


AfriPlantSci

Course Report

Plant Metabolism for Improved Nutrition and Health

NM-AIST, Arusha ~ 19th February - 5th March 2017






Plant metabolism for improved nutrition and health is a field of research with tangible applications across the world, but particularly in sub-Saharan Africa. The most recent estimate (2014-2016) from the UN Food and Agriculture Organization states that 233 million people in sub-Saharan Africa are hungry or undernourished. In his 2017 annual letter, Bill Gates wrote that "nutrition is the biggest missed opportunity in global health". Improving nutrition and health through understanding and manipulating plant metabolism is an area of active research in sub-Saharan Africa, and is also a particularly strong area of research at the John Innes Centre.

This first AfriPlantSci course was the result of a collaboration between the John Innes Centre (JIC; Norwich, UK), Biosciences for eastern and central Africa – International Livestock Research Institute Hub (BecA-ILRI Hub; Nairobi, Kenya), and the Centre for Research, Evidence, Agricultural Advancement, Teaching Excellence and Sustainability in Food and Nutrition Security (CREATES-FNS) at Nelson Mandela African Institute for Science and Technology (NM-AIST; Arusha, Tanzania). The course was hosted by CREATES-FNS at NM-AIST, who also contributed as faculty for the final two days of the course. The remainder of the course was led by John Innes Centre faculty, with staff at the BecA-ILRI Hub and John Innes Centre contributing to the practical sessions. Funding for the course was gratefully received from the BBSRC and the World Bank.

The course covered breadth and depth of plant metabolism, and how aspects of plant metabolism can be harnessed to improve human health and nutrition. Topics included starch metabolism, iron and zinc nutrition, targeted engineering for biosynthesis of beneficial natural products and medicinal plant ecology. Throughout the theoretical part of the course, an emphasis was placed on recent results and current techniques, with faculty members presenting and discussing their own research. Importantly, the course combined theory with practice; interactive practical sessions gave participants the chance to apply for themselves some of the innovative techniques described by the lecturers.

The workshop was advertised to African Masters and PhD students and early career researchers, with three places made available for students from the John Innes Centre. 107 applications were received, and from these 20 scientists were selected to participate in the course. The participants came from 14 different institutions located in 10 different countries.

Aims of the Course

- To cover a breadth of topics in plant metabolism, combining theoretical delivery with applied practical sessions.
- To provide opportunities for networking, and to break down the barriers between early career researchers and senior scientists.
- To develop participants' ability to think critically about large scientific problems in terms of manageable research projects.
- To build the capacity of African scientists.
- To increase capacity of the host institution, through interactions with staff and students in parallel to the course, and by donation of consumable items.

Course Facilitators

Name	Role	Institute	E-mail Address
Giles Oldroyd	Coordinator	John Innes Centre	giles.oldroyd@jic.ac.uk
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Course Participants

