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Final Narrative

Use this form to provide your final update to your foundation program officer regarding the results achieved for the entire project. In addition, please provide your perspective on key lessons learned or takeaways and input on the foundation's support of your work to ensure that we can capture and share learnings as appropriate both internally and externally.

The Final Narrative must be submitted in Word, as PDFs will not be accepted.

General Information

Investment Title	Building an Economically Sustainable, Integrated Seed System for Cassava in Nigeria		
Grantee/Vendor	International Potato Center		
Primary Contact	Graham Thiele	**Investment Start Date**	November 5, 2015
Feedback Contact[1]	Graham Thiele	**Investment End Date**	June 30, 2020
Feedback Email[1]	g.thiele@cgiar.org	**Reporting Period Start Date**	November 5, 2015
Program Officer	Lawrence Kent	**Reporting Period End Date**	June 30, 2020
Program Coordinator	Jeanne Bridgman	**Reporting Due Date**	September 30, 2020
Investment Total	$11,611,993.00	**Opportunity/Contract ID**	INV-009476 OPP1130642
Remaining Funds (If applicable)	$		

[1] Feedback Contact/Email: the full name and email of the contact whom foundation staff queries for various surveys.

Submission Information

By submitting this report, I declare that I am authorized to certify, on behalf of the grantee or vendor identified on page 1, that I have examined the following statements and related attachments, and that to the best of my knowledge, they are true, correct and complete. I hereby also confirm that the grantee or vendor identified on page 1 has complied with all of the terms and conditions of the Grant Agreement or Contract for Services, as applicable, including but not limited to the clauses contained therein regarding Use of Funds, Anti-Terrorism, Subgrants and Subcontracts, and Regulated Activities.

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Progress and Results

1. Final Progress Details

Provide information regarding the entire investment's progress towards achieving the investment outputs and outcomes. In addition, submit the Results Tracker with actual results as requested.

Executive Summary

Charitable purpose

The charitable purpose of this grant was to develop a sustainable cassava seed value chain, including commercial production and dissemination of cassava planting material. This seed value chain will serve as a vehicle to deliver better quality and more productive cassava planting material. Moreover, it will enable more efficient dissemination and adoption of new cassava varieties in order to improve productivity and food security, increase incomes of male and female cassava growers and village seed entrepreneurs, and enhance gender equity.

Strategy

The BASICS project, officially launched in April 2016 and ended in June 2020, has made significant strides toward the development of a sustainable seed system for cassava in Nigeria. The project started with a strategy of (1) creating institutional mechanisms to sustainably produce quality certified *breeder seed* (BS), *foundation seed* (FS), and *commercial seed* (CS), and (2) improving the way seed and seed information reach farmers and, conversely, how market feedback flows back to researchers so that market-preferred varieties are developed and made available. In this way, the seed system helps to more rapidly replace old varieties with higher yielding ones. This takes place under a market-responsive seed quality regulatory regime which emphasizes higher quality standards at the early generation seed (EGS) class levels (Figure 1).

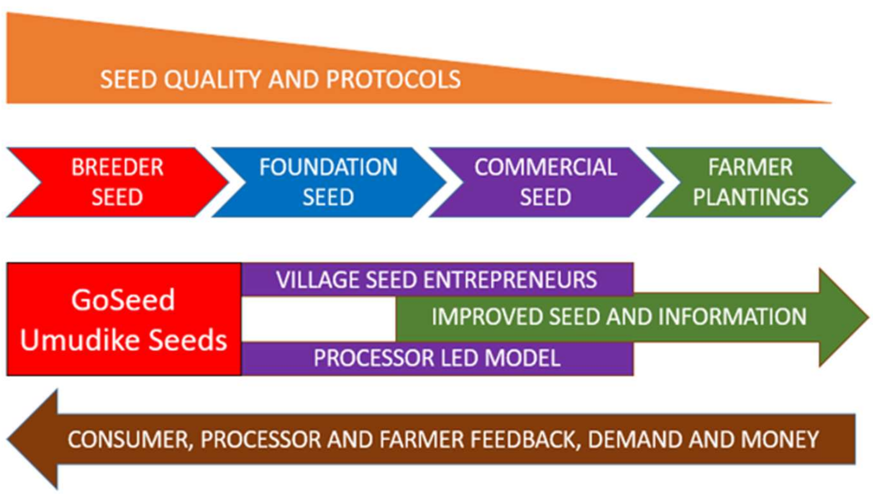


Figure 1. BASICS project strategy.

Recommendations for Phase II of BASICS

- The BS Component (BSC) should coordinate breeding and demand creation trials (DCTs) and involve stakeholders in the naming of varieties.
- There is a need to expand the use of information communication technology (ICT) tools.
- Produce FS closer to village seed entrepreneurs (VSEs) and explore virtual options to manage VSEs. Have more female VSEs and larger VSEs.
- Scale-up third-party seed certification and e-certification.
- Enhance involvement of processors in DCTs. Ensure sustainable access to EGS and adapt processor-led model (PLM) to be profitable for different types of processors.
- Use the seed flow map to plan annual seed production.
- Coordinate the Semi-Autotrophic Hydroponics (SAH) material into a seed system and seasonality of planting.
- Prepare to mitigate cassava brown streak disease (CBSD) with training and diagnosis.

Components

The project set out to establish the building blocks of a sustainable seed system at all levels of the value chain, while contributing to an enabling environment. The project was structured around four components: (1) **BSC** (which also addressed FS as EGS), to put in place a structure to rapidly multiply certified, clean (disease-free) EGS and market it to commercial seed growers; (2) **VSE Component**, which were set up as networks of trained, commercial seed producers and promote sales of quality seed of improved varieties; (3) **PLM Component** to establish a system whereby large- and medium-scale processors set up their own seed supply system of preferred varieties, supporting a network of outgrowers to ensure the planned quantity and quality of roots for their factory in a profitable manner; and (4) **Quality Seed Component** whereby a certification scheme is developed for all seed classes, and the capacity of the National Agricultural Seeds Council (NASC)—the national seed certifying authority—is enhanced to implement the scheme. In addition, a project management unit (PMU) consistently facilitated the component teams and ensured linkages between them, so that the building blocks were well-integrated and the project achieved its objectives.

EGS

To ensure a dependable supply of EGS, the project, through the BSC, addressed three main gaps: (1) slow and low multiplication ratio of cassava stems, (2) lack of availability of EGS, and (3) weak linkage to a pipeline of improved varieties that outperform those currently grown to accelerate variety replacement. The EGS component was led by the International Institute of Tropical Agriculture (IITA), jointly with the National Root Crops Research Institute (NRCRI). Fera Science Ltd (Fera) and NASC participated in the certification of BS and determined the value proposition of certified seed with Catholic Relief Services (CRS), whereas Context Global Development (CGD) and Sahel Consulting Agriculture & Nutrition Ltd (Sahel) participated in the DCTs with processors.

Slow and low multiplication ratio

To increase and speed up the multiplication of material derived from tissue culture (TC), a rapid multiplication technique (SAH) was piloted and refined for use. Today, both IITA and NRCRI have fully functional SAH facilities that are being used to generate clean nucleus seed for multiplication into BS and to manage their varietal inventories.

Lack of availability of EGS

To enhance the access to EGS and make its production commercially sustainable, the project helped to plan and establish commercial EGS enterprises at IITA (GoSeed) and at NRCRI (Umudike Seeds). GoSeed has established viable mechanisms to produce and market EGS to CS producers through a network of BS and FS outgrowers. Umudike Seeds is producing EGS in its own fields and with contracted FS producers. A study commissioned by the project identified larger farmers across Nigeria who are willing and capable of producing more FS if they have easy access to BS. Certified BS and FS are being produced in Nigeria for the first time, on 55 ha, in coordination with NASC. GoSeed and Umudike Seeds are up and running, with active SAH labs and established nurseries, and are producing and selling both BS and FS.

Weak linkage to pipeline of improved varieties

By establishing this EGS value chain, the project also linked seed multiplication and dissemination to the pipelines of new varieties coming from the research institutes IITA and NRCRI, thus working toward providing for a continuous influx of new, improved cassava varieties for farmers and processors. The project carried out DCTs in which improved varieties were trialed close to processing factories and the harvested roots were put through the processor production lines. In this manner, varieties that met the specific needs of the processors for consistently higher starch yields were identified (e.g., TME419, CR36-5, and IBA961632) as well as new promising ones in the breeding pipelines such as TMS13F1160P0004. This approach also provided valuable feedback to the breeding programs on which varieties are best suited to industrial-scale processing. Comparison trials between certified seed and farmer-saved seed (FSS) of the same variety did not show a yield advantage for certified seed, in part due to the cassava mosaic virus (CMV) tolerance of the improved varieties tested. Therefore, the demand for certified seed is driven more from access to new varieties and assurances of true-to-type, whereas clean (disease-free) seed was seen to be less important.

BASICS has been working closely with the NextGen Cassava project (NextGen) to enable the future varietal pipeline to be aligned to market needs. BASICS tested promising genotypes from NextGen with processors, providing valuable feedback on their industrial-scale potential and helping select candidates for variety release. The most promising varieties are already being multiplied in SAH and nurseries, which will significantly shorten the time needed to reach farmers with large quantities of this seed after these varieties are released.

VSEs

The VSE Component had three primary objectives: (1) VSEs to establish profitable businesses; (2) farmers to increase their incomes by planting quality seed of market-driven varieties; and (3) VSEs to effectively certify their seed fields with NASC, thus maintaining the overall integrity of the seed system. The VSE component was led by CRS to set up networks of trained CS producers and to market their seed across 18 local government areas (LGAs) of Benue state. NRCRI also established VSEs who were existing CS outgrowers in Abia, Akwa Ibom, Cross Rivers, and Imo states.

Establish profitable businesses

The VSE model demonstrated clear signs of sustainability through the attractive profitability of seed business enterprises for the seed entrepreneurs on one side, and value for money for the farmers purchasing seed on the other. Over the span of the project, CRS established 136 VSEs in Benue state, and NRCRI set up 50 VSEs in the South-South and South-East regions. VSEs established 700 ha of fields over four seasons; 90% passed certification. Profit was $1,000/ha for stems and roots in one season, and $1,600/ha for ratooned fields over two seasons. By choosing VSEs in the cassava-growing regions, the project tried to reduce the costs of transporting stems over long distances and to better respond to farmer demand. The VSE component forged a seed system value chain that delivers a steady supply of certified planting material of market-demanded cassava varieties to farmers, creating a reusable bridge to enhance the awareness, adoption, and commercial distribution of improved varieties of cassava.

The VSEs were trained in cassava agronomy, seed production, quality certification, and seed business management, resulting in increased capacity to produce quality certified seed. Many VSEs produced seed on more land than during the previous season and expressed their willingness to carry on in the seed business even after support from the project ends. As the project progressed, data showed that VSEs were making decent profits in their seed business, whether they harvested the roots along with the stems after the first year or if they ratooned the fields to get two stem harvests while harvesting the roots during the second stem harvest. BASICS facilitated the formation and registration of an association of VSEs in Benue state to enable the VSEs to be better organized, to foster unity, and to address their common challenges. By training the leaders of this network, they became the instrument to continue training the VSE members of the network, thus creating a sustainable mechanism to maintain the capacity of the seed producers beyond the life of the project via a members' fee scheme.

Farmers plant quality seed of market-driven varieties

The farmers who purchased and planted certified CS of new varieties reported higher yields and expressed willingness to buy more seed of new varieties in future. Some 218 farmers in Benue who bought improved stems in 2017 (44), 2018 (90), and 2019 (84) were surveyed to understand demand and patterns of purchase. Over 58% of the farmers surveyed bought TME419, about 21% of them bought IBA011368, and about 13% preferred IBA980581. Quality assurance and quality certification by NASC were found to be the two major drivers for the farmers to buy the certified stems. Almost all the farmers who bought and used certified stems thought it was a good decision; this bodes well for establishing a sustainable seed system. An analysis of data from 218 buyers (from 2017, 2018, and 2019 seasons) conducted in 2020 revealed that less than half (41%) of the buyers had patronized the VSEs for a second or third season. Of these, only about one-third (31%) repeated purchase of the same variety they bought in the previous one or two years.

Demand was increased for certified cassava varieties by using more than 100 market day promotions (MDPs); 3-2-1 messaging; 150 demo plots; a website (www.cassavastems.org); and advertisements such as radio spots, promo bags, billboards, and flyers.

VSEs effectively get their seeds certified by NASC

Almost 90% of VSE fields passed certification. Most of the VSEs expressed a desire to continue and expand their seed enterprise. They reported that the NASC certification helped to differentiate themselves from informal sellers. The project identified and worked with VSEs who mostly had less than 1 ha planted for seed; however, it turned out that the unit cost of identifying, enrolling, and backstopping such small VSEs may be high and unsustainable. So, the project pivoted to engaging larger VSEs for greater sustainability due to economies of scale. That is the way to go in the future.

PLM

The PLM Component had three objectives: (1) establish a consistent and stable seed production system on processors' fields, including the integration of macro-propagation technology; (2) compare and analyze networks of profitable outgrowers; and (3) develop adaptive multiplication management curriculum and training modules (BAQSTOPS) to model the economic sustainability of the cassava stem business.

The PLM Component, led by CGD in partnership with Sahel, and IITA aimed to provide technical and business advisory support to processors interested in taking more control of their cassava root supply chain by establishing a cassava seed unit.

The project held various consultations to identify cassava starch, flour, and gari processors who would be interested in producing seed of desired varieties, to manage their root supplies. Three processors were identified and vetted to have the capacity and motivation to take better control of their supply of seed of improved cassava varieties and to evaluate new ones. As part of the PLM, the processors set up SAH labs to improve their control over the supply of clean seed of high-quality, high-starch content cassava varieties.

The model showed the three processors willing to invest in cassava seed units and SAH labs: Flour Mills of Nigeria (FMN), Psaltry International Ltd (Psaltry), and Eagleson & Nito Concepts (Eagleson). The project accompanied the processors through the process of investing and establishing SAH labs to start producing clean seed of specific varieties for their production needs. The PLM component provided training and support to define business cases for each processor. Through its work with FMN, the PLM component showed that it is possible in Nigeria to achieve a commercial cassava seed system anchored by the processing industry. Psaltry and Eagleson followed FMN and now have SAH labs, seed production and financial models, production calendars, and outgrower impact models for meeting their raw material needs for processing, signaling a sustainable model for a cassava seed system.

Outgrower model

The three processors under the PLM use different outgrower models. The project undertook a study to describe and analyze the strengths and weaknesses of each model, interviewing the processor management teams, lead farmers, and hosting focus group discussions with some of the outgrowers. In the Eagleson model, 150 farmers participate in a government program through Eagleson, reducing risk through a tri-partite input risk-sharing model. Psaltry has many more outgrowers (1,390) that grow cassava on their individual farms, and the processor provides inputs and training support. Encouraged through the BASICS PLM model, FMN is exploring the option of developing its own outgrower model near its production facility at Shao Farms and has conducted a pilot outgrower scheme with 40 farmers. FMN provides these farmers with inputs and finance and receives the produce at the end of the planting season at a price agreed prior to field establishment.

Quality seed component

The project laid the building blocks to ensure quality assurance (QA) of all seed classes through the QSC. The QSC strove to develop a cassava seed certification system by (1) enhancing NASC's human and infrastructure capacities, (2) defining seed quality standards and regulatory protocols, (3) widening the scope of CS certification by promoting the adoption of third-party certification, and (4) establishing e-certification. These actions set in place a regulatory system for all seed categories. The QSC was led by Fera and, together with IITA and NRCRI, aimed at enhancing the operational capacity of NASC and implementing QA and seed certification at all levels of cassava seed production.

Enhancing NASC capacities

BASICS worked closely with NASC to enhance its ability to develop and enforce the standards for cassava seed certification. The project helped build the physical and human capacities at NASC, making certification of cassava seed more valued by the stakeholders and more widely accessible for the VSEs. Fera worked closely with NASC to establish a molecular diagnostics lab at their Sheda headquarters near Abuja, equipped with the appropriate facilities and instruments, to test seed for virus contamination according to established standards. An efficient and low-cost loop-mediated isothermal amplification (LAMP) assay for CMV was developed and calibrated. Fera staff trained 11 NASC staff on the molecular techniques, virus disease diagnostics, lab management, and seed health so that they could confidently manage their lab.

Defining seed quality standards

Seed QA protocols and certification standards were developed for all seed classes. BASICS succeeded in shifting the emphasis and stringency of certification from CS to BS. A major focus for Fera in this project was to develop the BS certification standard, which includes sampling and molecular testing protocols for CMV. Lack of reliable data from Nigeria on which to base the standards for various parameters was one of the major challenges faced. However, acceptable levels of CMV were set at the most appropriate levels with the available data and information. Because BS was being derived from SAH nursery stems, new standards were explored for both SAH plantlets and the nursery stems, termed "nucleus seed."

Third-party certification

As the certified seed system expands and grows, the capacity of NASC inspectors to cover the growing number of CS production fields will become more untenable. The project fostered the concept of moving toward a decentralized, third-party certification scheme. The Seed Act of 2019, recognizing cassava stems as a category of planting material or seed, allowed NASC to establish guidelines to define the processes, selection of third-party inspectors from local communities, their training, and managing their operations. BASICS piloted certification by third-party inspection agents in March 2020 in Benue state with the CRS VSEs.

Establishing e-certification

The project innovated the use of digital devices in the cassava seed value chain in Nigeria by developing the Cassava Seed Tracker (CST), which allows seed producers to be located online, making it easier to source and sell seed of all categories. The CST made e-certification possible, greatly simplifying and enhancing the efficiency of certification. Since piloting of CST in 2017, 694 field records (certification field units) have been uploaded by BASICS users covering the seed production years of 2016–2019. This includes 102 BS fields, 157 FS fields, and 421 certified seed fields. The CST was adopted and adapted by NASC as the "Nigerian Seed Tracker (NST)" to cover all crops and to ultimately support the regulatory body to migrate their system to e-seed certification. NASC staff were trained to manage the NST system, and an e-certification unit was established using ICT equipment funded by BASICS. This is a significant outcome of the project, whereby the national regulatory body has adopted an ICT tool to enhance and make its seed certification process more effective and efficient. The potential of CST to enable development of seed system in Nigeria was publicly recognized when it was chosen as one of the eight runners-up for high potential digital tools in Nigeria in the Google Impact Challenge.

PMU

The PMU, through the CGIAR Research Program on Roots, Tubers and Bananas (RTB), played a key role as an independent broker, enabling, supporting, and guiding the component teams in achieving the project's objectives in an effective, efficient, and integrated manner. PMU helped the teams stay on track so as to achieve overall objectives. The component teams tested new and innovative models of delivery on the ground, addressing the challenges along the way. BASICS learned that the PMU function is better served if it is independent of the teams directly implementing project activities.

Besides its project management role, the PMU contributed by building an enabling environment, driving toward sustainability and scaling out, and integrating with other projects.

Building an enabling environment

An enabling environment beyond the project helps component teams when the project is breaking new ground, as BASICS did. The PMU worked closely with all the project components to identify and clear the bottlenecks in the enabling environment. For example, by Y2 of the project it was clear that EGS supply was a weak link in the seed system. PMU commissioned expert consultancies to examine the existing informal seed markets and identify larger cassava farmers as potential FS producers. The PMU also crafted a strategy to develop the EGS system that helped create and develop two dedicated EGS companies, one each at IITA (GoSeed) and NRCRI (Umudike Seeds). The PMU advocated for defining and incorporating regulation appropriate to vegetatively propagated crops (VPCs) as opposed to grains. This advocacy contributed to the shaping of the Seed Act of 2019, wherein VPCs were recognized for the first time as seed and third-party certification became possible. The PMU created an effective platform for monthly, semi-annual, and annual interaction between the component teams that enabled them to better achieve their component-specific objectives.

Enhancing sustainability and scaling out

The PMU helped guide the component teams to enhance sustainability in various interventions, either by using the capacities within PMU teams or by bringing in external expertise. For example, when the PMY realized that VSEs with less than 1 ha of seed plots may not be sustainable and would need continued project support for long, it hired a consultant to identify, with the help of CRS, larger VSEs to be engaged by the VSE component. The PMU, in partnership with Sahel, helped IITA and NRCRI develop and implement robust business plans for their CS entities.

The PMU facilitated the further scaling of the BASICS interventions by identifying opportunities and building appropriate collaborations. For example, the PMU helped the Market Development in the Niger Delta (MADE) project, funded by the Department for International Development (DFID), to adopt the VSE model, which included a collaboration with NRCRI to take the VSE model to adjoining states. This larger scale is expected to bring in economies of scale for the VSE model and widen farmers' awareness of the benefits of using certified seeds. In discussions with the Central Bank of Nigeria, the BASICS PMU worked with IITA to facilitate a very large seed demand development possibility that could benefit the entire cassava value chain. The PMU constantly explored opportunities for leverage with mission-aligned projects and organizations such as the Alliance for a Green Revolution in Africa (AGRA), the Sustainable Trade Initiative (IDH), HarvestPlus, the German Agency for International Cooperation, agricultural universities, and other private sector stakeholders.

The PMU encouraged partners to publish not only scientific papers, but also blogs, manuals, social media, and others.

Integrating within and outside with other projects

A sustainable seed system needs to be well-integrated. Early in the project, mismatches of seed availability and the needed amounts of the various seed classes were observed. The project had to manage with limited seed availability for the private sector SAH labs, FS producers, and VSEs. The PMU developed the Seed Flow Map in Excel format, which helps integrate the three seed class producers and the project components. As cassava seed production takes nearly a year, including the time taken for selecting and preparing the land, advance planning is needed for meeting the planting and seed production targets. Each class of seed needs precursor seed material, which generally is produced by a different player. The changing varietal demand in a dynamic market adds to the complexity. The Seed Flow Map is a tool that allows a project team to enter targeted certified seed production by variety and land size, even if the projections may change over the years based on market feedback. The tool will then calculate the upstream need for FS and BS. The tool also estimates the production of certified seed, all based on certain assumptions. As the project teams input details of actual numbers, the assumptions can be validated or amended as needed. On the basis of the BASICS experience, any seed system project should start by developing a seed flow map.

The PMU also attempted to leverage other ongoing cassava projects for win-win outcomes. For example, it worked with the weed management project to help the VSEs enhance their productivity by using appropriate herbicides, interacting and leveraging the tools and capacities of the RTB cluster on improving farmer access to quality seed and improved varieties (RTB CC2.1), and exploring seed fairs with HarvestPlus, among others.

The BASICS PMU held a series of discussions with AGRA, IDH, and HarvestPlus to explore areas for synergistic collaboration. Common areas were identified in terms of strengthening the EGS system with AGRA and certified seed fairs to promote certified seed usage by farmers; no formal agreement was reached, however. This is an area to pursue further in Phase II.

Lessons from BASICS can be applied to other crops, such as yam and sweetpotato (e.g., by improving rapid multiplication, certification, and marketing). If a processor lacks an in-house source of seed, the CST can help connect market players. Indeed, the BASICS PMU helped connect with other RTB seed teams to share lessons.

Vegetative seed is so notoriously difficult to certify that, worldwide, there are few formal seed systems for any VPC other than potatoes, and that is mostly in northern, industrialized countries. BASICS managed to create a certified seed system for cassava, and do so on a commercial, money-making basis—an arrangement that shows every sign of living on after the project ends. It might have been easiest to do this in a small country, but BASICS worked in the most populated nation of

Africa (Nigeria), the world's largest producer of cassava. BASICS thus becomes a model for formal seed systems for VPC crops across the tropics.

BASICS PHASE I FINAL REPORT

1. Introduction

The charitable purpose of this grant was to develop a sustainable cassava seed value chain, including commercial production and dissemination of cassava planting material. This seed value chain will not only serve as a vehicle to deliver better quality and more productive cassava planting material. It will enable more efficient dissemination and adoption of new cassava varieties to improve productivity and food security, increase incomes of male and female cassava growers and VSEs, and enhance gender equity.

Cassava is the most important food crop for Nigeria, which is also the largest producer of cassava in the world, with almost 57m tons (t) of root production in 2018 (FAOSTAT). With over 6m farmers growing cassava, and many of the 190m Nigerians eating it as a staple food, cassava represents a strong entry point to enhance food, nutrition, and livelihood security in Nigeria. Despite its importance, and the fact that 46 improved varieties were released over the past decades, cassava yields have stagnated at less than 10 t/ha. One of the key reasons for such low productivity is a widespread use of low-yielding landraces and slow variety replacement due to an inadequately developed formal seed system. The BASICS project was approved in late 2015, with the ultimate goal of developing a commercial model for a cassava seed system in Nigeria that enables smallholder farmers to have sustainable access to vigorous and healthy planting material of farmer- and industry-preferred varieties of superior quality that enhance farm-level productivity and incomes.

There can be profound yield and productivity gains from using new, farmer- and industry-preferred cassava varieties that are resistant to viruses and other pathogens. In Nigeria, CMD and cassava bacterial blight (CBB) are existing threats to cassava productivity, and CBSD is an impending threat that is not yet present in Nigeria or West Africa. Timely access to this planting material—and planting more robust stems of superior physiological quality—is also an important source of cassava productivity gains attributable to seed. But to unlock these potential returns in Nigeria, stronger integration is needed among different levels of seed producers along the cassava seed value chain. Also required is a more incentive-based system that is transparent and competitive, and functions within an enabling regulatory environment.

More commercially oriented cassava seed systems will promote responsive feedback loops from BS to FS to certified seed and lead to a more efficient allocation of resources (financial, infrastructure, human, germplasm) throughout the system. This will lower the cost of production, dissemination, and adoption of high-quality cassava planting material of improved varieties, which is essential to achieving productivity gains from seed.

