NEXTGEN CASSAVA

Impact Report

NEXTGEN CASSAVA

NEXTGEN'S MISSION

Empowering smallholder farmers through innovative, sustainable cassava breeding.

NEXTGEN'S VISION

Connecting cutting-edge crop science to farmers, processors and consumers to deliver on cassava's enormous promise for African farmers and consumers with a new model for deploying advanced crop science to solve practical problems.

The Next Generation Cassava Breeding Project (NextGen) is blending advanced breeding technologies with equally sophisticated approaches to gathering market intelligence to serve a single purpose: meeting the everyday needs of millions of Africans growing, processing, cooking and eating cassava—the continent's second most important food crop.

NextGen was launched in 2012 as a partnership between Cornell University and the Nigeria-based International Institute of Tropical Agriculture (IITA, part of the CGIAR global consortium of agricultural research centers). Collaborators also include a number of national agricultural research systems (NARS): the National Root Crops Research Institute (NRCRI) in Nigeria; the National Crops Resources Research Institute in Uganda (NaCRRI); the Tanzania Agricultural Research Institute (TARI); the Brazilian Agricultural Research Corporation (Embrapa); and CGIAR's International Centre for Tropical Agriculture (CIAT), based in Colombia.

NextGen has employed a powerful assortment of advanced breeding tools to efficiently produce new, elite varieties of cassava that provide higher yields, superior disease resistance and preferred end-user characteristics. They are now growing in farmers' fields across the continent where the cassava they generate is easier to process and cook, a big plus for a continent where cassava is equally loved in households rich and poor. Equally important is the potential role of NextGen cassava varieties for opening up commercial opportunities for smallholder cassava producers by meeting both food demands and a growing assortment of non-food uses, which include ethanol, cardboard, pharmaceuticals and adhesives. For decades, a lack of good planting materials that reliably generate ample harvests of high-quality cassava has made

it difficult for African farmers to earn income from this crop.

The cassava developed by NextGen was met with high demand from local farmers because the project has combined cutting-edge breeding tools with new approaches to illuminating farmer preferences. These insights revealed distinctly different cassava preferences based on region, gender and economic status. With this seamless mix of crop science with social science, and of genomic intelligence with market intelligence, NextGen is providing a new model for successful crop improvement programs targeting smallholder producers in low-income countries.

NextGen's achievements to date are just a preview of its future success. Its advances in cassava breeding and market intelligence are now being extended across the continent via community of practice partnerships with national crop breeding programs. And it's attracting international collaborations with partners in Thailand, Cambodia, South America and the Pacific Islands.

"In a world facing new challenges to food security from climate change, it's critical to maintain and extend this cohesive and uniquely effective initiative that is finally giving cassava the attention it deserves," said Ronnie Coffman, director of International Programs in the College of Agriculture and Life Sciences at Cornell and principal investigator for NextGen. "For farmers and consumers across Africa, cassava is a popular, hardy, naturally climate-smart food crop that has been perennially long on potential but short on investment. Through the work of NextGen, cassava's moment has arrived—and at a time when its many attributes are urgently needed."

WHAT'S IN A NAME?

How farmer inclusion is expressed in NextGen cassava varieties

NextGen is known for its embrace of advanced crop science and breeding. But its success is equally grounded in its understanding of farmer preferences. Extensive household surveys have captured differences by region, gender and economic status, and the insights informed the project's breeding priorities. Most notably, farmers have imprinted their influence in the names they have selected for NextGen's new cassava varieties. These include:

'Game Changer' and 'Obasanjo-2'
These new varieties were developed for processing purposes due to their highly stable starches and dry-matter content. Gamechanger got its name because it outperformed a variety farmers believed would never be beaten. Obasanjo was named in honor of the toughness attributed to the 85-year-old former Nigerian President Olusegun Obasanjo.

'Hope' and 'Baba-70'
These varieties were developed for producing cassava well-suited for making excellent gari (a ground, cereal-like cassava product) and fufu (a doughy dumpling) common in many West African dishes. Hope was named for inspiring hope during the COVID-19 pandemic, and Baba 70 carries the nickname for the late and beloved Nigerian music artist Fela Kuti.

