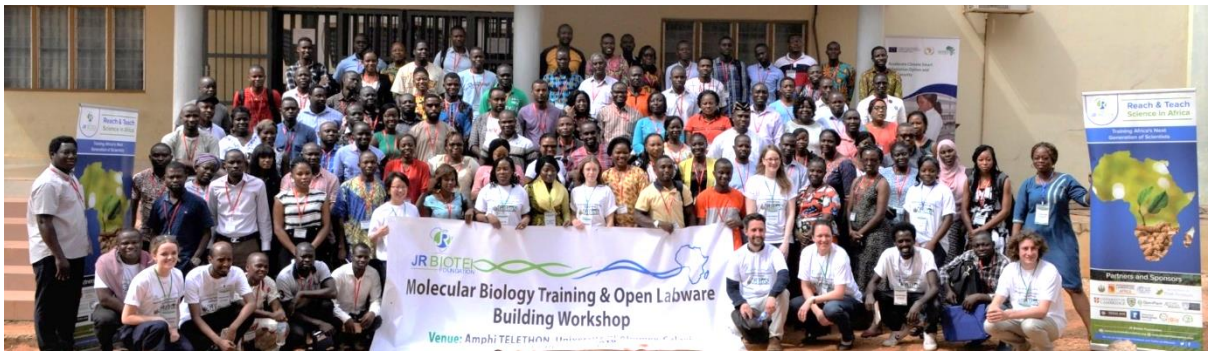
‘Reach and Teach Science in Africa’: Strengthening Agricultural Research Capacity to Tackle Food Insecurity in Africa

University of Abomey-Calavi, Benin Republic, West Africa, 1st-5th April 2019

A Report Prepared by Carol N. Ibe



In April 2019, early-career researchers from the Department of Plant Sciences, University of Cambridge organised a large-scale scientific training workshop in collaboration with the Laboratory of Genetics, Horticulture and Seed Science (GBioS) at the University of Abomey-Calavi in Benin Republic. The workshop involved 100 agricultural researchers from 19 African countries and was taught by 10 researchers from the University of Cambridge, University of Nottingham, the Pontificia Universidad Católica in Chile, and Texas A&M University, USA. The project was developed by Carol Ibe, a PhD student/Gates scholar at the Department of Plant Sciences, University of Cambridge and Founder of JR Biotek Foundation.

INTRODUCTION

Sometimes it's hard to know what you don't have until you've experienced it. What does a building you've never been in look like? How do you know what you're missing in a lecture?

When Carol Ibe moved from Nigeria to the United States for her biology masters, she encountered a completely different academic environment from her undergraduate degree that facilitated a changed in her career trajectory. She found greater access to lab infrastructure that is required for modern bioscience. Relevant and up-to-date reading materials and textbooks were readily available, and there was a focus on driving young scientists to ask key questions to shape their own research. This experience stayed with Carol and added to the changes she sought to develop in emerging African bioscience. One such example is the Molecular Biology Training & Open Labware Building Workshop, which took place at the University of Abomey-Calavi, Benin Republic from 1st-5th April 2019.

The Molecular Biology & Open Labware Training Workshop is part of the ‘Reach & Teach Science in Africa’ capacity building project developed to reach, teach and provide relevant academic resources to 1,000 Africa-based agricultural researchers by 2029. The workshop held in Benin Republic was the first of many. It was designed to provide core bio-scientific knowledge and

laboratory skills to Africa-based agricultural researchers who would lead their own future research agenda.

100 workshop participants, the Reach & Teach team and members of the host lab (GBioS) standing in front of GBioS on the last day of the lab practical session.

Recent studies have shown that despite growth, the number of scientists in Africa is still low compared to many other continents. Yet these same researchers are best placed to address pressing local African food insecurity challenges. They are best placed to develop the potential in local and indigenous crops. They understand the local agricultural challenges and know how the farmers will harvest the benefits these innovations can offer. For these reasons, these emerging scientists must shape, develop and lead research that addresses the challenges faced in Africa. The 2019 Molecular Bio-Training Workshop in Benin provided the opportunity for them to do so.