With a bold commercial orientation and seed value chain-wide approach, BASICS aimed to catalyze sustainable practices at all levels of the seed system. RTB brought in its expertise and cross-crop experience in scalable and sustainable seed system practices as the coordinating team for this multipartner project. IITA and NRCRI led the BS component, with the core objective of developing a sustainable system to make available both BS and FS of preferred varieties and to create a market-responsive pipeline of improved varieties while addressing issues such as low and slow multiplication ratio and the need for virus-free planting material. CRS and CGD piloted two commercial models (VSE and PLM) to make CS of improved varieties available to farmers. Fera worked closely with NASC and IITA to improve the seed regulatory system in a market-responsive manner.

Before the project began, there was skepticism about the possibility of developing a sustainable seed system for cassava:

- Would farmers be willing to buy cassava stems, given the widespread practices of using their own stems or borrowing from neighbors for free?
- Who would wish to be a cassava seed producer when there was no market for stems?
- Would it be possible to put EGS on a commercial footing?

Therefore, at the time there were a number of key gaps, including the following: inadequate awareness among farmers about the value of improved varieties and quality certified stems; absence of recognized certified seed producers at any of the seed class levels; and lack of information about who is growing, where, which variety, and in what quantities?

Despite these doubts and gaps, BASICS took a bold approach toward building a sustainable and integrated seed value chain in Nigeria. The project systematically identified the gaps in the seed value chain and then addressed those gaps. By the end of the project in early 2020, BASICS had made significant strides toward developing a sustainable seed system for cassava in Nigeria and had set up building blocks across the seed value chain that need further strengthening in Phase II. Continued strengthening of these building blocks put in place by BASICS and addressing the remaining bottlenecks will allow a widespread scaling of the sustainable seed value chain in Nigeria.

1.1 Lessons learned and pivots

Several lessons learned in 2019 helped to identify major pivots that, if taken on board later in the phase, will be key elements in Phase II:

Lessons Learned	Pivots
Growing body of evidence that seed of the same variety sourced from VSEs (certified) or from farmers' fields (farm-saved) is of equivalent yield potential	• Emphasis in marketing stems should switch to access to high-yielding new varieties and not on yield gains of clean seed per se. • Certification to pay more attention to trueness-to-type as the critical yield determinant given extensive mix-ups of varieties that frequently occur in practice.
Across many locations and markets, the variety TME419 was strongly preferred over other varieties, based on superior yield and other characteristics. Farmers were purchasing stems of this variety.	• Ensure adequate supply of TME419 in the near future through the seed value chain. • Scrutinize varieties to identify those that are better than TME419 (the leading market variety). • Segment market sector based on "product profiles" (descriptions of a variety's key traits demanded by users). • Use "catchy" and widely acceptable varietal names (not numbers) to improve both promotion and marketing of new varieties as well as mass communication. • Develop and implement a comprehensive new variety launch strategy after a variety's release
VSEs demonstrated the potential for stem sales at farmer level and a viable business case for VSEs, when a marketable variety is available. But there is limited scope for scaling the VSE model, including certification.	• Organize VSEs into large networks for better organization, peer learning, capacity development, and self-replication. • Engage larger entrepreneurs as VSEs. • Increase emphasis on EGS certification and lighter touch certification at CS level. • Explore innovative ways like insurance, market assurance, and targeted subsidies to reduce seed entrepreneurs' risk in these early stages.
Linkage to breeding pipeline is weak.	Improve linkages to breeding programs and to the new breeding metrics of genetic gain and differentiated product profiles that drives varietal replacement and a dynamic seed market.

This final report for BASICS Phase I covers the project implementation period from the launch of the project in April 2016 up until the end of the project in June 2020. The following sections summarize the important outcomes, key activities, and lessons learned in the four project seed system components: (1) BSC, (2) VSE component, (3) PLM component, and (4) QSC. Each component section starts with an introduction. This is followed by subsections for each outcome, within which are summarized the main activities leading to the outcome. The consultancy reports, findings from studies conducted during the project, and tools developed during the project have been referenced, numbered, and made available in a separate folder as annexes.

2. Breeder Seed Component

2.1 Introduction

As elite materials are developed by breeders, and selected for varietal release at national level, a system must be in place to rapidly multiply seed that is certified to be clean (healthy) and of high quality for farmers to plant. A formal system is designed to attest that the BS developed is true-to-type to the variety in question, and this is linked to a chain of stewardship—from BS to FS to CS—which is made available to farmers so they are guaranteed of getting stems of the correct variety and appropriate health status. This is often not the case with seed that is shared informally. We know from the Cassava Monitoring Survey that there is much confusion among farmers about what they are planting: they often think they are planting an improved variety when they are not, and vice versa. BS is ideally derived from TC material that is disease free. The process using standard technology is slow, and multiplication rates are low, thus necessitating development of novel, rapid multiplication technologies (RMT) for efficient BS production to bulk seed up faster.

BS is multiplied into FS, which is the seed class that is made available to CS growers to produce certified seed for sale to cassava farmers. Together, BS and FS are referred to as EGS. In the absence of certified EGS, informal trading and sharing of cassava seed have resulted in low yields, in part due to the lack of access to improved varieties (and thus lower varietal adoption), uncertainty around the varieties being grown, and planting of low-quality stems, often infected with viruses and other diseases. A certified seed system is geared to coping with emerging pests and diseases, by disseminating new resistant varieties and testing material for cleanliness, thus playing an important role in preventing the spread of such new threats, such as CBSD. In addition, through monitoring the sales of CS, farmer demand for specific varieties and trait preferences can be documented and inform the cassava breeding programs.

Consequently, the BASICS project heled design and establish commercial EGS enterprises at IITA (GoSeed) and at NRCRI (Umudike Seeds). Both entities received project support to develop business plans to establish commercially viable mechanisms to produce and market EGS to CS producers. By establishing this EGS value chain, the project also linked seed multiplication and dissemination to the pipelines of new varieties coming from the research institutes (IITA and NRCRI), thus providing a continuous flow of improved cassava varieties for farmers and processors. By adapting and refining an RMT, known as Semi-Autotrophic Hydroponics (SAH), the project has enabled the efficient production of clean BS in larger volumes and an effective form of inventory management.

NRCRI and IITA led the effort to produce BS annually in a planned manner to supply contracted FS producers in Benue, Southwest, and South-South/South-East focus areas. BS production was linked to crop improvement programs as well as to variety demo trials (i.e., DCTs) to generate demand for existing and new varieties to improve the rate of variety replacement, based on market demand and variety development by the national and IITA-based breeding programs. NRCRI established FS sites in Benue state in Y1 of the project, and this is now transitioning to Umudike Seeds. GoSeed established contractual agreements with 18 BS and FS producers/outgrowers identified by the project in nine states in the country. In 2018 GoSeed, with identified seed outgrowers, produced 30 ha of BS and 9 ha of FS; in 2019 GoSeed produced 39 ha of BS and 56 ha of FS.

IITA (GoSeed) and NRCRI (Umudike Seeds) have successfully institutionalized the sale of BS and FS in a more business-focused approach. GoSeed made $39,750 in the sales of 20,950 bundles of BS and FS from 2018 to 2020. Through extensive tracking over four years, the project monitored the economics of seed use across the entire seed system (stem production from SAH-nursery to BS and FS to CS production, through seed sales to farmers and value generation of processed roots). This information will be used to demonstrate economic sustainability and scalability, and thus serve as a best practice model to be replicated beyond the life of the project.

2.2 Outcomes and activities

2.2.1 RMT adapted and implemented

To increase and accelerate the multiplication of TC-derived material, SAH, an RMT originally developed for potato multiplication by SAHTECHNO LLC in Argentina, was piloted and refined for use in Nigeria for cassava. As of 2020, both IITA and NRCRI have fully functional SAH facilities that are being used to generate clean nucleus seed. Their commercial seed companies (GoSeed and Umudike Seeds) can rapidly multiply this seed as both BS and material for breeding trials. SAH allows inventory management for breeding purposes while permitting the quick adjustment of stock for generating BS according to shifting market demands. In this way, the emerging demand for varieties like TME419, IBA961632, and CR36-5 can be met quicker through rapid multiplication of clean plantlets in SAH. If some of the newly developed NextGen cassava varieties succeed in multilocation trials and are formally released, farmers will be able to access the certified seed of these varieties much more quickly, increasing the chances of adoption. As a result of successful demonstrations of SAH at IITA's laboratories, additional countries (Democratic Republic of the Congo, Mali, Zambia, Malawi, Togo, Sierra Leone, Rwanda, Uganda, and Tanzania) have shown interest in adopting the technology through the TAAT program (Technologies for African Agricultural Transformation), supported by the African Development Bank (AfDB).

2.2.1.1 Establishment and improvement of SAH

IITA and NRCRI established the first pilot SAH labs in Africa. This was complemented by three more labs set up by three BASICS partners, private sector processors, for their outgrowers and to provide their own dedicated cassava root production. Each SAH lab needs suitable air-conditioned premises that are fitted with metal racks; special lighting; separate rooms for cutting, storing, and multiplying plantlets; along with dedicated and trained technicians. IITA and NRCRI teams made many adjustments to improve the multiplication ratio and generate healthy cuttings, and to significantly cut production costs. These adaptations included the use of screen structures that do not require more costly temperature control, and efficient field establishment methods to ensure high survival and rapid growth of SAH plantlets in the field. The recommended nutrient solution was substituted with a cheaper, off-the-shelf fertilizer. The initial cost estimate was about $0.10 per SAH plantlet in 2017. This estimate remains unchanged, but the survival and further multiplication of the plantlets in the seed value chain have become more efficient, justifying this initial cost. This ten-cent estimate compares favorably with the cost of TC plantlets, about $1.00 each.

Table 2.1 shows the yearly production of plantlets over the length of the project. As of 2017, at IITA the SAH was in full operation, with an average monthly production of 30,000 plantlets from 13 varieties, for an annual production of 335,663 plantlets. At NRCRI, in 2018 the SAH lab was in full operation with about 16,000 plantlets produced from 10 cassava varieties, with promising genotypes being introduced from TC. Since the SAH is not carried out under sterile conditions, there is the risk of fungal contamination in the plantlet boxes if operations are not managed carefully. This happened at IITA in 2019, and activities were suspended for a period to allow a thorough cleanup and disinfection of the lab, reducing the total number of plantlets produced. Fewer visitors are now allowed into the laboratory, and the flaming of tools while cutting plants has been added to the protocol. As the inventory of varieties was adjusted in response to expected demand, this also led to fewer plantlets produced, as some new varieties had less TC starter material. Nevertheless, SAH-derived material in the nursery plots kept the supply of material for BS production going. In addition, GoSeed is piloting use of a commercial TC lab (Contec Agro) to help with the commercial production of TC materials to ensure more starting material in the future. The IITA SAH laboratory sold almost 3,000 plantlets to the processor SAH labs in 2019. In 2020 so far approximately 1,000 plantlets have been sold to other SAH laboratories. Production figures with the processors are shown under the PLM component (Section 4).

Table 2.1 SAH plantlet production by year

Institution	Q4 2016	2017	2018	2019
IITA	18,954	335,663	120,026	62,360
NRCRI	0	5,600	15,954	41,752

The SAH labs also allowed for an efficient inventory management. As demand for varieties shifted, plantlet production in the SAH for those varieties could be quickly adjusted. SAH also allows more effective development and multiplication of starting material of various varieties for different field trials for breeding activities. In 2018 adjustments were made to the inventory in the SAH production labs at IITA and NRCRI. Some varieties were phased out, as feedback from the field showed less demand, and other varieties were introduced into SAH labs and their production ramped up. For some varieties that were discontinued due to lower demand, a few plantlets were maintained to allow quick buildup in case demand were to rise again. As seen in Tables 1 and 4 in Annex 2A, in 2019 many new varieties from the NextGen and HarvestPlus projects were introduced, whereas several others were discontinued in the SAH production units at IITA and NRCRI. Therefore, the production of three genotypes (TME419, IBA961632, and CR36-5) was scaled up based on the results from DCTs and interest of processors to buy more of these varieties. TME693 was recently introduced into SAH because it is targeted for release due to its fresh market consumption traits, including good cooking quality (root mealiness after boiling).

A costing analysis was carried out for SAH plantlet production, and a break-even cost of $0.10 per plantlet has been calculated (Annex 2B, costing breakdown for SAH plantlets, IITA). Without SAH, starting material for BS would be derived directly from TC at a cost of $1.00 per plantlet, with much slower multiplication (30 weeks for a 50-fold multiplication, as compared with 15 weeks with SAH). Moreover, the value of the SAH RMT for inventory management and quick adjustments to starting material for BS production goes beyond simple numbers.

To explore other means of seed multiplication to complement SAH, two field multiplication methods were tested. The first method was propagation of green stem pruning from ratooned plants of mature seed production fields. The ratooning leads to numerous lateral green stems growing out from the original plant; these green stems are then pruned and planted. With good agronomic practices and supplemental irrigation (if needed), the establishment rate of green stems was about 80% and the multiplication ratio was 1:4 to 1:16. The second method was early ratooning at three months after transplanting of SAH plantlets, which induced branching and increased the stem production. This resulted in a multiplication rate of 1:2 within 12 months. These methods have so far resulted in establishment of an additional 0.5 ha of BS fields at IITA and have the potential to complement the post-SAH field multiplication, resulting in increased production of high-quality stems.

To further reduce production costs of SAH plantlets, a collaborative trial was established with the Cassava Weed Management project to identify efficient weed control options for managing SAH-derived plants in the field. Several pre-emergent herbicides are being tested with SAH plantlets in an ongoing activity.

IITA has carried out trainings on SAH as a result of collaborations between BASICS and other projects in other institutes, such as NextGen Cassava in NaCRRI (Uganda) and the Cassava Agribusiness Seed Systems project in the Rwanda Agricultural Board (Rwanda). Technicians from a private commercial lab in Mali, Agrobiotech, were also trained. The AfDB-TAAT Cassava Compact has supported development of SAH laboratories in Togo, Sierra Leone, Zambia, Tanzania, and the Democratic Republic of the Congo (DRC). The IITA–DRC lab was established and is fully functional with the introduction of more than 30 varieties in TC from Rwanda (Figure 2.1). IITA still provides laboratory supplies at cost to SAH operators within and outside Nigeria.

Figure 2.1. Cassava SAH propagation facility IITA–DRC.

2.2.1.2 Establishment of nurseries

SAH multiplication starts by obtaining virus-free plantlets from TC labs and planting them into SAH boxes. The plantlets in the SAH boxes are ready for cutting into new plantlets in about four weeks and thereafter every two weeks. After four cuttings, the plantlets in the first box are no longer kept for re-cutting and are prepared for planting into nurseries in the field. Standard operating procedure (SOP) manuals have been developed covering activities from field preparation, transplanting of plantlets and maintenance procedures, data collection and maintenance of records, precautions, and risk mitigation (Annex 2C). The nucleus seed nurseries are well-maintained, conform to isolation distances, and inspected by NASC. After one season's growth, the nurseries are usually ratooned so that two cycles of planting material for BS production are generated. Of the 62,360 plantlets produced in 2019 at IITA, 14,054 were transplanted to the field (see Annex 2D–SAH production and nurseries per variety per year—for details of the varieties transplanted to the nurseries). Of the 41,752 plantlets produced at NRCRI, 9,960 were transferred to the field. Production figures with the processors are shown under the PLM component.

2.2.2 Commercially viable system of BS and FS production

Before the start of the project, BS from IITA was sourced from well-maintained fields that had been multiplied for several cycles using stem cuttings from previous generations. The seed was checked for cleanliness in-house but was not certified by NASC; nor was there any formal FS produced. The seed went straight to growers, who then kept it from their own fields for many cycles. With BASICS, a formal system for EGS has been established. The seed is inspected and certified by NASC according to set standards of quality and cleanliness.

IITA and NRCRI are required to sell certified EGS through registered commercial entities. With the support of the project, both institutions successfully set up commercial entities to sell EGS: IITA (GoSeed) and NRCRI (Umudike Seeds). BASICS supported both entities as they formulated business plans, through contracts with Sahel. Owing to its advanced stage of operation, GoSeed produced EGS commercially, with more than 4,000 bundles of BS and 16,000 of FS sold in 2019. Umudike Seeds is at the early production planning phase. To inform the EGS and SAH production of variety demand, DCTs were set up at processor sites, and promising varieties were put through the processor production lines to evaluate the starch and/or high-quality cassava flour (HQCF) yield (see section further below on DCTs for details). After evaluating the DCTs, SAH and EGS production of the high-starch varieties TME419, IBA961632, and CR36-5 increased, as processors showed more interest in them. As new varieties were developed in the breeding pipelines, the most promising ones were incorporated into the DCTs to get an early evaluation of their processing potential and possible demand from processors.

2.2.2.1 EGS system in place to supply certified seed to CS producers of new improved varieties and EGS enterprises increase rate of turnover of varietal inventory in response to market demand

While SAH was being set up, the project started to produce and disseminate BS from conventional fields that were inspected and certified by NASC. Therefore, in 2017 IITA supplied 1,896 bundles of BS of eight varieties certified by NASC, from 5.5 ha of conventional BS fields, to NRCRI to establish BS fields. IITA used the seed to produce its own BS and to produce FS at IITA, CRS, and with a private producer, Renascent Agro-inputs Ltd. The seed supplied was in response to expected demand in 2018, from FS producers' orders placed with IITA and NRCRI. The varieties established were IBA980581, IBA980505, IBA070593, IBA010040, IBA961632, IBA011412, IBA070539, and TME419, selected according to their expected demand and performance. Thus, the certified BS production was set in motion and linked with FS production.

It became apparent from the first year of EGS production that seed production and expected demand were not well linked, as there is at least a 10-month lead time needed for supply after orders are placed for a particular seed category. The project PMU developed a seed flow map tool to capture the CS production plans of the VSEs and processors, thus providing an estimate for upstream needs for both FS and BS (see Annex 2E, seed flow map). The tool allows for production planning across the different seed categories.

As the SAH production ramped up, and nurseries were established in 2017, 1,000 bundles of SAH-derived stems were then harvested in 2018 by ratooning at Ibadan and Ikenne. The stems were certified by NASC and planted at Ago Owu covering 18.56 ha of BS fields. These were then transferred to GoSeed for commercial production and sales of EGS (see section on IITA GoSeed below). From the existing SAH nurseries, 1,469 bundles of cassava stems were harvested to establish 15 ha of BS fields in 2019. Pre-planting fields were inspected with NASC and production field information was uploaded into the CST. Production focused on market-driven varieties based on production and market research (TME419, IBA961632, IBA980581, CR36-5, and two biofortified varieties—IBA070593 and IBA070539).

In 2016 NRCRI established FS fields to meet the demand for the 2017 planting season of 35 VSE CS producers. In 2017 12.7 ha of FS were established in three locations in order to supply the expected demand of six different varieties in 2018 by VSEs—an estimated 4,550 bundles (Annex 2A, Table 8). The production was centered mainly on TME419 (6.9 ha), as VSEs were demanding more of this variety, and thus the linkages in the BASICS seed value chain were beginning to reflect market demand (Annex 2A, Table 8). In July 2018, 90 bundles of TME419 were supplied to CRS in Benue state, and 100 bundles of the same variety were supplied to the VSEs in Imo state. The stems were supplied at the cost of ₦1,000 (about $3) per bundle. To meet the demand for the 2019 planting season, about 5 ha of FS was established in 2018 by NRCRI at Amakama and Umudike and certified by NASC.

Renascent Agro Inputs and Seed, a private seed producer, started to produce FS in 2017. From 500 bundles of BS of eight varieties supplied by IITA in 2017, 6,700 bundles of FS of five different varieties were sold to cassava farmers in 2018, through the MADE project, of which most was TME419 (4,050 bundles). Renascent started to produce FS in three locations, totaling 18 ha in 2018, mostly TME419 (16 ha). Therefore, as the project progressed, FS production increased significantly, and the variety in demand (TME419) became the major component of the FS inventory.

Tables 2.2–2.4 show the production of BS in hectares per variety per year, for IITA and also for FS for NRCRI, reaching 55 ha of certified BS production between the two institutions.

Table 2.2 BS produced at IITA from 2017 to 2019

	Area Cultivated (ha)		
Variety	**2017 (Conventional)**	**2018 (SAH derived)**	**2019 (SAH derived)**
IBA961632	0.47	0.48	1.18
IBA980505	0.36	5.01	2.48
IBA980581	0.52	2.44	2.35
TMEB419	0.67	0.97	2.82
IBA010040	0.21	5.2	0.64
IBA070593	1.1	2.17	2.08
IBA011412	1.22		0
IBA070539	0.89	1.19	1.28
IBA011368		0.54	0.49
IBA980510		0.05	
NR8082		0.51	
CR36-5			1.16
TME693			0.32
TMS13F1343P0022			0.32
TMS13F1053P0015			0.14
TMS13F1053P0010			0.05
TMS13F1343P0022			0.32
Total	**5.44**	**18.56**	**15.63**

Table 2.3 BS produced at NRCRI from 2017 to 2019

Varieties	**2017 (Conventional)**	**2018 (Conventional)**	**2019 (Conventional)**
TMEB419	0.67	1.6	1.8
IBA980505	0.67	0.05	0.5
IBA980581	0.67	0.1	0.6
IBA010040	0.1	0.8	
IBA30572	0.1		
IBA961632	0.67	0.05	
IBA070593	0.67	0.7	
IBA070539	0.57	0.04	
IBA011412	0.57	0.8	
TMEB419	0.7		
IBA980505	0.5		
IBA980581	0.5		
NR 8082	0.3		
IBA011368			0.6
NR070220			0.5
Total	**6.69**	**4.14**	**4**

Table 2.4 FS produced at NRCRI from 2017 to 2018

	Area Cultivated	
Variety	**2017**	**2018**
NRCRI		
TMEB419	6.9	3.35
IBA980505	1.7	0.25
IBA980581	2.4	0.5
IBA011368	1.3	0.2
IBA30572	0.3	0.2
NR 8082	0.4	
IITA-TMS-IBA070593		0.5
Renascent		
TMEB419		16
IBA980581		1
IBA980505		1
Total	**13**	**23**

2.2.2.2 GoSeed and Umudike Seeds functioning as CS entities

At the start of the project, IITA and NRCRI established BS and FS production plots, which were certified by NASC. For the two institutions to sell certified EGS, they registered dedicated units as seed companies: GoSeed and Umudike Seeds.

In 2017 IITA registered GoSeed as a limited liability company and drafted a comprehensive business plan with the support of BASICS, developed with SAHEL (chosen through a competitive bidding process). The business plan was submitted to the Foundation in December 2018, and it has been implemented since April 2019 with active collaboration and support from Sahel. GoSeed recruited two members of staff (operations manager and communications executive), in addition to the four existing positions (manager, sales and administrative officer, agronomist, and SAH lab technician) to help implement the business plan. SAHEL also stationed Ms. Rahmat Eyinfunjowo at the GoSeed office to help with the implementation. An updated business plan was prepared in October 2019, taking into consideration the experience gained during the first year of GoSeed's operations. Likewise, a transition plan was prepared to guide the passing of material and resources to the commercial entities, and to separate the institutes' research and breeding activities from seed production.

IITA produced 19 ha of BS in 2018. As part of the establishment of GoSeed, these production fields were transferred to the commercial entity, with 3,350 bundles of BS transferred to GoSeed for planting 32 ha in 2018. IITA staff supported GoSeed staff in stem harvest and replanting of BS and Fs across Nigeria through the use of an outgrower scheme of contracted seed producers. The BS fields were certified by NASC, and some of these fields were used for testing the sampling protocol for diagnostic certification by NASC, together with IITA and Fera. All the samples (from 300 plants per ha) tested negative for CMV at IITA and NASC laboratories.

In 2019 ratoon harvesting took place on 39 ha of fields under GoSeed management; the land was maintained for further production in the 2019–2020 season. Another 10 ha were added in Lanlate and Ago Owu, Oyo state, to augment the transitioned fields, making a total of 50 ha of GoSeed-owned fields.

In accordance with the business plan, GoSeed sold 10,650 bundles of EGS in 2019, and projected sales of 32,000 bundles for 2020. Following commercialization based on seed orders, GoSeed and CRS completed a FS stem order placed in 2018 with the supply of 3,650 bundles of seed to the Benue state VSEs in 2019. In addition, 1,000 bundles were sold to BAOT Integrated Farms and 5,000 bundles to Riparian Farming Ltd.

As a strategy to develop the FS production sector, GoSeed facilitated the registration of five FS producers, including conversion of an outgrower in 2018 to a standalone FS producer: Wadahi Integrated Farms, registered in Lokoja, Kogi state. This producer purchased 1,000 bundles of BS to establish a 10-ha FS field. In addition, GoSeed enrolled 10 CS entrepreneurs to establish marketing links for the registered FS producers. GoSeed's sales volume for 2019 was 10,650 bundles of BS and FS; sales for 2020 are projected to be 6,000 bundles of BS and 32,000 bundles of FS (Tables 10 and 11 of Annex 2A). In terms of cost, working in line with the developed business plan, in 2019 BS was sold for ₦1,200/bundle and FS for ₦800/bundle.

In addition, GoSeed contracted the production of BS and FS with qualified outgrowers across Nigeria in a decentralized approach. In total, 8,660 bundles were harvested and replanted as BS and FS in partnership with 15 outgrowers across different agro-ecologies in Nigeria. These outgrowers were trained and engaged in the production of 30.8 ha of BS and 55.8 ha of FS (see Tables 12 and 13, Annex 2A).

In terms of marketing and promotion, GoSeed participated in two strategic exhibitions in 2019, gathering key existing and emerging stakeholder information and reaching out to potential clients via email and phone conversations. GoSeed successfully launched an e-commerce website for sales and promotion of EGS in Nigeria on November 2019. The website currently attracts an average of 240 visitors per month with 17.2% returning visitors to the website monthly. Through its operations and marketing manager, GoSeed is continuing to establish FS producers and is engaging CS producers as clients for GoSeed, as well as identifying service providers to increase sales. In addition, a digital marketing strategy for GoSeed is being developed to conduct online advocacy and build an online client base (https://iitagoseed.com/).

