



AFRICAN ORPHAN CROPS CONSORTIUM

MAY 2017 PROGRESS REPORT





African Orphan Crops Consortium, a NEPAD-led public-private partnership to empower African plant breeders and farmers.

An agroecological and genomics-based approach to ending malnutrition.

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BACKGROUND

Providing nutritious food and assuring food security for a growing world population is one of the key development challenges of our day. In sub-Saharan Africa, the challenges are particularly acute; some 233 million people are hungry and/or undernourished, according to a 2016 report by the UN Food and Agriculture Organization. Chronic undernourishment affects approximately 30% of the population. That level of hunger is one of the highest in the world. While the reasons for this are complex, they include widespread poverty, poor infrastructure and communications, diseases such as malaria and HIV and civil strife. As a result, the nourishment of a large percentage of African families is dependent principally on what they can grow themselves or buy locally.

The effects of malnutrition are well documented and include reduced muscle mass, decreased stamina, vitamin and mineral deficiencies that impair cognitive ability and more. In children under five years of age, a particularly pernicious effect of malnutrition is stunting – reduced height for age – which affects more than 25% of the world's children. In sub-Saharan Africa, the number skyrockets to 40%. Stunting is associated with poor brain development resulting in diminished mental ability, poor school performance and reduced earnings, while at the same time increasing the risk of chronic diseases including hypertension and diabetes. Eliminating stunting would boost developing countries' economies by USD 420 billion every year, according to the World Bank.

The African Orphan Crop Consortium (AOCC) is an African-led, international consortium founded in 2011 with the goal of sequencing 101 African “orphan crops” – species little studied by science but that have the potential of being of economic or nutritional importance to Africa – and training African plant scientists to, through this knowledge, improve the varieties in terms of nutrition, yield and their ability to stand up to climate change. The Consortium's founders were particularly interested in the ability to leverage these improvements to help combat Africa's high levels of childhood stunting.

It is the plants that Africans grow for their own consumption that are the AOCC's focus. The 101 crops selected for sequencing are grown in the back gardens of, and are a principal food source for, 600 million people who live in rural Africa.

Successes to date include:

- Training more than 80¹ top African plant scientists in the latest genomics techniques and equipment
- Creation of a plant breeding laboratory with the highest genetic sequencing capacity in Africa
- Recognition as a successful, uncommon collaboration of government organizations, scientific and agricultural bodies, universities, companies, regional organizations and non-governmental organizations

¹ By December 2017.



The launch of the African Plant Breeding Academy in December 2013

By creating a very active and collaborative cohort of plant breeders, the AOCC has also had the unintended consequence of revolutionizing the way agricultural science is done in Africa.

Dr. Firew Mekbib, part of the first class of the African Plant Breeding Academy (AfPBA), which began at the World Agroforestry Centre (ICRAF) in 2013, returned to his job as associate professor at Haramaya University in Ethiopia and set up a center to research 38 orphan crops which originated in his country by the World Bank and the Ethiopian government. Recently, Haramaya University was recognized as an African Center of Excellence for Climate-Smart Agriculture and Biodiversity Conservation by the World Bank and the Ethiopian government. Furthermore, five members of the second and third classes applied for and received a EUR 1.5 million grant from the European Union under the Mobility for Breeders in Africa (MoBreed) program. This program will be used to train 30 MSc and 10 Ph.D. students in five institutions across Africa to work on orphan crops. Other collaborative proposals have been submitted as well. Two graduates of the second class are starting a continuing education program to train assistant plant breeders in Ethiopia. In addition, several United States Agency for International Development and European Union grants involving members of the Academy have been awarded. Former and current students, all academics at the top of their careers, are working to connect the members of the various classes through seminars, symposiums, webinars and even the establishment of an African Plant Breeders' Association and an African Plant Breeding Symposium.

Given its focus and early successes, the AOCC was roundly praised during the 40th anniversary meeting of the United Nations Committee on World Food Security (CFS) in October 2016, a meeting that annually brings together governments, the private sector, non-governmental organizations (NGOs) and international organizations seeking to address food, nutrition and agriculture issues.

There was a side-event at the CFS meeting dedicated to the AOCC. Ibrahim Mayaki, AOCC co-founder and CEO of the Planning and Coordinating Agency of the New Partnership for Africa's Development (NEPAD), remarked at the event, "In terms of technology and institutional arrangements, [AOCC] is an uncommon collaboration that allows us to learn from each other."

The event featured a panel discussion opened by Her Excellency Amira Gornass, Ambassador of Sudan and Chairperson of the CFS, and moderated by His Excellency Yaya Olaniran of Nigeria. Both participants, as well as the commentators, were optimistic about the AOCC's ability to create a new framework for diversifying diets to eliminate hunger, improve nutrition and reduce malnutrition and stunting in Africa. They expect that the AOCC approach will spread to other parts of the developing world.