DESIGNING A WORKSHOP AROUND NEEDS

Holding a workshop for African researchers outside Africa can be challenging. It restricts the number of people who can attend due to the costs of travel and accommodation, as well as visa restrictions. It also negates the option for capacity building at the host institute and limits ongoing connections with visiting researchers. Carol understands this, hence the reason she established partnership with the Laboratory of Genetics, Horticulture and Seed Science (GBioS) at the University of Abomey-Calavi, Benin Republic to hold the 2019 Molecular Bio-Training & Open Labware Building Workshop.

From left to right: Ute Voss, Thomas Alcock, Carol Ibe, Ahmed-Noor Adam Agip (below), Dèdéou Tchopkonhoue (above), Enoch Achigan-Dako, Jennifer McGaley, Conor Simpson, Trisna Tungadi (below), Emily Servante, Leonie Luginbühl, Charlotte Adje

The workshop provided 100 early-career agricultural researchers from 19 African countries the opportunity to gain new knowledge and scientific skills, as well as to form a strong research network across the continent and internationally. The training was delivered through a three pillared approach of bioscience theory, DIY lab infrastructure and the 'Bio-innovation for Africa' pitching challenge. Each part was designed to complement the other pillars and tailored to the requested needs from previous exchanges with past participants.

ARRIVING AT THE UNIVERSITY OF ABOMEY-CALAVI

The day before the workshop, our team visited the University of Abomey-Calavi where the workshop will be held for one week. We were welcomed by our host, Dr Enoch G. Achigan-Dako, Head of *GBioS* at the *University of Abomey-Calavi,* who was very hospitable and a fantastic facilitator indeed. Enoch welcomed us with a tour of his new but excellent research and farming facilities, followed by sampling various bissap fruits, moringa and lemongrass teas, produced by EcoSeed, a sustainable seed enterprise founded by some of his PhD students.

A tour of a university farm owned by Enoch's laboratory. The farm has a nursery, borehole used to provide water for the plants, and portions of land used for field trials. They cultivate a wide range of fruits and vegetable, including orphan crops.

The co-founders of EcoSeed, Dedeou (left in the picture above) and Carlos (both in the picture below) participated in our second scientific laboratory training workshop held at the Department of Plant Sciences, University of Cambridge in September 2018. They participated in the 'Bio-innovation for Africa' pitching competition, which we developed to encourage African scientists to become more proactive and entrepreneurial in finding solutions to some of the most pressing problems faced on the continent.

Dedeou and Carlos presented their EcoSeed enterprise for the first time on an international stage during our first UK-Africa Food Security Symposium held at the Sainsbury Laboratory, University of Cambridge on the 11th-12th September 2018. They won the pitching competition with a cash prize of £1,500, and whilst in Cambridge, Dedeou and Carlos initiated connections between our team and their laboratory in Benin because they believed in the work we are doing and said it had made a huge difference in their professional lives. They needed the JR Biotek Foundation's

capacity building programme to be launched at their institution, the University of Abomey-Calavi, and that happened. Since returning to Africa, the EcoSeed co-founders have produced more varieties of vegetable seeds, which they are selling to smallholder farmers in local communities in Benin Republic.

Dedeou (right) and Carlos (left) standing with Carol (middle) after they won the 'Bio-innovation for Africa' pitching competition held during the first UK-Africa Food Security Symposium at the Sainsbury Laboratory, University of Cambridge in September 2018.

OPENING CEREMONY

Day one of the 'Reach & Teach' workshop commenced with a welcome reception, which included speeches from our collaborator, Dr. Enoch Achigan-Dako, dignitaries from the University of Abomey-Calavi (Pro-Vice-Chancellor of Academic Affairs, Pro-Vice-Chancellor of International Corporation and the President of the African Society of Genetics) and Carol Ibe. The inspiring speeches urged African governments and their development partners, tertiary education institutions and researchers to invest in high-quality research that effectively addresses food and nutrition insecurity on the continent.

