University of Nottingham
Future Food

A Year in the Life of the Future Food Beacon 2019/20

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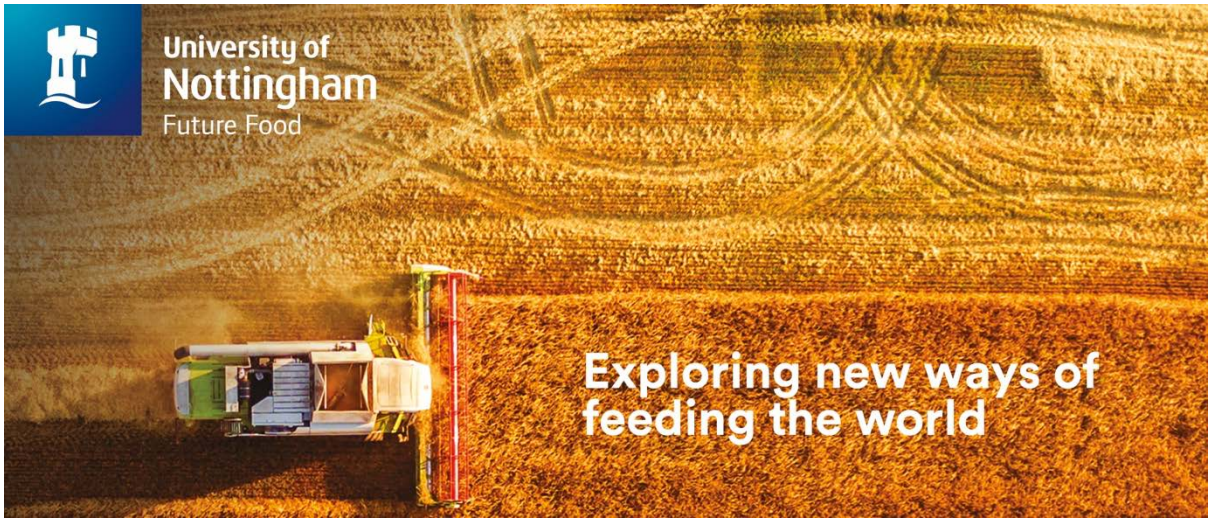
Table of Contents



LETTER FROM

Our Director

The Future Food Beacon is one of six Beacons of Excellence that the University of Nottingham is investing in to respond to a variety of global challenges.

By 2050, there will be an additional 2 billion people on the planet. Currently, 815 million people are chronically undernourished worldwide, while 680 million are obese. Coupled with the challenge of feeding a global population of nearly 10 billion nutritiously, are changes to the climate, rapid urbanisation, and social inequality. This growing global population will need sufficient calories and essential nutrients derived sustainably from innovative food systems. Food decisions are complex, influenced not only by production methods and quality but also by cultural and historical influences, personal choice, access and taste.

The Future Food Beacon brings together the power of genome-enabled plant and animal sciences with cutting edge nutritional science, food processing and manufacturing and digital technologies, informed by an understanding of the economic, legal, social and ethical issues that underpin and shape food systems. We are finding better ways to understand our food systems through transdisciplinary research.

Future Food Beacon researchers are developing solutions to these challenges, working with practitioners and policymakers, through four key research strategies: **Future proofing agricultural systems; Food for sustainable livelihoods; Food for health; and Smart manufacturing for food**.

In this second edition of our annual yearbook, we offer stories from the Future Food Beacon, including interviews with new group leaders, travel stories from research trips abroad, features on underused crops and a cross-section of updates on our cutting-edge research. We hope you enjoy the diversity of what we are doing!

Professor David E Salt

Group Leader Update

Measuring metabolites across the food chain: An interview with Dr Tristan Dew

Dr Tristan Dew is an Assistant Professor in Molecular Phenomics and a member of the Future Food Beacon. His work explores how mass spectrometry-based technologies can be used to rapidly assess metabolism within plants, animals and humans. In this interview, Tristan talks to Dr Lexi Earl about his research career, reasons for joining UoN, and his current projects.

Tell me about your work?
I lead the new Molecular Phenomics research group at Sutton Bonington. Molecular Phenomics investigates how the metabolism of living things relates to their genetics and their environment. We are currently building up a new Mass Spectrometry facility to offer both targeted and untargeted techniques to answer big questions across the food chain. On a day to day basis, this means I work with researchers in the plant, food, animal and nutritional sciences to develop novel techniques to accurately measure metabolites in a range of organisms.

Tell me a little about your research career?
My main expertise lies in profiling and exploring the metabolic fate of plant secondary metabolites – these are compounds that are not essential for growth, but help plants survive challenges from biological threats (e.g. fungal infection), and from environmental stressors (e.g. excessive UV exposure). Often these compounds imbue foods with colours and unique flavours, and when ingested may also influence their health. I did my BBSRC-CASE sponsored PhD in Food Biochemistry at the University of Leeds, where I was exploring whether tea (i.e. Camellia sinensis) has functional health properties for humans. This got me into the world of human intervention trials, the concept of healthy ageing, and made me think very carefully about the type and strength of evidence needed to make health claims for food. I continued as a lab manager and post doc as part of the Functional Foods research group at Leeds, where my research broadened out into other polyphenol rich foods (coffee, cocoa, berries and citrus fruits) and into a wider range of health areas ranging from clinical dermatology to cardiovascular disease. I developed several new analytical techniques to follow dietary components through the human body, sometimes in really novel tissue samples. I've since held lectureships in both biochemical pharmacology and food science, and before joining the beacon I was leading a successful MSc programme in Food Science and Innovation at Manchester Metropolitan University.

How did you become interested in science?
As a kid, science lessons and school plays grabbed most of my attention, so I think university lecturing was something of a foregone conclusion. My mum was also a great positive influence. She spent most of her career in analytical chemistry, and I think seeing

her labs for the first time was what swung it. She took the time to explain what each shiny piece of analytical equipment did, and how they all worked together to build a complete picture. I knew I wanted my own lab one day!

Tristan with his dog, Maple.

Why Future Food? What would you like to accomplish while you're here? How does being part of Future Food help you achieve your goals?

I thrive on solving new analytical problems, and the new mass spec facility is a powerful answer! Being part of the Beacon means the opportunity to collaborate with experts across the entire food chain, working on themes such as crop science, human nutrition, animal health, food quality, and the provenance and traceability of ingredients. A big pull was the Beacon investment in high resolution mass spec. The ability to pull in quantitative "all ion" data, potentially separating hundreds, if not thousands of chemical species in a single analytical run, is a real game changer. Nottingham has huge expertise in linking genetic traits with desirable phenotypes, such as drought tolerance, or pest resistance in crops. The expression of these genes will result in proteins, but those proteins enact their function through metabolism. Being able to survey the entire metabolome means we can get a real jump start on understanding the important mechanisms at play. This means I can contribute towards building a more sustainable global food supply.

What current projects are you working on?

I have so many exciting projects! Right now, I am working collaboratively on very sensitive methods to detect DNA/RNA modifications in a range of species, and to quantify plant hormones and their metabolites – this will help us to better understand how plants grow and adapt to various stressors. I'm also about to use a nontargeted metabolomics approach to map the changes undergone by Colombian cacao beans during fermentation. This entails using high resolution time of flight mass spectrometry to capture "all ion" data. We can then use multivariate statistics to pull out which compounds drive the important differences between the samples. Hopefully, we'll be able to link this to sensory traits in the final product, so we can understand why single origin cacao develops a unique flavour. I also have my own PhD students who are using high res mass spec to explore potential biomarkers of diet, and how to make a frothier cup of coffee.

Tristan with some of the first batches of ale made by Tristan's food science and innovation students at MMU.

How do you explain your research to an ordinary person?

Science works best when researchers have accurate and precise tools to measure small differences between samples. Mass spectrometry is often described as a very fine set of scales, used to weigh the mass of individual molecules. I use this technology to measure the concentrations of primary and secondary metabolites in plants, foods and even in humans. This can inform us to the health of an organism or the utility of a material being tested. Eventually, this can help us to make foods that are easier to grow using less resources, and that are tastier, more nutritious and longer lasting.

D**o you have a greatest career moment?**

I'm not sure about greatest, but completing my first lab build, and getting my first new course approved were both very proud moments. Creating valuable resources that others will benefit from is a real pleasure for me. Nottingham has a great reputation for supporting the long term development of early career researchers, so I get to help others, and can in turn benefit from the experience of world leading experts.

The inside of a LCMS rough pump, partway through a service.

Do you have any advice for young scientists?

Pick a discipline based on what you find truly magnetic and fascinating – this will keep you going through the hard bits. Also, try to understand that what seems straightforward to you might be quite complicated to others – and vice versa! This is why collaboration is so vital.

A triple quadrupole mass spectrometer being serviced (Agilent model 6410).

Researching fermentation in cocoa: Prof. David Salt

Prof David Salt recently visited the Cocoa Research Centre in Trinidad & Tobago. In this post he reflects on our cocoa project in Colombia, and the work we are developing with the CRC.

Our Colombian cocoa project began because we were interested in understanding the connections between the way fermentation works in cocoa beans and how this then affects flavour. We have known for a long time that fermentation affects flavour, but there has not been an in-depth, systematic analysis to understand what happens at the molecular and environmental levels. How do these factors interact to make the fermentation go one way or another? How does that then result in a particular flavour? The genetics of the cocoa tree and the environment interact together and affect fermentation. The end result is cocoa beans and chocolate with different flavours.

Prof. Salt looking at fermentation boxes filled with cocoa beans, with colleagues from CRC.

Until now, our understanding of fermentation has been fairly binary – it is either good or bad. If it is a good fermentation, the beans can be sold to make chocolate. If it is a bad fermentation, the farmer won't be able to sell the beans, or will get a low price.

Now, with the growth of the premium bean-to-bar market, single origin chocolate, scientists, farmers and chocolate makers are starting to dissect more carefully what happens during the fermentation, including analysing farm locations, genetic varieties, and other factors that might influence flavour development. People are becoming much more interested in all the various flavours cocoa can develop. This is very much like what has happened in the wine space, where the skill of the winemaker is used to tease out all the potential flavours of the grape. We seem to be at the very beginning of that in cocoa, and understanding fermentation is a key step in order to optimally express different flavours.

Prof. Salt inspecting cocoa beans drying at a farm local to the CRC.

Our Colombia project has been a stepping stone towards that understanding. But in order to further this research we need to be able to experiment in controlled environments, as well as understanding what happens in the natural environment, on the farm. It is useful to us, as scientists, to find out what creates good fermentations but also what causes bad fermentations. That is not something that can be done on-farm, because that would affect the farmers' ability to sell their cocoa beans and thus negatively affect their livelihoods.

Prof Salt looking at cocoa fermentations with a colleague from CRC.

By working with the CRC, we are able to experiment with fermentations in both the controlled environment of a lab and the natural environment on the farm. In Trinidad, the CRC has mapped the flavour regions across the island, and farmers document flavour against the location of the beans. We can then work with the CRC to understand fermentations that produce nutty flavours, or citrus or floral ones. The possibilities are endless. We are very excited about this developing collaboration.

Prof. Salt (left) with Prof Umaharan Pathmanathan (centre) and Darin Sukha (right) from the Cocoa Research Centre in Trinidad.

Visiting Research Fellows and Collaborators

Collaborations with Embrapa to research Brazilian agricultural practices

Pantanal, Brazil

The Future Food Beacon is developing a working partnership with Embrapa, Brazil. Embrapa, the Brazilian Agricultural Research Corporation, is part of the Ministry of Agriculture, Livestock, and Food Supply and is concerned with generating knowledge and technology for Brazilian agriculture. In late 2018 and early 2019, supported by the UoN International Collaboration Fund, six Future Food researchers travelled to various Embrapa research centres across Brazil, to meet with researchers and discuss opportunities of collaboration and research, showcasing existing expertise from our Sutton Bonington campus in soils, crops, and livestock. We are excited that we are able to fund six projects that emerged from these visits through our Future Food Innovation Fund.

Sustainable intensification – led by Dr Stephen Ramsden

Dr Stephen Ramsden and colleague amongst trees and pasture land in Brazil

This project focuses on demonstrating the economic and environmental sustainability of production systems based on on-going farming practices in the Brazilian savannah. The research will develop measures of sustainable intensification (across economic, environmental and social dimensions) for a sample of farmers from the Goiás region in Central West Brazil. Dr Ramsden explained, *"the idea behind sustainable intensification is to produce more, but with lower environmental costs and greater environmental benefits. Agro-forestry practices in Brazil have considerable scope to achieve this, delivering a range of benefits, including carbon capture and providing shade for livestock".*

Impacts of agrochemical use in the Brazilian Pantanal – led by Dr Lisa Yon

The Brazillian Pantanal is the world's largest tropical wetland and supports a unique, and highly diverse, ecological community. Evidence suggests that a combination of encroachment of intensive agriculture and widespread use of agrochemicals is impacting wildlife in the area. It is therefore essential to understand the impact of contaminants and the risks they pose to this ecosystem to identify strategies for reducing their impact. This project is a collaboration between the University of Nottingham, Universidade Federal de Mato Grosso do Sul (Fabio Roque) and Embrapa, and aims to identify the presence and ecological impacts of agrochemicals in aquatic systems by sampling invertebrate, fish and reptile tissues, in combination with environmental samples. Workshops in Brazil and the UK will lead to knowledge exchange activities, particularly around methodologies for quantifying organic contaminants. Results will inform future planned work on assessing the impacts of agrochemicals in this internationally significant environment.

Dr Lisa Yon with colleagues at Embrapa Pantanal

Improving combinatorial abiotic stress tolerance in upland rice –led by Dr Paulina Flis, Dr Rahul Bhosale and Dr Gabriel Castrillo

Rice is a key cereal crop, and rain-fed upland rice accounts for 47% of rice growing areas in Latin America. Upland rice has greater potential for water saving, reduced labour costs, and better adaption to climate change than its lowland counterpart. This project is based at Embrapa Rice and Beans, Goiânia and will characterise the performance of contrasting upland rice genotypes, determine the water status and nutritional profiles of upland rice grown under combined water and low phosphorous stresses, and will evaluate root architectural and anatomical traits of rice grown under these same conditions.

Assessment of Brazilian barley and wheat cultivars for pre-harvest sprouting tolerance – led by Dr Guillermina Mendiondo

Dr Guillermina Mendiondo and colleagues from Embrapa


Brazilian barley

Rainfall during the wheat and barley harvest occurs quite frequently in the southern region of Brazil, causing preharvest sprouting (PHS). The main end-uses of barley and wheat grains are malting and flour production, respectively, and both are negatively affected by PHS. Sprouted grains lose viability after desiccation and become useless for malting, an industrial process that relies on germination. Using elite cultivars of wheat and barley, developed in Brazil, this project is based at Embrapa Wheat, Passo Fundo, and will characterise the pattern of germination response in a set of malting barley and wheat cultivars in relation to PHS tolerance; make use of doubled haploid production technology, and use high throughput germination assay to evaluate germination response and grain size. This project is run in collaboration with Dr Foulkes, Rothamsted and the University of Buenos Aires.

Ionomics screening of a diversity panel of common bean (Phaseolus vulgaris L.) for the improvement of mineral nutrient content of the bean-based food products – led by Dr Paulina Flis

Beans are an excellent source of energy and nutritional value. This project is based at Embrapa Rice and Beans, Goiânia, and will determine the mineral nutrient profiles of 340 bean accessions from the Embrapa Active Germplasm Bank, selecting the genotypes with the highest mineral nutrient content. The project will then explore the nutrient content of bean-based food products, focusing on bean flour, before investigating the flour for nutrient bioaccessibility after in-vitro digestion. This research will help select bean genotypes with higher nutritional value that can be further used in developing bean-based food products.

Feed efficiency and dairy cattle – led by Dr Phil Garnsworthy


Brazilian cattle

This project is based at EMBRAPA Dairy Cattle (Gado de Leite) in Juiz de Fora and aims to improve the efficiency of dairy systems in Brazil through better matching nutrient supply, animal requirements and the genetic potential of growing and lactating animals. Brazil has the second highest dairy cow population in the world but is only the fifth highest milk producer and continues to import dairy products. The project will conduct a metagenomic evaluation of the ruminal microbiome of F1 Holstein x Gyr dairy cattle, correlating results with variables related to methane emission, feed efficiency indexes,

and animal performance. Comparison of these results with work conducted at Nottingham will allow scientists to identify similarities and differences between temperate and tropical cattle, ultimately informing breeding programmes in the tropics.