'Poundable'
This variety was developed for farmers who value cassava that can be cooked fresh. It has roots that have a mealy, malleable quality like that of yams. Farmers called it "poundable" because the roots can be easily prepared or pounded so they will develop a pleasing texture and taste when boiled.

NextGen's Impact

NextGen experts have radically transformed cassava breeding practices across sub-Saharan Africa and beyond. Their methods now serve as a model for other crops, as their approach works faster and smarter to produce better varieties.

Development and deployment of five advanced cassava varieties in record time:
NextGen embraced an array of breeding innovations to reduce the time previously required to complete a breeding cycle from ten to just two years, allowing new varieties to be developed more rapidly. NextGen varieties include cassava that offers better yields and stronger disease resistance, along with traits farmers, consumers and food commercial buyers prefer, like enhanced cooking and processing qualities.

Cultivating a new digital ecosystem for cassava breeders:
NextGen has developed a global repository of cassava intelligence with CassavaBase. This open-access, online platform now hosts 1,200+ users. With CassavaBase, scientists across the globe can explore the results of 2,700 cassava breeding trials and probe the many aspects of cassava's genetic diversity through a database that has catalogued some 11.2 million cassava genetic data points. For the first time ever, it's possible to compare trial results and trait performances across cassava breeding programs.

Energizing cassava work in national programs:
NextGen and its CGIAR partners have collaborated with National Agricultural Research Systems (NARS) in Nigeria, Uganda and Tanzania and embedded with others via community of practice (CoP) partnerships. Through this work, NextGen is supporting the teams, technologies, processes and practices that make advanced crop breeding accessible to low- and middle-income countries. For example, the CoP partnerships are elevating cassava improvement in Côte d'Ivoire, the Democratic Republic of Congo, Ghana, Kenya, Mozambique, Sierra Leone and Zambia.

Re-imagining the crop improvement community:
NextGen is expanding the community of experts involved in crop breeding to include social scientists, data scientists, food scientists and gender experts—and giving everyone's input equal value. For example, NextGen has deployed advanced tools for generating and analyzing data from multiple sources to develop sophisticated customer profiles of cassava farmers. This market intelligence has revealed a surprising diversity of trait preferences -- between men and women and across different regions, as well as among households with different levels of income and food security.

NEXTGEN CASSAVA CRACKS THE CODE

...of Cassava Plants and Cassava Farmers

NextGen was born from a belief that a new model was needed to fulfill cassava's enormous potential as the world's most versatile climate-smart crop—one capable of increasing food security and reducing poverty even in stressful growing conditions.

The project was initially notable for being the first large-scale effort to employ a new generation of genomic tools and breeding technologies to improve African cassava production. It's now equally renowned for employing advances in market research, data analysis, gender expertise and food science early in the breeding cycle to ensure that what comes out of research programs is aligned with sub-Saharan Africa's rich mosaic of cassava preferences.

NextGen is showing that tools commonly used in the world of consumer products—which generate sophisticated market intelligence, detailed customer profiles and compelling branding—can be enormously valuable for tapping the power of advanced crop breeding to achieve critical development goals. Those goals include reducing poverty and malnutrition; helping vulnerable communities adapt to climate change; promoting sustainable food systems; and empowering women with economic opportunities.

This seamless blend of insights, where exciting advances in crop breeding are combined with equally sophisticated tools and processes for understanding farmer preferences, is what sets NextGen apart.

The following sections take a closer look at NextGen's powerful integration of crop science with market intelligence.

NEXTGEN USHERS IN A

New Era of Cassava Breeding

Today, cassava is cultivated on millions of smallholder farms across sub-Saharan Africa and consumed daily in a wide range of African dishes. This versatile food crop can be harvested and boiled fresh or dried and processed into flour or cassava chips. Cassava is also increasingly in demand for a variety of industrial processes, including those used for pharmaceutical products and biodegradable plastics.