"AOCC represents an uncommon, multi-sector, multi-disciplinary partnership of 18 government organizations, scientific and agricultural bodies, universities, companies, regional organizations and NGOs," said Ambassador Gornass. "To these partners, add a network of 20 scientific and technical agricultural and horticultural organizations that are also devoted to improving consumer diets and smallholder livelihoods in Africa and elsewhere. The success of the AOCC offers a proof -of-concept to demonstrate the value of multi-disciplinary, multi-sector partnerships that will sustain African farmers."

Ambassador Olaniran added, "AOCC has made significant progress to demonstrate that plant research, training African scientists and providing free access to laboratories on 101 underutilized crops will yield an extraordinary food security return on investment that can be adapted elsewhere."

After the meeting, the UN Food and Agriculture Organization became a partner of the AOCC.

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THE HUMAN STORIES BEHIND THE AOCC

The consortium was born out of a 2010 conversation between Dr. Mayaki of NEPAD's Planning and Coordinating Agency, which has as its primary thematic area food and nutrition security, and Dr. Howard Shapiro, Chief Agricultural Officer of Mars, Incorporated. Mars had recently sequenced the cacao genome, and Shapiro thought this technology should be used to help eliminate malnutrition. Mayaki agreed.

The Consortium's primary focus is the African farm families who grow most of what they eat. Through their work, Mayaki and Shapiro believed that if the crop varieties grown by the farmers could be made more nutritious, higher yielding and more resilient in the face of climate change, drought and pests, they would have a profound impact on efforts to defeat the malnutrition and the stunting that affects so many Africans, particularly children.

In the summer of 2011, the two convened a meeting of like-minded organizations, including NGOs, companies and international scientific bodies, to discuss ways forward. In the same year, and after only a few months' work, the AOCC was accepted at the Clinton Global Initiative annual meeting as an organization to develop a comprehensive

program to alleviate stunting and malnutrition in Africa. It has been presented at every Clinton Global Initiative meeting since.

Mayaki also presented the AOCC to a meeting of African heads of state, who accepted it as an official program. Over 100 plant scientists were polled, and the 101 crops to be sequenced were chosen based on their responses.

In 2013, Dr. Tony Simons, Director General of the World Agroforestry Centre, who had previously helped establish the AfPBA, facilitated the establishment of the AOCC genomics lab at the Centre's headquarters in Nairobi, which graduated its first class in December 2014.

Simons describes the AOCC not as part of a theory of change, but as a "change of theory to help all players develop a holistic approach to Africa's food systems."

Some of the world's most prestigious plant scientists have developed and taught the AfPBA's curriculum (see "Our Instructors"). The students have been worthy of their teachers.

“AOCC was accepted at the Clinton Global Initiative annual meeting as an organization to develop a comprehensive program to alleviate stunting and malnutrition in Africa.”

SOME OF THESE STUDENTS INCLUDE:



Dr. Samson Gwali

Dr. Samson Gwali is Head of the Tree Improvement and Germplasm Research Programme at Uganda's National Agricultural Research Organization. He is working to improve the productivity and shorten the maturation time of shea trees, which provide the main cooking oil for the band of 21 African countries that stretches west to east from Senegal to Ethiopia.

Some 80 million people rely on shea oil. According to Dr. Gwali, "It's the oil that people use for their own nutrition. They store the nuts all year round and process the oil at home when it's needed, and also share it. The African Plant Breeding Academy has helped us because tree breeding is not a big priority in most African countries, which breed short-rotation crops. Nevertheless, this course is giving us genomic techniques that we can use to do selection from plants that take a long time to mature, like trees; for a tree breeder, the nightmare is the period of time it takes to get a second generation. Shea trees are important for nutrition, so we must understand their genetics. With some shea trees, people eat the fruit pulp, which is rich in Vitamin A and C.

"Yet in breeding, we are selecting key traits, in particular the amount of the oil from the kernels and a shorter time to maturity. Before we used proxy markers, but now it will be like the human genome where we know that this part controls sickle cell disease, for instance. We will look for trees with high breeding value, which can pass on those traits to their offspring. We will be able to breed very effectively. The course has given us very good insights into how to design and implement our programs."



Dr. Happiness Oselebe

Dr. Oselebe is a Nigerian plant scientist who is a lecturer in plant breeding and genetics in the department of Crop Production & Landscape Management, Faculty of Agriculture & Natural Resources Management, at Nigeria's Ebonyi State University. She spent 17 months studying the serendipity berry, an herbaceous vine, prior to breeding. Dr. Oselebe is also a principal investigator on the MoBreed project.

Speaking about the serendipity berry, she said, "It is found in the thick forest. But when I tried to domesticate it, it never flowered. This indicated that it may be plastic in its floral ontogeny requiring certain environmental signals/stimuli to trigger flowering." Undeterred by this, she turned her attention to bananas, yams, rice and other crops. But Dr. Oselebe has a lingering regret about the *Dioscoreophyllum cumminsii* vine, which produces the serendipity berry, because she sees the potential value of this plant as a crop.

"The berry produces a mucilaginous substance called monellin which is a low molecular weight protein that has more than 3,000 times the sweetness of sucrose on a molar basis. When you find the berry in the market, people scramble for it. Only people who live near the forest can easily access it. With disappearing forests, it is becoming an endangered species."