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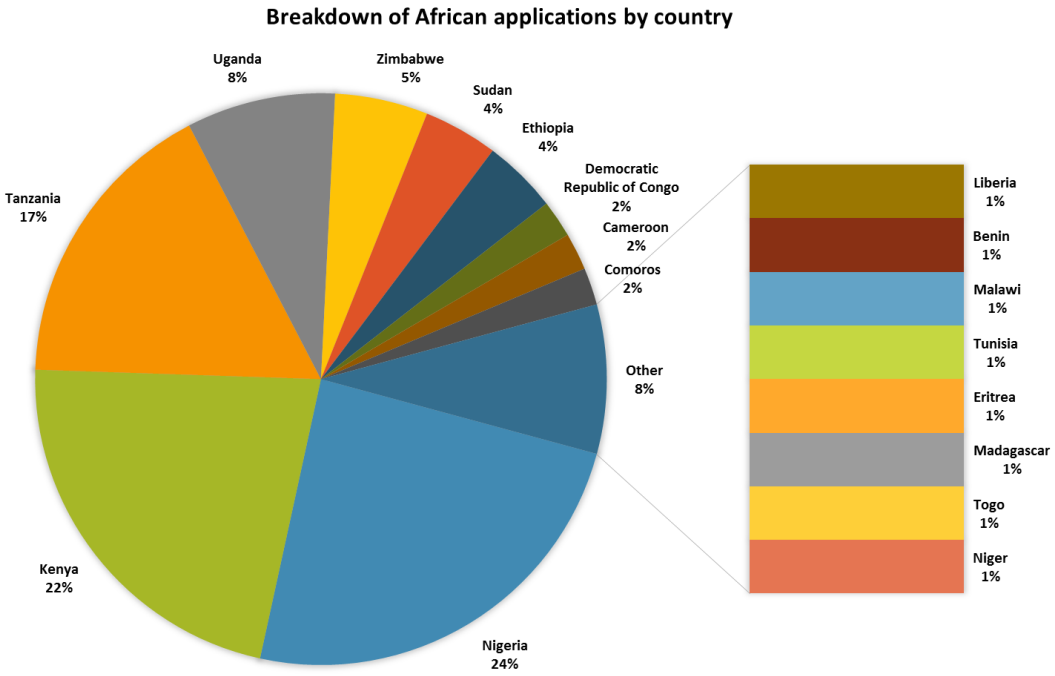
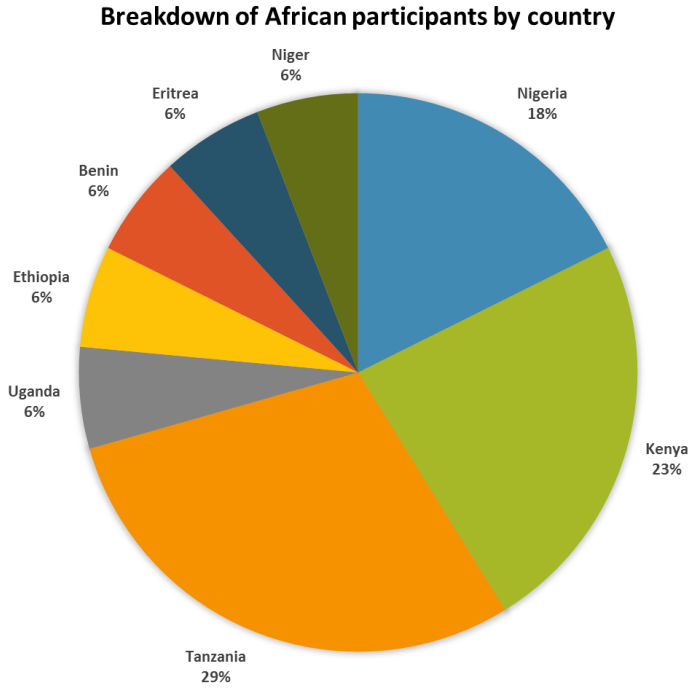
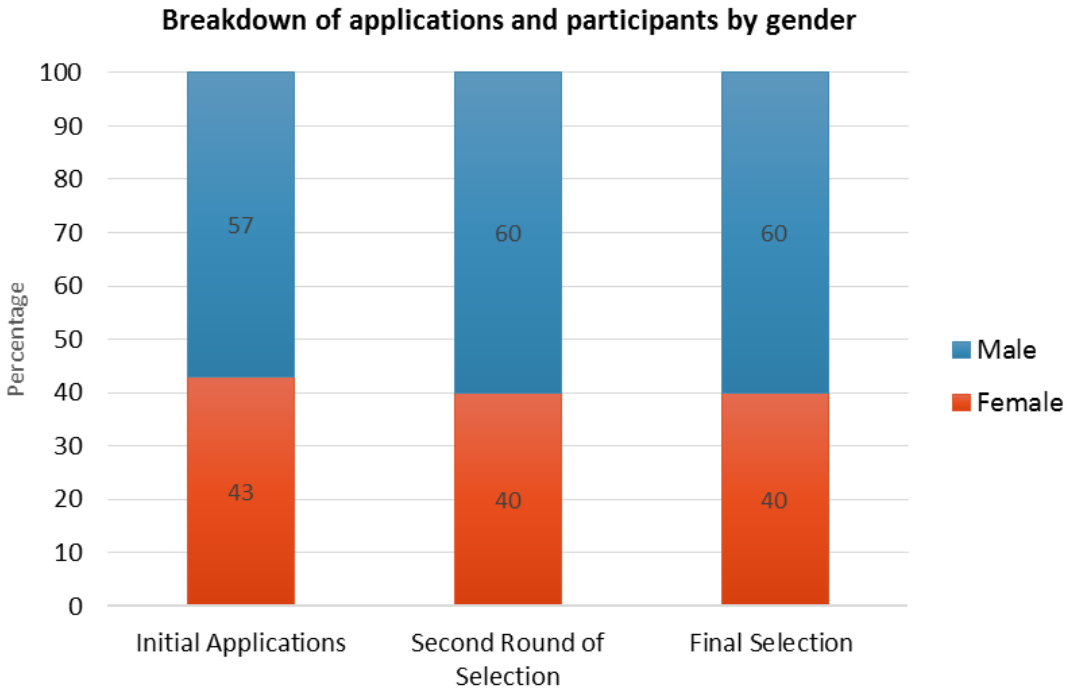
Application and Participation Data







Wordclouds (used for social media engagement) displaying diversity of countries, institutions, and crops of interest represented on the course:

John Innes Centre
Unlocking Nature's Diversity
biosciences eastern and central africa
ILRI
INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE
CREATES
The Nelson Mandela African Institution of Science and Technology
Arusha
Mt Kilimanjaro
Academia for Society and Industry
BBSRC
bioscience for the future
THE WORLD BANK

Course Contents

The JIC-led part of the course involved five faculty members from JIC, each delivering an introductory lecture, technical presentation, journal club and research seminar over a two-day period The research seminars were opened up to the public to benefit NM-AIST students and faculty members. The afternoons consisted of interactive practical sessions on techniques that related to the theory covered in the morning. The final two days of the workshop were organised and led by NM-AIST faculty, and focussed on nanoscience and medicinal plant ecology.