At the welcome reception on Day 1 of the workshop. Dignitaries from the University of Abomey-Calavi welcomed our team and the 100 workshop participants from 19 African countries. Carol encouraged African leaders to invest in their people's development and the many untapped and underutilised resources on the continent in order to feed the citizens and future generation.

Following the short welcome reception, Enoch and Carol were invited for inteviews with the national press. The interviews were aired on national TV stations and caught the government's attention. A few days later, Enoch received a phone call from the Minister of Agriculture, who visited their laboratory and farm facilities at the Univesity of Abomey-Calavi the week after the

workshop. The minister praised Enoch's research and the capacity building workshops, which he said they would support. This is the sort of positive change and influence the 'Reach & Teach Science in Africa' project is having across Africa.

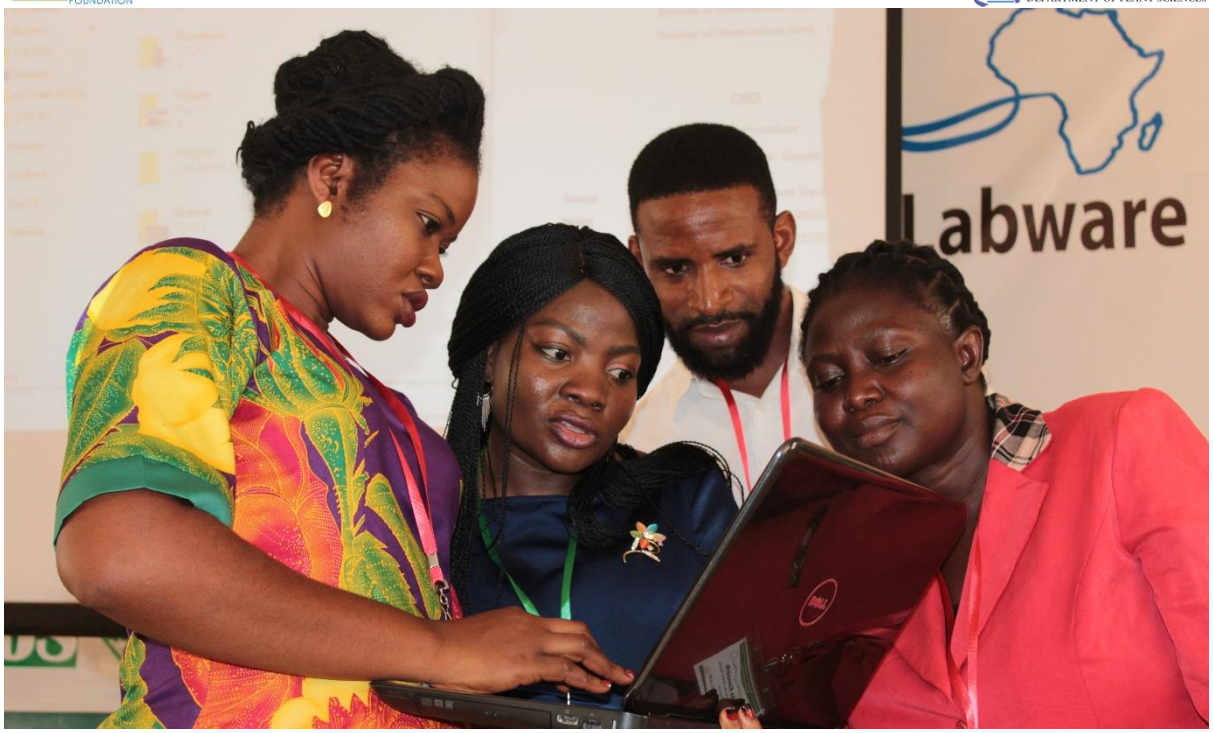
Press inteview with Enoch (Head of the Laboratory of Genetics, Horticulture and Seed Science, University of Abomey-Calavi) and Carol Ibe (PhD student/Gates scholar at the Department of Plant Sciences and Founder of JR Biotek Foundation).