But until NextGen was formed, cassava breeding had not received the level of investments and attention on par with breeding work devoted to African staple crops like maize. NextGen is making up for this gap by adopting a proven suite of advanced tools to rapidly deliver a wide range of competitive cassava varieties. These approaches include:

Using genomic selection to identify ideal breeding stock:
NextGen scientists and plant breeders have used advanced crop screening technologies to develop genetic fingerprints or "markers" linked to qualities such as disease resistance, starch quality and higher levels of vitamin A. This information has been used to rapidly scan the genomes of thousands of cassava varieties to more efficiently identify promising individuals and quickly detect evidence of beneficial traits in their offspring.

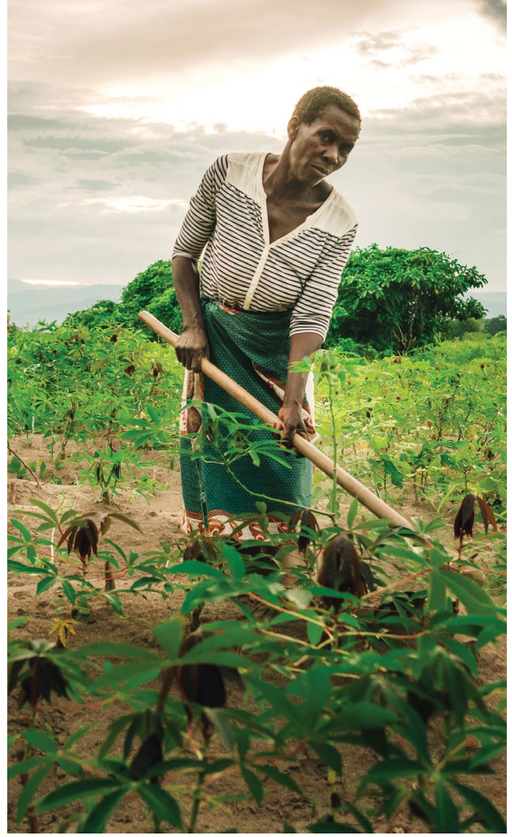
Deploying new, highly efficient phenotyping tools:
NextGen has been testing and deploying new tools such as near-infrared spectroscopy (NIRS) and ground-penetrating radar (GPR) to enable breeders to more rapidly and efficiently assess different qualities of new cassava varieties, technically known as "phenotyping." With these tools, crop breeders can quickly assess a high number of roots, even though they are already deep in the field, for food qualities and other key traits.

Flowering innovations:
Many important cassava varieties do not flower at all under natural field conditions, which slows down breeding work. NextGen scientists have developed methods to encourage flowering, including something called photoperiod manipulation, along with pruning practices and plant growth regulators. These methods can produce up to 15

times as much fruit and seed, which allows cassava breeders to generate many more progenies from their "crosses" of two cassava varieties.

Using advances in hydroponics to produce planting material:
Like other root crops such as yams or potatoes, farmers cultivate cassava from a piece of a cassava plant or "cutting," as opposed to a seed. Developing enough planting material to meet demand can be a bottleneck for replacing old varieties with improved ones. NextGen partners at IITA found a solution by adopting and scaling up a greenhouse method called semi-autotrophic hydroponics (developed by the U.S. crop science company SAHTECNO) that can produce 10 times or more seedlings than previous methods.

Breeding (and pre-breeding) for viral disease resistance:
Viruses that cause cassava brown streak disease (CBSD) and cassava mosaic disease (CMD) continue to devastate crops in East Africa. Continuous movement of germplasm and pathogens make further epidemics inevitable. To reduce the impact of outbreaks, NextGen has identified genetic sources of resistance and is introducing these "defender genes" into local cassava varieties in East Africa and also pre-emptively in West Africa.



CONFRONTING A CLIMATE CRISIS WITH CASSAVA

In Africa, the climate crisis is impacting all aspects of life--but especially agriculture. A surge of extreme weather events, abrupt shifts in precipitation patterns and steadily rising temperatures have diminished crop production and disrupted food systems. The effects of climate change are particularly challenging for vulnerable populations, such as women in households with low incomes.