Week 1	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Day 1 19/02/17	**Day 2** 20/02/17	**Day 3** 21/02/17	**Day 4** 22/02/17	**Day 5** 23/02/17	**Day 6** 24/02/17	**Day 7** 25/02/17
AM **08:30 – 12:30**	**10:00** Introductory session led by **Giles Oldroyd**	**Alison Smith** Introductory lecture	**Alison Smith** Journal club	**Janneke Balk** Introductory lecture	**Janneke Balk** Journal club	**Dale Sanders** Introductory lecture	**Dale Sanders** Journal club
		MID-MORNING BREAK					
		Alison Smith Technical lecture	**Alison Smith** Research seminar	**Janneke Balk** Technical lecture	**Janneke Balk** Research seminar	**Dale Sanders** Technical lecture	**Dale Sanders** Research seminar
		LUNCH					
PM **13:45 – 17:00**	**13:45** Introductory session led by **Giles Oldroyd**	**Practical 1.** Extraction of starch, microscopy	**Practical 2.** Quantification of starch	**Practical 3.** Staining grains for iron, FCR assay	**Practical 4.** Quantification of phytate	**Practical 5.** Staining grains for zinc	**Practical 6.** Demonstration of ICP-MS,
EVE		Drinks reception with **Alison Smith**		Drinks reception with **Janneke Balk**		Drinks reception with **Dale Sanders**	***GROUP TRIP OUT FOR DINNER***

Week 2	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
	Day 8 26/02/17	**Day 9** 27/02/17	**Day 10** 28/02/17	**Day 11** 01/03/17	**Day 12** 02/03/17	**Day 13** 03/03/17	**Day 14** 04/03/17
AM **08:30 – 12:30**	***EXCURSION***	**Sarah O'Connor** Introductory lecture	**Sarah O'Connor** Journal club	**Cathie Martin** Introductory lecture	**Cathie Martin** Journal club	**Theresa M. Allen** Nanoscience for plants 1	**James Kahurananga** Visit to NM-AIST Botanical Garden
		MID-MORNING BREAK					
		Sarah O'Connor Technical lecture	**Sarah O'Connor** Research seminar	**Cathie Martin** Technical lecture	**Cathie Martin** Research seminar	**Theresa M. Allen** Nanoscience for plants 2	***EXCURSION TO MONDULI***
		LUNCH					
PM **13:45 – 17:00**		**Practical 7.1** Preparation of plant extracts, quantification of phenolics	**Practical 7.2** Quantification of flavonoids purification by SPE column	**Practical 7.3** Yeast reporter assay	**Practical 8.** Demonstration of HPLC	**TBC** Nanoscience for plants 3	***EXCURSION TO MONDULI***
EVE		Drinks reception with **Sarah O'Connor**		Drinks reception with **Cathie Martin**	**16:00** Feedback session, followed by drinks reception with **JIC/BecA lab team**		

Feedback from Participants

Expectations

- Learn novel practical techniques in plant metabolism to use in their own research projects.
- Understand and use cutting-edge technologies to analyse plant nutrient/metabolite content.
- Gain advanced knowledge from leading scientists in the field of plant metabolism.
- Develop networks with current and future leaders in the field for future collaborations.

Positive Feedback

- Overall, the course was very well received, with students complimenting the content and delivery of the course.
- The participants particularly enjoyed the practical sessions, and noted that the theoretical and practical sessions linked well with each other.
- The journal clubs were also very popular; participants appreciated the interactive discussions and some participants commented that this was the first training they had received in critical evaluation of scientific literature.
- The participants appreciated the interaction with each other and with the faculty.

Identified Opportunities for Improvement

- The most frequently noted suggestion for a change to the course was to increase the time allocated for the practical sessions and for discussion of the results.
- The participants also highlighted a need for greater introduction to the practical sessions, including the rationale behind the practical and the overall aims.
- The lack of air conditioning and size of the lab at NM-AIST were raised as issues.
- There were some problems with accommodation (number of keys and cleanliness) and internet access.
- There was a lack of things to do in the evenings, and it was suggested that optional social activities in the evenings are arranged for future courses.

Quotes from Participants

"I would definitely recommend that scientists and students apply to the next course. During this course I have gained insights into iron and zinc homeostasis, and I have learnt new technologies that will advance my research. I was also able to build a network with other scientists that will be useful for future collaborative work." - ***Bassirou Sani Boubacar Gaoh, WACCI & ICRISAT, Niger***

"The workshop has brought us closer to the instruments that we read about in the literature. We've been able to have hands-on training on these instruments and we can now apply them in our future research work." **- *Ngozi Edoh, Donald Danforth Plant Center, USA***

"I enjoyed the journal clubs, as this was a chance for us to extend and apply what we had learned and to think critically about other people's work. The course was a great opportunity to meet and interact with senior scientists working in our fields." – ***Frejus Sodedji, University of Abomey-Calavi, Benin***