KNOWLEDGE AND SKILLS TRANSFER

On Day 1 of the workshop and every morning until Day 4, lectures on core molecular biology principles and laboratory skills, crop breeding, plant physiology, and statistical analysis were taught by the 'Reach & Teach' team. Catherine Danmaigona Clement (second from left in the picture below), a PhD student at Texas A&M University taught the course on statistics.

Catherine was one of the participants of JR Biotek Foundation's first training workshop held in collaboration with the International Institute of Agriculture (IITA) in Nigeria in September 2014. At that time, Catherine was completing her master's degree in plant breeding at the Federal University of Agriculture, Markurdi in Nigeria. She said, "following the workshop in Nigeria, I was awarded the Kirkhouse Trust funding to complete my experimental work in a laboratory at the University of Virginia. The knowledge and skills that I gained from the workshop contributed immensely to my practical work in Virginia."

After completing her master's degree, Catherine got into a fully-funded PhD programme in Plant Breeding at the Texas A&M where she is currently in the second year of her PhD. Catherine said the skills she gained from our workshop also helped her a lot in Texas. "I still have my laboratory manual from the training. In fact, it's sitting on my work bench in Texas because the knowledge and skills from the recombinant DNA technology module taught then, became very useful in my PhD research."



Catherine (second from left) and some of the workshop participants after her lecture on the use of statistical software to analyse data from crop breeding programmes. More than 90% of the workshop participants are involved in crop breeding programmes, therefore, the statistical session was very useful and highly impactful to them.

On the same day, Dr Enoch also gave a lecture covering ongoing work at the University of Abomey-Calavi which focuses on improving resources available for various 'orphan crops'. Three species that his group are particularly interested in are Miracle Berry, a fruit producing plant that causes sour flavours to be perceived as sweet when consumed; Cleome, a vegetable crop with potential for elevated vitamin A & C varieties to be produced; and Kersting's Groundnut, a crop of high economic importance for farmers in West Africa.

HANDS-ON LABROATORY PRACTICAL

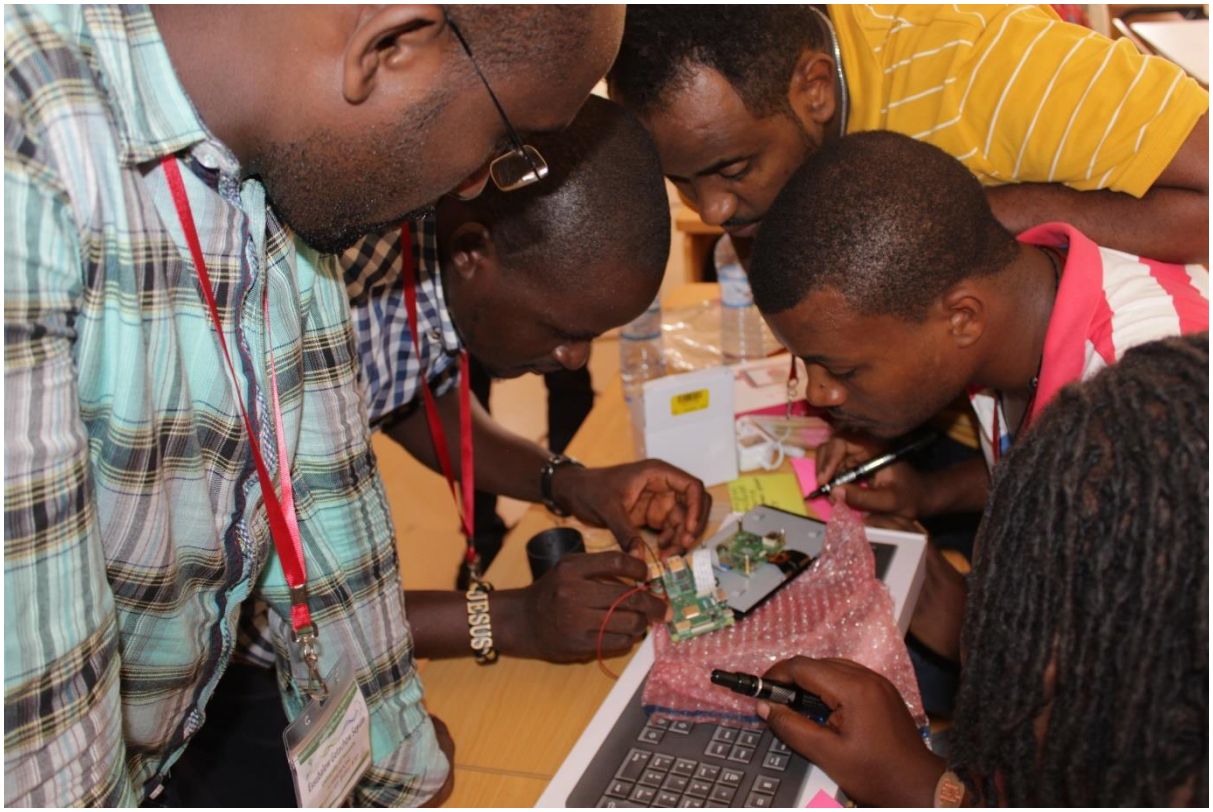
As lectures were held in the mornings, the hands-on laboratory sessions took place in the afternoons to enable the participants to first gain theoretical knowledge on core molecular biology and breeding principles before the laboratory practical. It was challenging to have one lab session for all 100 participants due to limited space, resources and teachers. For this reason, we split the candidates into groups of 25 people for the practical. The sessions focused on teaching basic molecular biology laboratory skills such as DNA extraction from plants, the Polymerase Chain Reaction (PCR), gel electrophoresis, even micro-pipetting as most of the candidates did not have experience in this before the workshop.