Prof David Salt, Director of the Future Food Beacon said,

"We are very excited to be developing our relationship with Embrapa, across a wide range of projects and disciplines. Brazil is an amazing country full of opportunities and challenges relating to the provision of nutritious and healthy food. Embrapa has revolutionised agricultural production in the country over its 47-year history and working closely with Dr Pedro Luiz Oliveira de Almeida Machado, the outgoing Embrapa Secretary International Strategic Relations, has allowed Future Food to develop new partnerships in Brazil which we hope to build upon in the future. In support of this working relationship we have also recently signed an MOU with Embrapa"

Redefining pearl millet: Dr Ndjido Kane

Dr Ndjido Kane is a plant geneticist and molecular biologist, based at Institut Sénégalais de Recherches Agricoles. Dr Kane directs CERAAS, part of the Institut Sénégalais de Recherches Agricoles (ISRA). CERAAS specialises in drought adaptation of plants in West and Central Africa. In this interview, Ndjido talks to Lexi Earl about his research on pearl millet.

Tell me about your research career? How did you become involved in research? What do you do?

I am a scientist, working on pearl millet. Pearl millet is a staple food for millions of people in Africa, and in Senegal it has multiple purposes. It plays an important role in food security and nutrition, particularly in young people and breastfeeding women. It is eaten as a porridge and forms part of our traditional food culture in Senegal. Pearl millet is very nutritious, rich in iron and zinc, and calcium.

I did my PhD in Plant Science, focusing on wheat, at the University of Quebec at Montreal, in Canada. I saw the opportunity of how research can contribute to food security, through increasing agricultural productivity and tackling challenges. I did a postdoc in industry, to understand the business of research, and then I decided to return to Senegal, and to contribute, through research, to agricultural enhancement.

I was initially interested in health science. I studied biology, thinking I would become a doctor. From there I moved to being a plant scientist. In Canada, at that time, you had to have a first degree in Biology, before you studied Medicine. After my undergraduate degree, I did a Masters in Plant Science and I really enjoyed it, so I continued studying plant science.

What was the original spark that made you interested in science?

My father was a doctor. He wanted me to become a doctor and I always wanted to be a doctor. So I became a doctor, but in plant science. My mom was a midwife too so I was always interested in science.

How did you begin working with Prof Malcolm Bennett?

I was put in contact through another colleague at IRD (French Research Institute for Sustainable Development) Dr Laurent Laplaze, who had already collaborated with Malcolm, and Laurent suggested that we might be able to work together. We spoke initially via Skype, and found there was lots we could do together. Malcolm was enthusiastic, and was interested in working on pearl millet, and I was interested in working on the hidden parts of pearl millet. I normally look at the breeding side, I never look at the root systems.

Networking partners meeting in Dakar, Senegal

Your two projects on pearl millet have different foci. How do you bridge working across so many disciplines?

In Senegal, when we are looking at a particular crop, we look at the whole value chain from breeding to the value-added project. So the projects are linked. The first project 'Anatomics in pearl millet' contributes to our breeding programme. We have not previously looked at root traits as targeted traits in breeding. We normally look at grain size, drought tolerance and so on, but the root is a key trait in drought breeding. Once we breed new varieties, it is important to know how the work is going to appreciated by other stakeholders, particularly those involved in processing and commercialisation. The second project focuses on enhancing the productivity of pearl millet. Once we have enhanced the millet, someone should make good use of it! At the moment, pearl millet is grown by rural, smallholder farmers. It is grown for their own consumption. They do not think about selling pearl millet or developing new products. If we can enhance pearl millet productivity, we will have a lot of pearl millet to eat and also to transform, to process, and to sell. We wanted to bring pearl millet into the light. If pearl millet only exists as a staple food for pearl millet, you never see it as a potential cash crop. You therefore need new products to encourage growing.

Pearl millet, at the moment, has a very low yield. So people usually eat pearl millet because it is very easy to cultivate, it is a staple food, and doesn't demand a lot of inputs. We work with stakeholders to introduce the idea of what more we can do with pearl millet. For example, we can create a mixture of pearl millet and wheat for flours and bread making.


Raw organic Bajra pearl millet in a clay bowl.

How does this research affect ordinary people?

It affects their daily life. In Senegal, when you have a new baby, one week later they are named and the food we prepare is made from pearl millet. The breastfeeding woman eats porridge made from pearl millet. If a woman gets married and leaves her home to join her new husband's family, she brings with her a bag of pearl millet seeds. If someone passes away, we prepare a dish from pearl millet. Pearl millet is culturally very important.

How are you increasing the production of pearl millet?

It is a combination of technologies. You have to produce more with less: less land and less water. And fewer human resources because young people are moving to the cities. Our role as researchers is to give the farmers options, starting from improved varieties, agricultural practices, small mechanization, and to accompany them on the journey.


Pearl millet network partners including Dr Ndjido Kane (second right), and Prof Malcolm Bennet (second left)

Do you have a greatest career moment?
I feel this every day. When you talk to the farmers, they have high expectations of you. He believes that you can do it, that is why he comes to tell you his problems. This feeling is great. You also get this feeling when you propose the farmers use new varieties, and they accept and test the varieties alongside their traditional landraces. This is a great moment because when African farmers decide to try your new varieties, it is huge! They trust you and believe that what you are giving to them is good for them, and will form part of their legacy. Legacy is very important so it is a very proud moment that you have.
If we can write policy briefs, and those are used to impact society, that is good too. There are a lot of channels that can create important moments for you as a researcher.

Tell us about your research institute?
I work at the Institut Sénégalais de Recherches Agricoles (ISRA), and we have five foci of intervention: crop production, forestry, livestock and animal health, fishery, and socio-economics. Our institution has different research centres and labs and I direct CERAAS, we specialise in drought adaptation. We have a regional mandate focusing on West and Central Africa. We are a Centre of Excellence for dryland crops. We have the mandate to work on six different crops, generate technologies and innovation, and then share it with other countries from West and Central Africa.
We have been running for ten years now. One programme is the West Africa Agricultural Productivity programme, funded by the World Bank and our governments. The idea is to have different hubs on the continent, specialising in different objectives. Once you have met your objective, you can share your findings with others. When this programme started, we had 9 different countries and two of them, Ghana and Senegal, were credited Centres of Excellence. We now have a mandate from ECOWAS to share technologies and innovation with others. Now we are looking to scale up.

Part of our work programme includes training PhD and Masters students. Over the last ten years we have trained over 300 students. We collaborate with universities in Senegal, across the continent, and also elsewhere, on PhD programmes. We co-supervise with universities because, as a research institution, we do not have a mandate to confer degrees. It is part of our mission to provide training and research opportunities to young people. 70% of the population in Africa are employed by the agricultural sector. It is therefore important to train the next generation of plant scientists.
When I joined my institution ten years ago, across West and Central Africa, we were six academics with PhDs working on pearl millet, and four were close to retirement. Now we are more than 20 academics with PhDs working on pearl millet.

What are your future research plans?
[Joking] You know as a scientist, if we stop doing research we have to retire and I don't want to retire! So I am going to keep going. More research! I've also worked on other crops (sweet potatoes, fonio, wheat). You can switch crops because the molecular and genetic tools for understanding them are the same. I have a particular interest in pearl millet because I would like to see those African crops that are called 'orphan', not be so. Wheat is not native in Senegal and yet it is a 'major' crop. I'd like for the orphan crops to become major crops, generate incomes, and contribute to food security.

Do you have any advice for young scientists or people who are thinking of becoming scientists?
Be creative and work hard. The scientific world is a very small community, and everyone needs funding. You have to fight. You have to be creative. If you are doing the same thing as everyone else you will not distinguish yourself. So you have to work hard and be creative. If you don't have new, creative ideas of how to do things, you are not a scientist. Never give up. Have good partnerships. Develop new ones. Keep an open mind. But mostly: be creative.

Leadership Team Research

Giving voice to farmers and producers: An interview with Associate Prof Anne Touboulic

Associate Prof Anne Touboulic researches sustainable supply chains from a social sciences perspective. She is based in the Business School and is a member of the Future Food Beacon leadership team. Dr Touboulic works often with rural food producers to co-create research to develop better food systems. In this interview, she talks with Lexi Earl about her career path, research plans, and teaching.

Tell me about your research career? Where did you start?

That is an interesting question I think! Currently I work in the Business School but I studied social sciences more broadly. My first degree was Politics, Philosophy and Economics and I was always really interested in issues of sustainability, and sustainable development and food. I am not sure where that all really came from to be honest! It might have been my upbringing in France. Everything in my childhood revolved around food, growing food, and things like that. I did my Masters dissertation on international food supply chains, I looked at Fairtrade, and then decided to apply for a PhD. I ended up doing a PhD in a Business School in an Operations and Supply Chain Management group. It was different from where I came from initially. My PhD was part funded by a large multinational company, PepsiCo. They were at a crucial moment in their relationship with farmers in the UK as they were starting to roll out a sustainability programme and they wanted to understand how they could work better with the farmers. So there was a large relationship angle to the project, a sociology lens, and then an operations lens too.

My PhD was very qualitative, using action research and approaches close to ethnomethodologies, but I was socialised into the field of OM&SCM (Operations Management and Supply Chain Management). I ended up getting a lectureship in the field, and now I am here still in an Operations and Information Systems group but with an interdisciplinary background that is probably quite different from most of my colleagues. My understanding of supply chains is perhaps more political than what you might normally find in Operations Management.

That is interesting though because that would mean you are thinking about things completely differently to how others in your department are thinking about things?

That is true. Generally, my colleagues are interested in techniques and solutions and models, and how to improve supply chains and operations. I am interested in how to improve supply chains but also in the underlying relational dynamics and the politics, the ethics, the inclusivity…

Methods used in social science research approaches

What teaching do you do?
I teach three modules, two at undergraduate level and half of a module at postgraduate level. The two undergraduate modules are introductions to Operations Management so that is about getting the students to understand how organisations work and make things happen, often behind the scenes. Both modules have a sustainability flavour but still cover basic concepts of OM. One is a very large module, first year, first semester so there are more than 300 students on the course. The other is optional and is shaped around a hands-on, creative assessment where students have to think about a sustainability challenge and how an organisation in a sector of their choice can deal with that challenge from an operations point of view. My second semester is the postgraduate module on Operations and Supply Chain Management, and I teach the whole supply chain side.

Tell me about your current research?
I've recently returned to focusing on the political issues within the supply chain so I am interested in exploring the power dynamics at play, particularly in food systems. These interests lead me to consider both global and local supply chains, issues around equity, ecological resilience, and pose questions around whose interests prevail in these systems and how can we change them to make them more sustainable? A lot of it has to do with food from a raw production point of view, working with rural communities, as well as with participatory research designs, trying to co-create visions for changing our food systems generally but involving different actors along a supply chain or system. I worked with farmers during my PhD and that enlightened me on how aspects of the supply chain can work or not work for them. My recent work with colleagues from the University of Birmingham and Queen's University Belfast is the question of value; trying to expand our understanding of what is meant by the value of food in the context of the supply chain. Much research thinks about the economic value, but they do not define value or unpack what is behind that economic value and how value is much more than that.


Mapping as a research tool

What are your plans for future research?
There are several things developing at the moment, and these are emerging as three different streams. One is a bit of activism in my field. I am part of an organising committee for the Sustainable Operations and Supply Chain conference, which is being hosted at Nottingham in February 2020. With colleagues, we are trying to push for a critical, engaged agenda in that sphere so we are organising a third day for the conference which is around research activism, trying to get delegates to think about these issues which they don't normally do in our field. My colleague Lucy and I were invited by the International Journal of Logistics Management to write something provocative for the community, for the 30th anniversary. We wrote on collective activism in our field, what it could look like, given the grand challenges in which we find ourselves, how we can think about research in a different way.
The second one is working with local and rural communities, linking up with researchers across the UK who do similar work around sustainable agriculture, trying to see how we can work together, especially given the way the food landscape in the UK is changing. The work on value that I mentioned earlier is part of this as well, and we are trying to shape the conversation in both the research but also policy field.
The third is around food poverty and food deserts. I had done a piece of work on that when I was working in Cardiff, and now being involved with the Future Food Beacon that has come up again. In Cardiff we worked with three disadvantaged communities in Wales. We had a participatory research angle, and

we worked with communities in Cardiff and the valleys, trying to understand from their point of view what issues they were facing in terms of access to healthy food. It led us to the Welsh government as well as third-sector and private actors within Wales to influence the agenda in terms of a portfolio of solutions and interventions that could work for those communities. It has tended to be very top-down led solutions so our contribution was very much a bottom-up perspective. Communities have very specific reasons why interventions do not work so how do we overcome those? And now I am continuing this, as part of my work with the Future Food Beacon, from a more international perspective, working with Dr Tereza Campello.
I think this involvement with communities and working with Tereza has allowed me to reflect on the role of research. The way we have constructed science and knowledge, and what they are, is very interesting. What is valid and what is not valid knowledge? And then we are often surprised when things do not work in practice.

How did you become involved in the Future Food Beacon?
I attended the launch event of the Innovation Challenge last year, because most of my research is focused on food. While there, I met Prof Tim Foster who knew my colleague Dr Sally Hibbert, and we then met up to talk about the Beacon and he asked if I would be interested in joining the Leadership team. I thought it would be a great opportunity to be involved in the Beacon but to also get a sense of what it is that the hard sciences actually do in that space. I've been trying to connect the Beacon with social sciences and humanities, and to get involved as much as possible.

What are the challenges that you face in trying to get interdisciplinary conversations going?
There are many challenges. Dr Matt Jones and I were trying to create an opportunity for social science and humanities researchers to come together to talk about their work on food, because we obviously don't know what everyone else is doing. But we were trying to organise this at the same time as a funding call came out from AHRC, and so the funding call took over our ambitions to do this. The university's, and even the Beacon's, key performance indicators do not seem to be around facilitating conversations, or at least they do not always help. So you have to navigate this landscape and we never ended up having those conversations.


Research workshop with Dr Anne Touboulic

That is interesting because those conversations are a really crucial part of forming a grant. You need to have them if you are going to have a successful bid.
Yes, so we took a step back and decided to leave it for now. It is difficult to have your voice heard sometimes. Working across disciplines exposes me to different discipline cultures. There is a very different culture in the sciences than in social science, and sometimes you do not get a chance to say much. Social science and humanities are also cheap! We can do very good research with very little money so we are not as attractive as the sciences because £200,000 from AHRC or ESRC are huge things for us but in the sciences, that is tiny. And the push is always on outcomes, rather than building foundations.

Do you have any advice for young social scientists? Or for people choosing between social science and science?
I think it is all about knowing yourself and getting to know yourself. It is not easy because the system does not give you time to do that, and then sometimes you can find yourself registered onto a course that is not at all for you. There is no such thing as a mistake, you can change your path if you find it is not for you so get to know yourself and your values, knowing where you stand. Take the time to find out what you really care about, what you are passionate about. Are you solution driven? Problem focused? At the risk of falling into broad brush representations, it seems the hard sciences are more solution-driven whereas social sciences are perhaps more focused on trying to understand the fundamentals of the problems before jumping to a solution. That doesn't mean that you cannot do solution-driven research in the social sciences! And these are quite simplified views. It is all about knowing yourself, finding the right people, finding the right project and advisor when you get to postgrad level.

Do you have a greatest career moment?
I feel like I am learning constantly. I never feel like I've ever reached where I need to be. It is quite nice that more and more students in our Masters want to research on sustainability and food, and that is great because I am pretty much the only person they would've encountered during that year who is doing that so something has filtered in! Getting invited to submit that paper on activism, maybe it is not a greatest career moment but getting the confidence to speak up in a discipline that is quite conservative, that took a few years and now I worry less about the consequences.

How does your research affect ordinary people?
I hope that I am inclusive enough in my research design that I don't actually design a research project without the input of the people who are facing the challenges that I research so in that way, I am hoping it will have an effect on them. But that kind research does take a lot of time, and when you think about all the pressures that you face in the university environment, you might get completely side-lined into short-term publication track. But hopefully it will make a difference. I know the work on food deserts in Wales has already made a difference because we were able to access the key people who hold the power and resources to get these initiatives going and get them around the table, and we managed to pilot some of those initiatives. The work I did through my PhD, where the farmers, as suppliers, had a forum and space to express their feelings, was very important. And it made a difference I think, or at least that is what they told me. I am not driven by making money for the corporations, but if I can give space to people to have a voice then that is it.

Using narratives to understanding eating disorders: an interview with Associate Professor Heike Bartel

Associate Professor Heike Bartel is a scholar in German Literature, based in the School of Cultures, Languages and Area Studies at the University of Nottingham. Dr Bartel's work explores the narratives of food, health and illness. She is a member of the Future Food Beacon Leadership team. In this interview, Dr Bartel talks to Lexi Earl about her research interests, working with medical practitioners, and the experience of interdisciplinary research.