To build a dynamic and committed customer base, awareness campaigns were organized and consultation meetings were held with prospective clients. Their concerns and expectations were related to the timely availability of off-takers of stems after production and help getting registered with NASC. GoSeed staff assisted the seed producers and clients in both of these regards.

So far, the success of GoSeed to promote its brand has been a combination of deploying seed production propositions to prospective clients with one-to-one contacts, a social media push, and promotions and participation in fairs and summits.

Umudike Seeds was fully registered as a limited liability company with the Corporate Affairs Commission of Nigeria to be dedicated to EGS production at NRCRI in September 2018. Mr. Mark Tokula was established as the CEO. Sahel was contracted with support of BASICS to develop a business plan and implementation strategy for Umudike Seeds. After a series of field visits and stakeholder forums, Sahel developed a draft business plan and submitted it to NRCRI for review. Training and capacity building in the seed business for operators of Umudike Seeds has commenced, and NRCRI management has allocated land to build an office complex for Umudike Seeds and construction work has started.

Demo plots were established in seven target states (Abia, Anambra, Imo, Ebonyi, Benue, Akwa Ibom, Nasarawa, and Enugu) in 2019. Contacts were started to allocate land for FS production and to identify key partners for an outgrower model. On the basis of demand for FS by producers for 2019, over 4 ha of BS were established in 2018, and approximately 5 ha of FS were also established to meet VSE demand. For both seed classes, TME419 was the dominant variety, with increasing demand from root growers. In 2019, 4 ha of FS were established in Benue and Abia states.

2.2.2.3 Identification and mapping of potential FS producers across cassava-growing zones of Nigeria

The availability of FS is critical for the seed system. Therefore, the BASICS project commissioned two studies to explore the typology of FS producers and to identify possible farmers who could fulfill this role (Annex 2F and 2G). A contractual agreement with NRCRI and then Umudike Seeds resulted in the production of 18 ha of FS in 2018 and 19 ha in 2019.

For the first study, a seed systems expert, Steve Walsh, was commissioned to help strategize a way to develop a private sector network of FS producers to meet the needs of the CS producers. He interviewed six prospective FS and CS producers to explore their motivations and constraints to become FS producers. And though they were all willing to produce FS if BS was readily available, they had concerns about market risks. The market for FS is subject to fluctuations, as CS producers can potentially ratoon their fields for an additional two cycles (thus not repeating FS purchases every year). Furthermore, at the start of the project, the VSE CS producers were accessing FS on credit from CRS, thus affecting the seed market.

A second study was commissioned in 2019 to identify larger cassava seed producers who could take on more risk and become either FS or CS producers (Annex 2G). The study surveyed 30 cassava entrepreneurs who could produce certified CS in Nigeria, preferably on areas larger than 1 ha. The survey identified larger cassava producers in the South–South and

South-East (Abia, Akwa Ibom, Imo, and Cross Rivers) and South-West (Oyo and Ondo). The study found mostly smaller scale producers in the North Central state of Benue. Overall, the cassava entrepreneurs were willing to start or to continue producing certified seed, with the expectation that this would generate higher incomes. The study identified six CS producers and four others who wanted to produce FS. This study resulted in a publication in the *Journal of Crop Improvement* (Bentley et al. 2020; https://doi.org/10.1080/15427528.2020.1778149).

GoSeed has established a network of contract BS and FS producers, as mentioned above. The contract is based on the operation of an outgrower system, where experienced cassava farmers are identified and vetted to produce the EGS. The farmers are provided with the initial stock materials, and use their own land to multiply the seeds under strict supervision, meeting GoSeed's and NASC's standards. At harvest, stems are bought back from the outgrowers and roots are given to them as compensation for the production. Nigerian law requires EGS producers to register as seed companies and to have internal capacity in plant breeding; but the farmers growing EGS at this time could not meet this requirement. To comply with the law, a contractual arrangement was made to link these producers with GoSeed and its plant breeding capacity.

The CST can be assessed at seedtracker.org. It can be used to visualize the location of seed producers, and thus gives a screenshot of the emerging certified seed system. More details on CST are found in the QSC section of this report.

2.2.3 Pipeline of new varieties reaching processors and their outgrowers

There are many improved varieties available, with new ones coming through the breeding pipelines. They are not usually tested at the medium- and large-processor level by putting the roots through processing lines. By placing variety trials close to processing factories, this enables the processors to test new varieties that may better meet their needs, while also providing valuable feedback to the breeding programs on which varieties are best suited for processing at industrial scale. Increased demand at such a scale creates both a strong market demand for cassava farmers, and a market for quality seed of improved varieties.

2.2.3.1 DCTs at processor sites

During the course of the project, IITA, in coordination with Context and the processors, set up DCTs each year, with increasing numbers of locations and varieties tested across the years (Table 2.5). Across the DCTs, particular varieties stood out, leading to changes in the production pipelines at the SAH plantlet and EGS levels. Information in the seed system was shown to flow effectively in both directions. Processors showed preferences for different varieties, depending on the products being produced in their factories, confirming the value of growing large amounts of roots of each variety in the DCTs, so that they could be put through the processing lines. This in turn created a need for a guaranteed supply of clean seed of the desired varieties for the processors and their outgrowers (see PLM component section for more details on processor outgrower schemes).

Table 2.5 List of DCTs during the project

Year	No. of Clones	Clones	No. of Location	Location	State
2016/17	8	IBA961632, IBA010040, IBA980505, IBA980581, IBA950289, IBA30572, CR36-5, TME419	3	Ikenne, Ago-owu, SHAO (Ilorin)	Ogun, Osun, Kwara
2017/18	11	IBA961632, IBA980581, IBA010040, IBA980505, IBA950289, IBA30572, CR36-5, TME419, IBA070593, IBA070539, IBA011368	6	Ikenne, Ago-owu, SHAO, Psaltry, Eagleson, Crest Agro	Ogun, Osun, Kwara, Oyo, Kogi
2018/19	10	IBA961632, IBA980581, CR36-5, TME419, IBA070593, IBA920057, IBA141092, TMS13F1053P0015, TMS13F1160P0004	7	Ikenne, Ago-owu, SHAO, Psaltry, Eagleson, Crest Agro, FUNNAB	Ogun, Osun, Kwara, Oyo, Kogi
2019/20	11	IBA961632, CR36-5, TME419, IBA070593, IBA920057, TMS13F1160P0004, TMS13F1153P0001, TMS13F1053P0010, TMS13F2110P0008, IBA090521, IBA090506	5	Ikenne, Ago-owu, Psaltry, FUNNAB, Abuja	Ogun, Osun, Oyo, FCT

The first DCT planted in 2016 and harvested in 2017 started with eight promising varieties at three locations: Ikenne, Ago Owu, and Shao Farms (Ilorin), in collaboration with the PLM component. The trials were harvested at different times, and farmers and processors participated in the harvest demos. Between 200 and 500 kg of the roots harvested from each variety from the Shao Farms DCTs were milled at Thai Farms processing facility and assayed for starch content and yield as well as gari production. Likewise, 150–300 kg of roots from the Ikenne trial were processed into HQCF; starch and fiber content were determined. As seen in Figure 2.2, the yields and dry matter content (DMC) varied between varieties and between trials, though certain varieties showed more stable yield and DMC (e.g., IBA961632). Across all trials, the varieties IBA961632, TME419, and CR36-5 had the highest DMC. TME419 also had the highest root yields.

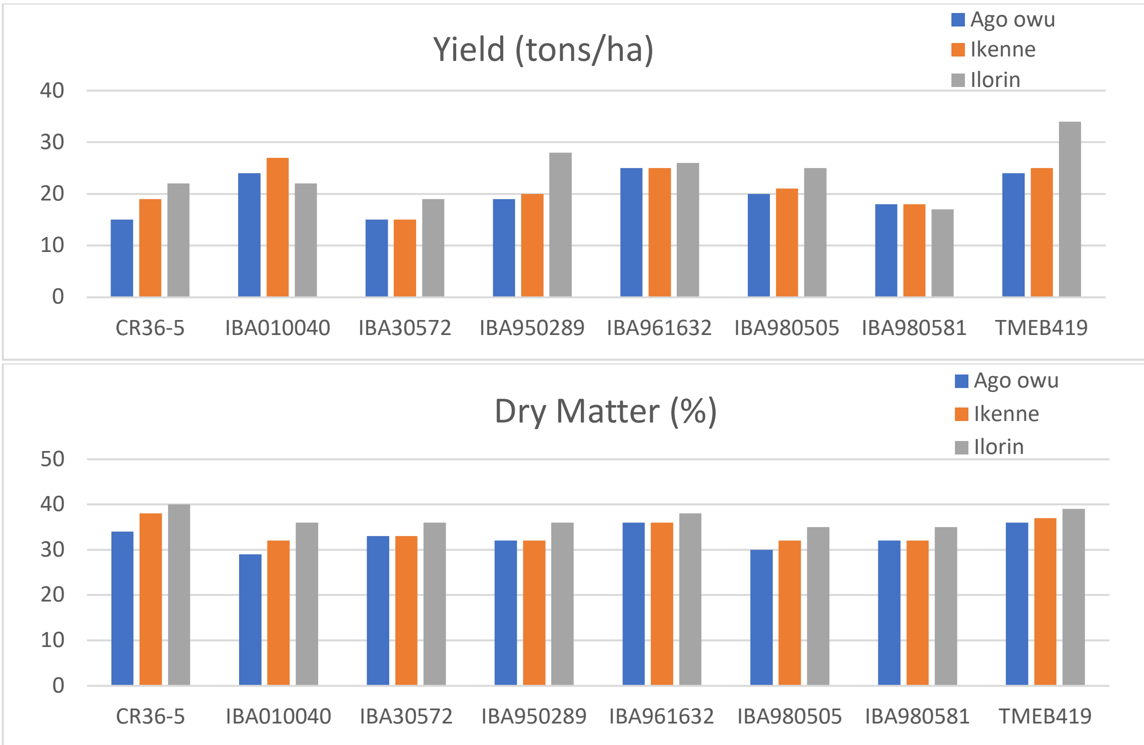


Figure 2.2 DCT yield (t/ha), DMC (%) at Ago Owu, Ikenne, and Shao (Ilorin) in 2017.

An important measure to consider is the starch yield, derived from the total root yield multiplied by the percentage of starch content. This starch yield can be projected per hectare by variety, which is an important combination since some varieties with high starch content have low yield (e.g., CR36-5). IBA961632 and TME419 had the highest starch yields. Nevertheless, a higher starch content such as that of CR36-5 can be of high value to a processor, and thus the results of the DCTs were used to inform the SAH and BS production going forward in the project, where there was an increase in the production of the three varieties IBA91632, TME419, and CR36-5.

In 2016 IITA established additional trials at the Ikenne and Ago Owu Farm sites to demonstrate the impact of plant spacing, density, and planting method on both stem and root production. The densities used were: 1 x 0.2 m (50,000 plants/ha); 1 x 0.4 m (25,000); 1 x 0.6 m (16,666); 1 x 0.8 m (12,500), and 1 x 1 m (10,000), where 12,500 plants per ha were used for the other DCTs. As shown in Figure 2.3 (A), the highest root yields were at 12,500 plants/ha. Stem yield was highest at 25,000 plants/ha, while 50,000 plants/ha was probably too dense and did not yield more bundles (Figure 2.3 (B). For seed producers, these data indicate the trade-offs between seed yields and root yields at different planting densities. Farmers can adjust planting densities according to their needs. For instance, if farmers want more roots, the density of 12,500 is preferred. If seed only is the goal, then 25,000 would be preferred. A combination of both root and seed would depend on the relative market prices and sizes of each, as well as the cost of certified seed to plant. For VSEs, such economic calculations were done and are shown in the VSE component of the report.

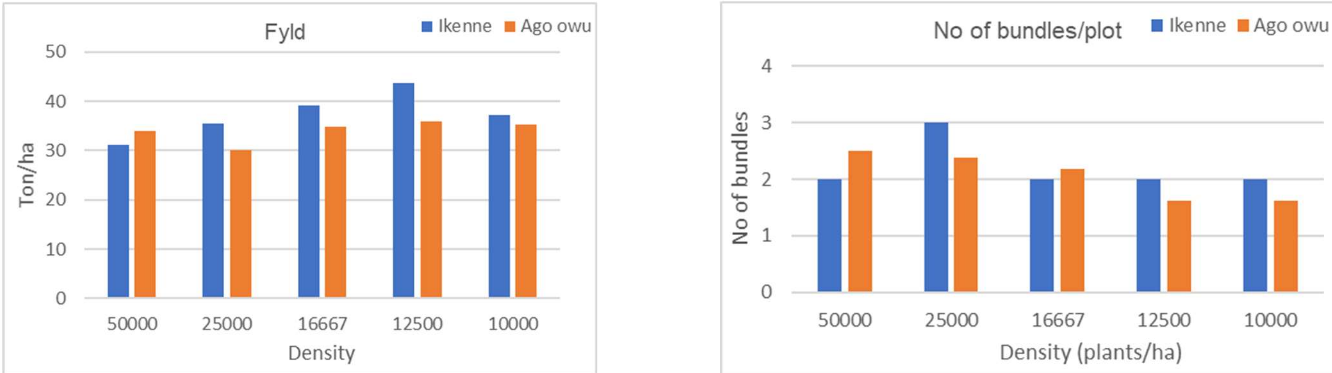


Figure 2.3 (A) Population density (plants/ha) effect on fresh yield (t/ha). **(B) Population density effect on number of bundles per plot.**

In 2017 the same varieties were planted and tested again in the DCTs, and three yellow cassava varieties were added to the trials. In addition, three additional trials were established on new processor farms—namely Psaltry and Eagleson in Oyo state and Crest Agro in Kogi state, resulting in six locations in total. The 2018 harvest showed similar fresh root yields across all six locations for most varieties, except at Shao (Ilorin) where performance was low for all varieties, as the site suffered from severe erosion; subsequent plantings were done in sites less prone to erosion. CR36-5 had the highest starch (Figure 2.4) and DMC (not shown), followed by IBA9611632 and TME419.

IBA980505 had lower starch and DMC but the highest fresh root yields. The yellow varieties IBA011368, IBA070539, and IBA070593 had lower root yields and starch content. These findings need to be considered in predicting their future demand.

Figure 2.4. Starch content (%) across DCT locations per variety, 2018.

The harvested roots from Shao (Ilorin) were sent to Thai Farms for processing into gari. On the basis of the gari yields from the peeled roots, the best performing varieties were TME419 and IBA980581 (21–22%). However, IBA980581 had the lowest starch content in Ilorin (at Shao, green bars in Figure 2.4) and thus was less desired by the processor. Nevertheless, smallholder farmers were impressed by the yield performance of IBA980581 during field demos, and this was reinforced by the gari yield.

The DCTs over two years showed that considering all traits, IBA961632, TME419, and CR36-5 ranked the best (Table 2.6), so their production was increased in SAH and in the IITA BS and FS outgrower production schemes. The biofortified variety IBA011368 ranked the lowest (so resulting in lower FS production) and was not included in neither the NRCRI SAH production nor in BS production. The yellow varieties were ranked lower, due to lower DMC.

Table 2.6. Ranking of varieties in DCTs across six sites in 2017–18 overall rank

Variety	Rank
IITA-TMS-IBA961632	1
TME419	2
CR36-5	3
IITA-TMS-IBA950289	4
IITA-TMS-IBA980581	5
IITA-TMS-IBA980505	6
IITA-TMS-IBA980581	8
IITA-TMS-IBA30572	9
IITA-TMS-IBA070593	10
IITA-TMS-IBA070539	11
IITA-TMS-IBA011368	12

At the DCT established at Psaltry with 11 varieties, the varieties with the highest yield per hectare were IBA950289, IBA980581, and IBA980505. However, all three varieties had lower starch content (under 18%, see Figure 2.4 above, orange bars). CR36-5 had the highest starch content of 23%, and IBA961632 had 22.3% starch content. Though the root yields were lower, CR36-5 and IBA961632 were strong performing varieties, closely followed by TME419 with a starch content of 19.8%. Psaltry checks for starch content and pays root outgrowers a premium for high starch roots. Starch content of cassava is important for the processors.

At the DCT established at Eagleson and Nito Concepts Farm (Eagleson), the primary processing commodity is HQCF. Therefore, the harvested roots from nine varieties tested in 2018 were processed into HQCF. In this case, IBA010040 had the highest flour yield from the roots (35%). Though IBA980505 had the highest yield, the processed flour from the roots was lower (29%). The other varieties that performed well were IBA980581, IBA961632 (26% each), and TME419 and IBA070539 (22% each). CR36-5 showed high water retention as the percent of flour was very low (13%). IBA950289 and the yellow cassava IBA070539 did not perform well either (20% each). These results, along with the agronomic traits of the varieties, led Eagleson to choose IBA980581, TMEB419, and IBA070539 as its preferred varieties. This DCT showed that variety preferences differ according to the processed product.

The new 2018–2019 DCTs were again established at the same sites, including the three processor partners' farms: FMN's Shao, Psaltry, and Eagleson, and an additional site at FUNNAB. The varieties included in these trials were adjusted, with the removal of the lower starch varieties and two of the yellow varieties. Four varieties were added, including two unreleased varieties from the NextGen project. These are experimental varieties in the final stage of breeder/selection testing as well as a local landrace check, 'Oko Iyawo', that was included only in the DCT at FMN's Shao. These varieties were included in the 2018 DCTs following IITA's recommendations.

At Shao Farms, at harvest in August 2019, the variety with the highest yield per hectare was CR36-5 (20.8 t/ha), followed by IBA980581 (16.6 t/ha). The NextGen variety TMS13F1053P0015 and the landrace control both failed to produce good yield: 11 t/ha and 11.6 t/ha, respectively. The NextGen variety, however, had the second highest starch content at 21.7%, after TME419, with a starch content of 23.7%. Eight cassava farmers participated in the harvest. Using visual observation, they expressed preference for six of the nine varieties (Figure 2.5A). These varieties included TME419, CR36-5, TMS13F1053P0015, IBA961632, IBA980581, and IBA980581. The farmers noted that these varieties would easily adapt to different soil types and environmental conditions such as drought. Nevertheless, TME419 and IBA961632 are the most favored varieties by FMN, and CR36-5 has strong potential to meet the processor's need for high starch content cassava roots.

At Psaltry, the DCT had 10 varieties planted in 2018, including two NextGen varieties, TMS13F1053P0015 and TMS13F1160P0004. The field was harvested in July 2019, with 38 farmers participating from eight of Psaltry's outgrower programs, presenting individual and collective perspectives on all the varieties (see Figure 2.5B and Annex 4A, Table 16 on farmer preferences). IBA010040 was the most preferred variety based on visual observation because of its large roots, light root peel, and perceived high starch yield; however, the field and factory tests showed this variety to have among the lowest starch contents. The other farmer-preferred varieties were IBA980581, IBA141092, TME419, and IBA961632. The

NextGen varieties did not have a high yield, although TMS13F1160P0004 had the highest starch content of the varieties. Field tests showed CR36-5 had the highest yield of 15 t/ha with 21.7% starch content, and TME419 with 20.8% starch content. The factory starch content tests supported the field test results, with TMS13F1160P0004 having 22.3% starch content, CR36-5 with 22%, and IBA961632 with 19.4%. To further demonstrate the performance of the most preferred varieties, the team shared the favorite varieties with the eight outgrower clusters represented at the field day. The lead farmer for each cluster received the planting materials—two bundles of cassava stems, including the most preferred variety (IBA10040) and one other variety: IBA980581, TME419, IBA961632, or IBA141092. The farmers are currently multiplying the stems in their fields.

Figure 2.5A Shao FMN DCT harvest, 2018.

2.5B Psaltry DCT harvest, 2018.

At the Eagleson DCT, the roots were harvested in July 2019. Owing to the poor management of the initial DCT, Eagleson's management asked that fewer varieties be included in its 2018 DCT. Therefore, only four varieties were planted: TME419, IBA961632, CR36-5, and IBA980581. IBA980581 demonstrated the highest yield at 13.2 t/ha but the lowest starch and DMC. TME419 and CR36-5 each produced 12 t/ha, with TME419 having a higher starch percentage. However, the yields were low from all four varieties compared with those from the 2017 DCT; TME419 had the most starch of the varieties. Owing to the low yields as a result of the erosion-prone site, it is difficult to draw conclusions from this DCT.

Mean results of the 2018–2019 DCTs across all locations showed that the genotype TMS13F1160P0004, one of the new NextGen cassava breeding products, consistently exhibited high potential for the key traits of starch content, DMC, gari, and fufu percentage (Tables 19 of Annex 2A). For the DCTs established in the 2018–2019 season in the seven trial sites, the four most promising high-starch varieties for processor demand were IBA961632, TME419, CR36-5, and TMS13F1160P0004. These varieties all have high DMC, high starch content, and high dry yield potential that satisfy demands of farmers and industrial markets. Consequently, these varieties will be promoted, and their sales should demonstrate increased adoption of improved varieties and the use of high-quality seed to improve productivity.

The stability of DMC over the growing season in the DCT trials was followed by sampling storage roots to estimate dry matter each month from six to 14 months after planting. Results in Table 21 and Figure 1 of Annex 2A showed that DMC was relatively high in the peak of the dry season in February and March. The DMC of most varieties declined in April and May with the onset of the rains. DMC then increased in May and June, and then was generally high in July–October. The varieties differed in their overall DMC but showed similar behavior across the growing season.

2.2.4 Value proposition of certified seed

It was hypothesized at the start of the project that disease-free planting material of higher physiological quality would provide a yield advantage over farmer-kept stems of the same variety (presumably of low quality and probably infected with viruses and/or other diseases). Therefore, comparison trials were set up to evaluate the probable yield advantage and quantify the value proposition for certified clean seed. Comparison trials showed that the yields of CMD virus-resistant varieties were not affected by the source of seed, with farmer-kept seed performing as well as certified clean seed. Therefore, the value proposition of certified seed arises more from the assurance on the identity of the variety and access to new improved varieties, rather than the cleanliness (health) of the seed. Indeed, in the informal seed markets, names given to the seed being sold frequently do not correspond to the actual identity of the variety. These trial results confirm that the idea that seed certification is more important at the EGS stage to ensure that the system does not inadvertently introduce new pathogens into local seed systems. But certification is less important at the downstream CS stage.

2.2.4.1 VSE versus FSS source comparison trials

A preliminary study in 2016 was carried out to compare the performance of seed from VSEs and from FSS. This also indicated similar yields from VSE seed and FSS, suggesting little or no yield advantage from growing certified cassava seed of the same variety. However, the trial was not replicated, and the seed sources were varied, thus preventing reliable conclusions. In September–October 2017, a trial to compare the agronomic and yield performance of cassava production from certified seed and from uncertified seed was set up in two NCRCI stations in Umudike and Otobi; stems were sourced from VSE seed and non-VSE FSS from seven locations across two LGAs of Benue state. Four CMD-resistant varieties were used in the trial: TME419, IBA011368, IBA980581, and IBA980505. The field trials were established using a randomized complete block design with three replications. Once again, there was no yield advantage for the certified seed; indeed, the FSS performed a bit better than the VSE seeds in the mean fresh root yield. For more robust conclusions, the trial was repeated in 2018, and the 2019 harvest showed similar results, with no differences in yield between the seed source classes. Consequently, for CMD-resistant varieties, there is no conclusive evidence that VSE-certified seed performs better than FSS. However, it became difficult to source FSS of the same varieties and to coordinate harvest of stems of similar ages. These trials need to be repeated with SAH-derived CS. There may be a yield advantage for certified CMD-susceptible varieties, however, yet resistance is an important attribute of improved varieties, and so susceptible varieties are not being targeted for dissemination. In any case, this trial shows CMD-resistant varieties are able to be disseminated in the cassava production landscape and the resistance maintains the yield potential in farmers' fields. The BASICS seed system is an important dissemination pathway for these improved varieties.

The results from these trials raised the point that the main value proposition for certified seed was not that the planting material was certified as virus free, but rather that the variety was certified to be true-to-type. Farmers look to access seed of a particular variety, and certified seed enables them to get the variety they need and not something different (even though it might have the same variety name) in the informal market. This highlights the importance of the seed system and its links with the breeding programs, ensuring that EGS production makes the seed of new varieties available as they are developed. As mentioned in sections 2.1 and 2.2 above, new promising genotypes have been incorporated into the GoSeed EGS system, starting from SAH on to BS and FS and testing in DCT trials.

2.2.4.2 Comparison of seed source, including SAH plantlets and stems, on performance

Another issue was whether generating clean material by putting varieties through TC followed by SAH might affect their performance. Therefore, a trial was set up in 2017 in three locations to compare SAH plantlets and SAH-derived stems, to certified breeder seed stems of the same four varieties that had been grown at IITA (i.e., IBA070593, IBA010040, IBA980581, and IBA980505) and stems from other sources. All four varieties used are highly resistant (CMD2 type) to CMD. Stems/SAH plantlets used in all three locations were from a common source. The three locations covered diverse agro-ecologies: (1) Ikenne in derived savanna, (2) Mokwa in Southern Guinea savanna, and (3) Umudike in humid forest (Figure 2.6).