LABWARE CONSTRUCTION WORKSHOP

At JR Biotek Foundation, we understand that training can have a reduced impact if the individuals involved lack the infrastructure to apply the skills we teach. However, we believe it's an opportunity for African researchers and students to take an innovative approach to some of the problems they face. This led us to integrate the labware construction module into the 'Reach & Teach Science in Africa' project.

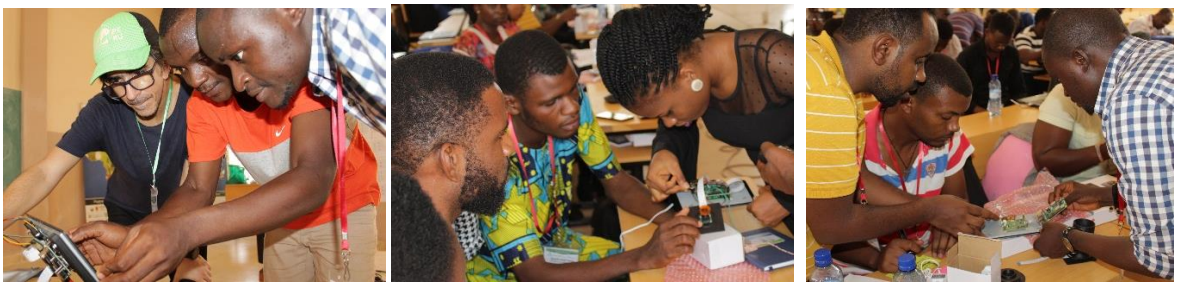
More and more, lab researchers are building and improving the tools they use for their work. There are now projects that specialise in not only shaping new research technologies, but ensuring they are more accessible to lower resourced labs. For instance, new cell-free expression systems can be stored at ambient temperatures to negate the need for refrigerators, and researchers are now printing their labware from 3D printers for a fraction of the cost of commercially available products.

Dr Fernán Federici (Pontificia Universidad Católica, Chile), a Plant Science Cambridge alumnus, led the labware construction session during the workshop in Benin. The participants were involved in a hands-on build-a-microscope session, where they built portable fluorescent microscopes that were eventually used to monitor fluorescent protein expression in cell-free systems.



Participants working collaboratively to build a mini-fluorescent microscope during JR Biotek's first labware construction session held as part of the 'Reach & Teach Science in Africa' project at the University of Abomey-Calavi, Benin.