Dr. Benjamin Dowiya Nzawele

Dr. Nzawele is from the L'Institut National pour l'Etude et la Recherche Agronomique (INERA) station at Mulungu in the east of the Democratic Republic of the Congo (DRC). His focus has been to search for orphan crops in the Okapi Wildlife Reserve.

"Pygmies were the ones showing me the forest. These pygmies do not cultivate fields but collect everything they need. They follow the season by the fruit. They know everything," he said.

Dr. Nzawele is particularly interested in what these forest people know about wild yams. He says that they are experts. "They will say, 'This type of yam, do not eat it. It is poisonous.' In DRC, cassava is disappearing because of disease (mosaic and cassava brown streak disease) so people are returning to yams. Wild relatives of crops that we cultivate are very useful for breeding programs."

"I was born into farming," says the scientist, who supervises 15 breeding programs at INERA Mulungu. His breeding objective is to have early maturing yams. "Many stay in the ground for one to two years. Very few mature in less."

Since completing the AfPBA course, he has been promoted to oversee research for all breeding in his country. He is also recipient of the Jon and Terasé Curtis fellowship for the AfPBA.



Dr. Enoch Achigan-Dako

Dr. Achigan-Dako is a researcher from Benin and now the principal investigator for the transcontinental MoBreed project. He is working to improve several orphan crops and he is equally passionate about each.

"Amaranthus can never disappear from our farms," says the senior lecturer at the University of Abomey-Calavi. "Within one month, you have your plant. But I want to cross *Amaranthus cruentus* with *A. dubius* for bigger leaves and taller plants. I also want to delay the flowering time, because once the plant flowers, vegetable sellers think it is old. They want tender leaves."

"With cleome, another leafy vegetable, I want to improve leaf quality – leaf size and nutrient content. I intend to cross the East and West African cultivars. In Benin and West Africa generally, it is mostly a medicinal plant." On his cleome team, the plant geneticist has two MSc students and one Ph.D. student, thanks to the Dutch Food & Business Applied Research Fund.

Speaking on the subject of the egusi melon (*Citrullus mucosospermus*), Dr. Achigan-Dako says it is eaten daily by almost everyone in Benin, Ghana, Nigeria and Côte d'Ivoire. "Its flesh is very bitter, so what we eat are the kernels of the seeds. They are delicious and rich in protein and oil. We need more and better seeds."

He also aims to cross egusi with the pink-fleshed watermelon. The two crops are so closely related that they look almost identical. Dr. Achigan-Dako wants to transfer the egusi's disease resistance to the watermelon because he says farmers use a lot of pesticide on watermelon.

THE DESIGN AND PURPOSE OF THE AFRICAN PLANT BREEDING ACADEMY (AFPBA)

The AOCC is generating DNA sequence information for 101 crops that could be of economic or nutritional importance to Africa. Yet, how does this information result in more and better food for African people? The answer lies with African plant breeders, those scientists who work to develop crop varieties that are more nutritious, higher yielding, and resilient to adverse growing conditions. The critical link is the plant breeder!

The AfPBA is designed to train African plant breeders in the latest approaches and tools to use DNA information in the breeding and selection process. This is empowering them to increase the efficiency and speed by which improved varieties are available to African farmers. The AfPBA is designed to sharpen skills, foster creativity, and encourage and enable African plant breeders.

The AfPBA offers an intensive six-week course delivered in three two-week sessions over 13 months. Concepts of genetics, experimental design and statistics, and plant breeding are shared by world-class experts in each subject area. Guest speakers model implementation through real-life examples of achieving complex breeding targets. Session 1 provides a foundation for decision making in cultivar development, and tools for data analysis are introduced. Session 2 aims to foster understanding of technologies that enhance genetic gain and speed development of new cultivars. Tools for deploying these technologies are then demonstrated and distributed. Session 3 focuses on best practices for producing volumes of quality seed for cultivar distribution.



Enoch Achigan-Dako upon delivering his project proposal to his peers and instructors in Class II, earning the UC Davis cap



Class I students working together



Darshna Vyas of LGC Genomics demonstrating techniques for the sampling and packaging of leaf samples to Class II students in preparation for DNA extraction and genotyping

The course culminates with participants presenting proposals that feature one or more of the methods and tools learned in the course, strategically applied to their own crop, their own breeding targets and their own market. Participants demonstrate that their newly acquired information, skills and tools have become an arsenal of working knowledge that enhances their success in developing improved cultivars that contribute to their national food security and economic vibrancy. They also receive useful feedback and tips from their class peers and the team of instructors.

An unanticipated outcome of the AfPBA is the spirit of collaboration that has developed and the enthusiasm that it has ignited. Often being the only plant breeder working on their specific crop in their country, participants in the AfPBA are invigorated by meeting other scientists working toward similar goals in similar crop species. Because of the interactions in AfPBA, participants have banded together to submit novel research proposals, develop new teaching materials, and create new venues for continuing education in their own countries. Former students are establishing a continent-wide association of professional plant breeders to support growth of the profession and continued professional development of their base. African plant breeders have been truly empowered!