While food staples like maize are under enormous stress, cassava stands apart for its natural ability to thrive in hot, dry conditions and poor soils. And while cassava may be unfamiliar to consumers in many parts of the world, it's already regularly consumed by 700 million Africans in dishes such as the cereal-like gari, doughy fufu, or via freshly boiled or roasted cassava roots.

The combination of toughness, consumer popularity and rapidly expanding market opportunities—which now include a wide range of industrial uses—has made cassava an ideal sustainable, climate-smart crop that can generate income for hundreds of millions of Africans who depend on farming to support their families.

Just because it's tough does not mean cassava is invincible. For example, the spread of devastating plant diseases—such as those caused by cassava mosaic and brown streak viruses—may be accelerated by climate change. The challenge is prompting NextGen scientists to focus on new approaches to developing disease-resistant varieties. Cassava also does not meet the full range of dietary needs, so NextGen scientists also have a partnered with other agriculture initiatives, such as HarvestPlus, to develop more nutritious varieties, such as those that offer higher levels of vitamin A.

But there is no question that cassava has attributes that give it a clear head start for becoming a cornerstone of developing more resilient farms and food systems across sub-Saharan Africa.

Smarter Cassava Breeding

USING MARKET INTELLIGENCE TOOLS TO UNDERSTAND FARMER PREFERENCE

At the start of the NextGen initiative, scientists were eager to unlock the genetic potential of cassava. But they were equally committed to exploring the preferences of people growing cassava. They wanted assurances that their advanced breeding tools would be applied to developing cassava varieties that would be rapidly adopted by African farmers. So, they applied the same level of scientific innovation and objective analysis to understanding farmer preferences that they were applying to understanding cassava genomics.

NextGen experts have employed a wide variety of tools in their effort to map the preferences of cassava farmers. For example:

- They used a software platform called 1000minds to conduct surveys in which men and women farmers were asked to rate their preferences for variables such as yield, color, food quality and hardiness. To further understand how individuals within households differ in their preferences, husbands and wives were surveyed separately and then together. In doing so, NextGen social scientists were able to capture both gender differences in cassava preferences and elements of the household decision-making processes.
- These insights were combined with additional data from a survey known as RHoMIS—the Rural Household Multi-Indicator Survey—which allowed the NextGen team to further segment cassava preferences with information on household food security status and income levels, in addition to the location and gender of the respondent.

Data on household preferences were triangulated with field studies to ensure that what farmers were saying in the surveys matched what they were cultivating in the field. It all came together to give NextGen breeders a highly nuanced view of the types of cassava they should be developing.

Overall a complex picture emerged. Cassava preferences differed between men and women, and notably, by region. Moreover, cassava choices among women farmers diverged depending on their levels of income and food security. For example, food quality traits were more important for households that lacked food security. Gender differences between men and women also were more pronounced in these households. In addition, households headed by women prioritized quality traits more than those headed by couples.

This nuanced data demonstrates the importance of approaching African smallholder farmers as a highly diverse and very selective group of cassava growers. And for national cassava breeding programs, this type of intelligence can perform double duty. It offers insights they can use to increase demand for a wide range of cassava varieties, which can help justify a healthy program budget. It also ensures they are serving the needs of marginalized groups like women farmers and farmers supporting impoverished households. This is a potent example of how serving social justice goals can become integral to the overall success of a crop breeding program.

> *The foundation of a solid crop value chain is based on varieties that perform well in the field while meeting a wide range of farmer and consumer preferences. NextGen understands how to balance these goals, and that's why there's strong demand across Nigeria for its new generation of improved cassava varieties."*
>
> **ALHAJI MUHAMMAD SABO NANONO**
> Nigeria's former Minister of Agriculture and Rural Development

THE POWER OF DIVERSITY

NextGen believes that diversity offers resilience. Everyone's expertise has equal value.

Science doesn't solve problems if it stays on the shelf. Working far beyond crop breeding, NextGen teams include social scientists, data scientists, food scientists, seed producers, farmers, processors and policymakers. Their combined talents ensure the dividends of NextGen's work are accessible and in demand.