Of course, a microscope is just one piece of the laboratory set-up, but this session introduced the participants to a growing number of accessible options that allow lower resourced labs to conduct modern scientific research. The participants understood the need for them to be involved in developing low-cost technologies that can help advance their research and teaching. They were also introduced to a variety of opensource technologies and software communities that they can learn/benefit from.



Participants building mini-fluorescent microscopes during the 'Reach & Teach Science in Africa' project at the University of Abomey-Calavi, Benin.

Grassroot approaches like the 'Reach & Teach' capacity building programmes not only invest in the researcher, but rather, they pave the way for innovations that are built on local understanding. This leads to solutions that align well with local needs and bring in a sustainable element that can be lost from more top down approaches. This line of thought is particularly championed in the 'Bio-innovation for Africa' Pitching Competition, which was held on the last day of the 'Reach & Teach' workshop in Benin.

'BIO-INNOVATION FOR AFRICA' PITCHING CHALLENGE

The 'Bio-innovation for Africa' pitching challenge was created by Carol Ibe to encourage African researchers and students to be more proactive and involved in finding practical solutions to some of the most pressing challenges faced in Africa.

A couple of weeks before arriving in Benin, all 100 participants were grouped into 18 teams to develop new ideas and projects that can potentially address challenges in food and nutrition, research and innovation, science policy development and implementation, and STEM (science, technology, engineering and mathematics) education across the continent. With all enthusiasm, the teams quickly set up WhatsApp groups and started working together. They met for the very first time in Benin but that was not difficult because most of them had already established connections through the Bio-innovation project.

The 'Bio-innovation for Africa' Pitching Competition judging panel during the pitch competition.

Every afternoon, while one group was in the laboratory for their hands-on laboratory practical session, all the other groups worked on their ideas. For some teams, it took a while to agree on one idea because they had many ideas on how some of Africa's numerous challenges, especially hunger, malnutrition and poverty can be solved.

On the last day of the workshop, all 18 teams pitched their new ideas for start-ups or non-profit organisations to a panel of expert judges. The judges included Adam Amoussou (Founder & CEO at Amosconsult Group, Benin who was recognised as a Forbes Africa Under 30), Dr Matias Acosta (postdoctoral research associate, University of Cambridge and Founder & Executive Director of Shaping Horizons) and a finance expert in one of Benin's national banks. Following a 5-minute pitch from each of the 18 teams, the judges gave constructive feedback, and shortly after, announced the winners of the competition.

WINNERS OF THE BIO-INNOVATION FOR AFRICA PITCHING COMPETITION 2019

The competition was split into two categories: start-up companies or non-profit organization. For each category, one winner (first place) and two runners-up were selected and awarded non-cash prizes. The winner of the start-up category was **Mwana-Mix**, an Africa-based start-up company looking to produce baby food that enhances nutritional efficiency of infants and children in sub-

Saharan Africa. According to the team, Mwana-Mix will be made with two African indigenous crops that are rich in vitamin A and protein.

The runners-up in the start-up category were 1) **Mobile Science**, a start-up company aiming to develop mobile apps to enhance STEM education in secondary schools across Africa, and 2) **Kaju-Agroprocessing company**, a start-up specialising in the production of healthy yoghurt from cashew apples, which are usually discarded and wasted after their nuts are collected.

Some of the teams pitching their start-ups or non-profit organisations to the judges.

For the non-profit category, the winner of the pitching competition was **ScInnovate Africa**, an Africa-based start-up consultancy firm aiming to promote science communication and science policy across Africa. The runners-up were, 1) **Beans Plus**, an organisation looking to produce affordable and time-saving spicy cowpea (beans) flour for low- to mid-income class citizens, and 2) **NARIA** (Networking Agricultural Research and Innovation in Africa), which aims to promote connections between researchers, extension workers and farmers in sub-Saharan Africa.


A group picture of all the winning teams with members of the judging panel and the 'Reach & Teach' team.