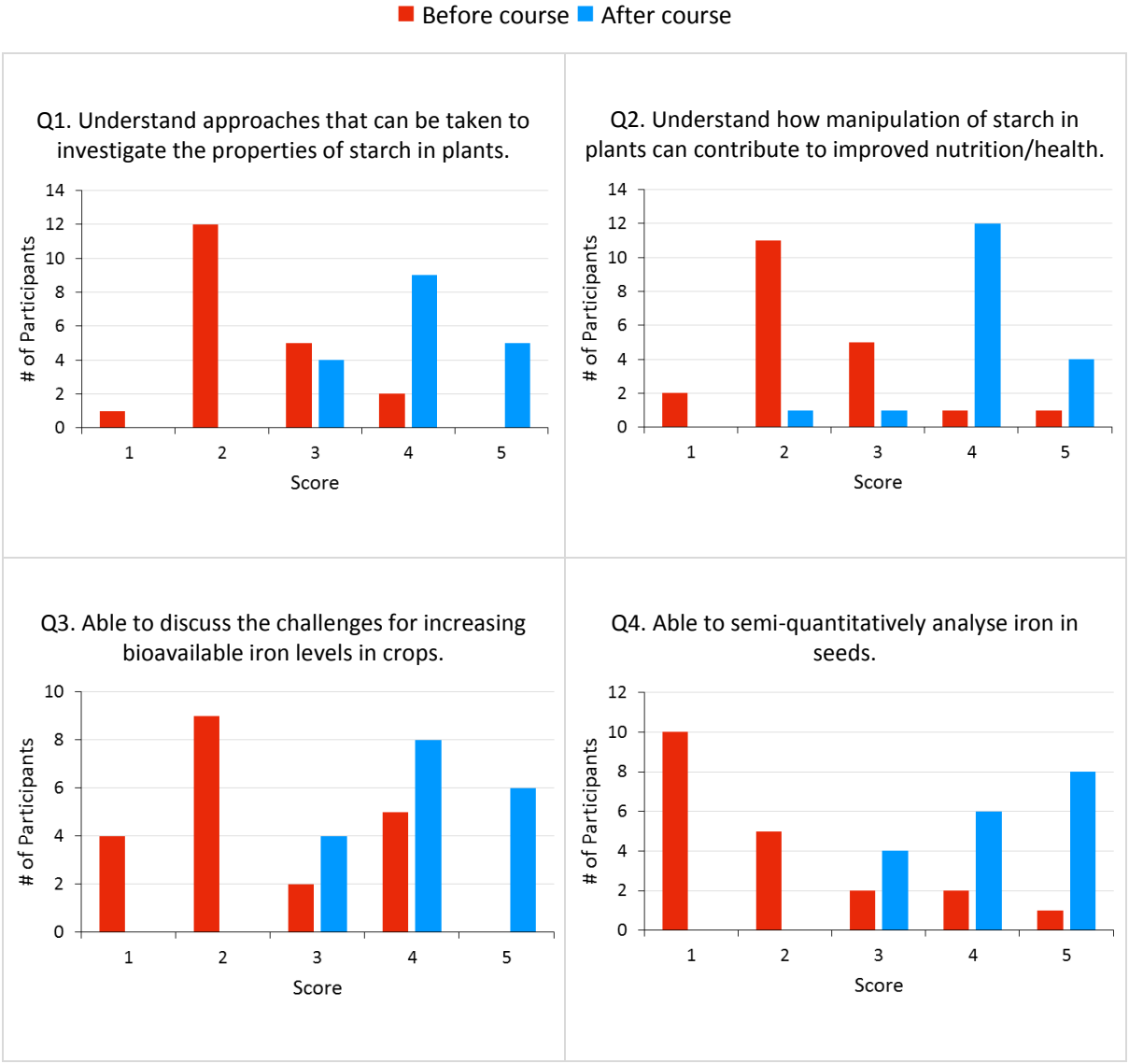
"I think the practicals complemented the lectures very well, and I think the balance of different subject areas within metabolism has been really good." – ***Jenny Walton, JIC, UK***

Evidence of Increased Confidence and Capacity

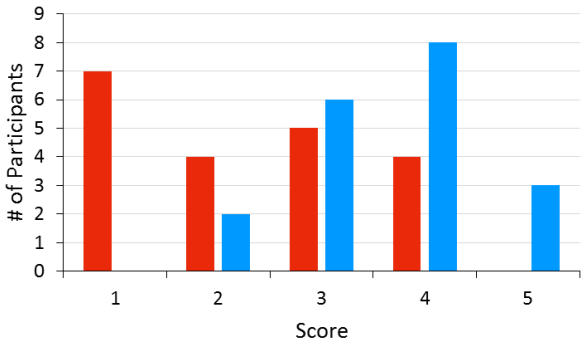
Participants were asked to rate their level of confidence/ understanding for each of the research-related statements below using the following scale:

1 = Not confident/do not understand the topic
2 = Understand the basic principles but limited confidence in discussing the topic
3 = Confident enough to discuss the topic with a peer in the field
4 = Confident in making your own research decisions relating to the topic
5 = Confident enough to teach others and provide advice

