respect to BNFB objectives and indicators, and also contributes to improving the understanding on the gaps and the actions vital for the scaling up of biofortification in Nigeria. These outcomes will be useful in designing strategic interventions for scaling up biofortified crops for nutrition security in Nigeria. The following recommendations emanate from the findings of the study:

- CIP and HarvestPlus should target more advocacy programs at raising the awareness level on the existence of biofortified crops in Nigeria.

- CIP should aim for the use of media channels such as television and radio for awareness creation and sensitization programs for stakeholders on the existence and importance of biofortified crops for their health.

- HarvestPlus, CIP and other research institutions should focus on improving the yield, maturity period, taste, color and texture of the biofortified crops based on the preferences of farmers and consumers.

- HarvestPlus and CIP should develop an intervention specifically addressing the bottlenecks that prevent disadvantaged groups from accessing and benefitting from biofortified crops.

- HarvestPlus and CIP should advocate for the establishment by the federal government of an institutional framework to support biofortification in Nigeria that is backed by law.

- CIP should carry out advocacy among the partners in the New Alliance for Food Security and Nutrition to ensure that part of their investment in agriculture in Nigeria is directed to biofortification activities.

- CIP and other partners in Nigeria should conduct advocacy programs focused on policy-makers for the mainstreaming of biofortification in agriculture and nutrition policies.

- CIP should create a biofortification innovation platform that incorporates all the stakeholders around the agricultural farming zones in each state, including farmers, researchers, input dealers, processors, marketers, financial institutions and consumers.

- CIP should implement capacity building interventions for key actors in the biofortified crops' value chain as follows:
  - Farmers: on-farm demonstrations on agronomic practices that increase yield and on storage of biofortified crops;
  - OFSP processors: new processing approaches that improve the taste, texture and dry matter content of the roots and processed products;
  - Researchers: techniques to develop new biofortified crops with high yields, resistance to diseases and pests, short maturity period, good taste and high nutritive value.

Annexes

Annex 1: Questionnaire for farmers

Questionnaire number: _____ (To be completed in the office)

SECTION 1: IDENTIFICATION

Location	State:		LGA:				Town:				
Sector	(1) Urban		(2) Peri-Urban				(3) Rural				
Name of interviewer											
Interviewer Phone #											
Date of interview											
Name of the Supervisor											
Farmer's Name											
Farmer's Phone #											
Farmer's Address											

SECTION 2: SOCIO-DEMOGRAPHIC INFORMATION OF FARMER

No.	Questions	Responses
1	**Household size** ≤ 4……..(1) 5-8……(2) 9-12……(3) Above 12…….(4)	
2	**Sex** Male……..(1) Female……(2)	
3	**Age (in years)** ≤ 20 ……..(1) 21-30 ……..(2) 31-40 ……..(3) 41-50 ……..(4) 51-60 ……..(5) 60 and above ……..(6)	
4	**Marital Status** Married …….. (1) Unmarried …….. (2)	
	Education No formal education …….(1) Quaranic education ……..(2) Pry. School education ……..(3) Sec. school education …….(4) Tertiary education ……..(5)	