Stem sources used:

- BS: Stem cuttings from the BASICS BS field
- SAH stem cuttings: First generation stem cuttings from SAH plantlets established in IITA-Ibadan
- SAH plantlets: Direct field planting of SAH plantlets generated in IITA
- Control stems: Cassava stem cuttings from researcher-managed seed fields

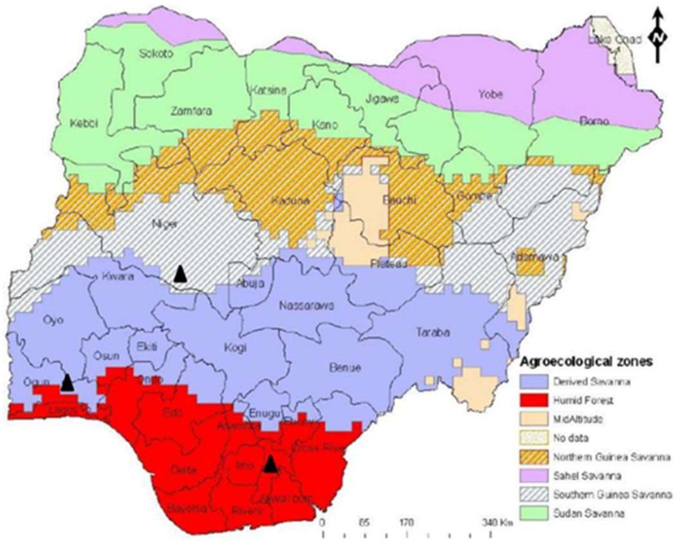


Figure 2.6. Location (Δ) of the three field trials in three diverse agro-ecologies: (1) Ikenne in derived savanna, (2) Mokwa in Southern Guinea savanna, and (3) Umudike in humid forest.

Trials in Ikenne and Mokwa established well, but due to poor establishment of SAH plants, the trial site in Umudike was discontinued. The type of planting material source did not show any differences in plant height, fresh root yield, or DMC. However, SAH plantlets had poorer establishment than stem-derived material, so care has to be taken to ensure good establishment of SAH plantlets (this is already a given in the nursery production plots). SAH-derived material performed the same as conventional stems, so going through the TC and SAH multiplication process was not found to have any effect on the performance of the variety.

A follow-up trial was established in 2018 by sequential planting of stems harvested from the first trial along with a new set of SAH plants, again at three locations. Objectives of this trial were to assess the performance of reused stems compared with the previous generation, and to obtain data for each measuring parameter for at least two years for validation. Stems were sourced from BS certified by NASC, SAH plants generated in the IITA SAH lab, SAH stems generated from established SAH plants in IITA research station, and farmers' fields as an additional control. Location, cultivar, and plant establishment percentage showed significant impact on storage root yield. Again, the type of planting materials (SAH stem, SAH plantlet, control, or breeder stem) showed no significant impact on yield attributes; SAH plantlets had lower establishment. Endemic foliar pathogens (white spot, brown spot, bacterial blight) and pests (whiteflies, green mite, and termites) detected in these trials were within the acceptable thresholds for certification (mean severity of ≤3) (see Table 22, Annex 2A). As anticipated, CMD was not detected in these trials since CMD-resistant varieties were used.

2.3 Lessons learned

The availability of EGS that responds quickly to market demands is critical for a functioning and commercially sustainable seed system. The BSC provided several lessons over the course of the project:

- SAH can quickly make available large amounts of plantlets to feed into BS plots, or the processors can multiply them in-house at their SAH facility and quickly get the new varieties into production (or place orders for seed from the two commercial entities, Go Seed and Umudike Seeds).
- SAH, like any new technology, needs wider implementation and awareness to be able to reduce unit costs (which stand now at about $0.10 per plantlet) through economies of scale and to enhance its adoption. Nevertheless, it is being implemented in other countries through the TAAT initiative, and it is also being adapted to other vegetatively propagated crops such as yam.
- In a pilot SAH laboratory of about 20 m^2 at IITA, the project has demonstrated a production potential to generate plantlets to cover about 10 ha of BS in one year.
- More efficient access to TC plantlets for replenishing or starting new varieties in SAH is needed. There is pilot work with a private sector TC lab, Contec Agro, in Abuja and Ibadan toward filling this gap.

- SAH can be combined with other technologies in the nurseries to increase the multiplication ratio.
- IITA and NRCRI have succeeded in institutionalizing the sales of BS and FS in a more business-focused approach, providing evidence that public research institutions can establish commercial entities to commercialize EGS in a commercially sustainable manner.
- There were doubts about the market size for EGS, but over time the project has shown that there is a large potential demand for EGS and certified seed provided they meet the needs of the buyer. This portends well for the development of a commercially sustainable seed system; however, more market research is needed.
- For better nursery management, increase the focus on mechanized operations to improve efficiency of labor and reduce costs of production.
- CGD has developed tools for seed unit production forecasting and operational budgeting, which are undergoing continued refinement in order to both plan future seed flows and to track operational costs to drive better understanding of unit economics.
- The DCTs provide an avenue to test new promising potential varieties with processors, thus providing feedback on real-life scenarios of performance under factory setting processing, while exposing processors to potential new and improved varieties with better product yields that will become available in the near future.
- The link with expected demand for particular traits and varieties is already informing the breeding programs as to what new varieties could be promoted.
- Comparison trials between certified seed and FSS did not show a yield advantage for certified seed, in part due to the CMD virus tolerance of the improved varieties tested. Therefore, the value proposition of certified seed arises more from assurances that the seed is true-to-type, and enhanced access to desired improved varieties.

3. Village Seed Entrepreneur Component

3.1 Introduction

Cassava stems are bulky and are not easy or economical to transport over long distances as the nodes on the stems are easily damaged in transit. Hence, it is important to produce seed as near as possible to the cassava farmers, and the geographically dispersed, community-based VSE is a potent model for commercial seed production.

The VSE is the last stakeholder in the chain of the seed business, producing certified seed for farmers' on-farm use. VSEs play a significant role in informing the upstream actors of changes in farmers' preferences as well creating awareness and driving demand for new varieties. The VSEs have the capacity to ensure continuous delivery of certified planting material of market-demanded varieties of cassava to farmers across the production areas. The VSE model is a reusable bridge for enhancing the awareness, adoption, and commercial distribution of improved varieties of cassava released into the Nigerian farming system.

The VSE component had three objectives: (1) VSEs have established profitable businesses; (2) farmers planting quality seed of market-driven varieties increased their income; and (3) VSEs regularly present their seed fields to NASC for certification toward maintaining the integrity of the seed system.

3.2 Outcomes and activities

The BASICS VSE component was led by CRS with a plan to establish more than 80 VSEs across 18 LGAs of Benue state. Another partner, NRCRI, was to promote a "lighter touch" approach in supporting a network of 50 VSEs, targeting farmers in Abia, Akwa Ibom, Cross Rivers, and Imo states. Over the span of the project, 186 VSEs (52 female VSEs) were engaged and trained, including 136 in Benue state, with at least 100 of them selling about 36,000 bundles of certified planting material (in total) to 1,400 farming households over three seasons, to plant more than 700 ha of fields of improved cassava varieties. Additionally, 50 VSEs were identified and supported by NRCRI in the states of the South-South and South-East. In 2018 the Taraba state government bought 4,000 bundles from VSEs, benefiting another 1,000 farming households with certified cassava seed of improved varieties. With the multiplier effect, over 2,000 additional hectares of cassava fields should be planted with improved varieties purchased from the VSEs, thus contributing to the further expansion of improved varieties.

3.2.1 VSEs as profitable businesses

Selection criteria were used to identify farmers who could become successful VSEs. When reviewing the most successful VSEs after four years, certain commonalities were identified that will guide selection of VSEs in the future. The VSEs were trained in cassava agronomy, cassava seed production, certification, and seed business management, resulting in an increased capacity to produce certified seed. Almost 90% of VSE fields passed certification. The project facilitated the formation of an association of the VSEs in Benue state to enable the VSEs to be better organized, to foster unity, and address their common business challenges. The leaders of these networks were progressively trained to independently continue training the VSE members of their network and maintain their capacity beyond the life of the project. As the project progressed, data showed that VSEs were making a profitable seed business, either through harvesting the roots with the stems after one year or ratooning the fields the first year to sell stems over two seasons.

3.2.1.1 VSEs are identified, screened, engaged, and trained

Selecting suitable VSE candidates was crucial for their long-term success. CRS and NRCRI selected the farmers based on the experience of the earlier Sustainable Cassava Seed Systems (SCSS) project implemented by CRS. Key criteria were (1) access to land and capital for a seed production business, (2) knowledge of cassava farming, (3) willingness and motivation to be a seed producer by learning new knowledge and skills, (4) financial capacity, and (5) willingness to abide by the BASICS Project VSE Code of Conduct (Annex 3A).

After four years of BASICS VSE component implementation and observing the performance of the VSEs, the selection criteria were improved for the future (Annex 3B_Selection criteria for VSEs). However, the strategy of placing VSEs further apart to ensure a large catchment area for each VSE was found to be not as effective as expected. Some areas had locational and agro-ecological advantages to cluster future VSEs together to develop into seed production hubs.

CRS VSE Activities. CRS surpassed the project targets for the number of VSEs engaged and trained, but overall production of CS was lower than projected. This was in part due to smaller fields and also due to the security challenges in Benue state in 2018 that made some seed fields inaccessible and others that could not pass the certification inspection due to financial challenges faced by the VSE. There were also some cases of poor management, a few fields that were not true-to-type, and some fields with varietal mix-ups (Table 3.1). CRS contracted five local partners to implement the VSE plan in Benue, including the Kejie Foundation in Adikpo, as well as NGO arms of the local catholic dioceses: Justice, Development and Peace Commission in Otukpo, Foundation for Justice, Development and Peace in Katsina and in Makurdi, and Caritas in Gboko.

Table 3.1 CRS VSE implementation

Particulars	Project Target (4 years)	Achieved (Y4)	Percentage Achievement (%)
Number of VSEs engaged	120	136	110
Number of hectares established	580	370	64
Number of VSEs trained	120	136	110
% of VSE fields certified	≥90%	88%	98
% female VSEs	30%	27%	90
Number of active VSEs	≥60	105	175
Number of VSEs who procure materials from foundation seed producers	≥60	73	121
Bundles of FSP procured	≥20,800	16,182	78
Bundles of seeds produced	≥232,000	110,000	64
Bundles of certified seeds sold	≥80,000	36,022	45

CRS organized a four-day training of trainers (ToT) for the implementing partners to start the operations in the second half of 2016. Three refresher ToT workshops (to build on lessons learned during the first trainings) were held over the project's four years. The first set of 28 VSEs were selected and taken on board in October 2016. In May 2017 another set of 96 VSEs were selected and engaged to increase the number of VSEs to 124. On the basis of an earlier market study (Annex 3C_Market survey), and the BASICS study on the potential sustainability of larger, informal producers (see Annex 2G;

Bentley et al. 2020 https://doi.org/10.1080/15427528.2020.1778149), 12 farmers who could commit more land to seed production were engaged in 2019, bringing the total CRS VSEs up to 136 (Annex 3D_CRS YR 4 annual report).

During onboarding, VSEs are brought together to have a shared understanding of the project, their roles and responsibilities, the project's expectations of them, and the importance of using certified foundation planting material to establish their seed multiplication plots. They signed a code of conduct at the end of the activity to seal their commitment to operating as a BASICS seed entrepreneur. The capacity of all 136 VSEs in the agronomy of cassava seed production, and certification and management of their seed business, was built through a series of trainings organized and facilitated by CRS with specialists from NASC, NRCRI, IITA, and Benue State Agricultural and Rural Development Authority (BNARDA).

The project successfully collaborated with NASC to certify the 325 ha of fields established by VSEs over the project period. The average certification rate was 88% (Table 3.1). Most of the fields that did not pass certification were constrained by inaccessibility caused by floods, security (farmer-herder conflicts), issues of varietal purity, and field sanitation resulting from financial constraints faced by VSEs.

CRS also established collaboration with GoSeed, the IITA seed commercial entity, to produce FS to supply VSEs in Benue state. The FS producers engaged by GoSeed were CRS VSEs who were selected and trained for FS production. They established 6 ha of FS fields in 2018 of the varieties TME419, IBA980505, and IBA980581—the source of much of the FS for VSEs fields in 2019.

There was a progressive increase in the sales of certified stems by the VSEs over the project period. As Figure 3.1 shows, in 2017 19 VSEs (six women) sold 5,429 bundles of planting materials (TME419, IBA011368, IBA980505, IBA980581, and IBA30572) to farmers from the certified fields planted in 2016 (Y1). In 2018 14,229 bundles of certified planting materials of the same varieties were sold to farmers in and outside the state by 81 VSEs (17 women). In 2019 87 VSEs (19 women) sold 16,294 bundles of four of the varieties—IBA30572 was discontinued—all within the state. By the end of 2019, there were 104 active VSEs; 16 were dropped in 2017 (including one deceased), seven were left in 2018, and nine in 2019 (including one who died).

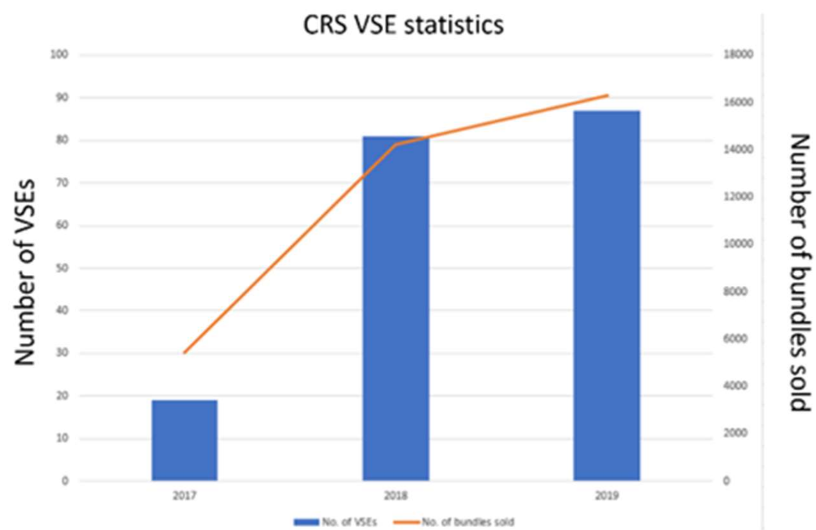


Figure 3.1. Numbers of VSEs and sales of certified stems by VSEs in 2017–2019.

Though the 2019 sales met the project target, it would have been more if not for the lingering herder-farmer conflict in Benue, which discouraged the movement of traders. This dampened market demand for cassava products and thus lowered the demand for seed. The prices of cassava products hit a high in 2017 and part of 2018, and then plummeted in 2019 and 2020, drawing in cassava farmers in the first half of the BASICS project but then losing many during the last two years (https://www.premiumtimesng.com/agriculture/agric-news/243196-prices-cassava-stems-reduce-67.html). In 2019 and 2020, farmers in some parts of Benue avoided remote farmland for fear of being attacked by herders. This lowered the number of fields planted and the demand for seed.

There was also low demand for the yellow variety (IBA011368) as farmers realized that it was less ''bulky'' when processed, with lower DMC and lower conversion ratio of roots to gari, reducing farmers' profits. Another reason for the low commercial demand for yellow varieties is the wide, free distribution among farmers in the state due to promotional activities by HarvestPlus. Yellow varieties accounted for about 26% of VSEs' production during the 2018–2019 season. But this will probably fall in coming seasons unless improved varieties with higher DMC are made available. Most VSEs are now seeking to grow TME419, which is in most demand, as well as IBA980505 and IBA980581 for which there is also some demand.

In 2015 CRS conducted a gender analysis in Benue and Oyo states as part of the SCSS project (2012–2016), besides learning some valuable lessons on gender and cassava seed systems while implementing the project. For example, female farmers face more challenges in accessing credit as they are financially disadvantaged and do not inherit land, which can be used as collateral, as well as several other land tenure problems. Female seed entrepreneurs reported discrimination while trying to secure funds to buy fertilizer. Consequently, BASICS emphasized building capacity and promoting social capital and networking among female seed entrepreneurs. NRCRI used similar approaches to mentor VSEs in the South-East and South-South. As a result of this support, there were almost as many successful female VSEs as males.

CRS planned and organized the training for the VSEs for the first two years of the project. Resource persons from IITA, NRCRI, BNARDA, and CRS were involved, drawing on their experiences in the earlier SCSS project. To ensure sustainability of the training, over the last two years of the project, CRS slowly withdrew and handed over the training to the local partners. In 2016 the project facilitated the formation and registration of an association of VSEs, named Benue State Seed Producers Cooperative Union, to enable the VSEs to be better organized and more united as well as to address their common business challenges. The association was supported as they wrote their constitution and started their activities through an equipped office set up in Makurdi, the state capital. The association's capacity and leadership were strengthened at the five chapters (Makurdi, Gboko, Otukpo, Katsina-ala, and Adikpo) and at state level through constant support to raise farmers' awareness of new varieties, sell stems, and engage with government and other relevant institutions. Capacity strengthening of the group needs to continue for a few more years to make them fully self-reliant. The VSEs were also linked to the agro-input dealers in their respective LGAs, thus improving supply and creating demand for CS. Figure 3.2 shows examples of the CRS activities in the VSE component.

Exchange of money and stems between customer and a VSE in Aliade market, Gwer East LGA.

Loading certified stems for delivery to Taraba state.

A billboard in the Tiv language along the Makurdi-Gboko road.

A VSE, Comrade Mrs. Bridget Angyio, inspecting her field in Aliade, Gwer East LGA.

A VSE, Mr. Michael Adah, also known as chief farmer, on his field in Okpokwu LGA.

Dancers pulling in the crowd during the market day promotion in Gwer East LGA.

Figure 3.2. CRS VSE component activities.

NRCRI VSEs Activities. To complement the more intense model implemented by CRS, a light touch model of VSE was also implemented by BASICS, led by NRCRI. NRCRI had over the years implemented an outgrower scheme for cassava farmers with its improved varieties. This was complemented by its recent World Bank-funded West African Agricultural Productivity Program implemented between 2012 and 2015. Fifty VSEs were selected, trained, and engaged by NRCRI in producing commercial cassava seed across the four states of Abia, Imo, Akwa Ibom, and Cross Rivers in South-East and South-South Nigeria. Unlike in Benue, where CRS worked through five local partners, NRCRI used its long-standing relationship with farmers and seed producers to develop the VSE network without partners. Compared with VSEs in Benue, the VSEs under the NRCRI management had larger seed production plots and longer experience producing cassava stems. The stem sale prices were higher in these regions than in Benue. The planting season was spread over eight to 10 months of the year, with stem prices ranging $1.4–5.2 per bundle, depending on market cycles.

As Table 3.2 shows, most (70%) of the NRCRI VSEs were male, although Akwa Ibom had the highest percentage of female VSEs (42%). In 2017 all 35 participating VSEs established fields, increasing to 50 VSEs in 2018–2020; 8,525 bundles of CS were produced in 2018 and 4,578 of them were sold to farmers. By the end of the project, the NRCRI VSEs were producing seed on 298 ha (Table 3.3).

Table 3.2. Distribution of NRCRI VSEs by state and gender

State	Male	Female	Total
Abia	9	3	**12**
Akwa Ibom	7	5	**12**
Cross River	9	2	**11**
Imo	10	5	**15**
Total	**35**	**15**	**50**

Table 3.3 NRCRI VSE implementation

Particulars	Project Target (4 years)	Achieved (Y4)	Percentage Achievement (%)
Number of VSEs engaged	50	50	100
Number of hectares established	200	298	149
Number of VSEs trained	50	50	100
% of VSE fields certified	≥90%	≥90%	111
% female VSEs	30	30	100
Number of active VSEs	50	38	76
Number of VSEs who source material from FS producers	50	36	76
Bundles of FSP procured	10,000	9,455	95
Bundles of seeds produced	66,000	45,252	69
Bundles of certified seeds sold	23,000	16,114	70

BASICS supported the VSEs in the field to see if they were ready to market seed and to judge market linkages in the project states. This was followed by market day promos to create seed customer awareness of the VSEs (Figure 3.3). The NRCRI team held 12 market day promos across the project states, at which flyers were distributed to participants to inform them of the quality of the VSEs' seeds.

The project has been looking at opportunities to scale through collaboration while developing its own network of directly managed VSEs. The VSE model was popularized in Southern Nigeria through partnership with other projects such as the DFID-funded MADE project, in which 60 VSEs were trained and their seed production plans were facilitated (Figure 3.3). The project also worked with a Chevron-funded Foundation for Partnership Initiatives in the Niger Delta whereby 13 VSEs were trained and brought into the VSE network in July 2019. Many other organizations such as Kolping Society of Nigeria, CARA Foundation, and FADMA (cassava seed market linkages with VSEs) have shown interest in collaborating and replicating the BASICS model. Most such initiatives are functioning outside of the NASC certification regime, mostly due to lack of awareness. BASICS has made them aware of the obligation for all CS producers and sellers to be registered with NASC and selling only NASC-certified seeds. They are taking steps in this direction.

A Success Story

Mr. Michael Anyam, VSE in Cross Rivers State

Mr. Michael Anyam is a VSE in Alesi Community in Ikom LGA of Cross River state. He established a 1-ha field of TME419 and IBA011368 in 2018 at Nsakwom, Alesi. He followed the NASC certification protocols and produced his seeds for sale. He sold 360 bundles of cassava seed and earned ₦210,000 ($585) from the seed as well as ₦100,000 ($280) from the sales of the roots. He spent the money building his family a home, up to the roofing stage.

He stated, ''Agriculture, particularly cassava, is a good business. It has helped me a lot and is still helping me and my family.'' He is happy to show visitors the 4-bedroom bungalow he is putting up with the money he is earning from cassava sales.

Mr. Michael (left) on his seed farm. Michael poses with his building under construction.

The VSEs under NRCRI were able to sell more than 16,000 bundles of certified seed to farmers in two seasons, 2018 and 2019. The VSEs are currently implementing e-extension among themselves though a WhatsApp group where technical and marketing issues are also discussed. Figure 3.3 shows examples of the NRCRI activities in the VSE component.

Cassava seed business was a first experience for many VSEs in Benue and for some of the VSEs near NRCRI. To help them transition from only growing roots to also producing stems, and to earn the respect of other root growers (who would buy their stems), a certain personality was needed and new skills had to be learned. So, BASICS planned and delivered the CRS and NRCRI VSE training to include the following modules:

1. Site selection, field preparation, planting material preparation, and planting
2. Soil testing, fertilizer, and manure use
3. Best agronomic practices in cassava production systems (e.g., weed management, soil conservation) and recommending a planting spacing of 1 x 0.8 m for a total of 12,000 plant stands/ha. The next step is to enroll them in a 1 x 0.5 m spacing, giving 20,000 stands/ha, which is ideal for a professional seed producer.
4. Integrated pest and disease management
5. Efficient harvesting, processing, and packaging of cassava stems and roots
6. Business development services, recordkeeping, and management for stems and roots
7. Enterprise/market development and strategies
8. Cassava seed certification protocols and practices
9. Using the CST

NRCRI developed a detailed training manual to cover all these points and used it to deliver training to BASICS VSEs and to other interested parties (Annex 3E_NRCRI Training manual).

The project also collaborated with the Cassava Weed Management Project, another BMGF-funded project to train CRS partners and supporting BNARDA staff in a ToT on weed management in cassava in 2018 and 2019. The project had commissioned a cassava market study, and the findings from this survey on farmers' buying behavior and the market dynamics were shared with the VSEs in both years to improve their market orientation.

The first NRCRI foundation seed for supply to VSEs in Akwa Ibom state.

VSE field of Julian Ikpoha in Akwa Ibom state ready for market.

Market day promo of NRCRI VSE team in South-East Nigeria.

MADE VSEs receive training at NRCRI.

MADE VSEs at a training by NRCRI.

Demo plot at Ariam Ikwuano LGA, Abia state.

Figure 3.3. NRCRI VSE Component activities.

3.2.1.2 VSE network leadership has capacity to lead activities

To enhance collaboration among small seed entrepreneurs, CRS continued to strengthen the capacity of the leaders and members of the VSE network. The leaders participated in training on Skills for Marketing and Rural Transformation (SMART), a CRS training program covering farmer group organization, financial education, and marketing basics (https://www.crs.org/our-work-overseas/program-areas/agriculture/smart-skills-smallholder-farmers). The post-test results of the trainings revealed that about 60% of the participants showed improved knowledge of the seed system. They also participated in training on the use of the CST (see the QSC section) provided to the implementing partner field officers. The other members benefited from the step-down trainings they conducted, supported by the network leaders. CRS facilitated the self-review and adoption of the constitution of the union by members of the network. At their first association meeting, new executives were elected to run the network's activities for the next two years, reflecting skills learned in the SMART training. The meeting was attended by 99 VSEs (26 women). The new executive included two women and seven men. The network's capacity was also constantly assessed, and findings were incorporated into activities with the aim of further strengthening the network. CRS facilitated the establishment of an office and engaging an office manager to improve how the network runs its activities in the state. This type of cassava-stem farmer organization is novel and is slowly becoming stronger, with the backstopping provided by BASICS.

Innovation. CRS, in collaboration with IITA, established a laboratory-to-field trial of the SAH technology to produce plantlets in Benue state. The trial, which was the first anywhere in Nigeria (and probably worldwide), involved transporting plantlets from the SAH lab in Ibadan for planting in Benue. The trial demonstrated the fact that the SAH plantlets are sturdy enough to endure a road journey of almost 10 hours, although the plantlets did need irrigation and care after planting. This bold experiment disproved two beliefs: that the SAH plantlets are too delicate to endure long transportation, and that only expert on-station care can manage the lab-to-field transition of these plantlets. This small trial in Benue produced more than 120 bundles of planting materials in 10 months.

3.2.1.3 CS VSE producers are viable and supply farmer-demanded varieties

Prior to SCSS, few farmers thought of cassava stems as a saleable commodity. Even fewer saw a business opportunity in cassava seeds. The BASICS project built on what the SCSS project piloted to further prove that seed entrepreneurs can produce certified seed of improved varieties, sell them to cassava growers, and that all involved can make money.

The VSEs were chosen based on an express condition that the project would provide all the training and mentoring in the seed business, but the VSEs, just like any other private business, had to use their own resources to run the seed production enterprise. Some VSEs did not perform as well as they could due partly to factors under their control and partly for other reasons (e.g., the farmer-herder conflict). To give a realistic business case, the less capable VSEs were discarded from analysis and the data from the top 50% of the VSEs were averaged out to understand the business case for VSEs.