CROP SCIENTISTS

SOCIAL SCIENTISTS

DATA SCIENTISTS

FOOD SCIENTISTS

FARMERS

POLICYMAKERS

PROCESSORS

NextGen has come a long way, yet its work is just beginning. The project's inclusive, holistic approach to combining new advances in cassava breeding with breakthroughs in serving farmer preferences is starting to have an impact. Now is the time to build on this success by broadening and deepening the partnerships established by NextGen. That includes:

Maintaining progress across a constellation of cassava varieties:
Threats like cassava mosaic virus and brown streak disease are rapidly evolving. And while cassava is hardier than most crops, it is not immune to the surge of climate-related challenges occurring across Africa. It's critical for cassava breeders to keep employing advanced tools to probe large populations of cassava varieties for valuable genetic traits that can help farmers adapt—and understand more about how crop genetics interact with different farming conditions to determine cassava yields, starch quality and other outcomes.

Sustaining the positive trajectory of genetic gain:
NextGen breeders have achieved a commendable rate of genetic improvement. It's critical for cassava breeders to keep employing advanced tools to sustain this level of progress, thus guaranteeing continuous delivery of future varieties that will ensure farmers working under challenging conditions can meet the food demands of growing populations.

Improving tools for understanding farmer preferences:
Similarly, farmer preferences for particular cassava traits are not static. It's important to continue to deploy a wide array of market intelligence tools and gender research to ensure breeding work is responsive to the evolving preferences of smallholder farmers, processors and marketers. The needs of women and youth in particular must be considered, as both play a critical—and often overlooked—role in cassava production.

Expanding partnerships with national programs:
Partnerships offer leverage. The partnerships built by NextGen's community of practice must be nurtured to become sustainable. There is a unique opportunity now to accelerate their capabilities to apply advanced tools and technologies to their cassava breeding work. A growing interest in adopting market intelligence tools—and adding expertise in areas like gender and food science—can improve the relevance of national breeding programs and hence their accountability to the societies they serve.

Building a new global network of cassava partners:
There is a unique opportunity today to build a global brain trust of cassava experts that can elevate the value of cassava for farmers and food systems around the world. NextGen partners already include Brazil and Colombia, and there is considerable interest in collaborations with other cassava-producing areas, including Thailand, Cambodia and the Pacific Islands.

BUILDING CAPACITY THROUGH COMMUNITY OF PRACTICE PARTNERSHIPS

By 2050, scientists predict that the global agricultural sector will need to produce 70% more food to feed the world's population. But meeting these challenges will come down to local capabilities and especially local knowledge of what farmers and consumers want and the rapidly changing climate and ecological conditions where they produce their crops.

NextGen leaders understand that national crop breeding programs in Africa are the critical link. The initiative has featured a strong focus on community of practice partnerships to help them adopt the tools, skills and processes that can identify valuable genetic variations in local varieties and match those traits with farmers preferences. Partner countries include Côte d'Ivoire, the Democratic Republic of Congo, Ghana, Kenya, Mozambique, Sierra Leone and Zambia.

NextGen teams already have coordinated national efforts to use advanced genotyping tools to identify local cassava varieties with a potential to contribute to breeding efforts focused on improvements such as high levels of vitamin A, high-quality starches and resistance to cassava diseases. The work also focuses on data quality and analysis. Meanwhile, when the pandemic hit, the teams quickly pivoted to conducting trainings via virtual platforms.

The next step is to extend the work of the community of practice partnerships to help more national programs adopt the tools and processes developed by NextGen to identify farmer preferences—and ensure breeding programs are meeting those demands.

> *NextGen is just beginning to reveal the true potential of cassava."*

SPOTLIGHT ON

Chiedozie Egesi

When Chiedozie Egesi was first beginning to work with cassava as a plant scientist, he recalled hearing a colleague from outside of Africa note that cassava was mainly a source of food for poor families. Egesi, a native of Nigeria, was quick to correct.