SECTION 3: FARMING INFORMATION

No.	Questions	Options	Responses		
6	How long have you been farming?	LESS THAN 1 YEAR……(1) 1-2 YEAR……(2) 3-5 YEARS……..(3) ABOVE 5 YEARS……..(4)			
7	Is farming your primary occupation?	YES……(1) NO……(2)			
8	If no, what proportion of your occupation is farming?				
9	Ownership of farm	SELF …….. (1) HIRED …… (2) GROUP FARM……(3) COMMUNITY FARM……(4) SPOUSE FARM……..(5) OTHERS (SPECIFY)……(6)			
10	Land holding size	LESS THAN 1 ACRE…… (1) 1-2 ACRE …….. (2) 3-5 ACRES ……..(3) ABOVE 5 ACRES…….. (4)			
11	Land holding type	LOWLANDS/FADAMA……(1) IRRIGATED……..(2) UPLAND RAINFED……(3)			
12	What category of farmer are you?	FARMER ONLY……(1) FARMER & PROCESSOR……..(2)			
13	Do you plant the following crops (*tick as appropriate)?*	SWEETPOTATO……(1) CASSAVA……(2) MAIZE……(3)			
14	For what purpose do you plant the crops?	COMMERCIAL……..(1) HOUSEHOLD CONSUMPTION…(2) BOTH……..(3)			
15	What is the proportion (out of a 100%) of the crops (cassava, sweetpotato& maize) to other crops that you produce?	CASSAVA: …….. SWEETPOTATO: …….. MAIZE: ……..			
16	How often do you plant these crops?	ONCE A YEAR……..(1) TWICE A YEAR……(2) ALL YEAR ROUND……..(3) OTHERS (SPECIFY)……(4)	Sweet potato	Cassava	Maize
17	Do you belong to an association?	Yes (1) No (2)			
18	If yes, which one?	FARMERS ASSOCIATION……(1) POTATO/CASSAVA/MAIZE FARMERS ASSOCIATION……(2) COOPERATIVE……(3) OTHERS (SPECIFY)……(4)			
19	Who are your customers? *(Multiple responses are allowed)*	WHOLESALERS……(1) RETAILER(S)……..(2) HOUSEHOLD CONSUMERS……..(3) ORGANIZATION/INSTITUTIONS……(4) EATERIES/CATERERS……..(5) PROCESSORS……(6) ALL OF THE ABOVE……..(7) OTHERS (SPECIFY)……..(8)			

20	WHERE DO YOUR CUSTOMERS COME FROM? *(TICK AS APPROPRIATE AND GIVE PROPORTIONS)*	WITHIN THE CITY .....(1) OUTSIDE THE CITY .....(2) FROM OTHER COUNTRY (SPECIFY) .....(3) OTHERS (SPECIFY).....(4) _____ 10	
21	WHERE DO YOU MARKET YOUR PRODUCE?	IN THE FARM.....(1) MARKET.....(2) NEIGHBORING MARKET.....(3) REGULAR CUSTOMERS COME TO CLEAR THE PRODUCT.....(4) OTHERS (SPECIFY).....(5)	
22	How do you reach your customers? *(Tick as appropriate and rank in proportion to make 10)*	THEY COME TO YOU.....(1) YOU GO TO THEM.....(2) BOTH.....(3) _____ 10	
23	Why do you choose to plant sweetpotato/maize and cassava?		

SECTION 4: AWARENESS OF THE NON-WHITE CROPS (CASSAVA, SWEETPOTATO AND MAIZE)
(*The interviewer should explain to the respondent what this means as the biofortified type)*

No.	Question	Options		Responses
24	Before now, are you aware of the non-white varieties of cassava, sweetpotato and maize?	YES……(1) (GO TO Q25) NO……(2)(**END INTERVIEW**)		
25	If yes, where *(tick as appropriate)*	FRIENDS……(1) MARKET……(2) COMMUNITY EVENT……(3) EDUCATIONAL CAMPAIGN (WHERE-CLINICS, SCHOOLS, ETC.),……(4) RADIO……(5) TELEVISION……(6) FLYERS……(7) BILLBOARDS……(8) OTHERS(SPECIFY)……(9)		
26	Do you plant the non-white varieties of cassava, sweetpotato and maize?	**Cassava**	**Sweetpotato**	**Maize**
	Yes……(1)			
	No……(2)			
		INSTRUCTION: If NO To ALL in Q26, Go To Q29		
27	If yes, What portion of your farm land do you use to plant the non-white varieties of the crops (cassava, sweetpotato and maize)?	LESS THAN 0.5 HECTARE……(1) 0.5-1 HECTARE……(2) 1-2 HECTARES ……(3) 2-3 HECTARES……(4) 3-5 HECTARES ……(5) ABOVE 5 HECTARES……(6)		
28	What is the average yield (in 50 kg bags) of the following crops in this area? (Please chose the crop that is applicable)	**Cassava (in local/50 kg bag)**	**Sweetpotato (in local/50 kg bag)**	**Maize (in local/50 kg bag)**
	In local unit			
	In study unit (50 kg bags)			
29	If No to Q26, why			

Section 5: For only the respondents who reported being aware of the non-white varieties of cassava, sweetpotato and maize

30	Based on what you have heard or seen about the non-white varieties of the crops (cassava, sweetpotato and maize), is there prospect for it in your area?	Yes……(1) No……..(2)	
31	If yes above, what are the prospects?		