The use of DNA sequence data to increase the speed by which farmers gain access to improved varieties and better livelihoods is one way that is making for more and better food for African people.

“ The AfPBA empowers African plant breeders to use DNA-based information, like DNA sequence data, and the latest tools in their breeding programs. This enables them to accelerate the development and release of more productive, more nutritious crop varieties to farmers and families. Certainly, time is of the essence in the battle against malnutrition and food insecurity. ”

AfPBA Director Dr. Rita Mumm.



Class II graduates

The AfPBA graduated its first class in December 2014 at the World Agroforestry Center in Nairobi, graduated its second class in December 2016 and began its third class in May 2017. Each year, competition for places becomes fiercer. The goal is to train 250 plant breeders and support personnel within six years.

The first class saw 21 scientists graduate. This class, which included four women, represents 11 countries across Africa and 20 different institutions.

The AOCC selected its second class from 252 applicants. 25 students (including six women) from 14 countries and 22 institutions graduated in December 2016 after training at the World Agroforestry Centre in a rigorous six-week program that stretched over 13 months.

With a total of 35 students, the third AfPBA class, which began in May 2017, was the biggest ever. All but one of the students holds a Ph.D. The 35 were selected from more than 340 applicants. Collectively, they represent 19

countries (including six not previously covered by Classes I and II). There are 18 women and 17 men.

Moreover, 25 are from countries of primary emphasis for the Alliance for a Green Revolution in Africa (AGRA), an organization founded and supported by Bill and Melinda Gates and the Rockefeller Foundation and a principal supporter of the AfPBA. Moreover, many of these students graduated from institutions that received substantial investments from AGRA: nine from the West Africa Centre for Crop Improvement (WACCI) at the University of Ghana and nine from the African Centre for Crop Improvement (ACCI) at the University of KwaZulu-Natal.

Grants to launch and enhance the graduates' plant breeding programs for African orphan crops have been established and will be awarded to AfPBA graduates. Additional fellowships are available through one of AOCC's partners, The Biosciences Eastern and Central Africa - International Livestock Research Institute (BecA-ILRI) Hub.

PLANTS AND LABORATORY

The AOCC genomics lab has some of the best equipment available anywhere in the world. In April 2017, Illumina, a leading manufacturer and marketer of integrated systems for the analysis of genetic variation and biological function, donated one of its top-of-the-line HiSeq 4000 sequencing systems to the Consortium. It is Africa's highest-capacity sequencer. The goal of the lab is to define the genetic diversity at the sequence level of 101 key parental lines for breeders to use for their programs. This information allows breeders to use the same strategies and technologies as Western crops such as maize to make rapid improvement in African crops.

The AOCC will be releasing its genome information to the public without restrictions through the GigaScience journal. Its first genome, finger millet, has already been submitted for release. Eight different species have been fully sequenced, with 21 more at different levels of preparation. Another 19 AOCC-nominated crops were being sequenced by other organizations. In total, 44 species will have been sequenced by the end of 2017.

Additionally, in collaboration with ARC, the AOCC is sequencing the transcriptomes of 50 species with funding by Illumina through its "Greater Good" Initiative. With the upgrade to the Illumina HiSeq 4000 sequencing system, which was donated to the AOCC by Illumina in 2017, the Consortium will also be able to work on sequencing parental lines from over 20 of the crops.

"I have seen nothing like the AOCC. As a Ph.D., I admire pure research. But AOCC starts with pure research, sequencing genomes, then trains people to do it, then makes technology available to them and helps them produce improved crop cultivars," said Ryan Rapp, Associate Director of AgriGenomics at Illumina, who attended the graduation of the second class. "The speed at which all of this has been accomplished is truly astounding."

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Finger millet is one of the 101 African orphan crops and the first to have its genome sequenced by the AOCC

PARTNERSHIPS

Below, in alphabetical order, are listed the partners of the AOCC and their roles and contributions. This is a working list, as new partners join frequently. Given that the African heads of state at the African Union assembly voted to endorse the AOCC initiative, all African governments are partners in the Consortium as well.