Can you tell me a little about yourself, your research, and your background?

I have a PhD in German; I am originally from Germany. I started at the University of Nottingham in 2000. I've been here since then. This is quite unusual for me as I am naturally a restless person. But here, when I get restless, I can do U21 things, visiting our partner universities or get involved with international projects, like those within the Future Food Beacon or GCRF projects.

I've always been heavily interested in literature, German literature is my field, but more and more I've become interested in comparative literature. I've always been interested in different perspectives, not the big master narratives but the marginalised ones, like those from gender studies, women's studies, contemporary women's writing, postcolonial studies. I am interested in the narratives of illness, health and recovery, stories from the other side of the medical curtain – the patients', people with lived experiences. My interest in these narratives has combined with my interest in food, and writing about food, and the wonderful descriptions of glorious feasts but also the history of eating as a history of the German people: shortages of war time, deliberate starving in the concentration camps, the iconic images of starving people, but then coming out of the war, the Wirtschaftswunder, the economic miracle. So not just descriptions of food but food as a mirror of history, of under- and overeating, but also in combination with stories of illness. This has led me to my current project on narratives of eating disorders. Obviously, there is a lot out there in the field of women's studies, both clinically because the numbers are very high in the Western world; women diagnosed with anorexia and bulimia, and binge-eating disorders are very high, and there is a lot of theoretical discourse. Anorexia as the waning woman, as a woman coming to terms with how much space she can take up in the world, as Susie Orbach puts it.

I became really interested in the other side and looking at male eating disorders which is under researched and underrepresented in all fields, medical and cultural studies. I started reading fictional stories but then also autobiographical writing in German, English, and French, and that led to a successful AHRC networking bid, working really interdisciplinary and stretching really far from Arts and Humanities to Science. I had a Co-I, Nadia Micali, who is a medical expert in clinical nutrition and a psychiatrist at the Great Ormond Street Hospital. The research network gave us a lot of room to brainstorm creatively, and enabled us to get authors, photographers, clinical researchers, charities, and men with lived experiences who are now in recovery.

How do you research narratives of illness from a humanities perspective? What is it like to move into that interdisciplinary sphere, and how does that change what you do?

The big difference is qualitative research. I have a few case studies of men with lived experience that are sometimes snapped up by people doing clinical research but it is really the qualitative research of the personal experience and how that is expressed through literature. That is my tool. I can explain through my work as a literary scholar: what perspective we are dealing with? How are stories of illness intertwined with stories of hierarchy? How does the patient talk? How does the doctor talk? Often you have quotations from medical practitioners or whole medical documents quoted. How does that change the dynamic of the story? How does someone who is restrained in hospital and force fed report their experience? How does the doctor comment on that? These hierarchies and experiences are really critical, and I have the tool as a literary scholar to tease out what is happening there and not just saying this is the story of failed recovery but this is the story of struggling with a medical and treatment experience, and that is something that medical scholars are really interested in. If you then put a few together, if you read the corpus of experience on male eating disorders, which is not that large, and you have certain patterns that repeat themselves, that then becomes interesting for medical scholars. Male experiences also differ from the experiences women report. One of the commonly assumed symptoms of anorexia nervosa, of not menstruating, men say well that doesn't apply to me but then filling that gap with something that is not being talked about and not discussed in medical literature because there are so few studies about that: sexual dysfunction, relationship with fathers, sexual relationships… I can add to that through the literature.

While medical researchers often have a very one dimensional view of a text, for example, the patient said this and we take it as that, I have much more room to manoeuvre. For example, someone remembering as a 35 year old the food they tasted as a six year old, that is not reality as it was. Through my scholarly training in memory studies, you can interrogate that. You cannot take for granted what is happening in that narrative. And looking at the genre definition, what are we talking about? Are we talking about stories of recovery? Stories of illness? Of health? Are we talking about stories of addiction? The blurring between eating disorders and addiction is something that the medical practitioners often keep very divided. If you examine the literary genre they are not that divided. If you are a binge eater, it is often intertwined with stories of addiction. I have a different playing field and when I look at medical articles, I can challenge some of the statements that are made.

How did you become interested in this research?

My starting point is exploring narratives, and an interest in writing about food, and bringing the two together. And not just focusing on the glorious feasts, but food as an expression of culture, of power, of hierarchy. If you look at women's writing, who cooks what for whom? When? With whose money? Who serves it? Who eats it? Who takes it away? That is a great expression of power represented through food. At the moment, we are quite unique in thinking about male eating disorders. We have a Twitter account– @ConsiderMaleEDs – as a message for GPs and practitioners. Very often male eating disorders are not seen and so we are targeting the GP audience. At the moment we have a group of seven men with lived experience, all in recovery, and all talking openly about their struggles. We are working together with an animation team called WovenInk, who have done work in the field of eating disorders before, and we are currently translating those experiences of men into a training animation for GPs.

Questions we put to these men were: Why was it so difficult to disclose to the GP or practice nurse what you thought or guessed was wrong with you? What would've helped? What definitely did not help? Hopefully the film will find its way as a training tool into modules for GPs and charities.

How do you go about researching these difficult topics? Food can be very emotive so how do you navigate the spaces of food, and illnesses that are linked to food?

The good thing is that food is such an easy topic to talk about. Our project is called Hungry for Words. It is about articulating, communicating, and understanding issues around food. We held several Hungry for Words cafes as part of the Being Human festival. We just had a few cards with words associated with food – hunger, fat, family – and a few empty cards and we invited adult males in various cafes all across Nottingham to sit down and talk to us for as long as a cup of coffee, about their experiences of food. I think the myth that men don't want to talk, and don't want to talk about their troubled experiences is not true. We couldn't shut them up! It is emotive but probably because it is emotive people talk about it a lot. I find when I work with schools, and I bring texts about disordered eating, little poems or a novel – The Year I Didn't Eat by Sam Pollen – the students can talk a lot about that. They can identify a lot of the patterns, be they obsessive compulsive behaviour, anxiety, or family relations. I make a point of having a counsellor from our partner charities, First Steps Eating Disorders, based in Derbyshire, with me when I work with schools because talking openly about these topics for the first time can kick loose a lot of stuff, and I want students to be able to take that somewhere. It is more a chat about good mental health than food. Mental health is often framed as negative, 'mental' is a swear word, and getting young people to consider good mental health is important. You're looking after your body, how do you look after your mind?

One of the other aspects I am interested in is food in colonial stories, and postcolonial contexts. Germany is very interesting because it is not one of the big former colonial powers but still has a colonial history, and that still plays a role in some texts as an undercurrent. Cultural elements are picked up by writers. Turkey, for example, was not under the colonial control of Germany, but some parallels to postcolonial studies can be drawn. Turks came after the war in the 1960s as guest workers to Germany, and were encouraged to come. They then stayed and became a minority in Germany, and brought with them a lot of food that is now a staple diet of German food. But there is also the aspect of using food to reinforce stereotyping and marginalising. I find in particular, the history that comes with food from foreign places, the exotic fruits that are associated with equally exotic women. This is very rich pickings for a scholar in contemporary culture. The glorification of certain foods to devour is often mirrored in a stereotype of the female coming from a foreign and exotic place, assumed ready for male consumption.

What are your future research plans?

In the future I would like to do something around stories of health, illness, recovery, and the role food stories play in that. That can be very patient oriented, or it could be stories of displaced people and the longing of food and memory, of nostalgia. I am also excited to see what the Beacon is doing, to bring in the medical and health humanities, and work on obesity questions, and to explore how the analysis of food stories might fit in there. I think literature and the arts and humanities has the power to pull everything together. For me literary philology and literary scholarship is the interdisciplinary approach to understanding the world.

What is the argument you make to ordinary people about the importance of arts and literature for the wider world?

It is not always an easy argument to make. I sometimes take a practical approach. See what happens when you do a creative writing workshop with some school children, asking them about writing different little chapters, changing the perspective in each, and how they reflect differently on different characters. I love poetry and I think poetry works so well in so many settings. If you take for example poetry slams or rap music, which is deeply lyrical and poetic, that can engage people in the genre who may not usually 'go for' poetry. Here in particular I don't believe in the division between high and low culture. I look at every type of literature, and other forms of expression. I find animation really fascinating at the

moment.

How do you explain what you do to ordinary people?
I am interested in stories, and stories that present very different perspectives. The perspectives of children, perspectives from people that are poorly. So not the parent's stories but the children's stories. Not the doctor's stories but the patient's stories. Stories of disability. There is a huge wave of books for children about people with disabilities who cannot express themselves verbally perhaps, but write beautifully. Stories from unusual perspectives that tell stories that are very often not told but are so important.

Do you have a greatest career moment?
I loved it when I was trusted with the interdisciplinary AHRC research network. The moment when I got that because it was a very bold move to bring all these different ideas and people together. I found it really scary but that was a great career move because I was being forced out of my comfort zone and I like that. We have now secured a follow-on-funding grant from the AHRC, so the story continues.

Do you have any advice for younger scholars?
I think the field of interdisciplinary studies is really important, particularly for younger researchers. Obviously, get a good foundation in your field, but then go further. In interdisciplinary work, with the mixing of disciplines, methodologies and approaches, the hierarchy goes a little bit out of the window and that is a really nice starting point for all. From my experience that also creates a nourishing environment for young researchers where they really get an opportunity to shine, and colleagues listen to their ideas because they are relying upon them, that fresh input. It does not come with the fixed pathway of one discipline. Go for everything. Say yes more than you say no.

Producing future proteins sustainably: an interview with Prof Andy Salter

Andy Salter is a Professor in Nutritional Biochemistry and is leading the Future Proteins Platform, a £1 million Innovation Challenge project funded by the Future Food Beacon. Andy has worked extensively on the molecular mechanisms whereby diet impacts upon lipid metabolism and metabolic disease, particularly cardiovascular disease. In parallel, he has developed a research portfolio looking at the sustainable production of healthy foods to meet the demands of the expanding and ageing global population.

Tell me about your current research work?

Historically my interests have always been in metabolic disease. My PhD was in diabetes and heart disease. I then did a postdoc in Canada on obesity and lipid metabolism. I came to Nottingham as a postdoc at the Medical School, spending five years looking at the hormonal regulation of cholesterol metabolism and cardiovascular disease. When I came to Sutton Bonington, I moved to looking at the impact of diet on heart disease. However, when I joined the Division of Applied Biochemistry and Nutrition in 1989, there were strong interests in agriculture, so I was working alongside animal, as well as human, nutritionists. Inevitably, my interests expanded and I became particularly interested in foods of animal origin, and whether we could make them healthier. This included changing their nutritional composition, such as reducing the saturated fat content of meat and milk, and reducing the cholesterol content of eggs.

About 10 years ago, I started supervising a student who was vegetarian, who wanted to do a study on the impact of vegetarian meals on health and I persuaded her to extend it to flexitarian diets, looking at meat reduction rather than total avoidance, and that is how we started in this area. Marlow Foods (the makers of Quorn) became interested in our work and we won an Innovate UK grant with them to specifically look at meat reduction on cardiovascular risk. The findings of this study were recently published in the journal, Food & Function.

Through working with colleagues in Malaysia I became involved with the work of Crops for the Future (CFF). One focus was to look at the feed used in fish farming and, while there was no real expertise in fish nutrition within the University, I thought it sounded interesting. I was shocked by all of wild-caught fish that was being used to feed farmed fish, and so, working with CFF-funded PhD students, we started looking at alternative feeds for fish, including insects. We then got a British Council grant to specifically look at using black soldier larvae as an alternative feed for sea bass. All of a sudden, almost without thinking, everything was changing direction! But it was interesting and exciting!

The last piece of the jigsaw was when Monkfield Nutrition, one of the biggest insect producers in the UK, got in touch with the University looking for expertise in insect nutrition. While we were just starting to work in this area, we talked to them and successfully applied for an Innovate UK Knowledge Transfer Partnership and started working with them to improve the nutritional value of feed and thereby reducing costs of producing their insects. All of a sudden we realised this was becoming a 'hot' area.

While for years, the impact of diet on health was the focus of most nutrition research, suddenly sustainability and the health of the planet were being recognised as key topics. I had some excellent colleagues around me who were starting to realise the same things as well. So that is what led us into this work.

When the Beacon started there was lots of excitement that the University had recognized Global Food

Security as a key research area and then the Innovation Challenge provided the opportunity to get involved. We started reaching out around the University and found there were pockets of interest in the sustainable production of protein, many of which we had not been aware of. Fortunately, we were successful and the Future Proteins Platform was born. Then the final thing that happened to me, completely out the blue, was to be asked to be part of a Working Group funded by the Rockefeller Foundation and World Wildlife Fund. The group is international, and from very different perspectives, including some excellent environmental modellers based in Santa Barbara, USA. The group is focused on sustainable production of protein to feed our growing and aging population. There are also colleagues with expertise in global nutrition and animal agriculture, including fish. In the first meeting we just sat around and talked. It has been absolutely fascinating for me, using existing data to do research rather than working in the lab to generate it. It is just as valid and just as interesting in many ways and we have several papers submitted to journals for review. That really made me sit and think – I've only got a few years left in my career – so how do I want to spend them? I've moved away from research a lot in the last 15 years, as I became more and more involved in University and School Management. I want to leave that behind again and focus on research. This seemed to be something people were excited to get involved with and we now have Future Proteins; with two postdocs, six PhD students and colleagues from around the University (including in Malaysia) working with us. It is really going right across the spectrum, from protein production to food processing and nutritional impact for both people and livestock.

So how are we going to feed the world?

My view is that the debate at the moment is becoming too polarised. There is a solution in the middle somewhere. There is no doubt that, in many industrialized countries, we have to reduce our consumption of animal products. In the US, many people are eating 2-3 times as much protein as they actually need, largely from meat and milk, and in the UK we are not far behind. However, there are still many people in the world, particularly in Africa, who would benefit from including more high-quality (such as animal) protein in their diet. So there has to be a reduction in consumption by some people and, perhaps, a re-distribution to others. We need to look carefully at reducing the impact of animal agriculture on the environment, but removing all animal products from the global diet could have serious impacts on the most vulnerable in society. We also shouldn't throw technology out of the window and say we need to go back to what we used to eat. We have fabulous science going on which can help. That is what I like about Future Proteins, we are looking at all of that. We are growing bacteria as potential feed for animals and fish, we are exploring how to reduce the 'anti-nutritional' factors, associated with many 'underutilized' protein-rich plant species and continuing to explore insects as both feed and food. We are particularly interested in using in vitro systems to measure the digestibility of protein from these novel sources and how it might be improved. It has developed into a very exciting multi-disciplinary project.

What made you first interested in science and nutrition?

Science – I think, like lots of people, when I was a kid at school, I thought I wanted to be a doctor but quickly realised I was never going to get the grades and had to do something else, so I went to university to do Biological Sciences. I thought I would be a biomedical scientist. I ended up with a job afterwards at Guy's Hospital in London as a Medical Laboratory Scientific Officer. I had no idea that I was working in the lab of one of the most eminent diabetiologists, at one of the most prestigious hospitals, in the world. Fortunately my boss, Prof Harry Keen, saw something in me and asked if I would like to do a PhD. I was incredibly lucky to be funded to do a PhD while also getting paid a wage! That was looking at lipoprotein metabolism in diabetics, who are more susceptible to heart disease, and trying to work out why that was. I thought it was really interesting and it all sparked from then. It wasn't until I then thought about what I might do next and I applied for a postdoc in Canada and was lucky enough to get it. I spent a couple of years working on obesity and lipoprotein metabolism in Canada, in Toronto. I then won a Fellowship from the British Heart Foundation to return to the UK and work at the University of Nottingham and I have been here ever since!

The nutrition side really was chance. I spent five years over in the Medical School and a job came up over here at Sutton Bonington, for a nutritional biochemist. There were a lot of animal nutritionists over here, a lot of the work being done related to agricultural production. However, increasingly, students were less interested in animal nutrition, they wanted to study human nutrition. So, the department has changed hugely since I began. In the 1990s, I worked with colleagues to set up our dietetics degree, having realised that a lot of our graduates were doing their first degree with us, going off to do dietetics at postgraduate level elsewhere and ultimately becoming dietitians working in the health service. We are now one of the biggest providers of human

nutrition/dietetics education in the country.