Why the 'Bio-innovation' challenge? The exercise raises the visibility for African researchers to present their challenges and the approach they can take to solve the problems. In previous workshops, this led to the creation and/or support of a water filter system in Kenya, a Kenya-based 'One Village One Poultry' initiative, a sustainable seed enterprise (Ecoseed) based in Benin Republic, and a Nigeria-based Science Hub to inspire secondary school children to pursue careers in STEM and agriculture.

Just after the workshop in Benin, one of the candidates whose team did not win the 'Bio-innovation' prize went ahead to create a non-profit organisation called 'Nigeria Tech Lab'. The organisation aims to provide STEM education focusing on the use of technology to solve food security challenges in Nigeria. They have organised their first workshop on 'python and java script', which involved students from universities in Nigeria. These are the sort of impact our programmes are having on the continent. It not only creates a platform for local needs to be

addressed, it creates an opportunity for networking and long-lasting collaboration between researchers across different countries.

PROFESSIONAL DEVELOPMENT WORKSHOP

As part of the 'Reach & Teach' workshop, we offer a professional development course, which aims to provide information and knowledge on how to effectively write scientific publications and grant applications, give excellent scientific presentations at conferences or meetings, network and be a leader in science. This year's professional development course in Benin was taught by Dr Matias Acosta (*Feodor Lynen Fellow*, *University of Cambridge*) in picture below (left).


NETWORKING DINNER/RECEPTION

After lectures and labroatory practical on Wednesday, Enoch and his team organised an official welcome dinner and networking reception at a hotel in the city of Cotonu. Tired and hungry, we thought we were just going to eat some good African meals, network and go home and get ready for the next day. But to our surpise, we were joined by the Vice-Chancellor, Pro-Vice-Chancellors and other dignitaries from the University of Abomey-Calavi. Our collaborator had also organised an inspiring Beninise cultural dance performance by a student-led society in their university. It was a great experience.





The evening was great, but it didn't end there. Towards the end of the dinner, Enoch and his team presented surprise gifts to our team. The gifts were beautifully tailored African outfits, which they apparatently made within two days of our visit because all the outfits were our perfect sizes. They didn't only present the gifts to us, they dressed us up right there on the stage – haha! It was amazing!


The welcome reception dinner ended with lots of dancing. Our team, collaborators and all 100 participants and special guests danced to some wonderful African cultural music. It was incredible. Some African female scientists taught Emily and Jen (first and second from left in the picture on the left) some African dance steps.



CLOSING CEREMONY

The 2019 'Reach & Teach Science in Africa' workshop came to an emotional close, which included an award ceremony for winners of the pitching challenge and presentation of certificates to all the participants. Carol praised members of the 'Reach & Teach' team for their amazing work and absolute commitment throughout the week and months before the workshop. She also gave the participants a few words of advice and encouragement to always work together for the good of the continent.



Enoch also presented his amazing team, which brought a thunderous applause from the audience. They truly were fantastic in organising the event and keeping us happy and comfortable throughout the week.

TOUR OF THE TRANSATLANTIC SLAVE TRADE ROUTE

The following day, the teaching team and a few participants travelled to Ouidah, a town to the West of Cotonou, where we learned about the dark history of slavery in the region. Between the years 1600 and 1900, it is estimated that over 11 million slaves were transported from West Africa to the Americas, many of these from Benin. Learning about these atrocities in one of the most directly affected regions and seeing the harsh conditions that slaves were exposed to, added a new layer of sorrow to our feelings surrounding these terrible practices.

Image: "The door of no return"! This was the end of our tour of the transatlantic slave trade route in Benin Republic. This was the coast where the ship awaited the slaves to board and they left their country and people with no hope of ever returning. It was a very emotional experience for us, but it reminded us of what humanity is all about and why we should keep striving and doing good for the good of others and the society.

OUTCOMES, POTENTIAL IMPACT AND FUTURE PLANS

The 'Reach & Teach Science in Africa' project held at the University of Abomey-Calavi, Benin Republic provided Africa's present and future agricultural researchers:

- State-of-the-art training in modern scientific concepts and laboratory techniques, which they can apply to improve agricultural research, productivity and food security on the continent.