- **Alliance for a Green Revolution in Africa (AGRA)** (Nairobi, Kenya) is an organization supported by the Bill and Melinda Gates and the Rockefeller Foundations, which supports the AOCC in many ways and has contributed USD 1.1 million to the AOCC's African Plant Breeding Academy.
- **Agricultural Research Council (ARC)** (Pretoria, South Africa) supports the AOCC by sequencing genes (transcriptomes) for the AOCC.
- **Biosciences Eastern and Central Africa – International Livestock Research Institute (BeCA-ILRI) Hub** (Nairobi, Kenya) is a shared agricultural research and biosciences platform providing laboratory services to African and international scientists conducting research on African agricultural challenges. It provides the AOCC with lab and project support, training of breeders, and the curation of germplasm used by the AOCC.
- **BGI** (Shenzhen, China) is one of the world's leading sequencing organizations. It is involved in sequencing, annotating, assembling and curating many of the 101 African orphan crop genomes as well as supporting development for the AOCC.
- **CyVerse** (Tucson, USA) is a collaborative that has developed a cyber-infrastructure for data-intensive biology driven by high-throughput sequencing, phenotypic and environmental data sets. It has helped the AOCC with analysis and curation of sequence and genotype data.
- **Food and Agriculture Organization of the United Nations (FAO)** (Rome, Italy) supports the development of the AOCC.
- **Google** (Mountain View, USA) provides rapid transfer of AOCC data worldwide using cloud space.
- **Illumina** (San Diego, USA) develops technology and kits for use in genetic research and has provided the AOCC with reagents to sequence the gene complement of 50 species and has donated their HiSeq 4000 Sequencer to the AOCC lab to sequence 10,000 accessions of African crops.
- **LGC** (Hoddesdon, UK) is an international life sciences measurement and testing company, providing reference materials, genomics solutions and analytical testing products and services. It has also provided genotyping services for AOCC plant breeders.
- **Mars, Incorporated** (McLean, USA) is one of the world's largest privately-owned food companies; it has provided over USD 2 million for the African Plant Breeding Academy, scholarships for breeding programs and support for AOCC lab personnel.
- **New Partnership for Africa's Development (NEPAD)** (Midrand, South Africa) a technical body of the African Union which has provided administrative, logistical and political support for the AOCC.
- **Thermo Fisher Scientific** (Waltham, USA) helps companies and organizations solve their research challenges; it has donated four Proton sequencers and four Chef Stations and reagents. It recently acquired Life Technologies which had donated four Ion proton machines to the AOCC.
- **UNICEF** (New York City, USA) supports the development of the AOCC.
- **University of California at Davis** (Davis, USA) is one of the world's leading agricultural universities. It manages the African Plant Breeding Academy and supports the AOCC laboratory.
- **VIB-UGent Center for Plant Systems Biology** (Ghent, the Netherlands) is a non-profit research institute in the life-sciences sector that has 1,200 scientists conducting basic research on molecular mechanisms. It has helped AOCC with bioinformatics and annotation of plant genomes.
- **Wageningen University** (Wageningen, the Netherlands) is a world-leading agricultural university working closely with AOCC to define the nutritional value of African crops and breeding lines.
- **World Agroforestry Centre (ICRAF)** (Nairobi, Kenya) hosts the AOCC laboratory and the African Plant Breeding Academy lab and helps manage its data.
- **World Wildlife Fund for Nature** (Gland, Switzerland) has worked with the AOCC since its inception, helping with initiation and vision.

NETWORK

The AOCC also works through a network of other organizations involved in agriculture and horticulture in Africa:

- African Bean Consortium
- Bioinnovate
- Bioversity
- CIAT
- Cleome Consortium
- Crop Breeding Institute
- Crops for the Future Research Centre
- Dow AgroSciences
- Discorea Consortium
- Ethiopian Orphan Crops Center
- Fababean Consortium
- Hohenheim University
- ICARDA
- IITA
- Lentil Sequencing Consortium
- MoBreed
- Canadian National Research Council
- NWO Food & Business Applied Research Fund
- Pan-African Bean Alliance
- Shea Consortium
- Sweet Potato Consortium
- University of Georgia
- USDA-ARS Subtropical Horticultural Research Station
- USDA-ARS, Wisconsin
- World Vegetable Center

The AOCC network continues to expand, adding major crop consortiums, CGIAR centers, universities, government institutions and foundations. The network serves as the connection to plant breeders, seed production specialists and farmers to deliver the products of the AOCC. It also serves as an advisory group for input and feedback for the AOCC program.

FUNDING AND THE FUTURE

To date, the AOCC has raised an estimated USD 40 million in cash or in-kind contributions, with an additional USD 20 million to be sourced to complete phase one, which involves sequencing the 101 African orphan crop reference genomes, sequencing 100 lines from each of these crop species as well as training 120 plant breeders. Phase two involves integrating genomic tools and strategies to develop new orphan crop varieties and training 130 breeding support personnel. Phase three involves working with seed companies and smallholder farmers to adopt and deliver diverse and nutritious crop varieties for African farmers and consumers.

Investments in measures to end stunting and malnutrition are among the best investments possible in terms of demonstrated returns. One study by a group of scholars led by John Hoddinott of the International Food Policy Research Institute found a wide range of cost/benefit ratios for anti-stunting investments in 17 high-risk countries, from 3.6 in the Democratic Republic of the Congo to 48 in Indonesia, with a median value of about 18, the figure for Bangladesh. The broad range is due to variables such as intervention costs, disease levels and national earning possibilities.

But the astonishing conclusion is that, in Tanzania, every dollar invested in preventing stunting brought more than USD 15 in benefits. For Kenya, it is more than USD 16, and for Sudan, USD 24.

The authors concluded that “there are significant, life-long economic benefits from averting stunting,” that there is consensus on which specific interventions are effective and what they cost, that “the benefit/cost ratios associated with implementing these interventions exceed one in all countries considered in our study” and that they “are larger than many other development interventions.”