"Everyone I knew growing up, from rich to poor, we ate cassava all the time," said Egesi, who serves as project director for NextGen and is also an adjunct professor of plant breeding at Cornell University. "You saw it everywhere."

Egesi also was keenly aware of cassava's benefit on a continent where most people work as smallholder farmers and the fate of their crops is tightly connected with their ability to support their families.

"Even my parents who were schoolteachers regularly cultivated yams, maize and melons and also cassava," he said. "And I remember there were years when the other crops did not do very well, but the cassava crop still produced a good harvest."

Egesi originally envisioned a future in medicine. Instead he earned a PhD in crop science, first working on yams before moving to cassava. He quickly developed a passion for this unique and often undervalued food crop. Egesi also has been a principal advocate for going beyond crop genetics and infusing breeding programs with a better understanding of farmer preferences.

"Cassava is an amazing crop, and I feel like with the work at NextGen we are just beginning to reveal its true potential," he said. "The next 10 years will be a critical time for advancing efforts to combat hunger and poverty, in Africa and around the world. I believe NextGen is in an ideal position to ensure cassava is a big part of the solution."

NEXTGEN FELLOWS: CULTIVATING A NEW CROP OF AFRICAN CASSAVA EXPERTS

With support from NextGen, dozens of young people have turned their passions into career pathways that will build capacity in Africa's agriculture breeding programs. NextGen Fellows have obtained advanced degrees from Cornell University's School of Integrative Plant Science, the West African Center for Crop Improvement (WACCI), a partnership between the University of Ghana and Cornell's College of Agriculture and Life Sciences, and Makerere University Regional Centre for Crop Improvement in Uganda. Equally important: of the 38 NextGen fellows, almost all have returned to work in their home countries, like these five PhD graduates:

Elohor Mercy Diebiru-Ojo (WACCI '17) is now a vegetative seed production expert at the International Institute of Tropical Agriculture (IITA) in Abuja. Her advances in cassava plant conservation via tissue culture and cryopreservation earned her selection as a fellow in the prestigious Norman E. Borlaug Leadership Enhancement in Agriculture Program (LEAP).

"After my PhD I returned to my home country to continue working on cassava, now geared to seed systems," said Elohor Mercy Diebiru-Ojo. ***"My experience as a NextGen fellow really helped me with my leadership and confidence levels, and I also acquired technical and interpersonal skills, important tools I am currently using to impact food security in my community."***

Lydia Ezenwaka Jiwuba (WACCI '18) is working with Nigeria's National Roots Crop Research Institute. An expert in genetic traits linked to green mite resistance, Jiwuba is drawn to cassava for its many uses, for foods like gari and fufu, and for livestock feed and bio-ethanol.

Ismail Kayondo (WACCI '18) is a post-doctoral fellow with the IITA breeding research team. He first became familiar with cassava growing up on a small farm in Uganda where he said his mother "always insisted on having cassava planted so we could be sure of food security and some income."

Paula Iragaba (Cornell '19) is a postdoc fellow with National Crops Resources Research Institute (NaCRRI) cassava breeding team in Uganda. Her doctoral work focused on understanding the social dynamics of food choices and analyzing the genetic background underpinning preferred cassava traits of smallholder farmers.

Alfred Ozimati (Cornell '18) is a postdoc fellow with NaCRRI cassava breeding team in Uganda where he is working on the integration of genomic selection into cassava breeding processes.

"Cassava is our daily food in Uganda," added Alfred Ozimati. ***"It's what we grew up with and what we still love."***

NEXTGEN'S

Timeline of Achievements

NEXTGEN CASSAVA

NOVEMBER 2012

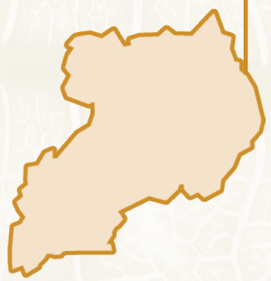
NextGen launches with support from the Bill & Melinda Gates Foundation and the Foreign, Commonwealth & Development Office (FCDO) of the United Kingdom.

MAY 2013

CassavaBase is launched--an open-access, online repository for information from cassava breeding trials.