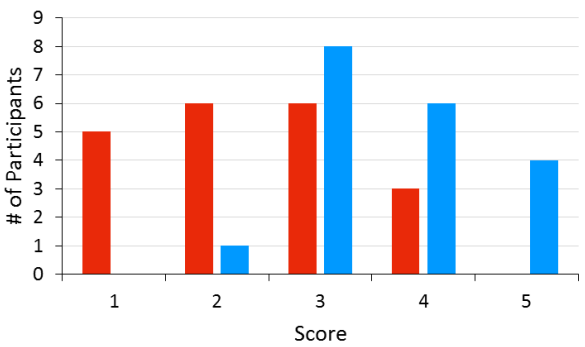
The same questionnaire was given to participants at the beginning and end of the course. Their responses are displayed in the bar charts below. For each of the statements, the participants' confidence and capacity increased during the course.



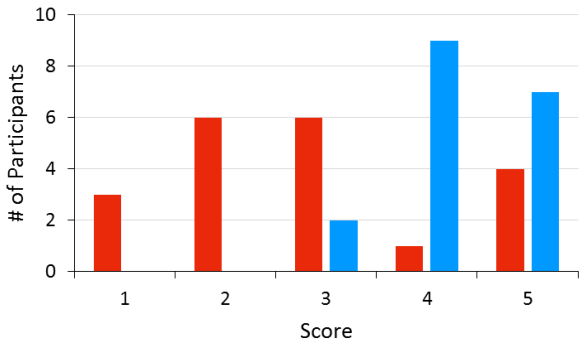
Q5. Understand how membrane transporters can contribute to plant nutrition.



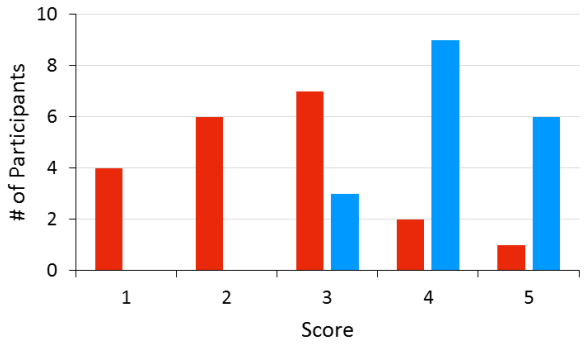
Q6. Understand how biotechnological approaches can biofortify crops for human nutrition.



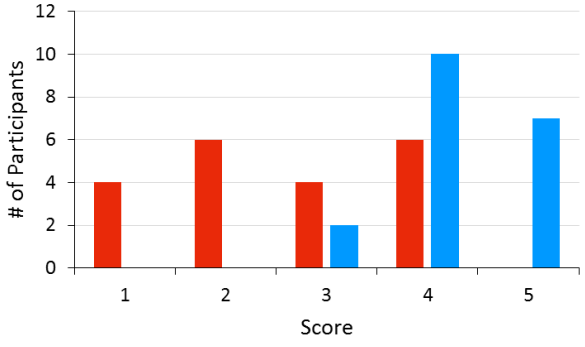
Q7. Understand how molecules in plants can be used for medicine.



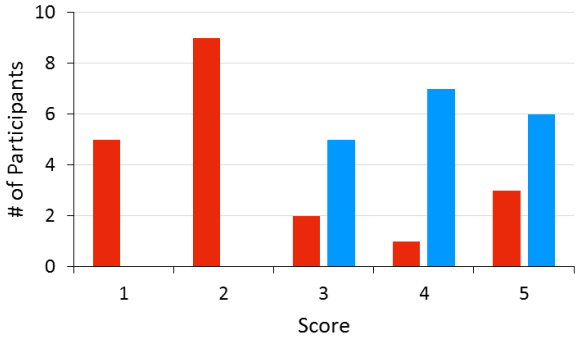
Q8. Understand how metabolic engineering can make molecules more accessible for medicinal uses.