Tell me about working across disciplines?
My work has been interdisciplinary for many years, frequently, for example, collaborating with animal and food scientists. As my interests have expanded over the last five years, into the area of food sustainability, it has been a real eye-opener to become more and more involved with, not only many aspects of agricultural and biological sciences, but also economics, the humanities and mathematical modelling. Part of that has been completely personal, my youngest daughter read Sociology at university, and inevitably I was asked to proofread lots of her essays. I'd been very dismissive, like lots of scientists are, about Sociology before then, but started seeing the importance of the impact of science on society and involving the public in deciding what we do and how we use our discoveries to the maximum benefit of all. I think the Beacon represents a great opportunity for researchers from all of these disciplines to interact. Inevitably, there were many suspicions at the beginning about the Beacon, that it would only benefit those who were involved in its creation. However, I have to credit David [Salt] and the Management Team for reaching out and bringing lots of disciplines together. I think the solution of problems like, 'how are we going to feed the planet?', have to be multidisciplinary. We can come up with all sorts of ideas, but if society is not willing to accept them, then it's a waste of time. The development and use of genetic manipulation within the food chain is a classic example. Twenty or thirty years ago, we just thought well here it is! Everyone is going to be cheering and clapping and then, all of a sudden, there was a massive backlash against the technology. I think it is important that we learn from these experiences and ensure close links between science and society.

I believe that engaging with the public is an important part of our job.

What kind of impact does your research have on ordinary people?
The public inevitably have an interest in nutrition and have some very strong opinions about it. One of the things I have done more and more of in the last few years, is getting involved in outreach activities. A lot of my early work involved using animal models, and you tended to keep it very secret because you were frightened. This was a period when animal liberationists were at their most active, you came out of the house every morning and checked under your car, it was that bad. As I've gotten bolder, I've tried to explain the strict regulation of such work and the lengths we are required to go to minimize suffering and to ensure our studies are well designed and necessary. One of the first outreach things I did was 'Pint of Science'. Turning up to a pub to give a talk, with no idea who might be in the audience, was nerve-wracking but it actually turned out to be very enjoyable. I've also talked at the University of the Third Age, and faced one of the most engaged and questioning audience of my career! I believe that engaging with the public is an important part of our job. People should, quite rightly, have complete freedom to decide what their diet is going to be, vegan, vegetarian, or omnivorous. We have a duty to try and make sure the public has the right information available, whether it is about their own health, or that of the planet, even if they don't immediately act upon it. In nutrition, in particular, there are plenty of other people who will give the public advice based on little evidence and, often, purely for their own gain. Over the last decade, I've become more and more involved in the Nutrition Society which, not only represents a forum for all of us who are committed to evidence-based nutrition, but also is actively involved with public engagement and education. Last year I became a Trustee of the newly formed Academy of Nutritional Sciences which was launched by the British Dietetic Association, Nutrition Society, British Nutrition Foundation and the Association for Nutrition. We hope this will become an influential voice (to both government and the public) in ensuring that evidence-based nutrition is at the heart of decisions (at both the individual and societal level).
So there are clear research impacts on people's lives but it is the challenge of translating that so people can understand it. And believe it.
And food isn't just about health, it is not just about keeping us alive. In all societies, food is about pleasure, culture, religion and all sorts of things. In the West many of us have a high meat diet, but as other countries become richer, their meat consumption also tends to increase because meat is a status food, and, in moderation, it can prevent malnutrition.

Do you have a greatest career moment?
Gosh. In one experiment, when I first came to Nottingham, we were looking at how hormones might regulate lipoprotein metabolism. Basically, we had an experiment where we added insulin to some cells. I was measuring the binding of LDL to its receptor. I remember standing by the radioactive counter watching the data come up and seeing that insulin directly increased LDL binding. A little later, my first in my very first attempt at 'molecular biology', we showed insulin regulates the expression

of the LDL receptor gene. That was really exciting! I have to say the biggest thing was getting the job here. I have to thank my old boss, Peter Buttery, for seeing something in me. I had a lot of freedom in my early days to do what I wanted to do.

Do you have any advice for younger scientists?

The first thing I always say to people who want to do a PhD is why? I always ask, do you think you are going to enjoy this because there is no guarantee when you're doing a PhD that it will enhance your prospects, and it can be three years of misery if you don't enjoy doing it. It can also be three years of joy. I enjoyed picking up a pipette, transferring one solution into another. If someone said for the rest of your career, you can go back in the lab, I would probably say great! So you have to enjoy it. The other thing is that while you have to have some direction, there are very few people who can predict where you will ultimately end up. As a biologist, you don't really know where it is going to go and if something sounds interesting, and it offers you an opportunity, don't be afraid to take it. I've got two ex-PhDs, who both have Faculty positions at the University of California in Los Angeles, purely by approaching someone at a conference and talking to him. That is one of my proudest achievements actually. I'm at the stage now where I have no particular ambition for myself, but to see other people I've helped make it, is so rewarding. We all have a responsibility to leave a legacy behind that our younger colleagues can continue with.

I'm at the stage now where I have no particular ambition for myself, but to see other people I've helped make it, is so rewarding. We all have a responsibility to leave a legacy behind that our younger colleagues can continue with.

Is there anything else you'd like to add?

The only other thing I would say, relates to taking chances. I don't think any of us really knew what the Beacon was going to do, and I don't know what it is going to do in the future. It has been disruptive to a certain extent but in a good way – bringing people together from different disciplines, not talking about university politics or teaching, but talking about research again. That has certainly enthused me again, and I thought I was starting to wane a little. It has been a real breath of fresh air. Sometimes you do need to stir things up a bit and that is what has happened.

Future Food Research Fellows Updates

Working between the field and the lab: understanding barley

August 1st is Lammas, a day traditionally celebrating the first harvests of the season. Summer wheat, oats, rye, and barley grains are all harvested from now until October, and the first loaf of bread is baked with the new grains. How does the beginning of the harvest season affect our researchers and their work?

Guillermina Mendiondo in the field of barley in mid-July

Dr Guillermina Mendiondo, Future Food Nottingham Research Fellow, works on barley, exploring how barley senses its environment, and the changes that occur in the field. Guille works both in the lab, and in the field so we spoke to her about what is happening with her barley plants at this time of year.

What have you been growing in the field this year?

I've been growing spring barley. This is a barley used mainly for animal feed and malting. I work with this barley because I have identified non-GMO mutant lines that we would like to test the performance of in the field. This year, I am testing two different mutant lines, and two or three alleles per mutant against the wild type. We have 64 plots growing the mutants and the wild types, and each plot is one square metre. We also work with this barley in the lab, investigating what happens when certain genes are cloned or silenced.

It is incredibly useful to work in both the lab and in the field because we can see how changes we make at the genetic level affect plant growth in the real environment. Watching what happens in the field feeds back into my lab work, allowing us to change things according to how plants have fared in the fields. When we see a particular phenotype in the field, we can investigate which gene this is associated with in the lab. This then links to breeders and growers, making changes that can benefit agricultural crops.

How have the plants fared?

The plants look okay despite a lot of rain at the beginning of the season. Heavy rain early on in the season can affect plant growth, ripening, and harvesting. Last week there were a number of heavy thunderstorms and some plants are damaged, having fallen flat (lodged). Lodged plants can easily become infected, and we have to try and restore the plants to standing upright again. This affects the harvest, which is now upon us!


Barley lodged after the storm. This makes it susceptible to disease.


Barley after being restored to standing position

How has the weather (rainy June, hot July, thunderstorms) affected your plants?
The weather is becoming challenging for crops. The plants are doing well this year but the unpredictability of the weather seriously affects our ability to plan, grow, and harvest crops. Some crops are more resistant to the changeable weather, and it is fascinating to see that in the field.

What does this mean for your science?
In order to do the experiments back in the lab, I need to obtain good quality seeds from the plants in the field. Unfortunately when the weather conditions are not adequate during harvest time, there may be a compromise in the quality of the grains. That is why thunderstorms and the unpredictable weather, like we had last week, are so damaging to our crops.

What happens now?
This year, we will harvest seed for bulking and germination experiments in the lab. Bulking provides seeds for the following year, and for the experiments we will run in the growth room and labs. Next year, my new PhD Student Jasmine Litter (iCASE BBSRC) will continue to evaluate the performance of barley mutants in a pathway that looks very promising to breed crops.

How do you detect differences in the plants?
In order to understand how different genes affect plant growth we focus on examining: duration of growing stages, the number of tillers, flowering times, height, grain numbers, and yield. This is done through actual physical counting of samples of grain in the field, following a standardised growth development scale. We examine the differences between the wild type and the mutants, or between different genotypes. Counting grains allow farmers to predict how much grain they will have at harvest, and allows us to monitor the differences between our mutant strains of barley and the wild type.
The barley harvest will begin in a few weeks, and then these grains will be used in experiments in the lab to understand certain traits that are beneficial for farmers.

Understanding plant microbe interactions

Dr Gabriel Castrillo is a Nottingham Research Fellow whose research focuses on the definition of the molecular mechanisms of plant-microbe interactions. He has won funding from The Leverhulme Trust, the Royal Society and recently, a joint award from the BBSRC (UK) and the National Science Foundation (US) in collaboration with colleagues from the University of Kansas.

Dr Castrillo's research is based in fundamental science, and examines the interactions between plant roots and microbes in the soil and their influence on plant nutrition. His Leverhulme Trust award explores the ways the plant microbiota modify root branching. Plants and microbes within the soil have a symbiotic relationship, and this allows branching roots to explore the soil environment, providing the roots opportunity to maximise their ability to capture water and nutrients. Roots are key to plant stability and growth, and co-cultivation of plant species with specific root microbiota bacterial strains can drive significant and specific changes in root branching patterns. Focusing on the regulatory gene networks that govern interactions between microbes and root branching, this research provides an opportunity to make use of plant microbiota benefits in order to secure food production. In the same line of microbes influencing root function, Gabriel has a Royal Society project that aims to study the transcriptional regulation of the processes that seal the root to the free flow of water and nutrients.

Gabriel has recently returned to the lab to conduct further research

Gabriel explained how it feels to have secured his first major funding award:
For me is like a dream come true. I have been working hard on having funds for my lab to have the possibility to answer questions that remain unexplored in our field. Now, I feel we can do good science, so I have the responsibility to demonstrate our hypothesis and deliver high impact results. I feel excited about the whole process of transforming these projects into publications, data and collaborations and also into new projects. I am sure it will help to take my lab and my career to the next level.

The BBSRC/NSF research will examine the evolution of plant microbiomes under stress conditions, in this case, drought. Drought has devastating effects on plant productivity, and the intensity and frequency of droughts is expected to increase in coming years due to climate change. Evidence suggests that soil microbiota may play a role in plant drought tolerance. Relationships between microbes found in the soil and plants is well evidenced in the fossil record, and indicates an evolutionary relationship influenced by water availability. Under drought conditions, plants often increase their roots which creates new opportunities for microbial colonisation.

Root-associated microbiomes can affect the physiology and health of host plants, and these interactions are shaped by genetic variation in both the host species and the microbiome members. This project will disentangle the relationships between microbial and plant fitness in the face of a shared abiotic stress. This work has important implications for future drought-resilient agricultural crops.

The BBSRC/NSF award is in partnership with colleagues from the University of Kansas, whom Gabriel first met as a postdoctoral research fellow in the USA. He explained:

I met Dr Maggie Wagner (University of Kansas) when she was a postdoctoral researcher at Duke University, and I was at the University of North Carolina, Chapel Hill. Nowadays, she is a very talented young principal investigator at the University of Kansas. Her research focuses on defining the genetic basis of plants' interactions with the soil microbiota. Her research goals and mine complement each other very well, so when I contacted her to explore the possibility of submitting a joint application to the BBSRC/NSF call, we immediately realised that our alliance was competitive and that we could create an application that will adapt to both labs' goals. It was a very exciting experience. I think we enjoyed the process of thinking about how to improve our knowledge of the role of microbiomes in improving the health of crops and wild plants under abiotic stresses. I like the experience of working in a very collaborative environment with researchers from different countries and backgrounds. I see this project as an opportunity to learn from another lab and gain experience in managing international projects. I expect important contributions to our field and I hope that this project can help improve agricultural productivity with a concomitant increase in the nutritional quality of food.

Understanding oil crop sustainability: An interview with Dr Thomas Alcock

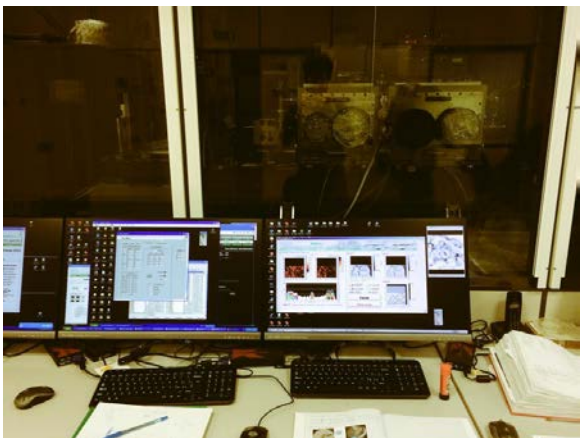
Dr Thomas Alcock is a postdoctoral researcher with the Future Food Beacon, researching oil crops and sustainability. Prior to this role, he held a Future Food Doctoral award, in which he worked on identifying the genetic basis of magnesium uptake in Brassica crops, with the hope of developing more nutritious vegetables. Here, he shares with us what he is currently up to, and how he got involved with both research and the Future Food Beacon.

Tell me about your work. What do you study?
I'm currently investigating variation in environmental sustainability among major edible oil crops, focussing on palm, soy, rapeseed and sunflower. I am specifically comparing greenhouse gas emissions produced across the entire oil production life cycle, from cultivation of the various crops, all the way through to packaging of the refined oil. With long-running public debate surrounding the sustainability of certain crops such as oil palm, looking into life cycle emissions from edible oil certainly isn't a new idea. The problem is that different research groups have previously used different ways of defining what makes up the "life cycle", different ways of measuring inputs and other parameters, and different ways of estimating greenhouse gas emissions from these input data. This has meant that emissions estimates have varied widely, with little confidence in which crops or production practices are the most sustainable. To address this, my approach has been meta-analytical, meaning I am extracting pre-existing life cycle data from the entire collection of literature on this subject, normalising it, and drawing conclusions based on the whole pool of knowledge. By using this approach, the hope is that a consensus set of emissions data can be teased out, that most accurately reflects the reality of which crops, or production practices, are the most sustainable.


Thomas Alcock (left) with an oil palm smallholder farmer in Malaysia.

How did you become interested in this field? How did you become interested in science?
I've been working with Brassica crops, including rapeseed, for a few years now, having previously investigated the genetic control of nutrient accumulation in Brassica during my PhD and in the following year. Given that the major use of Brassicas in Europe is as a source of vegetable oil, this put me in a good position to look further into oil crops, albeit from a different angle. Like many others, I am also highly concerned about the effects that human activity, including agricultural expansion, is having on the environment. Hence, comparing greenhouse gas emissions from different oil crop production practices seemed a very worthy cause to me, that I was excited to get stuck into. What really got me interested in this project though, was the opportunity to engage with international researchers working in tropical agriculture. Palm and soy are typically grown in the tropics, the former largely in South-East Asia, and the latter in Brazil and surrounding countries (as well as the USA and other more temperate regions). I hope to develop my research more towards the tropics in coming years, as such regions have huge potential for crop production, despite having had limited investment compared to more temperate regions such as Europe and North America. Many tropical regions are also more commonly associated with poverty and social welfare issues. Increasing the production of nutritious foods in these regions then, can not only help to feed the ever-growing population, but also help to improve the financial stability and wellbeing of farmers in developing countries.
My interest in science goes further back, but I wouldn't say ending up working in science was a given for me. Weirdly, biology was one of my least favourite subjects in secondary school, with physics being far more up my street back then! I ended up taking biology at A-level almost by accident due to timetabling clashes but quickly became immensely curious about life, where it all came from, and how vastly different solutions to the world's challenges evolved. This led me to study biology further at undergraduate level, at which point I developed an interest in plants, culminating in completing my dissertation on the effects of fungicides on crop growth. The PhD came next and has taken me to where I am today.

Tell me a little about your research career?
I'm still in the early stages, having only completed my PhD at the end of 2018. This was with Prof. Martin Broadley and Dr Neil Graham in Plant Sciences at the University of Nottingham and involved identifying genes controlling nutrient uptake in Brassica crops. I was given a lot of flexibility as to how I went about this which was great, enabling me to try out lots of different techniques. The highlight was probably working with researchers in Slovenia and North-East Italy mapping the spatial distribution of elements in leaves using x-ray fluorescence and synchrotron radiation. This produced some awesome images (hopefully to be published soon!) and also allowed me to think more in terms of physics for a change. Playing around with different techniques and disciplines is definitely a great way to keep science exciting.