SECTION 6: KNOWLEDGE OF THE NON-WHITE VARIETIES OF THE CROPS (CASSAVA, SWEETPOTATO AND MAIZE)

No.	Questions	Options	Responses
32	Before this survey, how well were you informed about the non-white varieties of the crops (cassava, sweetpotato and maize)	VERY WELL……(1) SOMEWHAT…….(2) NOT INFORMED…….(3)	
33	If your response above is either 1 or 2, where did you hear about the non-white varieties of the crops (cassava, sweetpotato and maize) *(tick as appropriate)*	FRIENDS……..(1) MARKET……(2) COMMUNITY EVENT……(3) EDUCATIONAL CAMPAIGN ((WHERE-CLINICS, SCHOOLS, ETC.),……..(4) RADIO……..(5) TELEVISION……..(6) FLYERS……..(7) BILLBOARDS……..…..(8) OTHERS (SPECIFY)……..(9)	
34	White-fleshed crops (sweetpotato, maize and cassava) does not contain vitamin A	TRUE……(1) FALSE……..(2) DON'T KNOW……(3)	
35	By eating the non-white varieties of the crops (cassava, sweetpotato and maize) a person's vision would be improved	TRUE……...(1) FALSE……..(2) DON'T KNOW……(3)	
36	How healthy or risky is the non-white varieties of the crops (cassava, sweetpotato and maize) to human health?	VERY RISKY……..(1) NEITHER……(2) VERY HEALTHY……(3) DON'T KNOW……..(3)	
37	How well do you know that the non-white varieties of the crops (cassava, sweetpotato and maize) can be made into products	VERY WELL……(1) SOMEWHAT……(2) NOT INFORMED…….(3)	
38	How willing are you to plant the non-varieties of the crops (cassava, sweetpotato and maize)?	VERY WILLING……..(1) SOMEWHAT……..(2) NOT VERY WILLING……..(3)	
39	Please identify any post-production activity(s) you participate in (You can select more than one response).	HARVESTING……1 WASHING ……2 SORTING……3 DRYING……4 PEELING/SHELLING……5 CLEANING/WINNOWING……6 GRINDING……7 STORAGE……8 PROCESSING INTO OTHER PRODUCTS….9 MARKETING……10	

Section 7: Attitudes towards the non-white varieties of the crops (cassava, sweetpotato and maize). This section is applicable to farmers who DO NOT PLANT any of the non-whites crops

NO.	QUESTION	OPTIONS	
40	If there is demand, would you definitely, maybe, or not plant the non-varieties of the crops (cassava, sweetpotato and maize)?	DEFINITELY……(1) MAYBE……(2) NOT PLANT……(3)	
41	Would you be more likely to plant if something about it is changed?	YES……(1) NO……(2) DON'T KNOW……(3)	
42	If yes above, what might make you more likely to plant it?		

THANK YOU

Annex 2: Questionnaire for consumers

Questionnaire number: _____ (To be completed in the office)

SECTION 1: IDENTIFICATION

Location	State:		LGA:				Town:				
Sector	(1) Urban		(2) Peri-Urban				(3) Rural				
Name of interviewer											
Interviewer Phone #											
Date of interview											
Name of the Supervisor											
Consumer Name (optional)											
Consumer Phone #											

Section 2: Socio-demographic information of consumer

No.	Questions	Responses
1	**Household size** ≤ 4……..(1) 5-8……..(2) 9-12……..(3) Above 12…….(4)	
2	**Sex** Male……..(1) Female……..(2)	
3	**Age (in years)** ≤ 20 ……..(1) 21-30 ……..(2) 31-40 ……..(3) 41-50 ……..(4) 51-60 ……..(5) 60 and above ……..(6)	
4	**Marital Status** Married …….. (1) Unmarried …….. (2)	
5	**Education** No formal education …….(1) Quaranic education ……..(2) Pry. School education ……..(3) Sec. school education …….(4) Tertiary education ……..(5)	
6	**Occupation** Trading ……..(1) Civil service ……..(2) Teaching ……..(3) Others (specify) ……..(4)	