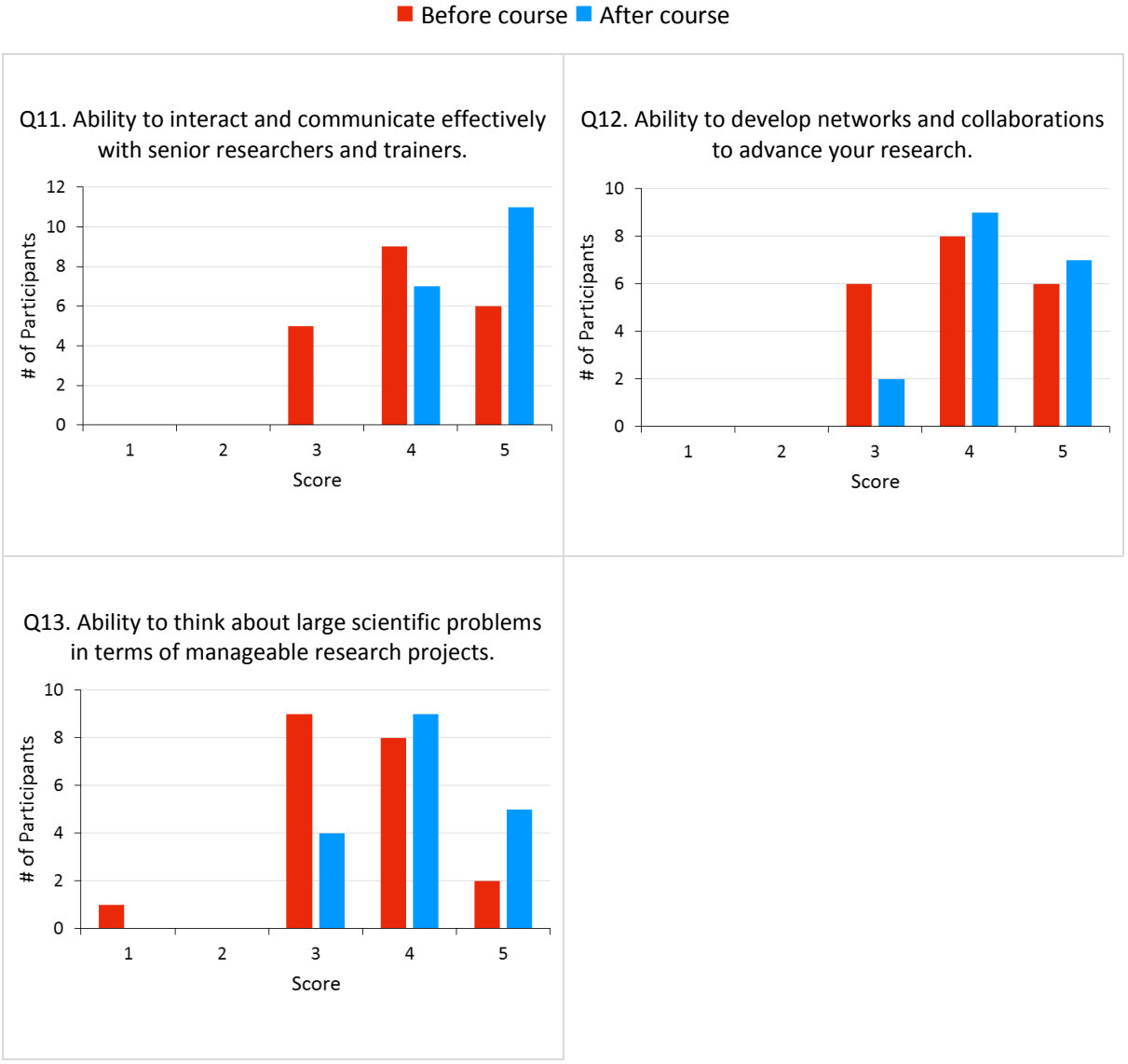
Q9. Understand how manipulation of secondary metabolism can improve nutritional properties.



Q10. Understand the techniques that can be used to identify specific secondary metabolites.



Participants were asked to rate their confidence in each of the statements below; with *1 = not at all confident* to *5 = very confident*. The same questionnaire was given to participants at the beginning and end of the course. Their responses are displayed in the bar charts below.



Feedback from Facilitators

"I've really enjoyed the level of engagement shown by the students. They've been very active, contributing a lot to discussions, and are clearly interested in the subject material. Working here at NM-AIST has had its challenges, but the benefit of holding the course here is that you have a much broader and more significant impact than if you ran the equivalent course in the UK. Not only do the students benefit from being able to engage with world experts, but we also leave a legacy behind at the institution, and have been able to contribute to the mission and vision at NM-AIST.

When you're doing science, you have to consider the scientific question you are aiming to answer and the theory underlying it, but also how you will answer the question in a practical sense. It's very important to combine theory and practical, and that is what we wanted to do with this course. We also wanted to get participants to think critically about published work and their own research programmes.

In hindsight, we needed to spend more time discussing the practical sessions. We assumed too much prior knowledge at the beginning of the course, and needed to offer a more basic practical training to cover topics such as standard curves and concentration calculations. We also needed more time to review the practical afterwards, and discuss the results. However, as the course went on we identified this and accommodated it as best we could." – ***Giles Oldroyd, Coordinator, JIC***

"There were many things I enjoyed about this course, but one of the best parts was getting to interact informally with students who had had very different scientific backgrounds and experiences in their home countries. From a teaching point of view, I would absolutely would recommend this course to other scientists. I've found the students to be an amazingly responsive, diverse and enthusiastic group of people who are determined to be good scientists and to ask sensible and challenging questions.

I think it's important to have these types of courses to allow exchange of ideas between different scientific cultures. I've been asked a number of challenging questions which have really made me think about how I do science, particularly in an applied sense. The principal objective of the course is capacity building, and the things we can do to help advance science in sub-Saharan Africa, and one of the unusual features about this course is that it has given participants practical experience alongside theory. From speaking to the students, the opportunity to translate what they have learnt in the lectures to real work at the bench was very important to them." – ***Dale Sanders, Lecturer, JIC***

I've enjoyed many aspects of this course, but it was particularly interesting to meet all the students from different countries. I would definitely recommend it from a teaching perspective; working here has presented challenges in the delivery of the practical sessions and you have to be able to improvise, for example when the electricity cuts out mid-practical. From a scientist's point of view, it's been very interesting finding out what the students want to get out of their research. At JIC, we mostly focus on pure science research, but in sub-Saharan Africa the emphasis is very much on applied science and getting products and technologies out to the farmers.