The synchrotron used in research

Immediately following my PhD, I did a bit of work for Dr Ute Voss characterising some auxin homeostasis mutants, and then was awarded the Future Food Beacon Doctoral Prize. This provided funding to continue work on the Brassica project for another year, which I used to look further into a hugely interesting mutant which accumulates twice as much leaf magnesium as wild-type plants. This mutant is GM-free, so has real potential for use in breeding programs to improve human and animal nutrition. Additional funding from the BBSRC Magnesium Network (MAG-NET) project allowed us to sequence this mutant, and work is still ongoing behind the scenes to pin down a controlling gene. After that, I was offered the oil crop sustainability post with the Future Food Beacon, which I have been working on since February.

What current projects are you working on?
As a post-doc, my focus is largely on the one major project on oil crop sustainability, as discussed above. I try to maintain involvement in other projects where possible though, for the sake of both curiosity and personal sanity! As mentioned above, the Brassica project looking into the magnesium accumulator is still ongoing. The sequencing data is currently with bioinformatician Michael Wilson, who is in the process of pulling out the most useful information alongside his other huge number of projects. I'm very grateful for his support! Other than that, I am involved in an ongoing collaboration with a group at Sao Paulo State University led by Prof. André Reis. This is based around their work on selenium uptake into plants. Selenium is an essential human nutrient but is lacking in many diets. The project aims to solve this by increasing edible crop tissue selenium concentrations through both fertilisation and breeding. A couple of the crops they are focussing on are cowpea and Brazil nuts. I took part in Brazil nut sampling on a farm in Amazon state in Brazil a couple of years ago and more recently I have been contributing to manuscript preparation for publication.


A Brazil nut nursery.

Why Future Food? What would you like to accomplish while you're here? How does being part of Future Food help you achieve your goals?
I've been at Nottingham for a while now, so I have seen the Future Food Beacon develop from its early stages through to where it is today. I attended some of the earliest meetings describing what the Beacon is all about and was impressed by the scope of research being planned. As someone who is interested in the role of agriculture in alleviating poverty, I find it great to see projects such as those on cocoa in Colombia being funded. By looking into what specifically controls variation in chocolate flavour, the quality of smallholder farmers' products can be improved, leading to better prices for the producers. It's also great to see investment in infrastructure and new facilities, which all researchers across the University can benefit from. Whilst working with the Beacon, I'd like to engage with as many researchers as possible across disciplines, which is made very easy to do through regular meetings and briefing events which are held for people across the platform. The Beacon also has many international links which I have already started to benefit from, such as those in Malaysia, and I hope to build on this in future. This is and will continue to be a huge help for achieving my goals of engaging in high-quality international research with the aim of using agriculture to help alleviate poverty whilst promoting sustainability.

Can you explain your research to an ordinary person?
Global demand for edible oil has been increasing dramatically over the last few decades. Much of this has been met by increasing production of oil palm, which in some cases is associated with tropical deforestation to provide space for expansion. This is devastating for local biodiversity, as well as a huge source of greenhouse gas emissions. Quite rightly, this

has attracted a lot of negative media attention. However, oil palm yields around 5-10 times more oil than other major oil crops, so it is feasible that, had the increase in demand been met by other crops, even greater areas of land might have been degraded. As a perennial crop with a useful life of around 30 years, it is also possible that oil palm enables a greater build-up of soil organic carbon than its annual competitors. Things are further complicated by the fact that many farmers in South-East Asia rely on palm for their income, so there are welfare issues surrounding oil crop expansion as well. My research aims to make a science-led, critical comparison of data available on oil crop sustainability, in order to empirically identify which oil crop(s) and production practices are the most sustainable, and which are the most damaging to the environment. This will in turn hopefully lead to further work focussed on improving sustainability in the more damaging parts of the supply chain.

Do you have a greatest career moment?
Hopefully still to come! I'm not sure there's a single greatest moment as of yet, though there have been a few good ones. Being successful in my first grant application for allocation of beam-time at the synchrotron in Italy was very exciting. Maybe less of a greatest career moment and more of a "greatest experience" was heading to Benin in West Africa to teach African researchers molecular biology skills as part of JR Biotek's Reach and Teach Science in Africa program. It was brilliant sharing best practices with hugely hard-working and motivated researchers, who have sadly been limited in their research capacity by availability of lab resources and funding. I hope to engage with further capacity strengthening initiatives in future, they are immensely rewarding!


Tom teaching in Benin

Do you have any advice for young scientists?
Don't be afraid to get out of your comfort zone from time to time, you might be surprised at what you are capable of! I'd also advise working on confidence in general as a lot in research and the wider world seems to come down to it. A "fake it till you make it" approach works to start with, but don't forget to develop the skills to match as you go too!

Does your research impact on ordinary people's lives? How?
I try to keep relevance and applicability in mind with my research choices. I have hopes for my work on high magnesium Brassicas to eventually get into edible crop cultivars to improve human and animal nutrition. We have had some positive early discussions with a crop breeding company about this which is promising. My work on oil crop sustainability could also have huge consequences depending on the conclusions we draw when the full dataset is developed. This could develop into a much larger project on crop sustainability, examining the effects that changing various stages in production has on greenhouse gas emissions, which could end up influencing policy decisions. Long-term, impact is something that I would like to strive towards, and hopefully one day achieve!

International Agriculture Doctoral Training Programme

Solving micronutrient deficiencies in staple crops: an interview with Mesfin Kebebe

Mesfin Kebebe is a UoN-RRes PhD studentship recipient. Their project is titled: Optimization and efficiency of soil geochemistry at national scale for improved human nutrition. Their supervisors are Dr Stephan Haefele (RRes), Prof. Martin Broadley (UoN), Dr Kirsty Hassall (RRes), Dr Samel Gameda (CIMMYT-Ethiopia) and Dr Tilahun Amede (ICRISAT-Ethiopia).

Tell us about how you came to do a PhD and what it has been like so far?

I am delighted to share my personal experiences so far as a first-year Future Food Beacon PhD student at the University of Nottingham (UoN) and Rothamsted Research (RRes) in the UK. My research career began in the early 2000s at the Ethiopian Institute of Agricultural Research (EIAR), a national research institute working on generating agricultural technology and information. The outputs of their work are used to improve the livelihoods of farming communities which make up 85% of the total population. I moved from the EIAR to a vibrant new organization, the Ethiopian Agricultural Transformation Agency (ATA), before then getting a position in an international research organization focusing on improving maize and wheat production and productivity under CIMMYT. As a research associate at CIMMYT, I was responsible for establishing field trials, including data collection and management. Along with these trials, my role included discussions with farmers about their opinions, which would inform design of the trials.

My PhD is part of the GeoNutrition project, whose objectives include mapping soils and biofortifying staple food crops with the micronutrients zinc and selenium through the use of fertilisers. It includes field trials on farms and research stations in the Amhara region of Ethiopia, working together with scientists at CIMMYT and ICRISAT. My project is seeking to optimise micronutrient fertiliser rates according to soil type and landscape features in Ethiopia.

In 2018, we established ~105 on-farm trials in three different districts in the Amhara region and four on-station trials in three different districts with two soil types in the same region. The wider project team visited these trials in October 2018. At harvest in early 2019, soil and plant samples were prepared and a subsample was shipped to UoN and RRes for further analysis, with a portion of the samples retained in Ethiopia for further analyses.

Mesfin in the field in Ethiopia with Prof Martin Broadley and others

My research focusses on studying the basics of soil

dynamics in relation to adsorption-desorption studies on Zinc, followed by establishing greenhouse experiments with source, rate and timing of Zinc applications to improve the grain Zn quality of teff (Eragrostis tef) in 2019-2020 and a further test of these findings on the farmer field in the 2021-2022 cropping seasons.
The early stages of my PhD have included supervisory meetings at UoN and RRes, the development of a draft research proposal, and training in soil analyses at RRes which is my primary location. In addition, I have taken advanced training courses, including statistics, and attended several research seminars. Whilst coming to terms with the cold winter, I have had ample chance to learn about the state of art research and knowledge from this unique institute (Rothamsted Research) that was founded over 170 years ago. Most agricultural researchers I know in Ethiopia would be so happy and inspired to be working at Rothamsted and/or universities like Nottingham.

Why did you decide to do this particular PhD?
Micronutrient deficiencies, usually termed as hidden hunger or MND, are becoming a serious health threat to nearly 80% of the 110 million people who lived in rural areas with limited access to fortified food and food supplements in Ethiopia. Hence, biofortifications of their own cultivated staple food crops is the only feasible and viable option to address hidden hunger and improve health through nutrition in Ethiopia. Therefore, I just wanted to be a part of this novel idea and get the chance to pursue my degree in this area with a focus on Zinc.


Harvesting field trials

How is doing a PhD different from your previous degrees?
I completed both my degrees (MSc, BSc) at home in Ethiopia and many things were limited including resources, chemicals and advanced laboratory equipment thus restricting my ability to do experiments. There was also less supervision, which focused mainly on the theoretical aspects of the science. Here in the UK, I have close supervision with regular monthly updates and the practical aspect of the sciences with full access to well fitted labs to do the experiments I need to do for my research.

How do you relax and cope with the stress of a PhD?
Initially, as I directly dived into the ocean of knowledge that is filled with lots of expertise I experienced fear and stress. How I can cope with the knowledge with these groups have found? Interestingly enough, as time goes on, the people around me are positive, very helpful and very sociable, and I started to cheer up and started the journey with a good mood.


Weighing selenium fertilisers in the lab in Ethiopia

Predicting micronutrients in the soil: an interview with Christopher Chagumaira

Christopher Chagumaira is a UoN-RRes PhD studentship recipient. His project is titled: Geospatial modelling of soil geochemistry at national scale for improved human nutrition and he is supervised by Prof Murray Lark (UoN), Prof Martin Broadley (UoN), Dr Alice Milne (RRes), Prof Patson Nalivata (LUANAR)and Dr Joseph Chimungu (LUANAR).

Why did you decide to do a PhD? What were you doing before?

I became interested in the applications of geospatial analysis in environmental planning and monitoring in 2007 when I was doing my undergraduate project at the University of Zimbabwe. My interest was raised further during an internship at the Environmental Management Agency in Zimbabwe. In order to develop my skills I joined the Soil Fertility Consortium for Southern Africa (SOFECSA) as a research fellow. I worked with smallholder farmers in rural communities of eastern Zimbabwe, conducting research in the areas of climate change adaptation, natural resource management and soil fertility. When I completed my Master of Philosophy, from the University of Zimbabwe, I got a chance to be engaged in several government and university projects that used geospatial analysis in mapping soil fertility status in rural communities in Zimbabwe. I became keen on developing my understanding of the statistical methods needed in this area and how they can improve communication of uncertainty, and consequently improve decision-making.

Why did you choose this particular scheme (Rothamsted-UoN)?

This scheme attracted me because of the long-standing track-record of collaborative research in sub-Saharan Africa where the aspect of using geo-information sciences and geochemistry to improve food and nutrition security is still in its infancy. I felt this is the right pathway for me to gain the knowledge and expertise to be able to contribute scientifically in order to improve the welfare of my fellow Africans.

How has your first year gone? Any highlights or successes?
When I started my PhD in autumn 2018, I was sceptical that I would be able to fully understand random function models, geostatistics and machine learning because I was intimidated by the 'complex' equations. But with a lot dedication and patience I started grasping the concepts bit by bit, and now I am confident of myself and looking forward to more intensive work as my PhD studies progress. I have developed an understanding in statistical modelling and computational skills.

Has undertaking a PhD been different from other degrees you have done? How so?
When I did my undergraduate and master's degrees it was very flexible and I could spend a few days without studying and having to worry a lot, because I knew I would be able to absorb and deal with the pressure. But the approach to a PhD is different in that it requires huge amounts of commitment and discipline. When you interact with established scientists you get challenged and motivated to push yourself to the limit.

What have you learnt through your first PhD year?
I have gained some life skills such a bravery and resilience. I have never been away from my family for more than a month and that has been one of greatest challenges I have had to cope with this year, although I was excited about the new opportunity ahead of me. But I was uncertain about many things, how would I fit into the new society and culture? Would I be able to cope with erratic UK weather? Would I be home sick? I have blended well with the rest of my colleagues and developed confidence to speak about my research in public. Building on the confidence, my presentation skills also improved over the past few months and I presented to several platforms, such as the Gates Foundation-funded GeoNutrition project meetings in Ethiopia, the Future Food briefing event and the UoN Postgraduate Symposium. I received positive feedback and received a gold award for my 1st year presentation in my Division, Agriculture and Environmental Sciences, at the 2019 UoN Postgraduate Symposium.

Tell us about your research. What do you study? Why is it important?
My research focuses on understanding and communicating uncertainty in spatial prediction of soil micronutrients, and other variables that affect their uptake in plants, to improve spatial resolution of baseline data. Improving the baseline data would greatly improve the ability of stakeholders such as agricultural and health practitioners to assess the risk of micronutrient deficiencies in their respective areas.

How do you explain your research to ordinary people?
Funny enough my research is aimed at identifying the best way to communicate uncertainty to a range of data users, with little or no statistical background. I will save that answer towards the end of my studies.

How do you cope with the pressure of doing a PhD?
Doing a PhD has its pressures and when I feel 'drained' I usually take a break. During the break I engage in several activities, mostly the UK weather decides what's feasible, such as nature walks, indoor & outdoor exercises, and travelling.

Breeding rice for higher temperatures: an interview with Tanvir Ahammed

Md Tanvir Ahammed is a UoN Rothamsted Research PhD studentship recipient. Their project is titled 'Exploring genetic diversity in rice for better nitrogen recycling and reduced ammonia emission under stress' and they are supervised by Dr Sigrid Heuer (RRes), Dr Erik Murchie (UoN), and Dr Kazuki Saito (AfricaRice).

Why did you decide to do a PhD?

I have a very inquisitive mind. I scrutinise almost everything. Why it is like that? How has it happened? What if that was not the case? I always ask myself these types of questions. Since my early school age, I had a soft spot for scientists because they are the ones who help the world to solve its problems, discover the unknown and make this world a better place to live in. The passion for becoming a scientist has motivated me to do a PhD.

What were you doing before?

After completing my undergraduate degree in Bangladesh, I moved to the UK to complete a Master's degree. After finishing my Master's, I joined at Fera (Food and Environment Research Agency) as a scientist where I mostly worked with plant diseases, doing research on the efficacy of different pesticides on various plant diseases. Afterwards, I worked at a nematology lab at the University of Leeds, where I worked with plant nematodes, generating some transgenic nematodes for functional analysis of some Meloidogyne genes.

Why did you choose this particular scheme (Rothamsted-UoN)?

This joint PhD programme between Rothamsted Research and the University of Nottingham has given me the opportunity to work in both of these excellent places, gain different experiences from two different labs and learn from the renowned scientists in both institutes. Also, my PhD project will allow me to work at AfricaRice Centre in Senegal, which actually attracted me most, as it is an excellent opportunity to gain some international work experience.

How has your first year gone? Any highlights or successes?

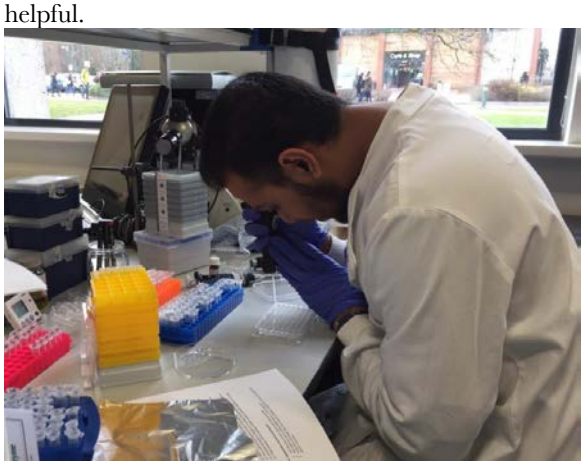
My project requires me to work at both Nottingham and Rothamsted, and I have spent my first year at Nottingham. Thus far, I have had a wonderful time here in Nottingham. I have learnt many new things, met lots of new people and made some good friends. I have found everything in the lab that I need for my research, and many helpful people in the lab who always support me in solving problems I encounter. I have made some significant progress in my project and found some interesting results.

Has undertaking a PhD been different from other degrees you have done? How so?

Undertaking a PhD is quite different from other degrees. I have a MSc degree from the University of Leeds and BSc degree from the Sher-e-Bangla Agricultural University in Bangladesh. The main difference between those degrees and PhD is that there is no specific curriculum for PhD, unlike other degrees. In the PhD, I have to work independently, manage my daily routine in the lab and office, set my own goals and accomplish those, and communicate my research to others by attending seminars and conferences. Undeniably the PhD is a unique opportunity to develop independent working skills and project management skills.