Section 3: Frequency and pattern of consumption of sweetpotato, cassava and maize crops and products *(tick as applicable)*

No.	Question	Responses		
7	Do you and your household consume the following crops or its product (tick as appropriate)	**Sweetpotato**	**Cassava**	**Maize**
	Yes……..(1)			
	No……(2)			

No.	Questions & Options	Responses		
		Sweetpotato	**Cassava**	**Maize**
8	**Why do you eat all or any of the crops?** Available ……(1) Affordable …… (2) Personal/Household preference ……..(3) Told nutritious……(4) It is our cultural food……..(5) Other(s) specify ……(6)			
9	**What quantity of each of the crop do you and your household consume weekly?** *(Please indicate how much is the heap)* Less than 1 heap/mudu/congo/bag……(1) 1-2 Heaps/mudu/congo/bag …… (2) 3-5 Heaps/mudu/congo/bag ……(3) >6 heaps/mudu/congo/bag……(4)			
10	**What type of each of the crops do you eat? (*Tick as appropriate*). Please explain non-white as the biofortified type** White type ……(1) Non-white type……..(2) Both……(3) Others (specify)……..(4) *If both, specify proportion of white to non-white*			
11	**If non-white, why?** Available……(1) Affordable ……..(2) Personal/household preference ……(3) Told nutritious/good …….. (4) Because of the color ……(5) Other(s) specify ……(6)			
12	**If white, why?** Available ……(1) Affordable …… (2) Personal/Household preference ……..(3) Told nutritious……(4) It is our cultural food……..(5) Other(s) specify ……(6)			

13	**Apart from the open market, where else do you get your crops** Farm……..(1) Supermarket……(2) Gift……..(3) Others (specify)……(4)			

Section 4: Awareness of the non-white varieties of the crops (cassava, sweetpotato and maize)

No	Question/sample	Options		Responses
14	Before now, are you aware of the non-white varieties of the crops (cassava, sweetpotato and maize)?	Yes……(1) No……(2)		
15	If yes, where	Friends……..(1) Market……..(2) Community event……(3) EDUCATIONAL CAMPAIGN ((WHERE-CLINICS, SCHOOLS, ETC.),……..(4) Radio……..(5) Television……..(6) Flyers……(7) Billboards……..(8) OTHERS (SPECIFY)……..(9)		
16	Do you consume all or some of the non-white varieties of the crops (yellow cassava, orange sweetpotato and orange maize)? (tick as applicable)	**Orange-fleshed Sweetpotato**	**Yellow Cassava**	**Orange Maize**
17	If No, why			
	INSTRUCTION: If NO To ALL in Q16, Go To Q20			
18	**If yes, how often?**	SWEETPOTATO	CASSAVA	**Maize**
	OCCASIONALLY……(1) WEEKLY……(2) MONTHLY……..(3) QUARTERLY……(4) WHEN IN SEASON……..(5) Others (specify)……(6)			
19	In what form do you consume it? FRESH……..(1) BOILED……(2) FRIED……(3) ROASTED……..(4) BAKED……(5) COOKED ……..(6) Others (specify)……..(7)			