I think that in hindsight I would have simplified some of the protocols. When deciding on partners for the practical sessions, we tried to pair up people who had lab experience with those who had none, and it was great to see some of the more experienced scientists explaining protocols and working through calculations with the less experienced participants." – ***Anne Edwards, Lecturer, JIC***

Future Perspectives

- Feedback from the participants indicated that this course provided a unique training experience by combining theoretical and practical approaches. It was acknowledged that opportunities for training in advanced practical techniques were limited in the region. Overall, the participants were strongly in favour of future AfriPlantSci training courses with a similar approach.
- It was suggested that the AfriPlantSci course should go “on tour”, and be hosted by a different institution each year. While there are obvious benefits associated with continuing to be hosted by NM-AIST, facilities for certain techniques, particularly molecular biology, are lacking and a course focussing on these techniques may be better hosted elsewhere. Going “on tour” would also build capacity a wider range of institutions; in addition to the benefits to the NM-AIST students participating in the course, numerous staff and students were trained in HPLC analysis, the university benefited from donated consumables, and the NM-AIST community were invited to the research seminars given by the JIC faculty.
- As the first two lecturers on the course, Alison Smith and Janneke Balk were present on the first day for the icebreaker session, and it was noted that this initial interaction not only helped the lecturers pitch their delivery/content to the audience, but also made these two lecturers more approachable in the eyes of the participants. It was suggested that future courses could be divided into two weeks, with each faculty member coming for a complete week, and an icebreaker session at the start of each week.
- It was suggested that future courses could allow time at the end of the course for participants to use what they have learned to design their own research project.
- Future topics to explore for AfriPlantSci workshops include biotic interactions, abiotic interactions, plant development for improved yield and crop genetics.

Photographs

Participants, organisers and faculty members get to know each other on the first day.

Ifekristi Ogunwobi (top) and Alison Smith (bottom) explain their research in the flipchart session.

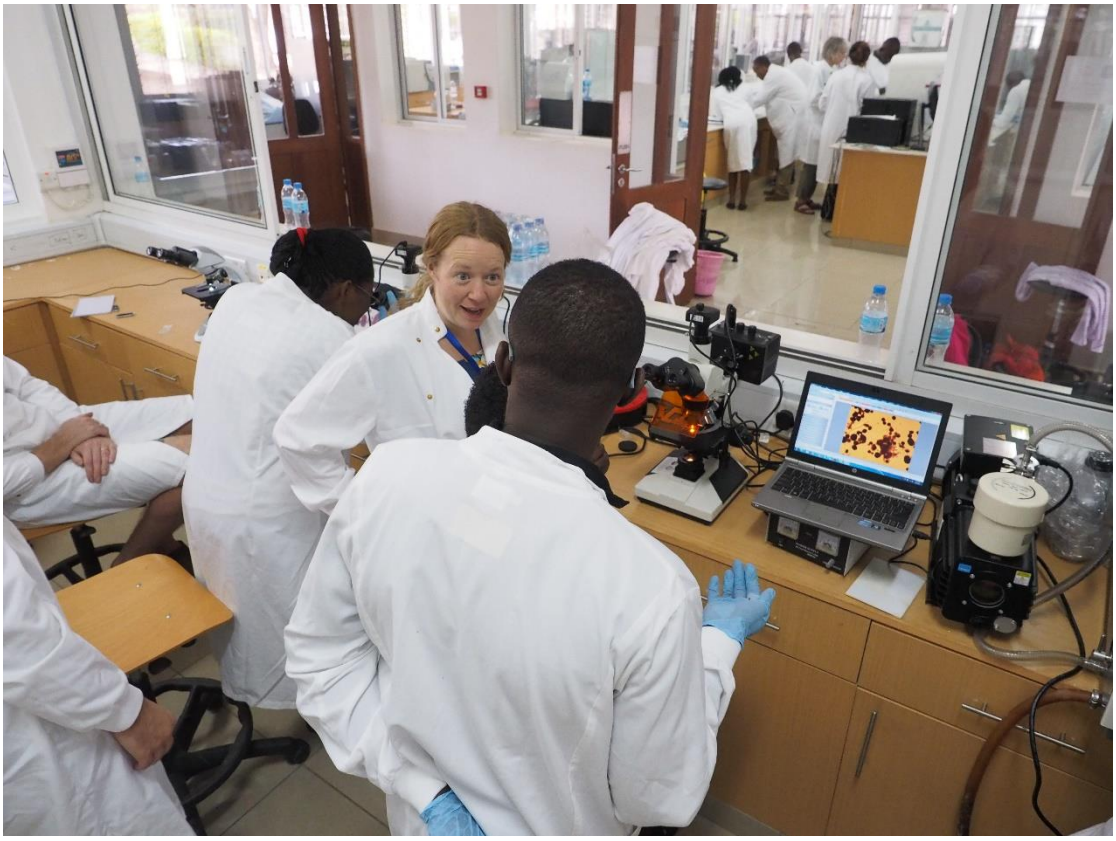
Ngozi Edoh presents her research on cassava to fellow course participants.