What have you learnt through your first PhD year?

I enjoyed the research throughout my first year. It has been a challenging year for me as this is the first time I am working independently on a specific project, and I have learnt so many things. I have learnt new lab techniques while also learning to manage my time and to network with people. I attended conferences and gave a talk at the annual postgraduate conference at the school, which was a good experience. The University of Nottingham provides professional training courses on various topics like presenting your research, project management, and statistics which I have found very helpful.



Tell us about your research. What do you study? Why is it important?

I am working on rice, the third most important staple crop in the world and the most important staple crop in developing countries. My research is focused on increasing the nitrogen re-assimilation efficiency in rice under high temperatures. Under high temperatures plants operate stress metabolisms such as photorespiration which results in free ammonia in the plant cell that needs to be recycled within the cell. I am looking at how efficiently different African rice varieties can re-assimilate this photorespired ammonia under heat stress in order to find out which genes are responsible for this trait. Global warming is a burning issue at the moment, and we need heat-tolerant crops to feed the burgeoning world population. My research fits in exactly there because hopefully, my project will produce results that breeders can use directly to increase nitrogen use efficiency in rice under high temperature.

How do you explain your research to ordinary people?

Plants need nitrogen for growth and development and most is taken from their environments. There are some biological metabolisms in the plants that produce free inorganic nitrogen that plants need to recycle in order to maintain a balanced nitrogen status for growth. However, under high-temperatures plant suffer from stress, and nitrogen recycling efficiency reduces, resulting in poor growth and yield or even death of the plants. My research is to try to increase this nitrogen recycling efficiency in plants so that plants can grow under heat stress condition even with low input of nitrogen fertiliser.

How do you cope with the pressure of doing a PhD?

Everyone says doing PhD is enormous pressure, but I enjoy these challenges. I like to do research and take challenges that keep me motivated to move forward to become a scientist. Alongside doing intensive work for my PhD, I try to maintain a balanced social life. I have lots of friends here. I am affiliated with a cricket team in Nottingham so every weekend we play cricket at the county level, and we go to different places in Nottinghamshire to play with other teams. I also play badminton, and attend different social gatherings that refresh me and give me the energy to do my PhD with a calm mind.

The importance of zinc in cereal crops: An interview with Veronica Guwela

Veronica Guwela is a UoN-Rothamsted PhD student recipient. Their project is titled: 'High zinc wheat for sub-Saharan Africa' and they are supervised by Prof Julie King (UoN), Dr Malcolm Hawkesford (RRes), Prof Martin Broadley (UoN) and Prof Moses Maliro (LUANAR) .

Why did you decide to do a PhD? What were you doing before?
I decided to do a PhD because I am very passionate about molecular breeding tools and their application in plant breeding, such as marker assisted breeding. I did a Master's degree in plant breeding using conventional techniques and I always wanted to do molecular work to enhance my skills. A PhD is also very important to me for my long term career goals because I want to conduct novel research and contribute to my field of study. Before I started my PhD, I was coordinating a USAID/AGRA funded project on scaling seeds and technologies at Chancellor College, University of Malawi.

Why did you choose this particular scheme (Rothamsted-UoN)?
The UoN-Rothamsted scheme was very appealing to me because I knew it will expose me to different perspectives of my research work with supervisory support from both institutions. It gives me access to state of the art facilities. I also hoped that it would expand my professional network and add more credibility to my reputation as a researcher and my research work.

Tell us about your research. What do you study? Why is it important?
My work is mainly focused on exploring the wider genetic diversity among wheat and wheat wild relatives in order to develop wheat lines with a high grain zinc concentration suitable for sub-Saharan Africa environments. I am interested in transferring the wheat-wild relative introgressions that have been analysed for high grain zinc concentration into African wheat and characterising them using molecular and cytological tools. The research is very important because zinc deficiency is a huge global challenge which affects more than 40% of people in parts of sub-Saharan Africa. Most people at risk of zinc deficiency are usually on low to middle incomes, who cannot afford to buy foods rich in zinc or fortified with zinc, and cereals make up their staple diet. Therefore, breeding for increased zinc will be the most affordable and easily accessible way to make the nutrients available to such communities.

How has your first year gone? Any highlights or successes?
So far so good. I am really enjoying my work. I spent the first 5 months of my PhD undertaking training in different laboratory techniques that I will need for my research, and it has been challenging and interesting at the same time. I had the opportunity to present my research at the 2019 Biosciences postgraduate conference and I was excited that my talk was voted the best in Plant and Crop Sciences!

Has undertaking a PhD been different from other degrees you have done? How so?
Doing a PhD is totally different from any other degrees because a PhD prepares you to be an independent researcher and also increases your desire to contribute significantly to your field. It opens up opportunities to network and to learn what others are doing in your field.

What have you learnt through your first PhD year?
I have gained enormous lab skills especially related to cytogenetics, genotyping and plant mineral analysis. I have done two talks within the space of 6 months thus improving my presentation skills. I have also learnt to be more disciplined, focused and resilient in order to achieve my goals.

How do you explain your research to ordinary people?
Zinc is one of the most important elements in human nutrition because it contributes to the physical and mental development of human beings. Dietary deficiency of zinc may result in high risks of infections, cognitive impairment and stunting in children while babies born to women with zinc deficiencies may have low birth weights. My research is therefore aimed at transferring genetic material responsible for increased zinc from some wild wheat varieties into cultivated African wheat as a way to increase the zinc concentration.

How do you cope with the pressure of doing a PhD?
I usually sing and listen to different types of music. Sometimes I watch a movie or read a motivational book.

Anything else?
I am grateful to be part of the Beacon community. I believe there is so much to learn from the diversity of research, skills and the people.

Researching the future of wheat: An interview with Manpartik Gill

Manpartik Gill is the recipient of a UoN-RRes PhD studentship. Their project is titled: Novel brassinosteriod dwarfing genes as alternatives for improved wheat grain yields. Their supervisors are Dr Stephen Thomas (RRes), Assoc Prof John Foulkes (UoN), and Emeritus Prof Peter Hedden (RRes).

Why did you decide to do a PhD? What were you doing before?

My goal before starting a PhD was to become an academic and to undertake a project of personal growth. Successfully being awarded a PhD position in a well renowned university provides a great opportunity to do both these things. My love for plants grew when, as a child, I would accompany my dad to his tissue culture laboratory where I used to see micro propagated plants, callus cultures growing in some jelly-like substances and cell suspensions under the microscope. These visits nourished my interest and curiosity in this field and while studying biology in school I could relate very strongly to it.

After leaving school, I undertook a B.Sc. Agriculture (Hons.) 4-year program at Punjab Agricultural University (PAU), Punjab, India, which is one of premier agricultural universities in India due to its pivotal role in successfully initiating the Green Revolution in India. The degree had a wide variety of courses but Genetics, Plant breeding and Biotechnology were the one's I connected with, as I felt they had huge potential in addressing the global food and feed requirements in the current era.

My interest in research was further developed when I was admitted to an M.Sc. in degree in Plant Breeding and Genetics at PAU, working on a project involving wheat grain quality improvement. This was the first time when I worked with wheat crop and was introduced to its importance for global food security. The aim of my project was to introduce low polyphenol oxidase and rust resistance genes in one of the premier wheat varieties of Punjab which is grown on a large acreage due to its superior chapatti making quality.

After successfully defending my Master's thesis, I started working as a Junior Research Fellow in the Department of Biochemistry in PAU. There I was introduced to acrylamide (a potential carcinogen) problem in wheat baked products. The specific aim of the project was to reduce the content of acrylamide in these products by exploiting both natural genetic variation and silencing the key genes by genome editing.

By undertaking these projects, I was able to learn about various techniques which are common in the world of molecular biology, breeding and biochemistry.

Why did you choose this particular scheme (Rothamsted-UoN)?

As I was committed to having an internationally

renowned PhD degree, I started searching for PhD positions in the UK, US and Canada. I was excited to learn about the "Nottingham- Rothamsted Future Food Beacon Studentships" from one of my teachers, and I applied for my current project and was selected. One of the greatest things about this studentship is that it gives opportunities for international students to be a part of these esteemed organisations which have always been at the forefront of agricultural science. Students are given a golden chance to shape their careers, working with scientists who are not only experts in their field of study but also great supervisors.

How has your first year gone? Any highlights or successes?

I feel my first year was a great success. I think I have evolved each day in some way or another, either by learning new experimental tools or by improving my interpersonal skills and building new friends and collaborations.

Has undertaking a PhD been different from other degrees you have done? How so?

Yes, there is a huge difference between my PhD and initial degrees both personally and professionally. On personal grounds, during my previous studies I was living at home and thus I didn't need to worry about anything such as cooking, cleaning etc., but now it's totally the opposite so I feel I have gained lots of managerial skills and have become way more independent which I may not have been back home. The other major difference lies in dealing with a diverse group of people who have different cultural upbringings. This had a huge impact on widening my perspective and creative skills. On the professional front, as a PhD is a long game there is a requirement to validate a concept and test the hypothesis on various dimensions. Now I am working with many collaborators trying to stitch various pieces together and validate a concept, which I feel is amazing.

Tell us about your research. What do you study? Why is it important?

Wheat is one of the most important cereal crops consumed; providing nearly 20% of the protein, dietary fibre and minerals globally. With the future population growth projections, wheat yields are required to increase by nearly 60% by 2050. However, this needs to be balanced against complications associated with climate change and land degradation.

The green revolution is an excellent example wherein the gibberellin phytohormone pathway were altered in wheat to make semi-dwarf varieties that produced dramatically high yields under higher fertiliser application. This transformed countries reliant on agriculture to become self-sufficient in wheat grain production and enabled food security.

Currently, I am working chiefly with developmental biologists. During my PhD we want to optimise the wheat architecture (primarily focusing on canopy architecture) by tailoring brassinosteroid (BR) phytohormone pathway. We wish to introduce novel alleles in various genes in the BR biosynthetic and signalling pathway in wheat by using both forward and reverse genetics-based approaches. The performance of modified wheat plants will be ultimately established in field trials.

How do you explain your research to ordinary people?

Photosynthesis is a process wherein plants absorb the sunlight with the aid of chlorophyll and convert the solar energy into the chemical energy in the form of complex organic compounds. What happens in the case of crops with droopy leaves is, sunlight is only absorbed by the upper canopy thus causing shadiness in the lower canopy. This causes reduced photosynthetic efficiency. We want to change the canopy architecture by making the leaves more upright and erect (at least on the upper canopy) so that there is more even distribution of light. Thus improving the photosynthetic efficiency of wheat and thus increasing grain yields.

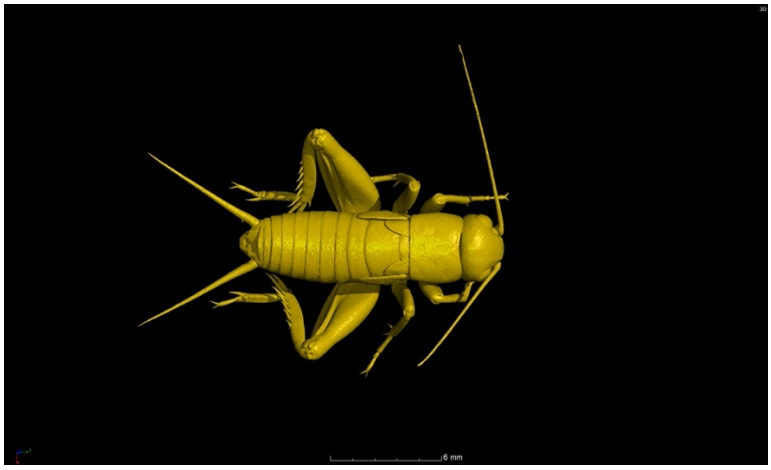
How do you cope with the pressure of doing a PhD?

I like to travel to various places on weekends, going to some parks and I love cycling to release my stress. Apart from that as I am a nature loving person, I sometimes go to the nearest park with my laptop and do some reading during the bright sunny weekdays to energise myself and break the monotony of the workplace.

Photographs courtesy of Graham Shephard

Innovation Challenge Projects

The Future Proteins Platform



Protein is an essential part of the human diet, providing an important building block for the body, as well as being used to build and repair tissue. As populations become increasingly wealthy, and urbanised, so the way they consume protein changes. Increased demand for meat, fish and dairy products is seen throughout the world as people move to cities and have more disposable income. Coupled with this is the growing global population which will inevitably require the production of more food, including more protein, and the effects we see of climate change which are altering how we are able to produce food.

Animal products, including meat, milk, eggs and fish are regarded as excellent sources of high quality protein. However, at present, farmed animals are fed high quality proteins, including soya and cereals, that could be fed directly to humans. Aquaculture remains heavily dependent on the unsustainable use of protein-rich fishmeal derived from wild-caught fish. Finding new plant and non-plant protein-rich alternatives to fishmeal, soya and cereals is therefore critical for the future long-term sustainability of both animal feed and healthy food.

The Future Food Beacon is therefore very excited to be supporting the Future Proteins Platform, a new, £1million project lead by Prof Andy Salter. The overall aim of this project is to evaluate novel plant and non-plant protein sources and to develop the most suitable ones for animal feed and/or human consumption.

To do this, the project team are:

- Investigating alternative means for generating protein, and whether these can be manipulated to improve quality or efficiency by which protein is produced
- Determining interventions which potentially utilise alternative, low-value feed sources to facilitate the sustainable production of such proteins
- Developing protein sources for us in aquaculture, farm animal production, or as human food ingredients.

The Future Proteins project draws on expertise across the University of Nottingham, including from Biosciences, Nutrition, Engineering, and Food Science. Six new PhDs have been recruited to UoN, both to the Nottingham UK campus and the Malaysia campus, as well as two postdoctoral researchers.

Understanding micronutrient deficiencies for better health: an interview with Dr Molly Muleya

Molly Muleya is a postdoctoral researcher on the Future Protein's Platform. Molly's research examines the protein and mineral digestibility from foods of dietary and planetary importance. Her research is at the interface of agriculture, food science, nutrition and health and seeks to understand factors across the food chain, that modify protein and mineral bioavailability of foods. Before joining the Future Food Beacon, she was an IMMANA fellow at the University of Nottingham and she completed her PhD in Food Science and Nutrition at the University of Ghent in Belgium.

Tell me about your research?
I work at the interface of agriculture, food science, nutrition and health. I'm interested in food security issues, mainly pertaining to mineral micronutrient deficiencies. About 1/3 of the global population suffer from one form of mineral deficiencies, of which iron and zinc are the most prevalent. One of the reasons for this is because many people, particularly from low-income countries, subsist on monotonous cereal staple foods. These staple foods have low concentrations of bioaccessible iron and zinc. That means that the proportion of minerals that can be potentially absorbed from the cereals is pretty low and this is mainly due to the presence of mineral binding compounds which restrict their digestibility. A lot of my work focused on the digestibility and/or bioaccessibility of iron and zinc in these staple crops. I am particularly interested in how certain processes employed along the food production chain can modify the mineral bioaccessibility of crops.

What kind of crops make up staple crops?
My focus has been on maize because maize is consumed by millions of people in sub-Saharan Africa, including Zimbabwe where I come from, and by people on other continents. I have extended this work to sorghum and millets too. In Zimbabwe, sorghum and millets used to be the staple foods before maize came into the picture in the 1920's. There is now more maize consumption than sorghum and millets. However, a lot of evidence now suggests millets are probably nutritionally superior to maize, so they are rapidly re-emerging into food supply chains and more and more people are adopting them in their diets.