VSEs have two business strategies: to produce seed in one season or two. In one season, the VSEs harvest the stems and roots after one season and start over afresh in the new season. In the second option, only the stems are cut for sale at certain height at maturity and the roots are left in the ground. The ratooned plants give a fresh flush and after another eight to 10 months, the second season stems are harvested along with the roots. Therefore the crop is cultivated over two growing seasons. VSE performance is summarized in Table 3.4.

Table 3.4 Financials of VSE in Strategy 1: harvest stems and roots after one season

Production Costs	**CRS VSE**	**NRCRI VSE**
Land (prevailing lease cost—actually paid or opportunity cost)	6,800	25,261
Seed (FS)	55,000	40,878
Labor (planting, weeding, harvesting, etc.)	85,717	182,310
Inputs (including herbicides and other pesticides, fertilizer)	40,450	73,865
Miscellaneous (fuel, repairs, transport, utilities, certification, fees, etc.)	28,200	17,926
Total Production Costs (Naira/ha)	**216,167**	**340,240**
Revenues		
Stem yield (bundles/ha)	300	412
Total revenue from stem sales (Naira/ha)	**204,000**	**329,870**
Root yield (t/ha)	15	15
Total revenue from root sales (Naira/ha)	**367,782**	**208,807**
Total Revenue (Naira/ha)	**571,782**	**538,677**
Summary		
Total production cost (Naira/ha)	**216,167**	**340,240**
Total revenue (Naira/ha)	**571,782**	**538,677**
Net profit (Naira/ha)	**355,615**	**198,437**
Total production cost (USD/ha)	**600**	**945**
Total revenue (USD/ha)	**1,588**	**1,496**
Net profit (USD/ha)	**988**	**551**

Financials of VSE in Strategy 2: the crop is ratooned and root harvest done along with the second stem harvest

Production Costs	**CRS VSE**	
	Season 1	**Season 2**
Land (prevailing lease cost—actually paid or opportunity cost)	9,100	
Seed (FS)	55,000	
Labor (planting, weeding, harvesting, etc.)	67,449	31,633
Inputs (including herbicides and other pesticides, fertilizer)	32,852	32,708
Miscellaneous (fuel, repairs, transport, utilities, certification, fees, etc.)	22,568	15,712
Total production costs (Naira/ha)	186,969	80,053
Stem yield (bundles/ha)	300	400

Total revenue from stem sales (Naira/ha)	204,000	320,000
Root yield (t/ha)		10
Total revenue from root sales (Naira/ha)		314,178
Total revenue (Naira/ha)	204,000	634,178
Summary	Two season summary in next column	
Total production cost (Naira/ha)		267,022
Total revenue (Naira/ha)		838,178
Net profit (Naira/ha)		571,156
Total production cost (USD/ha)		742
Total revenue (USD/ha)		2,238
Net profit (USD/ha)		1,586

Discussion of the data and the VSE business case:

- In Benue 20% of VSEs had seed production on less than 1 ha of land; 65% on 1–3 ha, and 15% planted on more than 3 ha. The proportions among the NRCRI VSEs are 17%, 74%, and 9%, respectively (skewed toward the middle group).
- About 30% of VSEs in Benue preferred ratooning, whereas none of NRCRI VSEs ratooned their crops.
- In Benue the VSEs made a net profit of $988/ha following one season seed production and $1,586/ha over two seasons, following the ratoon strategy; the figures for NRCRI VSEs was $551 for one production season.
- The cost of production (especially for land) was lower in Benue but the sale price for stems was higher. The yield of bundles of stems per hectare at less than 400 is less than ideal. In NRCRI project areas, the average production cost and sale price for stems were higher. The yield of bundles of stems per hectare was a little above 400 on average.
- The most grown cassava varieties were TME419 (90% of the farmers growing this variety) and IBA011368 (52%). Other notable varieties include IBA980581 (35%) and IBA980505 (13%), whereas IBA30572 was the least (4.3%) grown. Farmers routinely grew more than one variety of cassava; hence these above percentages have overlaps.
- Most of the entrepreneurs sold their cassava stems at the farm gate, followed by sales at the local market; little seed reached distant markets.
- Some VSEs were more successful if they were already engaged in promotional activities and in a cluster where their wares become prominent, branded, and placed in a market niche. Transaction costs for seed distribution are lower if VSEs are near the farmers, as in NRCRI project areas. The prominent ones also keep production records, which allow for business case calculation. Having "game-changer varieties" in the midst of other farmers also contributed. Some VSEs, especially in Akwa Ibom state, formed groups and cooperatives.
- The study indicated that improved cassava stem production is lucrative and could be sustainable.

3.2.2 Increased demand for certified seed as a result of demand creation

To generate market demand, the project engaged in various approaches to create public awareness of certified seed, VSEs, and the advantages of improved varieties. Demo plots across Benue state exposed new varieties to farmers. More than 48,000 farmers were reached through MDPs that showcased VSEs and the certified seed of improved varieties. Banners and flyers in the hundreds of thousands and some promo bags were distributed, promoting the VSEs and their cassava varieties. Radio spots reached more than 200,000 farmers. There was a review of the 3-2-1 messaging menu, a collaboration between CRS and Viamo to broadcast messages on cassava agronomy and business basics to farmers in Nigeria, to include information on cassava weed management, available cassava varieties, and the VSE contact information. More than 126,102 farmers accessed the agriculture call-in menu, including 14,421 who accessed information on the cassava sub-menu. These strategies greatly increased the demand for certified stems from 5,429 bundles in 2017 to 14,229 bundles in 2018 and 16,294 bundles in 2019.

3.2.2.1 Demand creation activities implemented

Prior to SCSS and BASICS, farmers generally planted cassava with stems from their own fields or asked neighbors for free or borrowed stems. Neither the givers nor the receivers saw these stems as a saleable commodity. Awareness had to be raised about the importance of the quality of planting material and of improved varieties, to benefit farmers, and to create a viable market for the seed entrepreneurs. BASICS used a combination of varietal demos, personal contacts, and digital tools to reach out to large numbers of farmers.

Demo plots. CRS collaborated with BNARDA to set up 145 demo plots across 16 LGAs in Benue state. They showcased major characteristics of all varieties promoted by the project in comparison with the common local varieties. The plots raised awareness of the appealing growth traits which attracted some buyers to ask about and buy varieties of their choice. The plots contributed at least 10% to the demand for materials purchased by farmers throughout the project life. Each plot was planted with one local variety (‘Wonono’ or ‘Akpu-fefa’) and six improved ones (TME419, IBA980505, IBA980581, IBA011368, IBA30572, and/or NR8082). In 2019 IBA011632 was introduced to the varietal mix as advised by GoSeed due to its high yield and starch content.

In 2019 the NRCRI VSE Component also established five demo plots in its four project states: one plot each in Abia, Cross Rivers, and Imo states and two plots in Akwa Ibom. The demo plots featured the TME419, IBA011368, IBA980505, and IBA980581 varieties (Figure 3.3 above).

MDPs. This was one of the innovative strategies conceived by CRS to promote demand for VSE products. They were carried out on community market days to increase awareness of VSE activities and to promote seed sales. A typical MDP involved music and dances by CRS staff and partners wearing colorful, branded and attractive costumes to draw shoppers’ attention and educate them on the project’s intent, the VSEs and their varieties, and the advantages of adopting them.

CRS and partners organized more than 100 MDPs during the project across the operational LGAs, reaching more than 48,000 farmers. During the events, more than 60,000 flyers and posters were shared, with information on improved cassava varieties their characteristics, best uses, and two phone numbers for contacting the seed entrepreneurs. NRCRI organized 12 MDPs across the project states (Figure 3.3). Flyers were distributed to about 2,000 participating farmers and to 1,000 other interested persons.

The MDPs improved farmers’ awareness of the improved varieties and of VSEs as suppliers of improved seed. The report of the buyers’ survey conducted in 2019 showed that 18% became aware of the VSEs and their varieties through the MDPs, whereas a similar study in 2020 showed that 24% of buyers knew of the VSEs because of the MDPs. Also, 79% of farmers who responded to a survey in 2020 had witnessed the promotions within their area.

Advertisements about the project’s improved varieties promoted were broadcast in English, Pidgin (Nigerian Creole), and the two main local languages (Idoma and Tiv) through more than 300,000 informational and educational flyers and banners. More than 30 advertising hoardings (i.e., temporary boarded fences set up in public spaces) were installed across the state to promote TME419, IBA011368, IBA980505, IBA980581, NR 8082, and IBA30572 varieties. The materials also included information for farmers about how to contact the VSEs.

Radio marketing. To further increase awareness and to reach more farmers in Benue and neighboring states, the project aired radio spots and 30–60 minute radio talk and phone-in programs in English and local languages on major radio stations in the state. An average of 100 radio slots were placed in each of the four seasons. Radio spots were aired beyond Benue to the neighboring states of Cross Rivers, Ebonyi, and Enugu in partnership with six radio stations, reaching an estimated 335,000-plus farmers. The radio program included several 15-minute discussions and phone-in sessions that attracted calls during and after the program. The phone-in program attracted about 60 calls; over 450 calls were received later, demonstrating a deepening of awareness. The callers were mainly male farmers (about 90% from Benue), and the rest from neighboring Taraba, Kogi, and Nasarawa states. The queries could broadly be grouped into eight categories:

- Is there more information about the cassava varieties advertised?
- Where to buy the stems?
- What more is there to know about the project?
- How are the stems sold and at what price?
- How much would a hectare worth of stems cost?
- How long does it take for the cassava varieties to reach full maturity?

- Where can the type of cassava that heals diabetes be bought?
- Could the project buy roots from the caller?

3-2-1 messaging. The ratio of extension agents to farmers is low, and the extension agencies have little time and few resources allocated for cassava. As a result, farmers have limited access to information on improved technologies, production practices, and markets for cassava, resulting in generally low yields. CRS explored a way to reach rural farmers, given their technological and other constraints. Airtel Nigeria, in partnership with a global development organization, Human Network International (now known as Viamo), offers as a public service a call-in system that provides free, on-demand information. The information ranges from health care to good governance to their consumers, including those in rural communities. The service is dubbed the “3-2-1 initiative,” as consumers can access the service by dialing 321 on their Airtel prepaid lines. The call provides public service information to mobile phone users in English as well as in Yoruba, Hausa, Igbo, and Pidgin.

CRS partnered with Viamo to develop and roll out the 3-2-1 messaging service for cassava farmers in Nigeria. CRS enhanced the menu with added sections with information on cassava agronomy and business skills, tailored for a wide spectrum of farmers. In response to suggestions from Loretta Byrnes, the BMGF external reviewer for the project (Annex 3F_Project External Review), the 3-2-1 messaging menu was improved to include information on cassava weed management, cassava varieties promoted and their characteristics, and the VSE contact information. Additionally, the information on the flyers and billboards were reviewed to highlight ways to access the 3-2-1 messages on the Airtel network.

The project continued to network with government and other programs to create demand and increase sales of certified planting materials. Also, CRS launched a website (www.cassavastems.com) for the VSE Component. The site provides information about the project; the VSEs (including those managed by NRCRI); and information about their fields such as varieties available, location, and contact details.

These demand creation activities led to a wider appreciation about quality seed and a viable business opportunity in seed production and sales.

3.2.3 Certified seed of new varieties available

New, improved varieties bring many important traits for cassava production, such as tolerance to major viral diseases such as CMD, higher yield potential, and higher starch content. But without an established seed system, these varieties have difficulty in reaching farmers. Through the VSEs, these varieties not only become available, but through the promotion campaigns, farmers also become aware and are willing to try them out. Indeed, through the project TME419 became more popular due to its high yield and high starch content, and farmers started buying more of it from VSEs. Another thing that endeared it to more farmers is the name “419,” which is a popular section of Nigeria’s Criminal Code that outlaws advance fee fraud. Thus, the name became easier to remember than other varietal names.

3.2.3.1 VSEs’ cassava seed buyers’ surveys

VSEs are the front end of the seed system. They can play twin roles of knowing what varietal traits the farmers, processors, and consumers want, while also promoting improved varieties and technologies. CRS and NRCRI organized market surveys to understand how the farmers sourced their seed and which varieties were in demand.

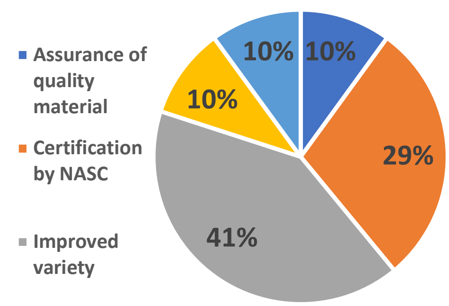
CRS surveys. An analysis of data from 218 buyers (from the 2017–2019 seasons) conducted in 2020 revealed that less than half (41%) of the buyers had patronized the VSEs for a second or third season. Of these, only about one-third (31%) repeated purchase of the same variety they bought in the previous one or two years. Table 3.5 shows the changes in the varietal mix change due to market feedback.

Table 3.5 Varieties sold by VSEs in 2017–2020

Varieties Sold by	2017	2018	2019	2020
CRS VSEs	TME419, IBA011368, IBA980581, IBA980505, IBA30572	TME419, IBA011368, IBA980581, IBA980505, IBA30572	TME419, IBA011368, IBA980581, IBA980505, IBA070593, IBA010040	TME419, IBA011368, IBA011632 IBA980581, IBA980505, IBA070593, IBA010040
NRCRI VSEs	Nil	TME419, IBA011368, IBA980581	TME419, IBA011368, IBA980581, IBA980505	TME419, IBA011368, IBA980581, IBA980505

About 41% of all buyers purchased from the VSEs because the varieties were improved varieties; 29% purchased because the stems were certified by NASC; and about 10% each purchased because of assurance of quality material, visual appeal of better quality stems, and information from the VSEs (Figure 3.4). Nearly all (99%) of the farmers agreed that their decision to purchase and plant the improved varieties was a good one and they would recommend that other farmers buy and plant the varieties. Almost all of the respondents agreed that the identified physical attributes of the improved varieties, including the rate of germination, quantity and quality of plant stand, and growth rate, were much better than those of the local varieties they or their neighbors planted around the same time.

Figure 3.4 Reasons for patronizing VSEs



Nearly all interviewed farmers who purchased stems expressed satisfaction with the services provided by the VSEs. Such services usually included guidance on handling and field management of the planting materials, discounts on bulk purchases, and free delivery for smaller orders or closer delivery locations.

The buyers' survey revealed that 14% of the interviewed farmers have completely replaced all of their cassava fields with the new varieties. About 17% have at least three-fifths of all their cassava farmland planted with improved varieties, and 69% have less than half of their cassava farmland planted with these varieties. Reasons given for retaining the old varieties included (1) easy access to free stems, (2) scarcity of the improved varieties, (3) preservation of legacy for comparison with the improved ones, and (4) familiarity with and quality of products. However, there is growing interest in replacing more of the fields with the improved varieties, as 82% of the farmers indicated interest in purchasing improved cassava seed from the VSEs in the 2020 season.

In Benue state, both men and women are involved in cassava production, and decisions about the cassava fields are taken by either or both parties (Figures 3.5A–D). About one-third (33%) of women said that they decide where to source stems by themselves, whereas about half (46%) of the men decide by themselves. Just under a half (47%) of the females and two-fifths (40%) of the men said that they decide jointly with their spouses. The rest said that their spouses take this decision or strongly influence it. About one-third (29%) of the women and close to half (45%) of the men indicated that they alone decide which variety to plant. A little over half (52%) of the women and about two-fifths (43%) of the men decide on the variety to plant jointly with their spouses. The rest said that the decision rests with their spouse.

Figure 3.5A Female decision: source of stems

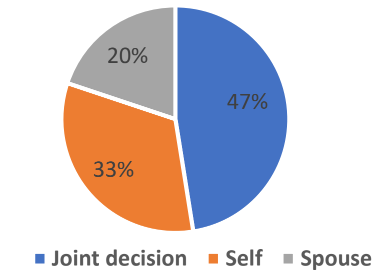


Figure 3.5B Male decision: source of stems

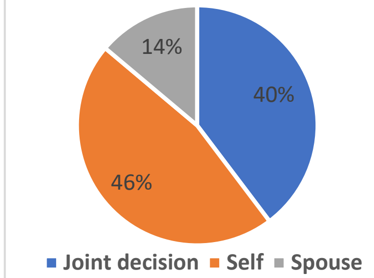


Figure 3.5C Female decision: variety to plant

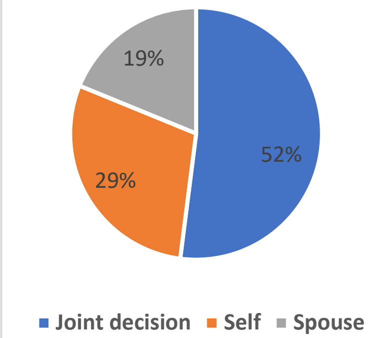
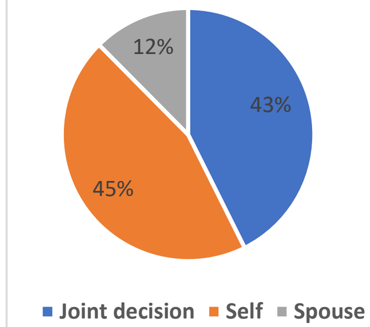


Figure 3.5D Male decision: variety to plant



Most buyers interviewed were satisfied with the unit price of the stems purchased, which ranged from $1.40 to $3 per bundle. Some of these respondents bought mini-bundles for as low as $0.14 for three, 1-m-long stems, especially during MDPs. Fifty 1-m stems make a bundle, and 50 bundles are needed to plant a hectare at a spacing of 1 x 1 m for 10,000 plants/ha.

About one-fifth of the respondents who bought stems in 2017 and 2018 had sold between one and 10 bundles to other farmers. About 42% of the respondents had at one time or the other within the last three seasons given stems to other farmers for free, further increasing the spread of the improved varieties.

Some two-thirds (67%) of the respondents were aware of NASC and certification, and almost three-quarters (74%) bought stems of improved cassava varieties in part because they were certified.

NRCRI surveys. NRCRI conducted surveys for the 2018 and 2019 farming seasons to ascertain why farmers buy certified seed of improved varieties of cassava and the seed characteristics preferred. Such information helps to identify intrinsic values that drive the demand for cassava seed, willingness to pay, continued patronage, and the factors that influenced this behavior in South-East and South-South Nigeria. This was conducted for actual customers in 2018 and for repeat buying in 2019.

In the 2018 season, most clients bought stems from VSEs because of the quality of the stem and root yield. The clients saw the performance of the varieties in the field and the yield at harvest. Some of the clients were already aware of the varieties (e.g., TME419) and trusted the VSEs to supply them with the required quality. The farmers were happier with TME419 because of its yield. The smallholders looked at a price range of ₦600–800/bundle to buy more seed and increase their cassava fields. Since the stems are expensive to transport, farmers preferred seed to be delivered at a mutually agreed place and price. In 2018 VSEs produced 8,525 bundles of CS, out of which they sold 4,578. In 2019 sales increased to 11,536 bundles. Sales are still going on in 2020.

In the second season of 2019**,** the study adopted a snowball sampling approach to select 61 respondents who bought certified cassava seed. The survey found that most of the clients go to the VSEs' fields to buy the seed. As the price of certified cassava seed rises above ₦1,000/bundle, more farmers buy uncertified stems. Before the BASICS project, the surveyed farmers bought fewer than 400 bundles of cassava stems, but in 2019 this increased to an average of 700 bundles. Most buyers of certified cassava seed are located not more than 10 km from the VSEs. Recent MDPs by the project team at NRCRI contributed to the stronger demand. TME419 was the most sought variety in the study area. Buyers in 2019 planted uncertified cassava seed on 33% of their cassava land. Two-thirds (66%) of the farmers were willing to buy seed in the 2020 farming season: 36% will do so to expand their production, and 23% will buy because the varieties are of high quality. Most (64%) will buy the same varieties they bought in 2018, whereas 31% will not buy cassava seed at all in 2020 but will recycle what they bought in 2019.

Some 62% of the respondents were aware of NASC certification on improved cassava varieties, whereas 71% bought due to certification and NASC endorsement of the VSEs. For sustainable certified cassava seed system in the study area, we recommend that the VSEs deal also in agricultural inputs alongside planting materials, to strengthen customer-client relationships and develop a good feedback mechanism for traceability.

3.3 Lessons learned

Owing to the bulkiness of cassava stems and the difficulty of transporting them, VSEs can play an important role in the seed system. Based on the four-year experience with the VSEs, the following lessons can be drawn for future interventions:

- Producing and selling seed is a viable commercial opportunity. This sustainable activity can be a channel for rapid dissemination of improved varieties and for gathering feedback from farmers. The proportion of female VSEs should be increased.
- Smaller VSEs need continued support, which is not possible after the project ends. Two strategies were tested during BASICS, and both have their place and need to be further refined and strengthened: clustering small VSEs into cooperatives on commercial lines and encouraging larger VSEs who have access to more resources and can use economies of scale.
- The strategy of placing VSEs further apart to ensure a large catchment area was not as effective as expected. Forming VSE clusters near each other had greater benefits, such as peer support, and were easier to manage. It is better to develop VSEs in appropriately located clusters instead of distributing them far apart, and such clusters will be seen by nearby farmers as seed hubs that they can depend on to procure their stems.
- Production and marketing of CS at a greater scale require forming VSE networks that harness member fees to pay for the required training in seed production and certification and other services that can enhance their commercial success.
- VSE clusters need to be linked to some commercial processing facility; some combination of VSE–PLM would be more commercially stable.
- The upstream linkage for VSEs needs to be developed, streamlined, and made efficient to provide them easy, timely, and affordable access to certified FS of demanded varieties and seed certification services. GoSeed and Umudike Seeds should establish FS producers close to the VSEs.
- Institutional buyers need to be recognized as legitimate clients and planned for. For example, the Central Bank of Nigeria is catalyzing a ready market for cassava seed of specified varieties, and the system currently has no capacity to meet this demand. Such demands will arise in future. VSE clusters and larger VSEs need to be keyed into such opportunities.
- Government campaigns of free seed distribution, either linked to elections or as disaster relief, affect the emergence of a sustainable, commercial seed value chain. But such government and other project-driven seed distribution campaigns are a fact of life in Nigeria. The VSEs need to be trained to make use of such opportunities commercially.
- The VSEs were also linked to the agro-input dealers in their respective LGAs, thus improving supply and creating demand for CS.

4. Processor-Led Model Component

4.1 Introduction

Processors benefit when the quantity and quality of the cassava root supply reliably and affordably meets their need. Whether roots for the factory are sourced from managed farms, outgrowers, or aggregators, processors prefer uniform roots with desired quality attributes, like high starch content, which translates into higher processing efficiency and profitability.

Through the BASICS project, CGD, Sahel, and IITA partnered to provide technical and business advisory support to processors interested in taking more control of their cassava root supply chain by establishing a cassava seed unit.

The PLM is customizable to the size and scope of a processor's root supply chain. Processors are motivated to implement the PLM because the prevailing cassava seed system cannot meet industry demand for high-quality planting material with profit-maximizing processing characteristics. By integrating macro-propagation technology into their operations, processors can spur a virtuous cycle of accelerated adoption of new varieties by farmers, increased on-farm productivity and profitability, and improved root processing profitability (Figure 4.1).

4.1.1 Commercial partners engaged

The BASICS project was designed to help one processor establish a cassava seed unit, and then replicate establishment with a second processor. FMN was prioritized as this program partner in 2016 because of its management's interest in establishing a seed unit, its diversified business interests, adequate cash flow to fund a SAH lab and establish a nursery, and the ability to absorb the risk of piloting new technology. However, through several management changes and corresponding shifts in priority at FMN, it became clear that additional processors should be added to the program so that viability of the PLM could be better assessed.

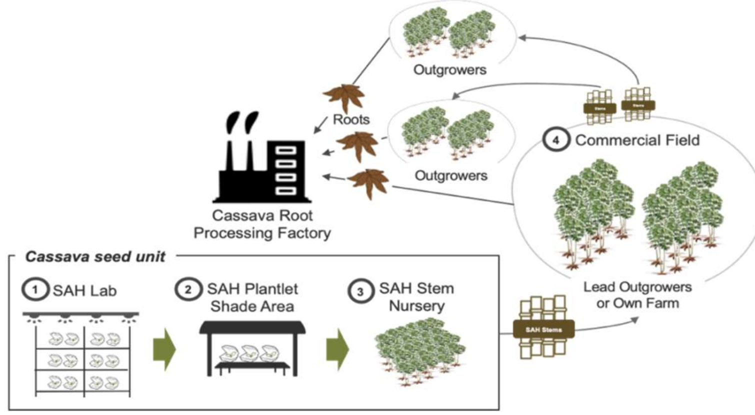


Figure 4.1. PLM for cassava seed (stem) production and distribution.

Following a formal partner vetting process in 2017, Psaltry and Eagleson were added as private sector partners in 2018. Both processors are female-owned businesses[1] that have incorporated female outgrowers into their root-sourcing schemes.

Each of the three processors sources roots from over a 1,000 ha of cassava farm. This large, commercial scale gives the processors a strong incentive to increase farmers' access to and adoption of cassava varieties with preferred processing characteristics.

Operating the SAH labs at the three processor sites has since led to the bulking up of the starter planting materials, resulting in transplanting the SAH plantlets to nursery sites for further multiplication. FMN now has 6 ha of SAH nursery in Shao, Kwara state, and has ratooned just a few stems to plant a 0.1-ha field in Sunti, Niger state. Psaltry and Eagleson have about 0.5 ha and 0.2 ha, respectively.

4.2 Outcomes and activities

4.2.1 Consistent and stable seed production system on processors' fields

The PLM component provided training and support to define business cases for each processor and accompanied them as they invested and established SAH labs to start producing clean seed of specific varieties for their production needs.

All three SAH labs are operational, with trained staff. The first processor to establish the lab, FMN, is now multiplying the SAH-derived stems in two states in Nigeria, Kwara and Niger. The other two processors, Psaltry and Eagleson, have started planting their nurseries with SAH plantlets. CGD and Sahel worked with the management of each processor to define their CS production targets, to model seed unit economics, and to design multi-year seed production plans to achieve their SAH-derived root supply objectives.