Giles Oldroyd introduces the first faculty member, Alison Smith, to discuss starch metabolism.

Participants evaluate the merits of scientific papers during the journal club session.

Participants in the laboratory at NM-AIST.

Josie Maidment advises Frejus Sodedji on further purification of his starch extract.



Tilly Eldridge supports participants in using light microscopes to observe starch granule morphology.

Janneke Balk lectures on iron nutrition, bioavailability of iron and biofortification of crops.

Ruth Omole, Bassirou Sani Boubacar Gaoh and Samuel Baiyeri in deep discussion during journal club.

Janneke Balk provides advice on investigating ferric chelate reductase activity in iron-deprived seedlings.

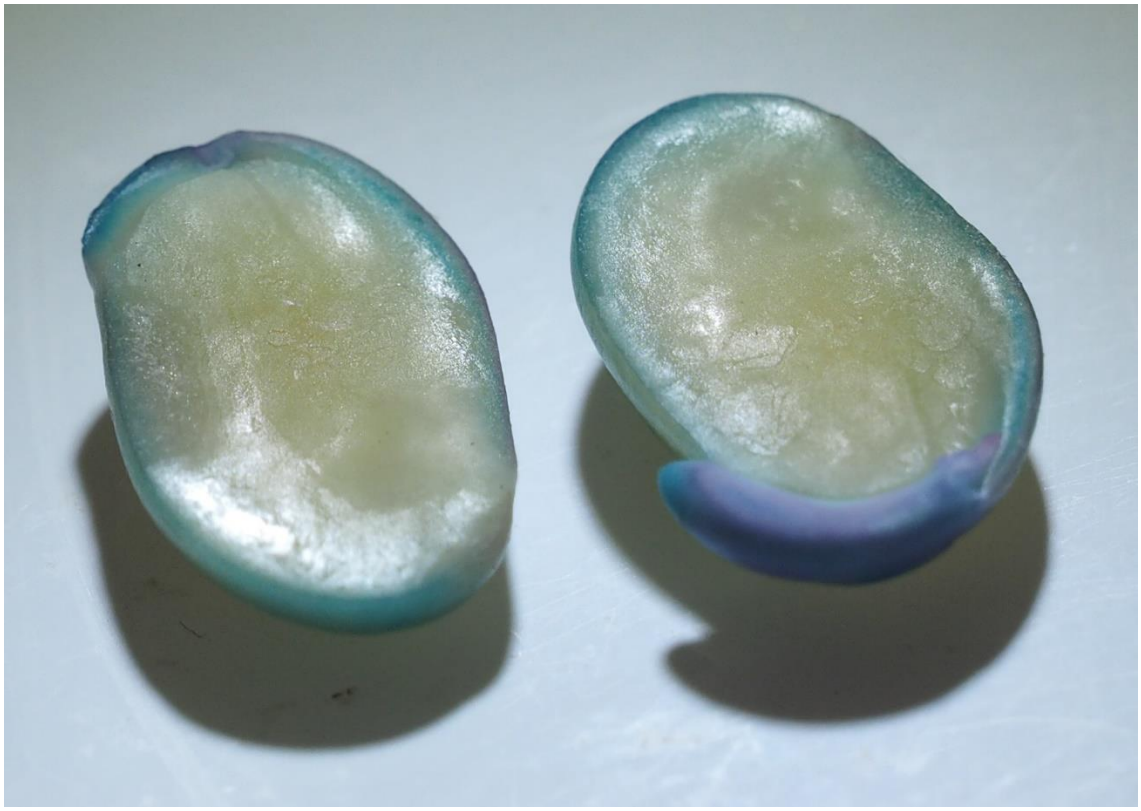


Image of lab-lab after staining with Prussian Blue to qualitatively investigate iron content.

Anne Edwards demonstrates use of pipette filler to Ifekristi Ogunwobe and Biniam Mesfin Ghebreslassie.

Fredrick Ng'ang'a introduces participants to quantitative analysis of nutrient content by ICP-MS.

Biniam Mesfin Ghebreslassie carefully pipettes DTZ reagent to stain grains and legumes for zinc.

Image of maize grain following staining with DTZ to visualise zinc.

Ngozi Edoh and Frejus Sodedji working together in the laboratory.

Giles Oldroyd observing the results obtained by Fred Masika and Trizah Koyi Milugo.

A wide array of samples ready for secondary metabolite analysis.

Sarah O'Connor discusses cutting-edge techniques for secondary metabolite analysis.

Sarah O'Connor delivers a research seminar on harnessing the chemistry and biology of plants.

Cathie Martin teaches participants about the importance of integrating nutrition and health studies.

Photographs were taken by Nathan Sukhnandan.