Their final conclusion was that “countries that want to generate and sustain broad-based wealth are likely to find that scaling-up these nutritional interventions to be some of the best investments they can make.” National and international governments and bodies are urged to contribute to this initiative.

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“Countries that want to generate and sustain broad-based wealth are likely to find that scaling-up these nutritional interventions to be some of the best investments they can make,”

OUR INSTRUCTORS

Our primary instructors, who teach the core of the course, are recognized leaders in their fields.



Rita Mumm - Ph.D.

Dr. Rita Mumm is the director of the African Plant Breeding Academy and also serves as a primary instructor in the program. She brings a quarter century of experience in plant breeding and the seed industry. Dr. Mumm was a pioneer in developing and releasing some of the first transgenic traits in crops with DEKALB Genetics Corp, and in establishing a high-throughput molecular marker system to implement genomic information in seed product development. Her expertise is applied to maize quantitative genetics; applications of genomic information to the development of improved crop cultivars; and deployment of traits created through genetic engineering, including efficient breeding strategies and stewardship of governmentally regulated materials.

Dr. Mumm was the founding director of the Illinois Plant Breeding Center at the University of Illinois and now enjoys emerita status in the Department of Crop Science. In addition to faculty at the University of Illinois, Dr. Mumm is principal at GeneMax Services, a consulting firm to the seed industry. She is a past president of the National Association of Plant Breeders and a named inventor on several -S patents, including one detailing the first glyphosate tolerant transgenic event in maize. Currently, she serves as a board trustee of the International Maize and Wheat Improvement Center (CIMMYT).



Allen Van Deynze - Ph.D.

Dr. Allen Van Deynze is the Director of Research at the Seed Biotechnology Center and Associate Director of the Plant Breeding Center at University of California, Davis. Allen received a BSc and MSc degree in plant sciences from the University of Manitoba, Canada and his Ph.D. in plant breeding from the University of Guelph, Canada. He did a post doctorate in molecular genetics at Cornell University in the Department of Plant Breeding and Biometry. Allen worked as a plant breeder for Calgene/Monsanto and Senior Scientist for Celera AgGen where he developed and implemented strategies to incorporate genomics and biotechnology into breeding programs.

As part of the SBC's mission to serve as a liaison between public institutions and seed industry, Allen is responsible for conducting research and generating and disseminating scientific and informational content for the Seed Biotechnology Center's educational and outreach programs. His research focuses on developing and integrating genomics into plant breeding of California crops. He has programs on cotton, lettuce, carrot, spinach, tomato, potato and particularly improving disease resistance and quality in pepper. With Dr. Kent Bradford, he co-developed and is organizer for the UC Davis Plant Breeding Academy and past chair of the US Plant Breeding Coordinating Committee. He has been involved in International and National policy including working on Cartagena Protocol on Biosafety and US Regulations for Biotechnology. He is an instructor for the African Plant Breeding Academy and scientific co-leader for the African Orphan Crops Consortium.



J. Bruce Walsh - Ph.D.

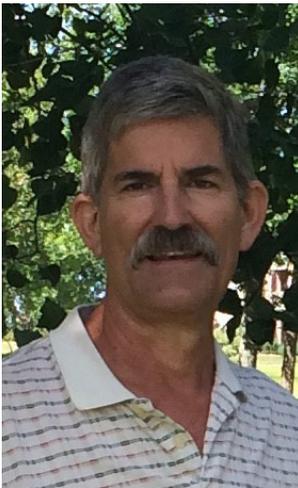
Dr. Bruce Walsh is a Professor of Ecology and Evolutionary Biology and Professor of Public Health at the University of Arizona, as well as an Adjunct Professor in the Departments of Plant Sciences, Animal Sciences, and Molecular and Cellular Biology. He is a preeminent instructor in Genetics, coauthoring (along with Mike Lynch at Indiana) "Genetics and Analysis of Quantitative Traits," one of the standard references on the application of quantitative genetics to breeding, evolutionary biology, and human genetics.

Over the past ten years, he has been invited to give short courses on advanced topics in quantitative and statistical genetics at many of the world's leading universities, including Wageningen, Edinburgh, Uppsala, Huazhong Agricultural University, Aarhus, Liege, Technical University of Munich, University of Helsinki, University of New England (Australia), and Peking University. Additionally, he has been an instructor for over a decade at the Seattle Summer Institute of Statistical Genetics, training over 500 students at just this institute alone. Bruce has taught over 10,000 undergraduates and is approaching 10,000 literary citations of his work.



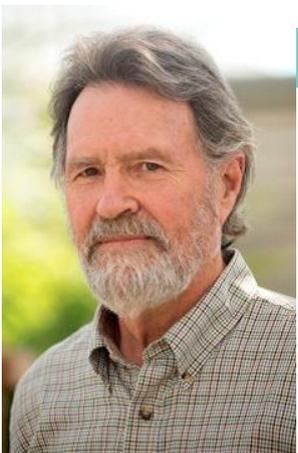
Iago Hale - Ph.D.