How did you become interested in this area of research?
I've always been interested in food and nutrition security. I grew up in a high density suburb in Zimbabwe where food security issues were real. I noticed there was always lots of food during the harvest season, followed by massive scarcity in the dry season. This was because of post-harvest losses due to lack of processing or preservation know-how. In addition, under-nutrition in children was prevalent and I became really interested in understanding some of the reasons for this. That is how I became interested in food science and nutrition. I went to do a Masters in Food Technology in Belgium, as I wanted to learn about the processing aspect of food in particular; how to add value to underutilised food ingredients in Zimbabwe. After my masters, the Zimbabwean government had just finished a micronutrient survey, and that survey revealed that about 30% of children under the age of 5 years were stunted. Stunting is a good indicator of zinc deficiency. And more than 50% of children were iron

deficient. That spoke a lot to me, so I decided to pursue a PhD examining the iron and zinc bioaccessibility of cereal crops – these are the major suppliers of dietary iron and zinc for vulnerable populations. My PhD research focused on food based strategies to improve bioaccessibility of iron and zinc in maize, sorghum and millet porridges typically consumed by children in Zimbabwe. Most people affected by mineral deficiencies are small-holder farmers who grow food on their own farms and do their own processing. The entire food chain, from farm to fork, is experienced on the farms, so I was keen to find household based processing solutions that are affordable, feasible and acceptable. I explored the potential of household cooking methods such as fermentation and food-to food fortification to modify the iron and zinc bioaccessibility of cereal porridges. The microorganisms produced during fermentation can produce important enzymes that can allow more iron and zinc to be released from the food matrix. Food-to-food fortification entails the fortification of foods with other food ingredients that have been identified to have high mineral concentrations or to have properties that can improve bioaccessibility. I looked at the potential of indigenous forest foods, like baobab fruit pulp which contains a high concentration of vitamin C and also edible insects like mopane worms.

How did you become interested in science and scientific processes?

There are things that we have always known, through traditional knowledge in Zimbabwe, but people didn't really know how to explain them. That is how I became interested in science, I wanted to scientifically validate some of the traditional knowledge about our indigenous foods, and be able to explain to people what we are doing, why we are doing it, how that might improve nutrition, and ultimately achieve food security for all.

After your PhD, what did you do?

I was fortunate to be awarded a fellowship from IMMANA, (Innovative Methods and Metrics for Agriculture and Nutrition Actions) funded by the UK's Department for International Research. The aim of the fellowship is to train and empower emerging leaders in agriculture and nutrition linkages. At the end of my PhD, I realised that the food processing step was a good way to add value to our staple foods, but the level of minerals in our staple crops were inherently low, and that is probably because of the agricultural aspect. So I wanted to focus on this aspect because agriculture is the key entry point for minerals into the food system. I joined Liz Bailey and Martin Broadley who were already working in that area. I investigated the effect of agronomic biofortification on mineral bioaccessibility of cereals and legumes. For example, I looked at how selenium fertilization could enhance selenium concentrations and bioaccessibility in major cereals and legumes in Malawi. I also examined how nitrogen based fertilizers amended with iron and zinc could modify iron and zinc bioaccessibility of major cereals and legumes grown in Zimbabwe. After the IMMANA fellowship, I got the opportunity to join the Future Proteins project.

Tell me about working on Future Proteins?

I am working on the digestibility of future proteins, particularly those underutilised proteins from plants, insect protein and new proteins that might be produced from bacteria, algae and fungi. Developed countries rely a lot on animal-based proteins, and it is predicted that as income rises in low-income countries, more people will also shift to animal-based proteins. However, the environmental degradation associated with animal production along with some negative health effects means that there is an urgent need to find other sources of protein. The digestibility of these alternative proteins underpins their success. They must be digestible – after consuming them, we must be able to absorb key amino acids that are

required for optimal health. Replacing animal protein with alternative sources of protein, could cause unintended effects of more mineral deficiencies because animal protein is a very good source of bioavailable iron and zinc. So alternative sources of protein must also be good sources of bioavailable iron and zinc. The work that I did during my PhD and IMMANA fellowship really fits in together with the work we want to do now in the Future Proteins Platform.
It seems a bit different to jump from minerals to proteins but proteins and minerals are connected. The type of compounds that restrict protein digestibility also do the same for minerals. It is a good opportunity for me to look at the two aspects at the same time. Most people who are vulnerable to mineral deficiencies rely on plant and/or under-utilized protein, so having the opportunity to study both the protein and mineral digestibility of future protein is like killing two birds with one stone.
I am working within a multidisciplinary team including soil scientists, plant nutritionists, and human nutritionists, so it has been highly stimulating and I am looking forward to some fantastic research in the future.

Do you have a greatest career moment?
That is quite difficult! I'm not sure if I have reached the greatest career moment yet. I think I've had great career moments, I'm looking forward to more great moments. When I finished my PhD, I felt that level of accomplishment – I did this and I've contributed to science! Then when I got the IMMANA fellowship, that was a proud moment for me because that fellowship is only awarded to five people globally for each cohort. It affirmed that the work I am doing is important, and is making an impact in the world. I look forward to achieving more great things, especially now with the Future Food Beacon. The availability of cutting-edge equipment and high level of cooperation with other researchers means that the sky is the limit!

Is research impact important to you?
Of course! All the work that I am doing is really work I can share with an ordinary person, and they understand. If I tell someone that I work in the field of food science and nutrition, they always ask, 'what kind of diet should I be on?', 'is this type of food healthy for me or not?' And so on….It is something we talk about almost every day. It is real and tangible to many people. It is something that people are asking more and more every day. It has an immediate impact to the ordinary person.

How do you translate your lab work into real world applicability?
With the work that I did in Zimbabwe, it was easy to translate it to the public domain because I was working with rural communities and I established learning centres where I could go and share evidence from the samples they had provided for research. Those learning meetings became routine. Publishing papers is important, that is part of sharing what I am doing with the rest of the scientific community and also engaging with the general public, industry people and policy makers.

Do you have any advice for any potential new scientists?
I think it is about pursuing what you really love. I've always wanted to do a PhD, but I focused on doing something that spoke to my heart. I identified the people who were pushing boundaries in that kind of research and could help me to advance my career. My advice for someone who wants to pursue a PhD would be to really know what they love, and aggressively seek opportunities to pursue that with leaders within that field. Don't be afraid to knock on important doors.

Working with worms: an interview with Dr Carlos Lopez Viso

Carlos Lopez Viso is a postdoctoral researcher on the Future Proteins Platform. He is working on the production of mealworms as a new source of sustainable proteins for aquaculture. In order to do that, he is applying genetic techniques to modify the protein and fat content of these insects.
Prior to joining the Future Food beacon at UoN, Carlos was a Research Fellow at the University Pablo de Olavide (Seville, Spain) where he got his PhD working on an innovative biotechnological process in fermenters. As an expert in C. elegans, he also researched using this nematode as a model organism for biomedical studies and screenings of drugs and nutritional supplements for treatment of genetic diseases. His interdisciplinary career has been developed in collaboration between the University and private companies.

Tell me about your research journey? How did you end up at UoN?
I am a biotechnologist. I did my PhD at University Pablo de Olavide (Seville, Spain) in biotechnology, engineering and chemical technology. I researched using waste to produce biodiesel through a biological process in bioreactors. It included genetic and engineering tools. Then I have carried out several projects based on screening with drugs, probiotics, plants and fungi extracts as disease treatments using a model organism in biomedical studies. Additionally, I have been involved in the creation of a spin-off, based on the production of live food for feeding fish larvae in aquaculture, which is related to my current project here (using different organisms).

That is quite a diverse array of projects. What connects them altogether?
The main connection is that I have worked with the same organism (Caenorhabditis elegans). This nematode was the first multicellular organism completely sequenced. Therefore, many genetic tools have been developed, being a quite famous nematode used for biomedical studies that we applied to our screenings. Additionally, the aim of my PhD project had a completely different approach. We implemented an innovative industrial bioprocess using this organism to obtain a waste re-evaluation.

What is it like moving through these different research projects?
It is exciting! We tried to apply the knowledge, resources and training we have about this organism; looking for links between complementary projects. For example, we used the available genetic knowledge about fat related diseases to modify the C. elegans composition in terms of fat accumulation for the biodiesel project. As another example, we carried out the optimization of cultures in bioreactors that could be extrapolated to other processes with different waste.

How do you explain your research to ordinary people?
I try to describe what biotechnology is about: to use biological tools (microorganisms, for example) and apply them to processes using genetics, engineering and technology knowledge.
In my previous research this meant we eliminated a residue, which is an environmental and an economic problem. In order to do that, we grew an organism on the residue to remove it and obtain a product that generates income. It allows the process to be more sustainable and profitable. For biomedical projects, the idea is to use a simple organism with interesting

characteristics to mimic human diseases. It is a good way to test drugs and nutritional supplements quickly, cheaply and without need for other more complex organisms. I have worked with C. elegans as a model of diabetes, obesity, infertility, Alzheimer's and Parkinson's.
Currently, I do research in order to produce new sources of proteins in a sustainable and cheaper way. Particularly, we are focused on the production of insects for fish feeding. To do that we try to improve characteristics of interest (fat and protein – both quality and quantity) through genetic techniques.

What will you be doing as part of the Future Proteins Platform?
The main goal of my current project is to produce new sources of protein using mealworms (an insect). We are focused on using the proteins in aquaculture. We tackle this project by applying genetic silencing by RNA interference which means we can modify the gene expression on the mealworms in order to increase the protein and decrease the fat matter content. We have designed diverse strategies to get suitable targets as the genome sequencing and a cross-species microarray for different larval stages. Additionally, I aim to be involved in different projects and participate in internal and external collaborations to promote a multidisciplinary environment that characterises the Future Protein Platform.
How does your research affect ordinary people?
We hope it will have a huge impact in society. Currently, our food system is not sustainable. We need diverse solutions at many levels. Fish consumption is one of these issues. As marine reserves run out, aquaculture is becoming increasingly crucial. If people want to eat good quality fish in the future, we need to find a sustainable source of protein to feed them. Otherwise, fish consumption will not be possible for ordinary families, maybe only for rich people. In this sense, our project aims to tackle this problem using insects as a sustainable source of protein not only for aquaculture, but also for other farm animals.

How did you become interested in science and working in the lab?
I am excited about the challenge of having a problem and finding a solution. There are sometimes more problems than solutions and more questions than answers! However, it is a pleasure when you have a hypothesis and you get results that can support it having a positive effect in society.

How did you know you were interested in science?
I think I have been interested in science all my life. I love nature. And I enjoyed making puzzles and model ships that, as science, is all about applying methods, techniques and being patient. Biology, maths and technology were the most interesting subjects at high school for me. In my opinion, having a multidisciplinary background lets me enjoy different branches of the science.

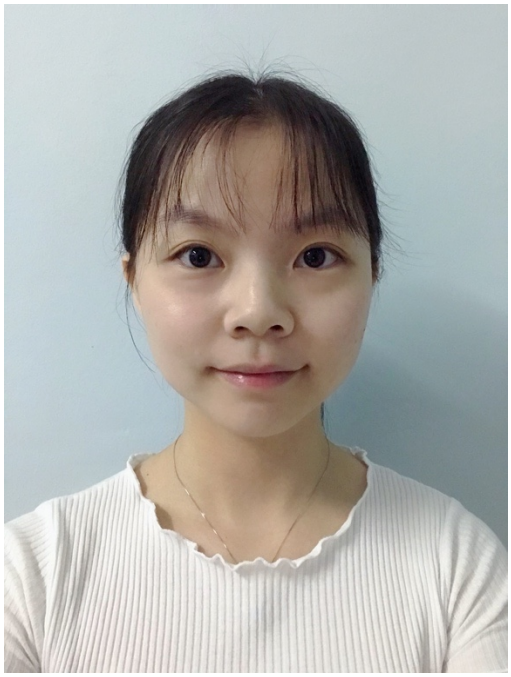
You have a very interdisciplinary background, what is it like being based in nutrition now?
Obviously, my current project has a final goal related with nutrition, which is not my main background but I am glad to learn more deeply about insects and nutrition. However, the way to tackle these questions is based on biotechnology; applying genetic and analytical tools which are in line with my background. I try to combine my previous experience with new learnings.

What is it like being part of Future Food?
I love being part of a multidisciplinary team. You can learn and collaborate all the time. People work towards common goals but with different approaches, and backgrounds. I think the best way to enrich yourself is in a space like this one.

Do you have any advice for younger scientists and PhD students?
You should do whatever you want. I know it is a topic, but it is true. The scientific difficulties do not matter if you are doing the kind of work you are really passionate about. Everyone needs to find his own way.

What do you think you might do in the future?
I like both environments (academia and industry). Above all, I like applied science. Basic science is essential but I prefer working on applied projects. I feel it is more exciting because you can see the potential social impact. Therefore, I will probably stay in academia and try to work on applied projects. I am open minded about it and I might consider moving into the industrial sector linked to research and development.

Using Bambara groundnut for animal feed: an interview with Tee Ann Jo



Ann Jo Tee completed her bachelor's degree in Biotechnology in 2018 and she is currently a first year MPhil/PhD student, part of the Future Proteins Platform. She is very interested in studying microbiology and has a strong passion to explore more about the potential applications of microorganisms in biotechnology industry. Her current research area mainly focuses on using microbial fermentation as an efficient strategy to enhance the nutritional composition of underutilised crop species thus making it an extra feed source for animals or even as a feasible protein source for future human consumption in order to tackle global food insecurity, hidden hunger and protein-energy malnutrition issues. Ann Jo's research project is titled: Enhancing utilisation of alternative crops using fermentation and she is supervised by Dr Yin Sze Lim, Prof John Brameld, Dr Tim Parr, and Prof Andy Salter.

Why did you decide to do a PhD? What were you doing before?

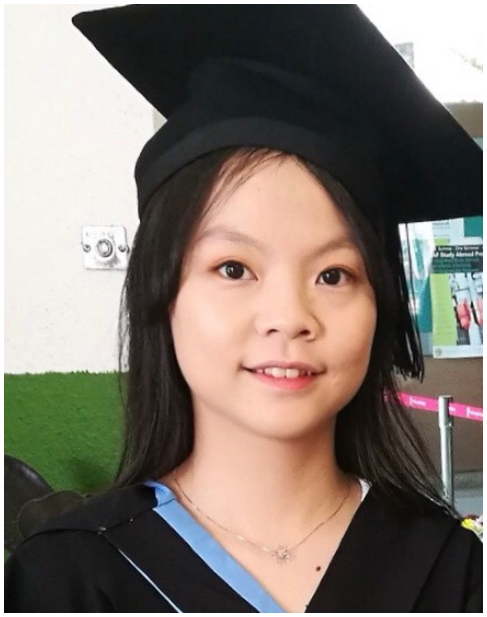
After I graduated, I worked in a feed formulation company as a microbiologist for almost a year. Some challenges and unresolved gaps that I faced during that time truly inspired me to deepen my knowledge in this particular area, to develop feasible solutions in order to overcome those problems.

Why did you choose this particular PhD project?

For me, this PhD project really comes at the right time. It coincidently matches what I want and the scope/background of study relates to what I have been working on for nearly a year.

How is your first year going? Any highlights or successes?

There are always ups and downs during research. Things have gone quite smoothly from the very beginning, but due to the sudden unexpected pandemic Covid-19 that has occurred all over the world, Malaysia experienced a 28-days Movement Control Order (MCO) period which really disrupts my planning and affects the research progression. During the first year of study, I managed to complete a literature review paper and achieve part of my research milestones.



Has undertaking a PhD been different from other degrees you have done? How so?
Yes. A PhD is totally different from undergraduate study, it fully focuses on applying research to practical problems, developing feasible solutions to complex issues and designing effective professional practices within the research field. Pursuing a PhD requires the skills of self-discipline, time management and critical thinking.

What have you learnt through your first PhD year?
I have managed to learn some new research/lab skills and sharpen my presentation skills during conferences. I have also learned how to manage and plan my time wisely and make sure there is always a balance between my research life and time to relax.

Tell us about your research. What do you study? Why is it important?
My research mainly focuses on exploring the effectiveness of microbial fermentation to unlock the hidden potential of underutilised Bambara groundnut as an alternative animal feed which could further contribute to sustainable food and nutrition security within the context of an ever-growing global population and rapidly changing climates.

How do you cope with the pressure of doing a PhD?
I will normally watch movies and drama, have some workouts or have a talk with my family and friends to release my stress.

Making better proteins: an interview with Kamil Szepe

Kamil Szepe is a first-year PhD student, part of the Future Proteins Platform. Their project is titled: Improving the nutritional quality of future protein and they are supervised by Dr Simon Avery, Prof Paul Dyer, Dr Rebecca Ford, and Dr Cormac O'Shea. Kamil's PhD investigates the effects that nutritional composition of growth media and induction of mistranslation via physiological and chemical signals has on amino acid composition of protein in fungi, including mycoprotein for food.

Why did you decide to do a PhD? What were you doing before?
I was enrolled in an undergraduate MSc Integrated Genetics course at UoN. I would say that my decision for doing a PhD was motivated by the fact that I enjoyed both the work and the environment that I experienced during my MSc project.