Section 5: Knowledge of non-white varieties of the crops

No.	Questions	Options & Codes	Responses		
			Sweetpotato	Cassava	Maize
20	Before this survey, how well were you informed about the non-white varieties of the crops (Cassava, Sweetpotato and maize)	Very well……(1) Somewhat……(2) Not informed at all…….(3)			
21	If your response above is either 1 or 2, where did you hear about the non-white varieties of the crops (Cassava, sweetpotato and maize) *(tick as appropriate)*	Friends……..(1) Market……..(2) Community event……(3) EDUCATIONAL CAMPAIGN ((WHERE-CLINICS, SCHOOLS, ETC.),……..(4) Radio……..(5) Television……..(6) Flyers……..(7) Billboards……..(8) Others(specify)……..(9)			
22	White-fleshed crops do not contain vitamin A	True……(1) False……..(2) Don't know……(3)			
23	By eating the non-white varieties of the crops (Cassava, sweetpotato and maize), a person's vision would be improved	True……..(1) False……..(2) Don't know……(3)			
24	How healthy or risky is the non-white varieties of the crops (Cassava, sweetpotato and maize) to human health?	Very risky……..(1) Neither……(2) Very healthy……(3) Don't know……..(3)			
25	How willing are you to consume the non-white varieties of the crops (Cassava, sweetpotato and maize)?	Very willing……..(1) Somewhat……(2) Not very willing…….(3)			
26	Do you feel the non-white varieties of the crops (Cassava, sweetpotato and maize) should be talked about on media?	Yes……(1) No……(2)			
27	If Yes, above, how important is it to talk about the non-white varieties of the crops (Cassava, sweetpotato and maize)? on media (Radio, Television, Posters)?	Very……(1) Somewhat……..(2) Not very……..(3)			

Section 6: Attitude towards the non-white varieties of the crops (Cassava, Sweetpotato and maize)

NO.	QUESTION	OPTIONS & CODES	RESPONSES		
28	If the non-white varieties of the crops (Cassava, sweetpotato and maize) is found in market, would you definitely, maybe, or not buy/use it?	Definitely……(1) Maybe…….(2) Not buy/use….(3)	Sweetpotato	Cassava	Maize

29	What might make you more likely to buy/use it?
30	What problems do you foresee in eating or using the non-white varieties of Cassava, sweetpotato and maize? Suggest solutions?

Section 7: Willingness to pay for the non-white varieties of the crops (cassava, sweetpotato and maize)

What is the cost of a quantity *(let the respondents tick the measure and then the price under the price column)* from white crop? How much are you willing to pay for the same quantity if it is the non-white varieties of the crops (Cassava, sweetpotato and maize)?

NO.	ROOTS (IN BAGS)	MEASURES *(TICK AS APPROPRIATE*		NGN (N)
31	WHITE FLESHED SWEETPOTATO	DUST BIN BASKET		
		HEAP		
32	ORANGE-FLESHED SWEETPOTATO	DUST BIN BASKET		
		HEAP		
33	WHITE CASSAVA	DUST BIN BASKET		
		HEAP		
34	YELLOW CASSAVA	DUST BIN BASKET		
		HEAP		
35	WHITE MAIZE	MUDU/KONGO		
		50 KG BAG		
36	ORANGE MAIZE	MUDU/KONGO		
		50 KG BAG		

Section 8: For only the respondents who reported being aware of the non-white crops (cassava, sweetpotato and maize)

37	Based on what you have heard or seen about the non-white varieties of the crops (Cassava, sweetpotato and maize), is there prospect for it in your area?	Yes……(1) No……..(2)	
38	If yes above, what are the prospects?		

THANK YOU

Building Nutritious Food Baskets

The Building Nutritious Food Baskets: Scaling up Biofortified Crops for Nutrition Security seeks to reduce hidden hunger by catalyzing sustainable investment for the production and utilization of biofortified crops (Orange-fleshed sweetpotato (OFSP); vitamin A (yellow) cassava, vitamin A (orange) maize and high iron/zinc beans) at scale. The project is implemented in **Nigeria** and **Tanzania**, to demonstrate how biofortified crops can be scaled up through a multi-crop ("food basket") approach. BNFB draws on complementary expertise for scaling up through a partnership between CGIAR centers and programs, regional organizations and other public and private sector agencies to create a movement that will eventually reach the target populations. BNFB's hypothesis is that scaling up is dependent on supportive policy environment, strong institutional capacities and availability of proven technologies.

CIP International Potato Center
A CGIAR Research Center

CIAT
International Center for Tropical Agriculture
Since 1967 / Science to cultivate change

CIMMYT
International Maize and Wheat Improvement Center

IITA
Research to Nourish Africa

HarvestPlus
Better Crops · Better Nutrition

CGIAR
Science for a food-secure future

FARA
Forum for Agricultural Research in Africa

NEPAD
TRANSFORMING AFRICA