Dr. Iago Hale, an assistant professor of specialty crop improvement at the University of New Hampshire (UNH), USA, is inspired by the potential of plant breeding to enhance health, rural livelihoods, food security and ecosystem integrity. After studying physics (BA) at Dartmouth College and living and working internationally for a number of years, including in East Africa, Dr. Hale attended the University of California, Davis, where he received his MSc in international agricultural development and Ph.D. in horticulture and agronomy (plant breeding specialization). His research activities are diverse and include pre-breeding (gene discovery and characterization) for rust resistance in wheat; breeding hardy kiwi cultivars (*Actinidia spp.*) for the northeastern United States and understanding their potential impact on the region's forests; and investigating the effects of domestication and dislocation from centers of origin on plant-associated microbial communities (model species: *Phaseolus vulgaris*). Dr. Hale has taught graduate-level courses on the design, analysis and interpretation of experiments at UC Davis and UNH and looks forward to working with plant breeders from across Africa as they develop their programs through this academy.



Todd Wehner - Ph.D.

Dr. Todd Wehner has been working on plant breeding at North Carolina State University since 1979. He attended the University of California, Berkeley, receiving his A.B. in botany in 1975 and the University of Wisconsin-Madison for a MSc in Agronomy and a Ph.D. in plant breeding and plant genetics in 1979. Dr. Wehner took over the cucumber breeding and genetics project at North Carolina State University, Raleigh in 1979 and, in 1993, he took on the additional responsibility for breeding and genetics research on watermelon and specialty melon. His research has emphasized improved selection methods; recurrent selection for fruit yield, earliness, quality and parthenocarpy; resistance to chilling, nematodes, foliar fungi; and germplasm evaluation to provide industry with new traits for the development of improved cultivars. He was an advisor for production of pickling cucumber in Sri Lanka in 1993, watermelon in China in 1999, and cucurbit seed collection in Zimbabwe in 2001. He led expeditions to collect germplasm from China in 1994, the Republic of South Africa in 1996, and Turkmenistan in 2008.



Kent Bradford - Ph.D.

Dr. Kent Bradford is a Distinguished Professor of Plant Sciences at the University of California, Davis. Dr. Bradford received BSc and MSc degrees in biochemistry and horticulture from Michigan State University and his Ph.D. in plant physiology from UC Davis. He has been on the faculty at UC Davis since 1982, serving as Chair of the Department of Vegetable Crops from 1993 to 1998 and as Director of the UC Davis Seed Biotechnology Center since 1999. He teaches University and Extension courses on seed production and quality and received a Fulbright Scholar award in 1999 to teach in Argentina. He was awarded the Career Seed Science Award from the Crop Science Society of America in 2002 and was elected a Fellow of the American Association for the Advancement of Science in 2003. Dr. Bradford's research interests are in identifying the genetic and molecular mechanisms regulating seed germination, in applying mathematical models to describe seed germination and dormancy behavior and in applying methods to enhance seed quality and longevity.



Rale Gjuric - Ph.D.

Dr. Rale Gjuric is Director of Education at the Seed Biotechnology Center, University of California, Davis. He is the founder and president of Haplotech, a company specialized in technical services and consulting in plant breeding. Dr. Gjuric received his Ph.D. from the University of Manitoba, Canada. Previously, he held the positions of Breeding Manager of DL Seeds Research and Managing Director of DSV Canada in Winnipeg, Canada. Dr. Gjuric is an accomplished plant breeder with numerous canola varieties and hybrids released in his 15 years in the private sector. His current focus is in service to the plant breeding industry with special interest in organization and optimization of plant breeding programs. Under his management, UC Davis Plant Breeding Academy program has expanded and branched to Europe, Asia and Africa, making it the most recognized program of its kind. He was also instrumental in establishing and delivering a number of short courses catered to the needs of seed industry professionals.