4.2.1.1 Processors establish and manage seed multiplication unit

Conventional BS Stem Nurseries. CGD and Sahel worked with FMN, Shao Farms, and IITA staff to create and refine the initial "Cassava Attributes Wish List and Characterization Matrix," outlining processors' top priorities for cassava in both processing and agronomic categories. This tool was used to help select the four varieties (IBA980505, IBA980501, TME419, and IBA961632) that Shao Farms then planted in a 4.5 ha nursery, planted with 100,000 stems from IITA. This nursery was established to provide insight on the different varieties and their performance attributes and to help the processor bulk up seed ahead of planting material output from the SAH lab.

The nursery was then ratooned, yielding 1,560 bundles that were used to plant 26.3 ha for commercial production. The 4.5-ha nursery and the 26.3-ha fields were not harvested for commercial root planting in 2018 as harvesting was delayed for another year due to differing management priorities. Both nurseries began to be harvested in July 2019. Of the four varieties making up the 26.3-ha commercial field, TMEB419 was harvested and used to plant a 40-ha field for FMN's 2020

[1] Eagleson is owned and managed by Ms. Nike Tinubu, and Psaltry's manager and CEO is Mrs. Yemisi Iranloye.

commercial production. IBA961632 was harvested to plant a 6-ha field at Shao in Kwara state, a 1-ha field on their Agripalm Farm in Benue state, and a 1-ha field in their Golden Sugar Estate in Niger state. IBA980581 was harvested and given to 10 farmers around Shao, Kwara state, for them to compare with their local landraces. IBA980505 was discarded as it was deprioritized for commercial production. The FMN management discontinued the ratooned 4.5-ha nursery because the plants were diseased due to the one-year delay in harvesting.

SAH Production Units and SAH-derived Nurseries. In 2017 FMN selected staff to run its SAH lab at Shao. IITA trained FMN's staff on lab operations, cutting, and growth room management. Later, CGD and Sahel (working with IITA) also held a series of training sessions for field laborers and nursery staff at Shao Farms as a means of building long-term stem production expertise within their personnel. When the lab opened, IITA supplied the first batch of starter materials (30 boxes of IBA980581) for use in the multiplication pilot cycles. Cutting for these pilot cycles began in September 2017, and by the end of the year more than 40,000 plantlets were generated. CGD provided wireless tablets and installed a FieldBooks app for lab technicians to track and report on the progress of lab multiplications.

In 2018 SAH production reached about 200,000 plantlets of eight varieties: TMEB419, CR36-5, IBA070593, IBA961632, IBA980505, NR8082, IBA980581, and IBA011368. However, the FMN seed unit reduced multiplication in early 2019 due to the transition in management. There was yet another management transition in October 2019, which resulted in the lab moving from Shao in Kwara state to Sunti in Niger state to ensure better oversight of the lab. This move halted seed unit operations and delayed the meeting of program targets. Fortunately, the SAH lab has resumed operations in Sunti as of February 2020.

In late 2018, a 2.5-ha nursery was established at Shao with plantlets of IBA980581, which was then ratooned and the stems were planted on a 1-ha field in Niger state in 2019 (see Table 3, Annex 4A "FMN Nursery Field Establishment"). Also in 2019, FMN established a 6-ha nursery of SAH plantlets of IBA980581 at Shao. Together with the multiplication fields of conventional BS (see the section above), FMN plans to set up a network of outgrowers around these nurseries in three states (Kwara, Niger, and Edo). A similar outgrower model will be managed for cassava stem and root production. Nurseries across the four states will supply quality stems to outgrowers to produce cassava roots for processing and certified stems for sale. The new management plans to pilot an outgrower scheme, to better understand how outgrowers can best support FMN's commercial production.

Eagleson and Psaltry leveraged economic analysis tools developed by CGD to draft their seed unit investment case proposals in 2017. Partnership agreements were signed with the management of each organization in 2018. Each firm's SAH lab was constructed and became operational in 2019. IITA provided source plantlets for both processors, as well as training of their technical staff. Nursery sites were also set apart to start planting SAH plantlets.

In June 2019 Psaltry received its first starter SAH plantlets from IITA, composed of IBA070593, TMEB419, IBA961632, and IBA980581. These were topped up by additional boxes of IBA980581 and IBA070593 in September 2019. As of March 2020, Psaltry has multiplied the following per variety: IBA980581 (439 boxes), IBA070593 (426 boxes), IBA961632 (97 boxes), and TMEB419 (119 boxes). Psaltry's most preferred varieties for starch are TMEB419 and IBA980581.

Eagleson's SAH lab received its transfer of SAH plantlets, which consisted of IBA980505 and TMEB419, on 1 July 2019. The second batch of SAH plantlets of TMS-IBA070593 was received in October 2019. As of April 2020, Eagleson has multiplied the following amounts of plantlets: IBA070593 (37 boxes), TMEB419 (10 boxes), and IBA980581 (35 boxes). These three varieties are the preferred varieties for Eagleson's HQCF-processing needs.

Psaltry and Eagleson have both established SAH nurseries in their fields. Psaltry has planted the following varieties: IBA961632 (40 plantlets), IBA070593 (343 plantlets), IBA980581 (228 plantlets), and TMEB419 (53 plantlets), about 0.5 ha in total. They have 10 ha of land set aside for nurseries and will continue to transfer SAH plantlets to the nursery as they multiply in the lab. They plan on harvesting the first batch of stems in March–April 2021, and some of these stems would be ratooned for planting on Psaltry's commercial fields for stem multiplication. They would also give some of the stems to their tier one farmers for stem multiplication. Eagleson, on the other hand, has transferred about 0.2 ha of SAH plantlets to their nursery comprising TMEB419 (12 boxes), IBA980581 (18 boxes), and IBA9611632 (10 boxes). They plan on harvesting in October and multiplying the harvested stems on their designated multiplication plots. The stems would then be ratooned for commercial planting before the end of the planting season.

CGD assessed the state of cassava seed unit operations for Psaltry and Eagleson in 2019. Psaltry seed unit operations are affected by constrained access to BS, lack of technical skill for transplanting SAH plantlets to the field, and low survival rates in the lab as a result of insect pests in the substrates and seed source management protocols. Eagleson's lab operations came to a near standstill due to the erratic power supply and inadequate back-up power as well as a pest infestation in its substrate. Further clouding the future of Eagleson's seed unit is IITA's assessment that the organization has not proved itself a good steward of the SAH plantlets. To address the substrate pest problems of both labs, IITA has since gone to both labs and trained each organization on better preservative measures. Figure 4.2 shows a summary of the overall assessment of the three processors in handling SAH-derived seed.

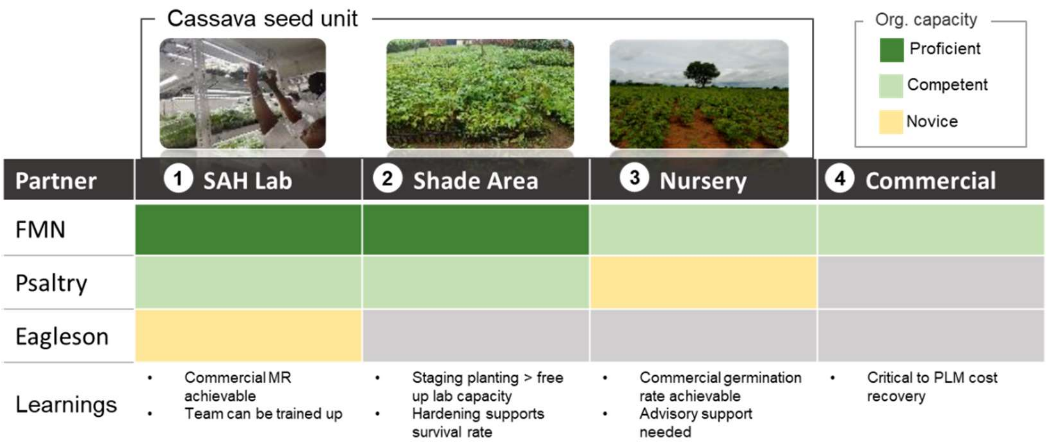


Figure 4.2. Assessment of processors' capabilities in establishing and operating seed production units.

CGD and Sahel conducted subsequent site visits in early 2020 to work with the management of Psaltry and Eagleson to address the constraining factors. Psaltry has made the necessary changes recommended by IITA; the future of Eagleson's seed unit is less certain.

CGD and Sahel are continuing to liaise with FMN to better understand their go-forward strategy and to support the rebuilding of their production plan following the transition to Sunti, Niger State.

4.2.1.2 Processors plan and implement seed production of preferred varieties in response to findings from demand-creation trials

As mentioned above, Psaltry and Eagleson are multiplying and planting nurseries of their preferred varieties. FMN is emphasizing the varieties TME419, IBA961632, and IBA980581. They showed an interest in CR36-5 from the high starch results in the DCTs. Consequently, FMN has been evaluating and refining the best agronomic practices to grow this variety.

4.2.2 Networks of profitable multipliers

The three processors under the PLM use different outgrower models. The project undertook a study to describe the models and analyze their strengths and weaknesses. Since SAH material has only now been transferred to nurseries, it is too soon to evaluate how the incorporation of new varieties and clean seed is translating into higher production and profitability for seed producers, root growers, and processors. Following the schemes in Figure 4.2, once the seed is grown for root growers, who use their seed for production, the projections in the models can be tested and profitability evaluated in the second phase of the project.

4.2.2.1 Networks of outgrower seed multipliers are incorporated into production plans by processors, to produce high-quality improved varieties in the catchment area

Sahel surveyed 90 experienced cassava farmers across 16 villages in the Moro LGA of Kwara state, near FMN's farms in 2017. The survey aimed to understand the varietal preferences of cassava growers, the availability of quality cassava stems, and farmers' stem sourcing strategy. The survey also assessed the production and marketing priorities of cassava growers and their perceptions of the cassava seed system project. The survey revealed that these farmers had not been exposed to improved varieties for over a decade and were mainly growing two landraces (Oko-Iyawo and Odongbo). Yet they were willing to try new varieties that were preferred by the processor (if they performed better) and to participate in an outgrower scheme with FMN, provided that growing the stems is profitable. The growers understand the processor's priority of starch stability and DMC, but farmers also need to grow varieties to feed their households.

In 2018 Sahel and CGD conducted research on the outgrower models used by the processors aligned with the project, to understand the dynamics of the existing outgrower schemes as well as how to improve the existing structure and build a sustainable outgrower model that could be replicated. Sahel interviewed the processors' management teams and met with lead farmers to discuss the benefits and tradeoffs of the outgrower models. They hosted focus groups with some of the outgrowers in each production area to discuss farmer demographics, the service structure, and the terms of contracts between outgrowers and processors. Processors implemented different models. In the Eagleson model, 150 farmers participated in a government program through Eagleson to incentivize the production of cassava and reduce risk through a tripartite input risk-sharing model. The Nigeria Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL) directly funds farmers for production with Eagleson's training and supervision. Eagleson then processes all of the roots into HQCF. This tripartite partnership between the farmers, Eagleson, and NIRSAL is in its third year (see Figure 4.2A for a diagram of this model).

In the Psaltry model, 1,390 farmers grow cassava on their farms within an 80 km radius from Psaltry's processing facility (Figure 4.2B below). Psaltry provides inputs like fertilizers, chemicals, funds for weeding, and mechanization to its outgrowers. They are currently formalizing the inclusion of SAH stems into the inputs package for their outgrowers. Psaltry also provides outgrowers with training in best cassava-farming practices.

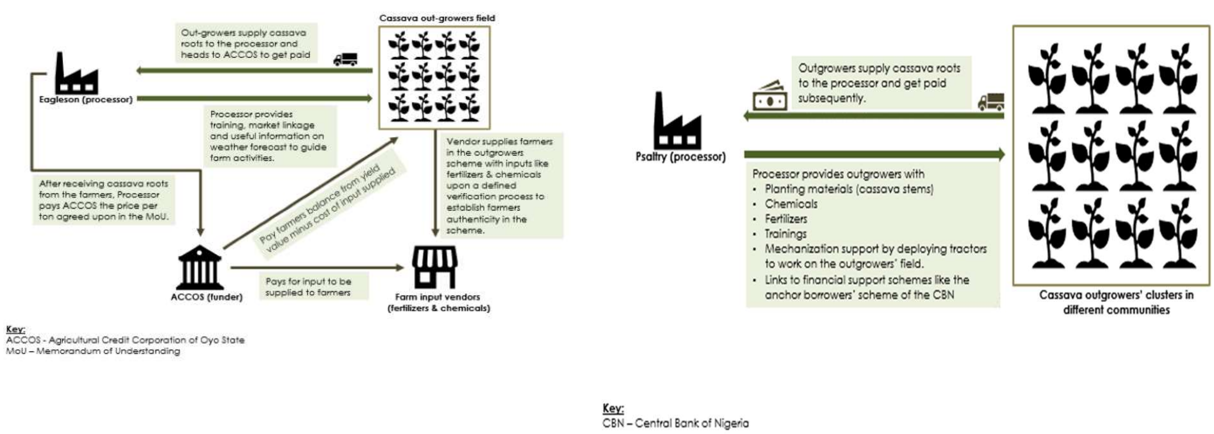


Figure 4.2. (A) Eagleson outgrower model. (B) Psaltry outgrower model.

FMN's Thai Farms in Ogun state conducted a pilot outgrower scheme in 2017–2018 with 40 farmers. Thai Farms provided inputs and finance to farmers and bought the produce at harvest at a price agreed before planting. This was discontinued due to the change in management. However, the new management is looking to establish a pilot outgrower scheme in Shao, Kwara state.

4.2.3 Adaptive multiplication management curriculum and training modules

As part of building a method for inventorying and training on production best practices, CGD, Sahel, and IITA drafted the BAQSTOPs manual (Figure 4.3). The manual is structured around three best practice pillars of business, agronomy, and quality. It is supported by a set of standardized tools and operating procedures (STOPs) to help implement CS production.

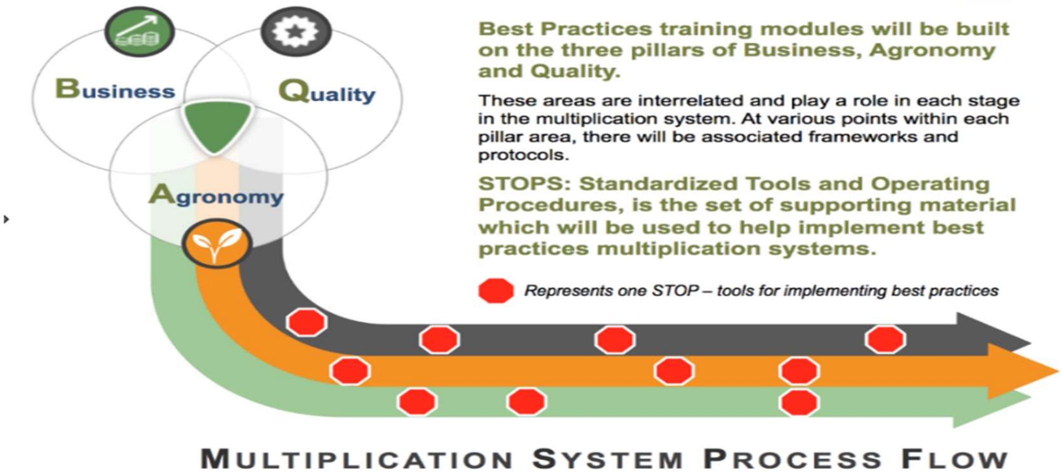


Figure 4.3. BAQSTOPs manual overview.

Through direct engagement with processors, CGD and Sahel drafted the business component of the manual (Annex 4B BAQSTOPS v12). IITA is drafting the agronomy and quality components of BAQSTOPs.

4.2.3.1 Model the economic sustainability of cassava stem business

CGD and Sahel developed the business component of BAQSTOPs. This toolkit helps the processors evaluate the resource requirements and to anticipate the economic returns associated with the PLM.

The toolkit has a narrative component and a set of six Excel-based tools. The narrative introduces the vertical integration model for cassava seed production (i.e., the PLM) and walks processors through three increasingly detailed business analysis screens (Table 4.1).

1. Strategic screen—planning level

- Goals and seed production targets (work backward from root demand)

2. Business model screen—design level

- Economic justification (high-quality roots and processing throughput)

3. Process screen—implementation level

- Organization and seed production planning (sequencing activities to suit the agro-climatic situation)

The Excel-based tools enable processors to tailor assumptions to their particular situation and to determine whether the PLM is right for their organization. These tools are interlinked and exist as worksheets by the same name within the Cassava Seed Unit Analysis Toolkit[2] (see Annex 4C_ Cassava Seed Unit Analysis Toolkit (PLM Model) v9).

Table 4.1 Tools that comprise the Cassava Seed Unit Analysis Toolkit

Analysis Screen	Tool Name	Purpose
Strategic	Cassava Seed Requirement Calculator	Evaluate seed requirement to meet processor needs across multiple seed classes
Strategic	Processing Value Calculator	Assess differential revenue from processing roots from SAH-derived stems
Strategic	Outgrower Value Calculator	Assess the value of adopting improved seed from a cassava farmer perspective
Business Model	Cassava Seed Unit Pro Forma	Evaluate production volume estimates, land requirements, costs, and profitability associated with the PLM
Business Model	Investment + Operating Cost Calculator	Enter the investment, variable, and fixed cost assumptions related to the SAH Lab, SAH Plantlet Shade Area, SAH Stem Nursery, and commercial field production
Process	Production Planning Calendar	Evaluate the timing of cassava seed production activities over successive field multiplication cycles

[2] SeedSim was a tool initially designed to support the seed production planning process. This tool allowed the processing partners to input their capacity and supply information to simulate unit outputs over time from the lab, nursery, and field. The ProCost model, on the other hand, was designed as a unit economics analysis tool for seed multiplication. Both models have been redesigned into the above mentioned six tools to make them more user friendly.

CGD used earlier versions of these tools to help Psaltry and Eagleson develop their seed unit production and financial model and a production calendar, and to analyze outgrower impact; see Annex 4D: PLM Production Model (Eagleson) and Annex 4E: PLM Production Model (Psaltry). The production models were co-developed with the processors' managers and received feedback needed to tailor the models to suit their strategies and plans.

The financial projection for Psaltry shows that the firm would be profitable after three years, assuming 1,708 ha of commercial (C2) production and net present value for the next seven years of $2,210,141. The financial projection for Eagleson shows profitability after three years, assuming 95 ha of commercial (C1) production and net present value for the next seven years of $191,493. The financial projection summaries for both seed units are provided in Annexes 4D and 4E.

The analysis of the outgrower adoption impact for both processors showed that the outgrowers could make more profit using the improved seeds from the lab (Annex 4B_BAQSTOPS Business v12). Their profits are boosted by increased starch content and root yield; these are assumed to increase by 25% and 29%, respectively, for Psaltry, and 20% each for Eagleson. The cost of seed stems is assumed to be reduced by 12% for Psaltry and 17% for Eagleson. Consequently, Psaltry outgrowers would be projected to increase their profit per ha by 469%, and Eagleson outgrowers by 39% (including a 20% increase in harvesting costs).

A detailed management report, "Implementing a Rapid Multiplication Unit of Cassava Stems at Flour Mills of Nigeria" was prepared for FMN that documented the critical activities done from the start of the BASICS project through 2019, to optimize their system and improve their productivity (Annex 4F_ Progress Report on FMN SAH RMU Implementation). The report includes the following:

- Establishment and operation of the SAH-plant laboratory and SAH stem nursery
- Setup and management of DCTs
- Establishment of the conventional cassava stem nursery and commercial fields

The report provides a full overview of the PLM activities with FMN and highlights key insights, challenges, and lessons learned by CGD and Sahel in managing the project and partnership with FMN. While the partnership faced numerous challenges, it proved that a commercial cassava seed system, anchored by the processing industry, is achievable in Nigeria. The report shows estimates of CS production in SAH plantlet production, assuming full capacity, as compared with the actual amounts of material coming out of nursery seed in which the only CS produced in 2019 came from the original nursery with conventional stems. Nevertheless, it provides a schematic of potential seed flows and production per seed category. Potential benefits and lessons learned from the FMN report reveal that the integrated seed unit can provide value to FMN through increased availability of high-quality cassava stems for improved root-to-starch processing efficiency and additional revenue from cassava stem sales.

4.3 Lessons learned

Integrating seed production with industrial processors was a complementary path to the VSE model of getting CS production out into the cassava production areas. The processors would have strong incentives to have more control over the supply of varieties with desired attributes (e.g., high starch content). What is more, seed producers and cassava root outgrowers who supply the processors would have access to clean seed of these improved varieties. The implementation of the PLM resulted in several lessons learned:

- It is important to screen and identify processors who are willing to invest in the in-house capability to produce EGS of improved varieties.
- The strategic, financial, and operational capacity of processors to establish a cassava seed unit (an SAH Lab, SAH Plantlet shade area, and an SAH stem nursery) must be assessed as discussed in the business toolkit.
- SAH-anchored seed systems allowed processors to (1) reduce overall seed costs, (2) replenish material and stems by planting time, and (3) incorporate new, improved processing varieties.
- The value proposition for a seed unit is about speed to replace varieties.
- DCTs create processor demand for new varieties and showcase that different varieties are best suited for different processed products.

- Cassava seed sales alone are insufficient to justify the business case for a processor to establish a cassava seed unit. Rather, it also derives from the benefits of an assured root supply of the desired variety.
- By projecting six to seven years into the future, the PLM shows profitability to the processor, usually starting from year three. This profitability, however, is based on some assumptions regarding the SAH lab (total production capacity of the SAH system), nursery (total stem bundles harvested for commercial planting), and commercial planting (revenue from bundles and starch/ha).
- For a cassava seed unit to be financially sustainable independent of a processing factory, a processor would need to identify an elite variety that farmers are willing and able to pay for, and it would need to manage stem multiplication for several generations to bulk up enough seed to cover the investment and fixed costs associated with running the SAH lab.
- Outgrower farmers can make more profit using the improved seed derived from processor SAH labs.
- Different options for processors must be explored, such as sourcing SAH-derived stems for nursery establishment as opposed to having a SAH facility in-house. There is no one-size-fits-all approach to establishing a cassava seed unit.
- Research is needed to identify best management strategies and contractual arrangements for working with outgrowers.
- The Business Component Manual and the corresponding Cassava Seed Unit tools enable processors to tailor assumptions to their particular situation and to determine whether the PLM is right for their organization.

5. Quality Seed Component

5.1 Introduction

For a seed market to function and be economically sustainable, developing the confidence of all stakeholders in the integrity of the product is essential. To this end, under the leadership of Fera and together with IITA and NRCRI, the project aimed at enhancing the operational capacity, efficiency, reach, and market responsiveness of NASC in delivery of its mission of "Ensuring the supply of good quality seed" (www.seedcouncil.gov.ng), implement quality assurance and seed certification at all levels of cassava seed production, and determine the value proposition of certified seed together with the BSC. Before the project, cassava stems were seldom seen as a marketable commodity, so few cassava farmers had ever heard of formal quality standards for cassava stems or of asking for NASC certification when procuring seeds. Before BASICS, BS in Nigeria was never certified, and it had no nationally approved quality certification protocols, because BS was produced through designated organizations.

BASICS set out to work closely with NASC to enhance its operational capacity, processes, and systems for developing and enforcing the standards for certifying cassava seed classes (BS, FS, and certified or CS) and to develop ICT tools, especially the CST, and to digitalize QA procedures. The project also envisaged setting up seed quality diagnostic facilities at NASC and, through a twinning alliance between NASC and Fera, bringing to Nigeria the "best practices" in cassava seed certification as drawn from other crops and countries and, especially, through similar projects in Kenya, Tanzania, Nigeria, and the UK. These practices encompassed certification protocols, diagnostic lab facilities, customer service standards, sustainable financial practices, and staff training.

During the course of the BASICS project, NASC enhanced its facilities by relocating from Abuja to a large acreage location at Sheda, about an hour's drive by car from the city center of Abuja. These new premises allow them to invest in infrastructure as needed to help develop the seed sector. The NASC headquarters has transformed its physical and human resources capacities during the project. NASC and the Federal Ministry of Agriculture have advanced an intention to set up a "center of excellence" for seeds to cater to the West African region. The passing of Seed Act 21 LFN 2019 was a step in the positive direction for cassava seed system for the following reasons:

- For the first time, vegetatively propagated planting material has been recognized by the Seed Law.
- Stringent sanctions have been stipulated for spurious seed sellers, and this has the potential to create a market for the quality-compliant, registered seed enterprises.

- The provisions under the law allows NASC to modify regulations to suit the needs of the cassava seed value chain. An example is allowing NASC to authorize a third-party to certify commercial certified seed, and use of digital tools, like CST, for QA and seed certification.

Under these provisions, digital tools and third-party certification were first piloted under BASICS in the last quarter of 2018 and 2019, respectively, exploring a practical way to enhance the reach and affordability of seed certification services for seed entrepreneurs.

5.2 Outcomes and activities

The QSC played a key role in developing the cassava seed system by strengthening NASC in Nigeria: enhancing regulatory skills, defining seed regulatory protocols, and changing the mindset of seed producers to accept NASC, not as a policing regulatory body, but as an enabler of the seed system itself. In the early years of BASICS, NASC´s biggest challenge was convincing seed producers that registering their fields for certification would increase the market price of their seed. In overcoming this barrier, NASC demonstrated how a government regulatory body, under a responsive leadership, is essential to progressing a seed system attuned to market requirements.