JULY 2013

NextGen selects breeding parents using genomics, a first in cassava history, cutting the breeding cycle time from 10 to two years.



FEBRUARY 2015

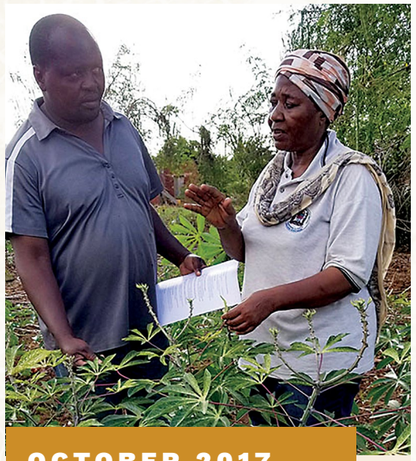
NextGen conducts its annual meeting in Uganda, bringing together dozens of cassava researchers from partner countries and beyond.

FEBRUARY 2016

NextGen successfully pilots Near-Infrared Spectroscopy (NIRS) to address the challenges of expensive food quality evaluation in cassava improvement.

JANUARY 2016

NextGen participates in the World Congress on Root and Tuber Crops (WCRTC) in Nanning, China.



OCTOBER 2017

NextGen launches first gender-responsive participatory variety selection (PVS) trials in Uganda, engaging both men and women farmers in identifying the top cassava varieties for Ugandan consumers and producers.

MAY 2017 – 2018

10+ PhD students graduated with support from NextGen, ensuring the future of cassava breeding will continue to excel in the hands of young African scientists.

APRIL 2018

Phase 2 launches with the addition of plant virus experts from the Leibniz Institute and a focus on producing varieties resistant to Cassava Brown Streak Disease. New partnership begins with CGIAR's Excellence in Breeding initiative. Community of Practice Partnerships launched to strengthen collaborations with national breeding programs.

FEBRUARY 2018

NextGen receives U.S.$35 million in new funding from the Bill & Melinda Gates Foundation and U.K. aid in the United Kingdom. Second five-year phase launched.

APRIL 2020

First product Advancement Workshop in West Africa with International Institute of Tropical Agriculture (IITA) and Nigeria's National Roots Crop Research Institute (NRCRI) provides a streamlined process for advancing and releasing NextGen cassava varieties.

OCTOBER 2019

NextGen Survey Division leader Hale Ann Tufan wins the Norman E. Borlaug Award for Field Research and Application for her gender-responsive approach to crop breeding.

DECEMBER 2020

Five new cassava varieties are approved for release—Game-Changer, Hope, Obasanjo-2, Baba-70 and Poundable—in Nigeria.

SEPTEMBER 2020

Due to the pandemic, NextGen conducts its annual meeting virtually. 130+ cassava researchers are in attendance from more than 18 countries.

MARCH 2021

Chiedozie Egesi earns the Fellowship Award from the Biotechnology Society of Nigeria for his efforts mentoring young scientists and developing biofortified foods for Nigeria.

AUGUST 2021

Chiedozie Egesi wins the Achiever in Agriculture Award in Nigeria for improving productivity, research and innovation in agriculture.

NEXTGEN'S PARTNERS

College of Agriculture and Life Sciences, Cornell University, USA

- Buckler Lab
- Global Development
- Jannink Lab
- Setter Lab

National Crops Resources Research Institute (NaCRRI), Uganda

National Root Crops Research Institute (NRCRI), Nigeria

International Institute of Tropical Agriculture (IITA), Nigeria

Tanzania Agricultural Research Institute (TARI), Tanzania

International Centre for Tropical Agriculture (CIAT), Colombia

Brazilian Agricultural Research Corporation (Embrapa), Brazil

Leibniz Institute DSMZ, Germany

Boyce Thompson Institute (BTI) for Plant Research, USA

University of Hawaii, USA

USDA Agricultural Research Service, USA

Makerere University Regional Center for Crop Improvement (MaRCCI), Uganda

West African Centre for Crop Improvement (WACCI), Ghana

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