Note: Some of the workshop participants have informed us that they are using lecture notes from the workshop to teach hundreds of students in their universities. By reaching 100 Africa-based researchers, we indirectly reached thousands of undergraduate and postgraduate students who they lecture and/or supervise, with more relevant and up-to-date teaching materials that we provided during the workshop.

- Knowledge and hands-on experience on how to build low-cost bio-instrumentation, which provides an alternative for expensive laboratory instruments that are not readily available in many universities across Africa.
- A unique platform for relationship building, knowledge exchange and formation of new research partnerships to address food insecurity in sub-Saharan Africa.

- The project created an opportunity for UK researchers to visit African universities and meet agricultural researchers from the lowest income DAC countries. This inspired our team from the UK to learn about the real challenges hampering research and innovation in Africa, and how they may contribute their knowledge, skills and resources to enhance innovative research via collaborations with researchers in the poorer nations in Africa.
- The 'Bio-innovation for Africa' pitching competition encouraged the participants to develop solutions to some of the challenges faced in Africa. The exercise led to new Africa-based start-ups and non-profit organisations aiming to address challenges in Africa's agriculture, education and other sectors.
- **A follow-on workshop** is planned to take place at the University of Abomey-Calavi, Benin in June 2020. It will provide a more specialised hands-on laboratory training tailored to meet the research needs of early-career researchers and plant breeders from our previous workshop. In the future, we hope to establish the 'Reach & Teach' capacity building in other universities across the continent because that will enable us to reach more, teach more and form more collaborations that can effectively end hunger in Africa.

OUR TAKE HOME MESSAGE

In our experience developing capacity building programmes for African researchers, it is evident that African countries need a new generation of researchers and bio-industry leaders who can drive innovation forward across key sectors on the continent. Rather than depending on tools or technologies tailor-made for developed countries, African researchers must be enabled to develop their own solutions because they have a better understanding of the problems and are better placed to solve them. This is the goal of the 'Reach & Teach Science in Africa' capacity building project. To equip African researchers with knowledge and technical skills they need to develop, lead and conduct world-class research that solves specific problems in agriculture, health care and the environment on the continent.

Looking at the plethora of untapped and underutilised resources in Africa, including arable lands, food and crop varieties, even human resources, it may be fair to say that if Africa can feed itself, it can feed the rest of the world because it has the potential to do so. For this reason, we strongly encourage African governments and all key stakeholders, including international governments, NGOs, research councils, universities and funding organisations to work together and invest in building research capacity in African tertiary education institutions because that is where the innovations so desperately needed to end hunger in Africa can come from.

To learn more about JR Biotek Foundation and the Reach & Teach Science in Africa, visit our websites at www.jrbiotekfoundation.org and http://teachsciafrica.com/.

ACKNOWLEDGEMENT

Special thanks to the 'Reach & Teach' 2019 team for their time and effort in developing and teaching the workshop.

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- Conor Simpsons, PhD student, Department of Plant Sciences, University of Cambridge, UK
- Dr Trisna Tungadi, Postdoctoral Research Associate, Department of Plant Sciences, University of Cambridge, UK
- Dr Leonie Luginbuehl, Postdoctoral Research Associate, Department of Plant Sciences, University of Cambridge, UK
- Dr Noor Agip, Postdoctoral Research Associate, MRC, University of Cambridge, UK
- Carol N. Ibe, PhD student, Department of Plant Sciences, University of Cambridge, UK

Special thanks to the 2019 'Reach & Teach' guest lecturers for teaching the workshop.

- Catherine Danmaigona, PhD student, Texas A&M University, USA
- Dr Fernan Federici, Assistant Professor, Pontificia Universidad Católica, Chile
- Dr Matias Acosta, Research Associate, Material Sciences, University of Cambridge, UK
- Dr Thomas Alcock, Research Associate, University of Nottingham, UK
- Dr Ute Voss, Research Associate, University of Nottingham, UK

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