5.2.1 Efficient, market sustainable services for seed certification by NASC

As a foundation activity of BASICS, the senior management at NASC travelled to witness and learn from the innovations in seed certification in the UK (Fera), Kenya (Kenya Plant Health Inspectorate Service, and Tanzania (Tanzania Official Seed Certification Institute [TOSCI]; Annex 5A_Y4 Annual Report_FERA). The activity in Tanzania linked with the BMGF-funded BEST project implemented by MEDA. After that exposure, a tailored program of training, "'Twinning'—The NASC Roadmap for Development," was agreed between NASC and Fera that oversaw reciprocal visits for the duration of BASICS. These activities raised the aspirations of NASC to improve the services offered in Nigeria, whereby key NASC management and technical staff have gained exposure to best practices in seed certification. It is to the immense credit of NASC management, and the vision of its director general, that such an opportunity for professional development was wholeheartedly embraced.

Under the "The NASC Roadmap for Development," BASICS has furthered key innovations like the CST, a molecular diagnostic lab for CMD testing, and third-party certification. Thanks to its new market-oriented service culture, NASC has set out its ambition as a center of excellence for seed certification for Nigeria and the West Africa region. During BASICS, the profile of cassava seeds was systematically enhanced in the eyes of farmers, seed producers, processors, government officials, and researchers through the concerted efforts of all stakeholders. The project team consistently promoted the use of certified seed by regular participation in high-profile industry event such as Agra Innovate, with more than 5,000 stakeholders attending. For several consecutive years, BASICS created and championed SeedConnect Africa as a public-private sector forum that drives seed standards in the region and beyond. By supporting such activities and highly publicized ministerial visits to the seed diagnostic labs, regular media outreach to farmers and seed producers, BASICS has been able to significantly bring cassava seed into focus of stakeholders.

BASICS also successfully advocated for including cassava into the wider seed system roadmap for Nigeria that was developed by Wageningen University and Research and Sahel by participating in the Netherland's government-funded NASC seed sector development stakeholder consultations and report development (Annex 5B–Seed Sector review).

5.2.1.1 Seed certification protocols and procedures: in development of the breeder standard for cassava seed

BASICS successfully worked with NASC toward evolving a seed quality regulatory regime that enabled a new, sustainable seed system in Nigeria. This involved developing, socializing, and implementing seed certification standards that were more stringent at BS and FS levels and more pragmatic at CS level. During the SCSS project, NASC had developed certified and FS certification standards, but no BS standard was specified. A major focus for the QSC in this project was creating the BS certification standard.

The step change achieved by BASICS was the ability to source BS from *in vitro* nuclear stocks to use at scale as SAH material. Hitherto, BS had only ever been maintained by field multiplication. The innovation of SAH allows a new, higher standard of BS to be achieved that can flow down to improve the standard of FS and, ultimately in the hands of smallholder farmers, as certified seed.

The BS certification protocols were developed for the first time in Nigeria through a series of consultative interactions between various stakeholders under BASICS, while also drawing on the experience gained with yam under the BMGF-funded YIIFSWA project (Annex 5A_Y4 Annual Report_FERA). The review of scientific evidence and expert consultation led to a proposed seed certification standard that serves for all the main vegetative seed crops, recognizing generic features and then defining crop specific needs. Accordingly, the *Guidance on the Setting of a Certification Standard for Vegetatively Propagated Seed for Nigeria* (Annex 5C) was co-drafted by Fera, NASC, IITA, and NRCRI, and undertook a successful public consultation in March 2020. The proposed standard for cassava BS as progressed by that standard is presented in Table 5.1.

Table 5.1 Proposed cassava pest and off-type standards as developed by Fera under BASICS in February 2020 for the consideration by NASC on certification standards for vegetatively propagated seed for Nigeria

Factor	BS	FS	Certified Seed
Variety			
Off-types (max. incidence)	0	10 (2)	20 (5)
Pests & Diseases			
CMD Field (max. visual incidence)	0	10* (5)	20* (10)
CMD Molecular test (%) (max. incidence; ACMV &EACMV)	0	NA	NA
Cassava bacterial blight (max. incidence, exceeding severity 3)	2.5	10* (2.5)	20* (2.5)
CBSD† (max incidence for CBSV & UCBSV by molecular tests)	0	0	0
Scale insect (max incidence, exceeding severity 2)	0	2.5 (0)	20 (5)
Cassava Green Mite (max incidence, exceeding severity 3)	1	10* (3)	20* (5)

Figures in parenthesis indicate proposed new standards under FS and certified seed schemes and are stated as indicative of the better standard that may be achieved as BS feeds through the seed system. The figures stated are subject to further research and review.

* The current standard only counts plants with a severity score exceeding 3.

†CBSD testing would be part of the national surveillance and vigilance programme for CBSD causal viruses and would only be tested for according to the agreed practice under this scheme (e.g., to confirm suspect plants based on symptoms).

Expert consultations and a review of the literature revealed that BS could not be produced in the field at a higher level of biosecurity than that already implemented for FS. Even though SAH provides a virus-free source material for BS, and a potential yield gain, there is a subsequent risk of infection from CMD in susceptible varieties. However, susceptible varieties are not promoted for use by BASICS or participating institutions. On this basis, and also the inherent difficulty of distributing cassava stems, Fera and NASC advocated strongly for the consideration of a screenhouse system for cassava stem multiplication. Referred to by Fera as "cassava pencils," such production of vegetative stems is proven in roses and cassava.

BASICS had been at the forefront of advocacy for the regulatory regime to recognize the importance, opportunity, and unique challenges in the seed system development for vegetatively propagated crops so the sector can be nurtured.

5.2.1.2 Establishment of modern seed diagnostic lab at NASC

Complementing visual inspection of fields for CMD with lab diagnostics of the causal viruses was essential for maintaining seed quality, especially at BS level. Cassava varieties with tolerance to CMD may show no symptoms but still harbor varying levels of CMD virus. A joint study by NRCRI and Fera on 80 fields (40 VSE and 40 farmers' fields) over two seasons showed that about a third of all VSE fields of CMD-tolerant varieties had CMD virus but only about 50% of these expressed CMD symptoms. The data generated by BASICS on CMD virus infection of VSE CS and FSS in 2017 and 2018 demonstrated, for the first time, that a molecular test applied to the certification of cassava CS could reduce levels of CMD virus in certified seed, below that achieved by visual infection. These findings were used when applying the molecular tests to BS, where testing is more cost-effective. To achieve this outcome, a molecular seed-testing facility was required at NASC.

Fera worked closely with NASC and NRCRI to design, install, and commission a molecular diagnostics lab at Sheda, and then to establish SOPs for testing cassava BS for CMD viruses. A well-equipped molecular seed-testing laboratory at NASC was commissioned in 2018 by the Hon. Minister of Agriculture and Rural Development, Chief Audu Ogbeh, in the presence of the director general of NASC, Dr. Olusegun Ojo (Figures 5.1, 5.2, and 5.3). While commissioned for BASICS and cassava testing, Fera ensured that the facility could test seed for many crops as will be essential for its sustainability, including tomato, maize, rice, potato, yams, and sweetpotato. NASC has invested its own resources and has set up a reliable power supply to the freezers and air-conditioning in the lab by establishing a solar power plant at the site.

Olusegun Ojo, director general of NASC (with NASC cap, left) with Audu Ogbeh, OFR (Order of the Federal Republic), honorable minister for agriculture, and chairman of the NASC Governing Board.

Audu Ogbeh: “BASICS project is a well-articulated and strategic intervention geared at entrenching and popularizing the sustainable use of disease-free vegetative seed propagation material in Nigeria and the region.”

“The NASC board recognizes the extraordinary contribution of BASICS for introducing a novel Cassava Seed Tracker in line with the e-certification drive of NASC, as this will bridge the gap of the dwindling manpower and create transparent and traceable seed certification systems for the council. I can proudly say that BASIC project has brought the future to the Nigerian Agricultural Seed Council!”

Figure 5.1. Commissioning of seed testing laboratory at NASC.

Figure 5.2. Fera and NASC staff unpack equipment for the NASC laboratory.

Figure 5.3. NASC and Fera staff validate the NASC equipment.

Underpinning this achievement, Fera, NASC, and NRCRI staff undertook a series of exchange visits. In partnership with NRCRI, Fera developed a new, easy to use LAMP assay for CMD viruses (see box below), and validated that enough tests can be done to certify a BS field. Ms. Nneka Okereke of NRCRI undertook two three-month placements at Fera to progress this research. This is the first molecular diagnostic available in kit form for a plant disease in Africa (Figure 5.4). Under the earlier Great Lakes Cassava Initiative project, Fera had developed LAMP assays for CBSD (UCBSV and CBSV). These can also be made available in kit form and can be an option for TOSCI and NASC to explore further.

Figure 5.4. CMV LAMP assays.

CMD LAMP kits, an innovation widely shared on *Twitter* (https://twitter.com/julianjsmith1/status/1115622393995833344)

Fera has worked with OptiGene (UK) to provide the African cassava mosaic virus (ACMV) and East African cassava mosaic virus (EACMV) LAMP assays as a kit. Each kit provides for 50 reactions. All reagents of the kit are stable at room temperature.

The full development of the LAMP assay through to the development of the kit is now drafted as a scientific paper for publication in a peer-reviewed journal (see draft abstract in the box below).

Abstract: A real-time loop-mediated isothermal amplification for detection of cassava mosaic virus

African cassava mosaic virus (ACMV) and East African cassava mosaic virus (EACMV) are the causal agents of cassava mosaic disease which results in significant losses throughout cassava growing areas of Africa. Loop-mediated isothermal amplification (LAMP) assays were developed for detection of ACMV and EACMV in symptomatic and symptomless cassava leaf material. LAMP primers were designed based on published sequences of the DNA-A segment of ACMV and EACMV. The EACMV assay is predicted to detect all variants for which sequence has been published, including the recombinant Ugandan strain EACMV-UG, with the exception of the variant of EACMV from Malawi, EACMMV. A set of primers was therefore designed specifically for the EACMMV sequence, such that the two assays (EACMV and EACMMV) together cover all published sequence variants and could be used individually or in multiplex. The performance of the ACMV and EACMV/EACMMV LAMP assays was compared with that of real-time PCR, and at least equivalent sensitivity was observed; the ability to detect ACMV in symptomless samples collected in the field in Nigeria was demonstrated. LAMP was carried out using a battery-powered instrument (the Genie III), with a reaction time of 30 minutes. The assays can be used in parallel with a plant control LAMP assay targeting cytochrome oxidase, to confirm successful extraction of DNA from samples returning a negative result for CMVs.

The project trained NASC staff by visits to Fera; Fera staff also visited NASC. Most of this training focused on molecular seed testing, although training was widened to include seed health and pathology. For example, in 2018 six NASC staff members participated in a two-week training program at Fera in the UK. They are now fully capable of managing the lab on their own. One of them, Ms. Mewase Tolulope Rebecca, now heads the Molecular Seed Diagnostic Laboratory for NASC.

To augment the staff capacities at NASC, IITA organized one-month trainings for Ms. Agbaeze Hannah in laboratory management and for Ms. Mewase Tolulope Rebecca in virus diagnostics and seed health testing for seed certification.

Both participants attended the courses in March 2019 at the Virology and Germplasm Health units of IITA. On returning to NASC, the trainees have used their new skills on the job. A second training course was organized for nine NASC staff members from 26 August to 6 September 2019. Eleven people were trained on virus disease diagnostics and seed health testing (Figure 5.5).

Figure 5.5. NASC staff in the virus diagnostics and seed health testing training at IITA, Ibadan.

The Testing of BS for CMD Viruses. Following the capacity building described above, NASC tested 20 BS fields for CMD virus in 2019, independently of Fera. The protocol co-developed by Fera and NASC (Figure 5.6) requires the collection of 300 field samples per field and 12 molecular tests of 25 leaf samples per field. Two BS fields were found to have CMD and therefore would be rejected under the new standard. Testing on this scale verifies the major gains achieved by NASC under BASICS.

Rebecca Tolulope (NASC) instructs on how to sample a field, including:

- Field codes and traceability of samples
- Combining the sampling with the normal pest and disease scoring
- Picking and bagging a leaf
- Pressing a leaf disc from a pool of 25 leaves

The NASC demonstration plot was used to practice selecting a quadrant of 25 plants, picking one leaf from each one and bagging them

The NASC inspectors practiced taking a leaf disc from pools of 25 leaves. A simple system is used which uses a 5 ml laboratory tube as the cutting device; the sample goes directly into the tube to be taken to the laboratory

Figure 5.6. Testing of breeder seed fields for CMV by NASC inspectors.

5.2.2 Online CST system for monitoring seed production, certification, and demand

5.2.2.1 Digitalization to improve compliance to QA and seed regulations

The lack of awareness of seed regulations and the high cost of seed certification, including logistical complexity, are the main bottlenecks to improving compliance with seed certification procedures. To simplify seed certification and integrate the cassava seed production value chain, BASICS developed the CST web app (CST, www.seedtracker.org/cassava). The CST, developed by IITA with NASC, digitally links multistage seed value chain actors, offers real-time tracking of the seed production database, generates geographic maps, and offers analytics.

The application, usable on any internet-enabled device, is customized to Nigerian cassava seed certification procedures and the implementation protocol of NASC. The app supports seed field registration, field inspection, and certification of seed lots, including barcoded labels for easy traceability. It has offline functionality as well. Information related to cassava varieties released in Nigeria was digitized for users to access key features of improved varieties with photo records. The CST started the innovative use of digital devices in the cassava seed value chain in Nigeria, to collate and visualize the seed production fields, and to provide a platform for e-certification by NASC.

The potential of CST was publicly recognized when it was chosen as a finalist for digital tools in Nigeria in the **Google Impact Challenge**. The CST team, led by IITA and NASC, received a $125,000 grant to further enhance Seed Tracker at a ceremony in Lagos in November 2018. This award led to the development of the Android version of the Seed Tracker, which was released on 1 November 2019. The award comes with mentoring by the Google team, which is expected to improve the customer experience on the platform, thus helping in enhancing its adoption.

The CST prototype was piloted in mid-2017 for validation. In October 2018, NASC formally commissioned CST use for cassava BS certification in the South-West region as the first e-seed certification in sub-Saharan Africa. Since then, 59 BS fields in the South-West were recorded on CST for NASC certification. The CST was used alongside the conventional system (an official requirement for now), although NASC is expected to replace the paper-based system with a digital one. Steps are being taken in that direction with provisions for e-certification in the certification protocols following the enactment of the Seed Act (2019). All the BASICS seed production field data are registered in CST to create curatable inventory, seed data management, and analytics. Data entry was facilitated by the implementing institutions (i.e., IITA, CRS, and NRCRI). Since the CST was piloted in 2017, 705 field records have been uploaded by BASICS users covering the seed production years 2016–2019. Each record represents one certification unit (field) and includes 102 BS fields, 165 FS fields, 424 certified CS fields, and 10 demo trials (Figures 5.7 and 5.8). The data generated from the analytics feature of CST is presented below.

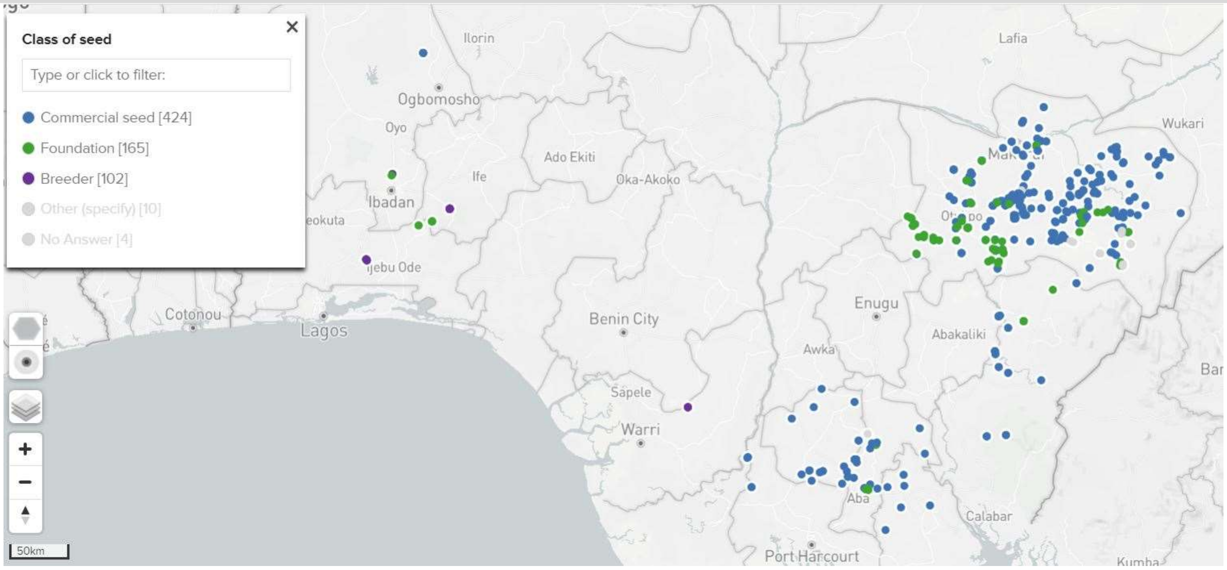


Figure 5.7. Geographic distribution of the BASICS cassava seed fields in Nigeria (2016–2019).

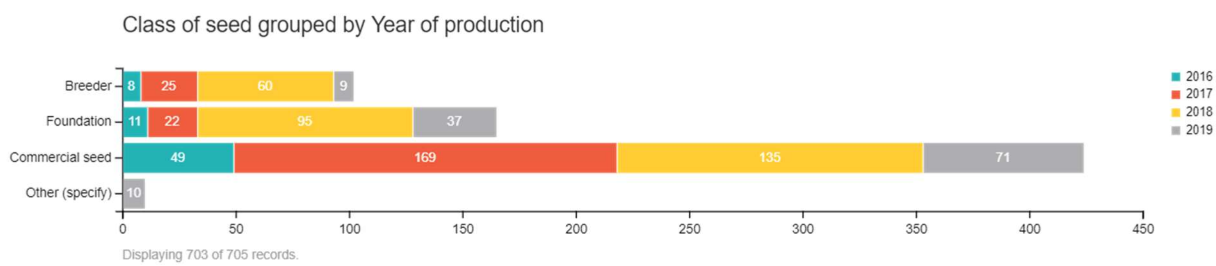


Figure 5.8. The number of cassava seed production fields by seed category and production year.

The CST provides easy visual analytics of seed production, whether by seed category, location, or year of production. Figure 5.9 shows the distribution of seed categories by region of the country. Of 705 BASICS seed fields, 451 were in the North-Central zone, 118 in the South-West zone, 69 in the South-South zone, 62 in the South-East zone, and one in the North-East zone. Figure 5.10 shows this distribution further broken down by year. The estimated number of bundles of each seed class for 2016–2019 is summarized in Figure 5.11.

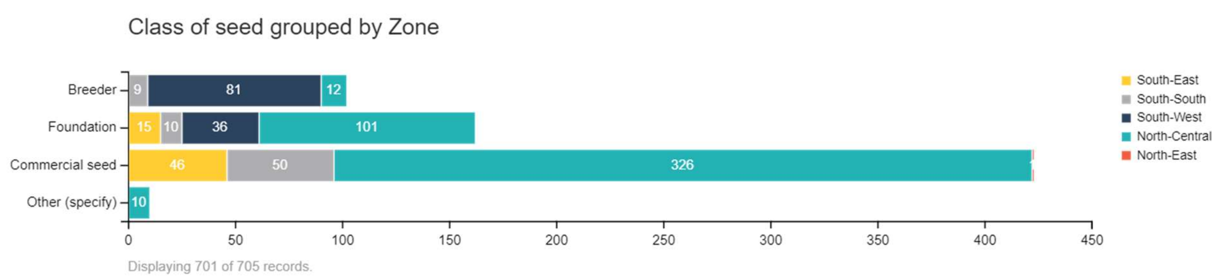


Figure 5.9. Distribution of cassava seed production fields by seed category and zones in Nigeria.

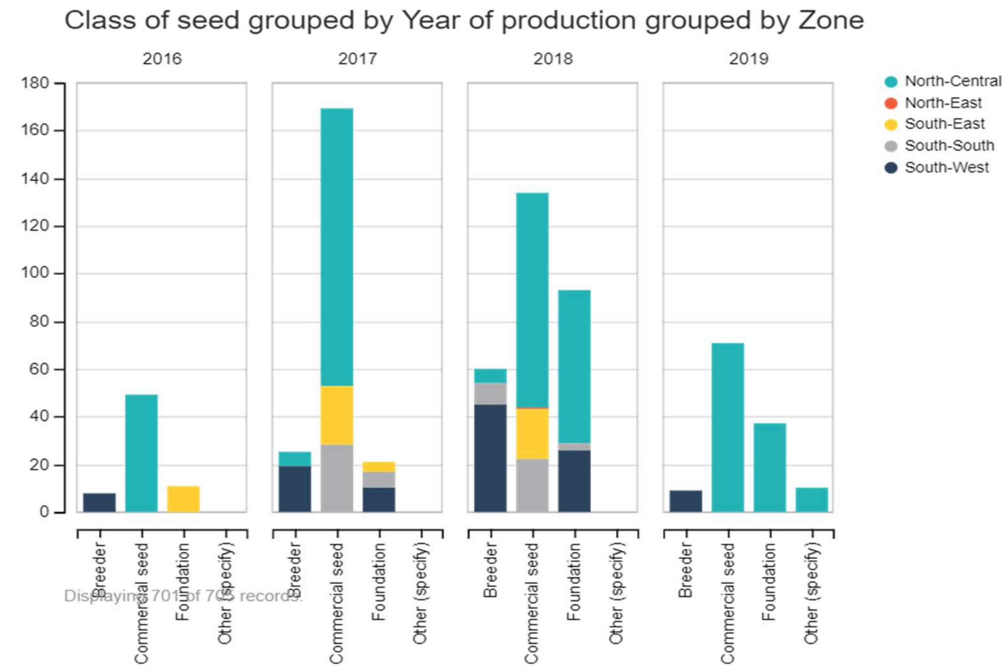


Figure 5.10. Summary of BASICS seed production by year, class of seed, and zones in Nigeria.

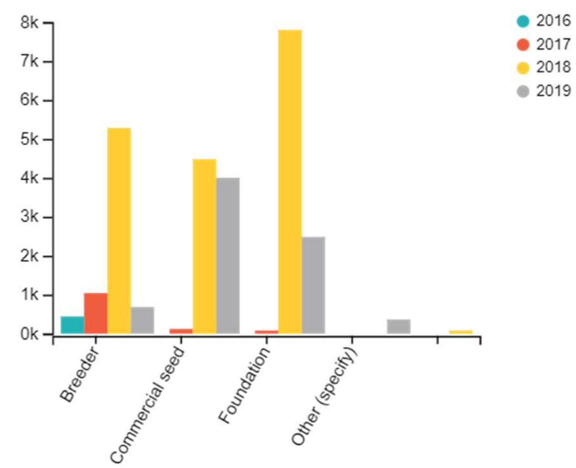


Figure 5.11. Estimated number of cassava stem bundles (x 1000) by class of seed and year of production.

5.2.2.2 Capacity building on CST

BASICS continued to strengthen the capacity of NASC inspectors on cassava seed certification, while training seed producers to apply CST and to identify cassava pests and diseases in the field. Eleven training events were organized jointly by IITA and NASC, and two training events by CRS and IITA between February 2017 and April 2020. In 2019 four training courses on CST were organized for NASC and seed producers in Nigeria. About 100 persons were trained in the four courses organized in different zones across the country: Asaba, BUABU-Zaria, IITA-Ibadan, and Makurdi, Benue (Figure 5.12). The workshop in Benue included VSEs and field officers, and program managers of CRS. Participants were provided with tablets loaded with CST (Figure 5.13). Two training workshops, one each in 2018 and 2019, specifically focused on training two NASC IT staff on managing the CST platform.

Figure 5.12. Participants of the CST training workshops at Asaba (left) and Ibadan (right).

Figure 5.13. Training NASC seed inspectors in cassava pest and disease identification and using the CST app.

5.2.2.3 CST adoption by NASC

The BASICS project has taken steps to internalize e-certification in NASC by upgrading ICT capacity and training in-house staff to manage the CST platform. Piloting CST in Nigeria demonstrated its high potential for e-seed certification, national seed inventory management, and mainstreaming national seed production. Following NASC's request, with complementary funding from other projects (YIIFSWA-II, Google.Org and CRP-RTB), BASICS and IITA broadened the CST platform to accommodate all crops, through the purpose-built NST to migrate the regulatory body to e-seed certification. Features include accreditation of seed producers, seed fields, seed certification, and seed data management. NASC staff have been trained to manage the NST system, and an e-certification unit was established using the ICT equipment funded by BASICS. Twenty-six fields have been registered using the NST.

The first module of seed producer accreditation was released in an official function held as part of the SeedConnect Africa event on 15 April 2019 in Abuja, in the presence of the NASC board of trustees and the Federal Ministry of Agriculture and Rural Development (Figure 5.14). Efforts have been continued to enhance Seed Tracker features to fit NASC's seed certification services. This is a significant outcome of the project, whereby the national regulatory body has adopted an ICT tool to enhance and make its seed certification process more effective and efficient. A dedicated Seed Tracker Control room was established at NASC's HQ in Sheda to manage e-seed certification operations of NASC. This was commissioned in an event held on 21 February 2020.

Figure 5.14. Launching of NST by NASC during Seed Connect event held in Abuja.