THE BOTANICAL AND COMMON NAMES OF THE AOCC'S 101 CROPS

	Scientific name	Common name
1	<i>Abelmoschus caillei</i>	Okra
2	<i>Adansonia digitata</i>	Baobab
3	<i>Allanblackia floribunda</i>	Tallow tree
4	<i>Allium cepa</i>	Onion
5	<i>Amaranthus blitum</i>	Amaranth
6	<i>Amaranthus cruentus</i>	Grain amaranth
7	<i>Amaranthus tricolor</i>	Vegetable amaranth
8	<i>Anacardium occidentale</i>	Cashew
9	<i>Annona reticulata</i>	Custard apple
10	<i>Annona senegalensis</i>	Wild custard apple
11	<i>Artocarpus altilis</i>	Breadfruit
12	<i>Artocarpus heterophyllus</i>	Jack tree
13	<i>Balanites aegyptiaca</i>	Balanites
14	<i>Basella alba</i>	Vine spinach
15	<i>Boscia senegalensis</i>	Aizen/nabedega
16	<i>Brassica carinata</i>	Ethiopian mustard
17	<i>Canarium madagascariense</i>	Canarium nut / ramy nut
18	<i>Carica papaya</i>	Papaya
19	<i>Carissa spinarum</i>	Carissa
20	<i>Casimiroa edulis</i>	White sapote
21	<i>Cassia obtusifolia</i>	Sickle senna
22	<i>Celosia argentea</i>	Celosia
23	<i>Chrysophyllum</i>	Star apple
24	<i>Citrullus lanatus</i>	Watermelon
25	<i>Cleome gynandra</i>	Spiderplant
26	<i>Cocos nucifera</i>	Coconut
27	<i>Colocasia esculenta</i>	Taro
28	<i>Corchorus olitorius</i>	Jute mallow
29	<i>Crassocephalum rubens</i>	Yoruban bologi
30	<i>Crotalaria juncea</i>	Sunn hemp
31	<i>Crotalaria ochroleuca</i>	Rattlebox
32	<i>Cucumis metuliferus</i>	Horned melon
33	<i>Cucurbita maxima</i>	Pumpkin
34	<i>Cyphomandra betacea</i>	Cape tomato
35	<i>Dacryodes edulis</i>	African plum
36	<i>Detarium senegalense</i>	Sweet detar
37	<i>Digitaria exilis</i>	Fonio
38	<i>Dioscorea alata</i>	Yam
39	<i>Dioscorea dumetorum</i>	Bitter yam
40	<i>Dioscorea rotundata</i>	Yam
41	<i>Diospyros mespiliformis</i>	African persimmon
42	<i>Dovyalis caffra</i>	Kei apple
43	<i>Elaeis guineensis</i>	Oil palm
44	<i>Eleusine coracana</i>	Finger millet
45	<i>Ensete ventricosum</i>	Enset
46	<i>Eragrostis tef</i>	Teff
47	<i>Faidherbia albida</i>	Acacia (apple-ring)
48	<i>Garcinia livingstonei</i>	African mangosteen
49	<i>Garcinia mangostana</i>	Mangosteen
50	<i>Gnetum africanum</i>	African gnetum
51	<i>Hibiscus sabdariffa</i>	Roselle

	Scientific name	Common name
52	<i>Icacina oliviformis</i>	False yam
53	<i>Ipomoea batatas</i>	Sweet potato
54	<i>Irvingia gabonensis</i>	Sweet bush mango
55	<i>Lablab purpureus</i>	Lablab bean
56	<i>Landolphia spp</i>	Gum vine
57	<i>Lannea microcarpa</i>	Tree grape
58	<i>Lens culinaris</i>	Lentil
59	<i>Macadamia ternifolia</i>	Macadamia
60	<i>Macrotyloma geocarpum</i>	Geocarpa groundnut
61	<i>Mangifera indica</i>	Mango
62	<i>Momordica charantia</i>	Bitter gourd
63	<i>Moringa oleifera</i>	Drumstick tree
64	<i>Morus alba</i>	Mulberry
65	<i>Musa acuminata</i> AAA Group	Banana
66	<i>Musa balbisiana</i>	Banana
67	<i>Musa x paradisiaca</i> AAB Group	Plantain
68	<i>Opuntia monacantha</i>	Prickly pear
69	<i>Parinari curatellifolia</i>	Mobola plum
70	<i>Parkia biglobosa</i>	African locust
71	<i>Passiflora edulis</i>	Passion fruit
72	<i>Persea americana</i>	Avocado
73	<i>Phaseolus lunatus</i>	Lima bean
74	<i>Phaseolus vulgaris</i>	Green bean
75	<i>Plectranthus esculentus</i>	African potato
76	<i>Plectranthus rotundifolius</i>	African potato
77	<i>Psidium guajava</i>	Guava
78	<i>Riciodendron heudelotii</i>	Groundnut tree
79	<i>Saba comorensis</i>	Rubber vine
80	<i>Sclerocarya birrea</i>	Marula
81	<i>Solanum aethiopicum</i>	African eggplant
82	<i>Solanum scabrum</i>	African nightshade
83	<i>Sphenostylis stenocarpa</i>	African yam bean
84	<i>Strychnos spinosa</i>	African orange
85	<i>Syzygium guineense</i>	Waterberry
86	<i>Talinum fruticosum</i>	Ceylon spinach
87	<i>Tamarindus indica</i>	Tamarind
88	<i>Telfairia occidentalis</i>	Fluted gourd
89	<i>Tylosema esculentum</i>	Marama bean
90	<i>Uapaca kirkiana</i>	Wild loquat
91	<i>Vangueria infausta</i>	African medlar
92	<i>Vangueria madagascariensis</i>	African medlar
93	<i>Vicia faba</i>	Fava bean
94	<i>Vigna radiata</i>	Mung bean
95	<i>Vigna subterranea</i>	Bambara groundnut
96	<i>Vitellaria paradoxa</i>	Shea butter tree
97	<i>Vitex doniana</i>	Chocolate berry
98	<i>Xanthosoma sagittifolium</i>	Elephant ear
99	<i>Xanthosoma spp</i>	Cocoyam/arrowroot
100	<i>Ximenia caffra</i>	Sour plum
101	<i>Ziziphus mauritania</i>	Jujube



The World Agroforestry Centre is a
member of the CGIAR Consortium

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