5.2.2.4 CST application beyond BASICS

The CST is finding widespread usage, including the examples listed below:

- CST has been adapted for GoSeed production and inventory management; similar efforts will be made for other programs.
- Seed Tracker was adopted by the BEST Cassava project in Tanzania and promoted for use by e-certification by TOSCI. The program, piloted in 2019, currently hosts 147 seed field records with e-certification data.
- Seed Tracker was adopted for monitoring and evaluation by the BEST Cassava project to track seed flow from BS to certified seed level, including input costs and sale inventory for cost-benefit analysis.
- Seed Tracker was adopted for RENIVA Cassava Seed System project of EMBRAPA in Brazil, and the program was piloted in November 2019.
- IITA's CST team championed the launching of "IITA Digital Services" on the 1 November to connect Seed Tracker, Akilimo, GoSeed Tracker, Herbicide Calculator, and other apps for the cassava value chain.
- The Seed Tracker platform was used to develop Cassava Business Connector for connecting seed producers to root producers, processors, and other end users. The program has been piloted for use in West Africa by the AfDB TAAT project in August 2019.
- Seed Tracker is part of the 12 tools (methods, models approach, and ICTs) of the RTB Seed Toolbox aimed at understanding and supporting seed system development.
- ISSD (Netherlands) funding (2019–2022) was received to study advantages of Seed Tracker compared with conventional system in Nigeria and Tanzania.

5.2.3 Use of third-party CS certification service providers

The seed industry in Nigeria has evolved to be a central force in the West Africa seed industry, controlling about 70% of the seed used in the region. The Nigerian seed industry evolved from a single seed company in 1975 to 314 by 2019, with more companies awaiting approval by the governing board of NASC. The upsurge of seed companies in Nigeria has resulted in increased seed certification (seed field inspection, supervision of postharvest operations such as seed processing, drawing of samples for laboratory testing, and related regulatory tasks). As the seed sector grows, NASC must increase its seed certification capacity, to protect Nigeria from fraudulent practice that would undermine the prosperity and longevity of a CS sector.

Until the SCSS and BASICS projects, cassava seed fields were not certified by NASC. Nor did they demand attention from the seed inspectors, who devoted their time and resources to certify grain crops, mainly rice and maize. NASC now has to inspect hundreds of certification units of cassava—expected to grow into thousands per year in the coming years—besides the added demand to certify other vegetatively propagated crops. Some innovative increase of NASC capacities and reach is needed, while maintaining standards and keeping certification costs low (or lower).

On the basis of powers inherent in Seed Act 21 LFN 2019, Nigeria is joining other nations to decentralize seed certification by authorizing private entities to complement NASC. Guidelines must be developed. A draft document has been prepared in line with OECD guidelines for the Authorization of Third-Party Seed Inspection Organization. The licensed seed inspectors (LSIs, or third-party inspectors) were piloted for the first time in Nigeria during the 2019 cassava planting. The pilot was led by CRS in Benue state, with Fera and NASC.

5.2.3.1 Concept of third-party inspection agents

The general objective of NASC-authorized LSI is to further strengthen the Nigerian seed system through partnership with private seed certification agents. By outsourcing the certification of CS, third-party inspection scales up the capacity of NASC to certify, increasing the number of CS production fields. The private third-party inspectors are properly trained only to certify CS, in the same manner as NASC inspectors.

The private seed certification guidelines define the required qualifications of the candidates who will be selected, trained, and accepted by NASC as LSIs, to carry out their tasks under the close supervision of NASC.

5.2.3.2 Report on first pilot in Nigeria

Eighteen private seed inspectors were selected to become LSIs, then trained and deployed by NASC to inspect the seed plots of VSEs managed by CRS. The first evaluation of the pilot program was held in Makurdi, Benue state, on 10 March 2020, in collaboration with CRS and the PMU of the BASICS project.

A focus group discussion was used to capture the perceptions of the LSIs, VSEs, and the NASC mentors on the workings, challenges, and suggestions for future success of the program. A structured questionnaire was also used to elicit information from the participants to gauge their challenges, strong points, and suggested changes for improving the strategy. The private seed certification is still being refined, but a summary from this workshop is given in the box below.

Feedback from the LSIs during the learning workshop, March 2020

What went well:

- NASC officers were detailed in their trainings of the LSIs, and the shadowing exercise provided a good exposure to the LSIs as to the work involved.
- The seed fields were already uploaded on the tracker and it made inspection easier.
- VSEs were accommodating and favorably disposed to the new arrangement. This bodes well for future expansion of the program.
- NASC ground staff saw the LSI intervention as a big relief on their choked certification schedule.

What did not go well:

- The LSIs demanded higher payment, safety kits, insurance, identification tags, transportation, and others. All these issues need a balanced approach to keep them interested while not increasing the final cost to the seed producers.
- There was a lack of coordination for report format and time frames.
- The LSIs were not evenly distributed across the locations.
- There were still some knowledge gaps among the LSIs on varietal/disease identification.

Way forward

- Well-planned capacity building and handholding are needed to make LSIs fully prepared.
- Security of LSIs should be worked out by NASC and CRS.
- Means of identification and protective gear for LSIs must be provided immediately.
- Payment timing, format, and amount must be well spelled out and not delayed.
- Provision of transport support for LSIs should be investigated (motorbikes seem to be the most preferable means of transportation) and how it will be costed.
- Reporting templates should be harmonized, and quality regulation ensured.

5.3 Lessons learned

- Seed quality regulation is important to maintain the integrity of the system. It enhances stakeholder confidence in the system, which is key for its sustainable operation. The QSC under BASICS laid some key building blocks in the seed regulatory regime and raised the profile of certified seed in the cassava community.
- BASICS has decisively increased the aspiration and capacity of NASC as a regulatory body. The establishment of the seed diagnostic lab, capacity building of NASC staff to handle various regulatory activities, development of seed certification protocols for cassava, piloting of CST, and third-party certification have all improved the profile of cassava at NASC.
- Surveys with cassava stem buyers and VSEs have shown that they value a NASC seed quality certificate. However, the monetary value of this still needs to be worked out, to keep seed producers incentivized yet not make the regulated seed producers uncompetitive compared with the unregulated ones, while weaning the seed system from extraneous project support.
- Meticulous data collection and more experimentation are needed to work out the most appropriate, market-friendly and yet scientifically robust seed certification protocols.
- E-certification using the NST makes certification by NASC much more efficient and effective, yet more training of VSEs is required to ensure that data are uploaded.

- CST can be used to help inform the seed market and improve transactions between seed value chain players.
- The technical capability of the Seed Tracker has been amply demonstrated, but the next steps in sustainable adoption include its mandatory use for seed certification as well as further enhancing user experience through improvements in the platform's user interface and its utility to all stakeholders. A change from the conventional system to digital systems in NASC will also require CST to be internalized in the stakeholders' daily operations.
- Third-party certification looks promising. Farmers are accepting it and the LSIs who shadowed the NASC inspectors as a part of the training have shown interest in continuing and expanding the work. However, more pilots need to be carried out to tease out issues of feasibility, effectiveness, and affordability.

2. Geographic Areas to Be Served

Provide the final list of countries and sub-regions/states that have benefitted from this work and associated dollar amounts. If areas to be served include the United States, indicate city and state. Add more rows as needed. More information about Geographic Areas to Be Served can be found here.

Location	Foundation Funding (U.S.$)
Nigeria: districts of Oyo, Ogun, Osun, Kwara, Abuja, Cross Rivers, Akwa Ibom, Imo, Abia, Benue, Anambra, Niger, and Eketi	11,611,993

3. Geographic Location of Work

Provide the final list of countries and sub-regions/states where this work has been performed and associated dollar amounts. If location of work includes the United States, indicate city and state. Add more rows as needed. More information about Geographic Location of Work can be found here.

Location	Foundation Funding (U.S.$)
Nigeria	10,921,993
UK	690,000

4. Lessons Learned

Describe the top one to three takeaways or lessons learned from this project.

The BASICS project has been able to conclusively sow the seeds of a sustainable seed system. The following are three key lessons learned from the project implementation:

1. The demand side is critical for a sustainable seed system to get established and thrive. Owing to low virus load in Nigeria, the value proposition of certified seeds is more around access to true-to-type seeds of new, improved varieties and less around cleanliness of the seeds. Seed demand also emanated from farmers expanding their cassava fields and from processors wanting to source specific varieties. Seed system players that follow these value chains can hope to see greater success.

2. Slow and low rate of multiplication of cassava is a major bottleneck in both the scale-up of existing varieties and in the context of a newly released variety. BASICS successfully tested, adapted, and demonstrated the efficacy of SAH as a useful RMT. Further refinement of the process to improve its efficiency, unit cost reduction, and finding a niche application for it in the value chain are the areas for further work in future.

3. The gaps between the different seed classes was an impediment in establishment of the cassava seed system by making the supply system unreliable. BASICS established vehicles for reliable EGS supply and identified the need to support larger, community-clustered CS entrepreneurs. This needs to be further developed.

5. Feedback for the Foundation

Provide one to three ways the foundation successfully enabled your work during this project. Provide one to three ways the foundation can improve.

These were really helpful:

- Extensive engagement and encouragement by BMGF on various issues throughout the project period is highly appreciated and has helped the project team to deliver significantly in this difficult project. Many bold decisions were taken through the implementation period that has laid good foundation to build on; Nigeria is well on its way to fostering a sustainable seed system. The key push and budgetary adjustments allowed for the establishment of IITA (GoSeed) and NRCRI (Umudike Seeds). This should lead to a material shift in the way seed system was organized in Nigeria prior to BASICS.
- The convening in Seattle and the external evaluation have helped the project team identify areas that worked well, and also those needing further work and improvement.
- The guidance on collaborations coming from the Foundation's vantage position is helpful. BASICS started exploring collaborations with mission-aligned projects and institutions like AGRA.

Areas that can be considered for future:

- At the beginning of the project, the PMU wanted to draw lessons from previous efforts in this direction from across the countries. It was not easy to find. So, it may be useful to develop a policy to make project reports publicly available (minus the financial sections) on the lines of open access. This will help future projects. It may also help if the reporting template specifically forces every project team to identify areas of challenges and list down suggestions for future work, so this may provide some starting points for the next teams.
- It may be helpful to build in-country capacities if a suitable way of developing the next rung of project leadership drawn from the country of operation is developed as a part of deliberate strategy under each project. This will enhance sustainability of the project outcomes.
- Gender responsiveness was considered in the proposal and implementation by the implementing teams, considering the major role of women in growing and processing of cassava. However, BMGF had its eyes focused on sustainability of the seed system, so the gender focus was not high on the agenda. This could be an area for improvement, despite some good achievements during the project (e.g., in terms of assuring gender balance in recruitment of VSEs).

6. Global Access and Intellectual Property

If your funding agreement is subject to Intellectual Property Reporting, please click the following link to complete an Intellectual Property (IP) Report.

If not, please acknowledge by typing "N/A": ______

To delegate permissions to another member of your project team or for any questions regarding the Intellectual Property Report, please contact GlobalAccess@gatesfoundation.org.

7. Regulated Activities

Do you represent that all Regulated Activities[1] related to your project are in compliance with all applicable safety, regulatory, ethical and legal requirements? Please mark with an "X":

__X___ N/A (no Regulated Activities in project)

_____ Yes

_____ No (if no, please explain below)

1 Regulated Activities include but are not limited to: clinical trials; research involving human subjects; provision of diagnostic, prophylactic, medical or health services; experimental medicine; the use of human tissue, animals, radioactive isotopes, pathogenic organisms, genetically modified organisms, recombinant nucleic acids, Select Agents or Toxins (www.selectagents.gov), Dual Use technology (http://export.gov/regulation/eg_main_018229.asp), or any substance, organism, or material that is toxic or hazardous; as well as the approvals, records, data, specimens, and materials related to any of the forgoing.

8. Subgrants

If your grant agreement (not applicable to contracts) is subject to expenditure responsibility and permits you to make subgrants to organizations that are not U.S. public charities or government agencies/instrumentalities, please complete the Subgrantee Checklist and attach a copy with this progress narrative for each such subgrantee.

Financial Update

The purpose of this section is to help the foundation understand how programmatic performance affects actual expenditures over the life of the investment.

Feel free to reach out to your foundation contact for support with these progress reporting requirements.

Note: Budget template and financial narrative instructions can be found here. If you are using an older version of the budget template, this information could be in a different location in your template.

1. Latest Period Variance:

"Latest period variance" compares expenditures that occurred in the reporting period against the most recent forecast. See "Financial Summary & Reporting" sheet in the foundation budget template for calculated variance (for example, column AD, starting on row 29 for period 1). Note that the allowable variance is defined in your grant agreement.

Latest Period Variance:

1. Did the project spend more-or-less than anticipated in comparison to the most recent forecast? Please explain the primary drivers and their causes of the overall variance for the latest period (for example – programmatic changes, delays in recruitment).
2. Please provide a detailed explanation for any expense category in which the variance was greater than 10%. This should include an explanation of programmatic decisions affecting expenditure amounts and/or how actual costs differed from prior assumptions.

Consolidated Summary: Year 4 & NCE Period.

The summary for Year 4 & NCE implementation status is as shown below. The total forecast during this period was $4,605,143 against a total expenditure of $4,596,032. This resulted to 99.8% implementation rate with an underutilization variance of 0.2%.

Category	Forecast (Year 4&NCE Period)	Total Executed	Burn Rate	Budget Variance	% Variance
IITA	1,654,675	1,654,675	100.0	-	-
CRS	1,105,858	1,105,858	100.0	-	-
CGD	618,664	605,291	97.8	13,373	2.2
FERA Science Limited	93,808	93,808	-	-	-
PMU - RTB	651,106	645,732	99.2	5,374	0.8
Indirect cost	481,032	490,670	102.0	(9,638)	(2.0)
Grand Total	**4,605,143**	**4,596,032**	**99.8**	**9,110**	**0.2**

Consolidated Summary: Project life Period.

The cumulative project expenditure for the whole project life was $11,602,883 against a total budget of $11,611,993 resulting to an overall burn rate of 99.9% with an underutilization variance of 0.1% as shown below: -

Category	Total Approved Budget	Total Executed	Burn Rate	Budget Variance	% Variance
IITA	3,391,360	3,391,360	100.0	-	-
CRS	2,688,030	2,688,030	100.0	-	-
CGD	1,799,308	1,785,935	99.3	13,373	0.7
FERA Science Limited	690,000	690,000	100.0	-	-
PMU - RTB	1,771,220	1,765,846	99.7	5,374	0.3
Indirect cost	1,272,075	1,281,713	100.8	(9,638)	(0.8)
Grand Total	**11,611,993**	**11,602,883**	**99.9**	**9,110**	**0.1**

IITA - BS component: Detailed Summary: Year 4 & NCE Period.

During this period, IITA managed to implement all the activities including the purchase of two trucks with approval from BMGF for use in phase II of basics project. IITA reported a nil overall variance with minor variances within the allowed limit of 10% in between budget categories, as shown in the summary below: -

Category	Forecast (Year 4 & NCE Period)	Total Executed	Burn Rate	Budget Variance	% Variance
Personnel	197,203	195,855	99.3	1,348	0.7
Travel	30,549	29,268	95.8	1,281	4.2
Consultants	240,151	240,151	100.0	0	0.0
Capital Equipment	180,000	183,255	101.8	(3,255)	(1.8)
Other Direct Costs	314,057	313,361	99.8	696	0.2
Sub-awards	552,929	552,987	100.0	(58)	(0.0)
Indirect cost	139,786	139,797	100.0	(11)	(0.0)
Grand Total	**1,654,675**	**1,654,675**	**100.0**	**-**	**-**

IITA - BS component: Project life Period.

IITA total burn rate for the whole project life was 100% with a nil overall variance. IITA implemented all the activities during the project life according to the agreed plans and deliverables including the donor-approved project changes for the establishment of GoSeed and Umudike Seeds and consultancy for NRCRI. The summary below is the status of implementation during the project life: -

Category	Total Approved Budget	Total Executed	Burn Rate	Budget Variance	% Variance
Personnel	472,012	470,664	100	1,348	0
Travel	96,610	95,329	99	1,281	1
Consultants	279,998	279,998	100	0	0
Capital Equipment	209,216	212,471	102	(3,255)	(2)
Other Direct Costs	728,407	727,712	100	695	0
Sub-awards	1,309,151	1,309,209	100	(58)	(0)
Indirect cost	295,965	295,976	100	(11)	(0)
Grand Total	**3,391,359**	**3,391,360**	**100**	**-**	**-**

CRS: VSE component: Detailed Summary: Year 4 & NCE Period.

The total burn rate for CRS during this period was 100% with a nil overall variance. CRS has both positive and negative variances beyond the required limit of 10% on personnel, Travel, Consultants and subawards budget categories.

On personnel, the project manager left the services of the organization before the end of the project which led to underutilization of this budget line. The variance on the travel budget line was majorly affected by travel restrictions due to COVID–19.

The consultants budget category which is overutilized by 21%, was attributed to additional costs for the consultancy services engaged in regard to capacity strengthening for the VSEs Network in Benue state towards ensuring their sustainability beyond the project life as a result of a recommendation from the previous assessment and also as was advised by Lorretta Byrnes in her Evaluation report.

The sub-award line item was overspent because the subcontracts were extended for two more months beyond the earlier planned period. Below is a summary of CRS implementation status during this period: -

Category	Forecast (Year 4 & NCE Period)	Total Executed	Burn Rate	Budget Variance	% Variance
Personnel	388,069	315,501	81.3	72,568	18.7
Travel	80,173	63,373	79.0	16,800	21.0
Consultants	14,930	18,061	121.0	(3,131)	(21.0)
Capital Equipment	-	-	-	-	-
Other Direct Costs	170,603	187,106	109.7	(16,503)	(9.7)
Sub-awards	331,122	383,780	115.9	(52,658)	(15.9)
Indirect cost	120,961	138,034	114.1	(17,073)	(14.1)
Grand Total	**1,105,858**	**1,105,858**	**100.0**	**-**	**-**

CRS: VSE component: Project life Period.

CRS utilized all the funds according to the approved budget during the project life with an overall burn rate of 100%. The variance on all the categories are below the allowable limit of 10% except for consultant category of 12.8% variance beyond the budget which occurred in the last period of the project as explained above. The summary for the whole project period is tabulated below: -

Category	Total Approved Budget	Total Executed	Burn Rate	Budget Variance	% Variance
Personnel	883,588	811,019	91.8	72,569	8.2
Travel	215,213	198,413	92.2	16,800	7.8
Consultants	24,395	27,526	112.8	(3,131)	(12.8)
Capital Equipment	32,798	32,798	100.0	-	-
Other Direct Costs	377,307	393,810	104.4	(16,503)	(4.4)
Sub-awards	801,507	854,166	106.6	(52,659)	(6.6)
Indirect cost	353,222	370,296	104.8	(17,074)	(4.8)
Grand Total	**2,688,030**	**2,688,030**	**100.0**	**-**	**-**

CGD: PLM component Detailed Summary: Year 4 & NCE Period

Context managed an overall burn rate of 97.8% with an overall underutilization variance of 2.2% during this period. All the variances on the budget categories were kept within the allowable limit of 10% as indicated in the summary below:

Category	Forecast (Year 4 & NCE Period)	Total Executed	Burn Rate	Budget Variance	Variance
Personnel	159,873	159,273	99.6	600	0.4
Travel	49,028	47,003	95.9	2,025	4.1
Consultants	306,619	298,708	97.4	7,911	2.6
Capital Equipment	-	-	-	-	-
Other Direct Costs	22,518	21,356	94.8	1,162	5.2
Sub-awards	-	-	-	-	-
Indirect cost	80,626	78,951	97.9	1,675	2.1
Grand Total	**618,664**	**605,291**	**97.8**	**13,373**	**2.2**

CGD: PLM component Project life Period.

In overall, Context managed an implementation rate of 99.3% with an underutilization of 0.7% variance. Context managed to achieve their programmatic performance target as planned. The summary below shows the implantation status for context for the whole project life: -

Category	Total Approved Budget	Total Executed	Burn Rate	Budget Variance	% Variance
Personnel	385,358	384,758	99.8	600	0.2
Travel	195,678	193,653	99.0	2,025	1.0
Consultants	910,573	902,662	99.1	7,911	0.9
Capital Equipment	-	-	-	-	-
Other Direct Costs	73,076	71,914	98.4	1,162	1.6
Sub-awards	-	-	-	-	-
Indirect cost	234,623	232,948	99.3	1,675	0.7
Grand Total	**1,799,308**	**1,785,935**	**99.3**	**13,373**	**0.7**

FERA: Quality seed component: Detailed Summary: Year 4 & NCE Period.

During the last period of the project, FERA achieved a burn rate of 100% with minimal variances within the budget lines as shown below: -

Category	Forecast (Year 4 & NCE Period)	Total Executed	Burn Rate	Budget Variance	% Variance
Personnel	61,808	61,783	100.0	25	0.0
Travel	17,075	16,653	97.5	422	2.5
Consultants	-	-	-	-	-
Capital Equipment	-	-	-	-	-
Other Direct Costs	14,925	15,372	103.0	(447)	(3.0)
Sub-awards	-	-	-	-	-
Indirect cost	-	-	-	-	-
Grand Total	**93,808**	**93,808**	**100.0**	**-**	**-**

FERA: Quality seed component: Project life Period.

FERA used all the funds as per the approved budget with a burn rate of 100% during the whole life of the project. All the programmatic performance plans were effectively delivered. A summary of FERAs implantation status is indicated below: -

Category	Total Approved Budget	Total Executed	Burn Rate	Budget Variance	% Variance
Personnel	333,022	332,997	100	25	0
Travel	94,674	94,252	100	422	0
Consultants	-	-	-	-	-
Capital Equipment	105,241	105,241	100	-	-
Other Direct Costs	157,063	157,510	100	(447)	(0)
Sub-awards	-	-	-	-	-
Indirect cost	-	-	-	-	-
Grand Total	**690,000**	**690,000**	**100**	**-**	**-**

PMU-RTB: Detailed Summary: Year 4 & NCE Period.

PMU has an overall expenditure rate of 99.8% with an overall overutilization variance of 0.2%. This was attributed mainly by the budget lines of personnel, travel, consultants and other direct costs.

The activities under the budget lines of travel, consultants and other direct costs were impacted by COVID–19 related travel restrictions.

The variance on personnel was attributed to more time which was dedicated to the project by the project team during the close out period. A summary of the implementation status is as presented below: -

Category	Forecast (Year 4&NCE Period)	Total Executed	Burn Rate	Budget Variance	% Variance
Personnel	389,231	424,829	109.1	(35,598)	(9.1)
Travel	85,000	70,911	83.4	14,089	16.6
Consultants	40,000	29,526	73.8	10,474	26.2
Capital Equipment	-	-	-	-	-
Other Direct Costs	136,875	120,466	88.0	16,409	12.0
Sub-awards	3,473,004	3,459,631	99.6	13,373	-
Indirect cost	481,032	490,670	102.0	(9,638)	(2.0)
Grand Total	**4,605,143**	**4,596,032**	**99.8**	**9,110**	**0.2**

PMU-RTB: Project life Period.

In overall, PMU managed an overall expenditure burn rate of 99.9% with a variance of 0.1% during the whole project life. All the project activities were implemented as planned.

The main drivers for the overall variance as reported in the summary below arose during the last project period as highlighted above.

Category	Total Approved Budget	Total Executed	Burn Rate	Budget Variance	% Variance
Personnel	1,078,016	1,113,614	103.3	(35,598)	(3.3)
Travel	182,988	168,899	92.3	14,089	7.7
Consultants	97,393	86,919	89.2	10,474	10.8
Capital Equipment	46,816	46,816	100.0	0	0.0
Other Direct Costs	366,007	349,598	95.5	16,409	4.5
Sub-awards	8,568,698	8,555,325	99.8	13,373	0.2
Indirect cost	1,272,075	1,281,713	100.8	(9,638)	(0.8)
Grand Total	**11,611,993**	**11,602,883**	**99.9**	**9,110**	**0.1**

In conclusion, BASICS project successfully implemented the agreed plans as well as some new plans during the period with due approval from the donor. All the key deliverables were achieved within the approved budget.

2. Sub-awards (if applicable)

This sub-award section provides visibility to an often critical component of the grant spending where the budget template provides limited insight. The total of actual disbursements for this reporting period should equal the actual sub-award expenses reported on the "Financial Summary & Reporting" sheet in the budget template for this reporting period.

Use the table below to provide the detail of all sub-grantee(s) or subcontractor(s).

Organization Name	Actual Disbursement for this Reporting Period (U.S.$)	Total Disbursed from Primary Awardee to Sub to Date (U.S.$)	Total Sub-Awardee Spent to Date (U.S.$)	Total Contracted Amount (U.S.$)
CGD	569,878	1,785,935	1,785,935	1,799,308
Fera Science Ltd	184,169	690,000	690,000	690,000
IITA	1,316,311	3,391,360	3,391,360	3,391,360
CRS	1,067,400	2,688,030	2,688,030	2,688,030

- Last disbursement is underway.

For sub-awards greater than $1M, please provide explanatory detail as requested in the latest and future period sections above.

Note: It is the foundation's discretion to ask for updated sub-award budget files as part of the traditional progress report review process.

3. Other Sources of Support (if applicable):

Other Sources of Support include interest earned, current foreign exchange impacts, and co-funding (in-kind and other contributions).

Other Sources of Support (if applicable): Explain any notable impacts from other sources of support.

The total interests earned during the life of the project amounted to $6,966.55. These funds were not put into use until the end of the project life. A summary of interest earned during the life of the project is as summarized below: -

Revenue	Period 1	Period 2	Period 3	Period 4	Period 5 (NCE)	Total
Interest Earned	$2,288	$1,819	$1,185	$1,509.41	$164.14	**6,965.55**

Checklist - As you review your answers to questions in the financial update section, ensure that your report provides the following:

1. Explanation of how project expenditures differed from plan and the implications on programmatic progress to date.
2. Explanation of how future period projections differ from the original budget and previous forecasts, and the implications.
3. Explanation of other sources of support (funds) from other funders, interest earned or converting to non-USD currencies.

For Foundation Staff to Complete

Analysis (required if PO assessment differs from grantee/vendor assessment or if there are unexpended funds)

Progress Analysis

Include analysis of significant project variances and key learnings that may inform portfolio discussions for progress against the strategic goals.

Budget and Financial Analysis

Include analysis of unexpended funds or over expenditures. Refer to the Unexpended Grant Funds Policy for options available when recommending how to handle unexpended grant funds, or reach out to your primary contact in GCM.