Why did you choose this particular PhD project?
It was advertised during my MSc research project in the same lab. Originally, I thought about trying to find a job in industry (e.g. technician) and deciding whether to apply for a PhD a year later (probably for courses starting in autumn 2020). But since this position came up and I really enjoyed working in my lab group I considered applying. Another factor that further reinforced my decision to compete for the position in this project was its novelty and seemingly very open scope. I realised that I'd get an opportunity to learn many technical and experimental skills and have good flexibility in terms of what direction I want to take these skills in the future. Involvement with Quorn, as an industrial supervisor, was a cherry on top, firstly, because I had heard positive opinions about Quorn as industrial supervisors from a colleague doing a Quorn funded-PhD, and secondly, I think that more sustainable ways of protein production such as microbial protein will become much more prevalent, making it a prospective career choice.

How is your first year going? Any highlights or successes?
Based on the feedback from my year one viva and industrial supervisory meetings, it is going well. I was due to present some of my research at a Quorn conference, and I was designing and optimising certain selection screens that I was going to use in Quorn labs. Now, with the lockdown, these plans were cancelled or postponed but hopefully things will continue to go in the direction they did prior to the pandemic.

Has undertaking a PhD been different from other degrees you have done? How so?

Yes, in my opinion doing a PhD is basically a full-time job, whereas other degrees I have done were taught degrees. During a PhD, although you mainly work for your project you also have a responsibility to other people that you work with (and vice versa). In undergraduate courses the only person that is affected by for example, missing a deadline, is you – by getting a lower mark. During the PhD there are people in the group – supervisors, industrial partners – who all have their expectations and all put their time into my project, so I owe it to them to consistently do my best to achieve the project goals. The PhD also gives you good opportunities to socialise with other specialists and insert yourself in scientific community.

What have you learnt through your first PhD year?

I improved in every area that I was taught during my undergraduate course. This includes things like presentation skills, organising work, effectively conveying ideas to others and writing. I believe that these are quite easy to miss, and I don't really realize that I have improved until I look back on my work from the past. In terms of technical skills, I did learn how to use equipment like HPLC, a lot of various methods ranging from DNA amplification and genetic modification, through designing selections screens, to running enzyme activity assays. I'd say that the most important skill I developed in the lab so far is the ability to troubleshoot problems and generally work on my own. This was a bit challenging in the beginning, having only had previous experience of lab work that was planned and organised by someone else with instructions and protocols laid out.

Tell us about your research. What do you study? Why is it important?

I am looking at ways of improving protein quality in yeast and F.venenatum. I am investigating the effect of growth media, amino acid synthesis and stress on the amino acid profile of the protein product with the hope that some or all of these can be used to deliberately change amino acid of the protein to, for example, improve protein texture, or increase the abundance of certain amino acids, making the product a better nutritional source. Things learned from this project could then hopefully be extrapolated to other organisms which could help in two main ways: 1) to provide nutritional protein in places where populations suffer from lack of adequate intake of specific amino acids; and 2) to make more protein sources of good nutritional quality which will hopefully decrease reliance on meat, helping make our food industry more sustainable.

How do you cope with the pressure of doing a PhD?

I generally find PhD work less stressful than my undergraduate years because I used to work full-time during my studies to sustain myself financially. Now having only one project to work on and mostly consistent working days/hours I try to spend free time by socialising with friends e.g. having them over for dinner or just going out. I also like visiting cultural heritage sites or going to see art exhibits/performances.

Making sense of food waste: an interview with Hina Kamal

Hina Kamal is a PhD candidate with the Future Proteins project. Hina's project is titled Food recycling: Utilising food waste for valuable proteins. Her supervisors are Prof Asgar Ali, Dr Le Cheng Fohm, and Dr Tim Parr. Hina's research is focused on food waste recycling, in the context of understanding protein extraction methods, protein yield outcome, protein nutritional quality and utilization into product development. She joined the University in October 2019 from United Arab Emirates University (UAEU), where she was a Research Associate at the College of Food and Agriculture.

Why did you decide to do a PhD? What were you doing before?

The "challenge" of being an independent researcher is the sole reason I decided to do a PhD. Research has always been very appealing to me as a student. I completed my undergraduate studies BSc (2003-2006) and MSc (2006-2007) in Food Science & Technology from Karachi University, Pakistan with a GPA of 3.5 & 3.4 respectively. While studying I used to write articles for a local English newspaper, called "The Dawn". The reason for stating this to highlight two facts: (a) a keen interest in the field of study other than the syllabus and (b) in the year 2009, I was offered my first job, as a Research Assistant at UAE University (UAEU) solely on the capability of researching and drafting.

During the 8+ years of research at UAEU, I co-authored 10 manuscripts and have been associated with multiple externally and internally funded research projects, focusing mainly on clinical studies, product development and studying the functional and bioactive peptides under the parasol of two departments – the Departments of Food Science and Nutrition. However, my crowning achievement was winning the "Alltech Young Scientist Award, USA", where I was ranked 1st in UAE and 3rd in the Middle East/ Africa region.

Why did you choose this particular PhD project?

As a researcher and also as a student, I always wanted to pursue an area where the projects have the capacity to grow out from the laboratory setup into society and this project provides that opportunity.

How is your first year going? Any highlights or successes?

Currently, I have entered my 8th month of year one. The first four months were active in the collection of samples and in carrying out some initial experiments, along with attending the graduate school trainings. However, so far under the current circumstances (Covid-19), I have been focussing on writing reviews. In fact, one review on "protein extraction and utilization-current status and opportunities" has already been submitted to Comprehensive review of Food Science and Food Safety. Another review

studying the cavitation technique has been submitted to my supervisor for review.

Has undertaking a PhD been different from other degrees you have done? How so?
Pursuing a PhD is a completely different phase. It requires one to multitask and often be proactive. On multiple occasions many tasks are important and of high priority, hence one simply does not learn just how to be an effective researcher, but it is a self development course too.

What have you learnt through your first PhD year?
I would say self-belief. Even though it is still the initial year, there have been many occasions starting from procurement to actual pragmatic laboratory experiments, where I have fought battles of 'why' or 'how' in my head. The need and importance of the work becomes effective if one relies on self-perseverance and belief.

Tell us about your research. What do you study? Why is it important?
The main objective of this project is food recycling as the future food. It provides an in-depth knowledge of different extraction methods and efficiencies for the recovery of protein from food waste. In my opinion while food waste is not a new concept, increasing concerns about chronic hunger, nutritional deficiency, food security and sustainability have intensified attention to alternative and sustainable sources of protein for food and feed. Initiatives to extract and utilize protein from food waste on a commercial scale have been undertaken, mainly in the developed countries, but they remain largely underutilized and generally suited for low quality products. Focusing on nutritional quality, yield and functionality of the isolated protein as a valued recycled ingredient is indeed very engaging to me as a researcher.

How do you explain your research to ordinary people?
Luckily, my objective is not that alien to the ears of the society. So I usually find myself having an interesting conversation. Usually I try to educate them about the concepts of reducing food waste, this includes: buying less fresh produce, storage conditions of food, buying the ugly vegetables etc. Most people have the concept of converting food waste to compost, so when I highlight the idea of reutilization of food waste fit for human consumption that can be marketed in many products as a functional ingredient for both small and big scale business, they are rather excited.

How do you cope with the pressure of doing a PhD?
As an international student, initially it was different, but not difficult to cope with pressure of doing a PhD. I find cooking therapeutic and I do enjoy learning different cuisines.

Reducing protein malnourishment: an interview with Joe Godrich

Joe Godrich is a PhD candidate with the Future Proteins Platform. Joe's project is titled: Natural protein ingredients – the impacts of reduced refinement. Joe is supervised by Dr Jo Gould, Prof Tim Foster, and Dr Peter Rose. The project investigates the structure-function relationship of protein produced without high refinement. Prior to joining the Future Proteins team, Joe finished his BSc in Food Science.

Why did you decide to do a PhD? What were you doing before?
I graduated in July 2019 with a BSc in Food Science at the University of Nottingham. I chose to do a PhD because I thoroughly enjoyed my final year research project and decided I would like to pursue further studying instead of going straight into the food industry.

Why did you choose this particular PhD project?
I developed a real interest in sustainable protein sources after studying black cricket protein in my research project as a potential foaming agent substitute of egg white protein. I also get the opportunity to work with my final year project supervisor again, who specialises in protein and has various insect protein projects with different countries. The area of science for my PhD creates an opportunity to make a difference and help many people on a local and potentially global scale, with the aim of helping to process food ingredients that will reduce protein malnourishment and improve the overall nutrition of people in developing countries.

How is your first year going? Any highlights or successes?
First year has been very contrasting so far, I began the academic year with a broken wrist so couldn't use the labs. Due to this, I used the first few months to gather literature as it was a new area of science for me. Before Christmas I had written a draft for the literature review that will hopefully form part of my thesis. My first experiment was then planned at the start of 2020 and I got into the labs in February up until the university shut. I'd say a highlight and success would be my literature review draft, which I will now make changes, and add more literature to, over the coming weeks working from home, as well as having a few other potential papers to write to prepare me for going back into the labs to run experiments.

Has undertaking a PhD been different from other degrees you have done? How so?
Doing a PhD has a lot more responsibility than my undergraduate degree, I need to organise meetings and choose when I go into the labs and read literature. Although there are training modules, not much is taught to you and most of it has to be done by yourself, you are only guided by your supervisor and other academics. Working at a desk in an office-style building is different to working from home or in the library. However, I find it easy to concentrate and there are plenty of friendly faces that are always happy to help you with your research and answer any questions you might have.

What have you learnt through your first PhD year?
I've attended a variety of training modules in my first year so far. These modules have helped me to improve skills when it comes to planning my research, scientific writing, being a more effective doctoral student, writing a literature review and helping to decide which practical methods are applicable to my research. On a personal level, not getting consistent results with my first analysis experiment and now not being able to use the labs have improved my resilience and productiveness. I am a lot more self-motivated than I was on my undergraduate course, meaning searching and reading new literature has also been made much easier.

Tell us about your research. What do you study? Why is it important?
I am currently studying the effects of antinutritional factors (ANFs) in legumes, a very sustainable protein source. ANFs can bind to nutrients and digestive

enzymes, reducing their bioavailability and utilisation in the body when consumed and consequently wasting vitamins, minerals and essential sulphur-containing amino acids. Processing methods can reduce ANF levels without altering the product quality or nutritional value. However, many common processes use high refinement like soaking and thermal treatment. There is potential to use lower refinement and therefore more sustainable techniques such as extrusion, popping and high-pressure processing to reduce the ANF content in legumes.

How do you explain your research to ordinary people?
My work aims to increase nutrient bioavailability, utilisation and protein digestibility of plant-based protein sources such as legumes using more sustainable refinement techniques. This research could then help to reduce protein malnourishment in poorer parts of the world such as Africa, as plant protein is cheaper and more abundant than animal protein in many developing countries. Although I am currently studying ANFs in plant material, the research might move on to the effect of ANFs in insects, which are another sustainable protein source.

How do you cope with the pressure of doing a PhD?
In my free time, I enjoy socialising with my friends in a number of ways. Football, squash, lacrosse and badminton are a handful of sports and societies that I regularly play with people inside and outside of the university. As a group in food sciences, we try and do as many team-bonding and socialising activities as possible, including bowling trips and going for meals. I also play the bass guitar and lead guitar, which help me to unwind if I've had a stressful day.

Anything else?
I am enjoying PhD life and cannot wait to get back in the labs when we can return to the university. I have lots of experiments lined up and am excited to read lots of new literature to help expand my knowledge in this research area, as well as communicating with people in food sciences and the Future Food beacon, whilst we have to work from home.

Understanding genetic variation in winged bean: an interview with Niki Tsoutsoura

Niki is a PhD candidate with the Future Proteins Platform. Niki holds an MSc. in Crop Improvement from the University of Nottingham. During her MSc studies, she became familiar with underutilised crops like winged bean. Underutilised crops are relatively underexploited as they have low economic importance or agricultural significance in developed economies, therefore they receive less attention and limited research is conducted. Winged bean, as a legume, has a high protein content and nutritional value and contributes in nitrogen fixation, soil fertility and structure, making it a promising future crop. Niki's project is titled: Winged bean – a new soybean for the tropics? She is supervised by Dr Sean Mayes, Prof John Brameld, Dr Wai Kuan Ho, and Prof Festo Massawe.

Why did you decide to do a PhD? What were you doing before?
I decided that I wanted to do a PhD back in 2014, during my Erasmus placement in SRUC in Edinburgh, because I was and still am fascinated by research. I enjoy broadening my knowledge and gaining new research skills.

Why did you choose this particular PhD project?
I am interested in food security and finding ways to feed a fast-growing population under climate change. I believe part of the solution is in underutilised crops. Underutilised crops carry resilience and disease resistance traits that are important in breeding programmes. My PhD is about an underutilised crop named "winged bean" that has high protein content, resembling soybean. Winged bean is grown in tropical regions, where the cultivation of soybean is not favourable. In the tropic regions of Asia and Africa, people are facing protein–energy malnutrition that causes severe and lethal diseases. I chose this PhD because it aims to investigate the genetic variation of an underutilised crop in order to give a better understanding of the desirable and undesirable traits that winged bean carries and the potential to be bred to be a 'soybean for the tropics'.

Tell us about your research. What do you study? Why is it important?
In a global level, I consider my PhD important because it aims to battle food insecurity in tropic regions, where adults and mainly children are hospitalised and die from protein malnutrition. Regarding my personal development skills, I will gain skills and deepen my knowledge in genetics and food science.

How do you explain your research to ordinary people?
I am working with an underexploited bean that has high protein content like soya. In tropic regions, where people are protein malnourished and soybean is not favourably grown, this bean, "winged bean", is cultivated. Studying the different winged bean varieties, their genetics and protein composition, will help to identify the important characteristics that are essential for improving the cultivated varieties.

How do you cope with the pressure of doing a PhD?
I always try to have a balanced and healthy diet, meet with friends and find time for my hobbies (yoga, pilates, gym) in order to keep my mental and physical health.

Transforming chicken feed for the future: an interview with Hannah Dallas

Hannah Dallas is a PhD candidate with the Future Proteins Platform. Her project is titled The application of methanotroph bacteria Methylococcus capsulatus as chicken feed. Hannah is supervised by: Dr Ying Zhang, Prof Michael Lee, and Tithira Wimalasenaf. Prior to joining UoN, Hannah completed a Masters in Medicinal and Pharmaceutical Chemistry at the University of Loughborough.

Why did you decide to do a PhD? What were you doing before?
Before starting my PhD here at Nottingham, I was working on my Masters in Medicinal and Pharmaceutical Chemistry at Loughborough. I had been drawn to the more biological aspects of my undergrad work and looked for that in PhDs when I realised how much I enjoyed the research and work required for my Masters.

Why did you choose this particular PhD project?
For my Masters project I had designed an experiment based around the isolation of novel bacteria from soil samples. I analysed their excreted metabolites in the hopes of identifying a novel antibiotic producer. When I started applying for PhDs, I was looking for ones that would allow me a similar kind of subject to research and one where I had connected with the supervisor.

How is your first year going? Any highlights or successes?
It took a while to adjust to the lab procedures and there was a steep learning curve for me coming from another field. However, the community in my lab and building as a whole has been wonderful and made the adjustment a lot smoother. I saw a lot of progress in the start of 2020, adjusting my standard operating procedures to achieve a consistent methanotrophic growth with fermenters, and have been trying to develop other skills until I can go back to lab work.

Has undertaking a PhD been different from other degrees you have done? How so?
The most significant difference between this PhD and my Masters is the time commitment for setting up the longer running experiments, with working in the lab late in the evenings and coming in on the weekends too. There is a still a lot of freedom, as with my Masters, but it is clear that supervisors and the like are a lot more invested and happier to give up their time to discuss things.

What have you learnt through your first PhD year?
The most significant lab-based thing I have learnt in the first part of the year is the set-up, run and shutdown of fermenters. In the later months I have been brushing up on my Python skills, using it for analysis of the data I had collected from the fermenter.

Tell us about your research. What do you study? Why is it important?
I work with a methanotrophic bacterium, *Methylococcus capsulatus* (Bath). I'm investigating the applications of this wildtype as a single-cell protein and a supplement in chicken feed. Using fermenters, I am developing methods for optimum growth and analysing the biomass for its lipid, amino acid and sugar content, etc. Once I have an accurate picture of the wild-type growth I will begin modifying the bacteria to improve its nutritional content based on the requirements of broiler chickens. In the later stages of my PhD, the biomass collected from my fermentations will be used in an animal study.

How do you explain your research to ordinary people?
When I've described my work to my family, I tell them that I work with methane consuming bacteria, and I'm seeing if I manipulate the way they grow so that when I dry them, I can feed them to chickens. The idea is that we will eventually be able to supplement their feed with the cells to make feeding them cheaper and more efficient.

How do you cope with the pressure of doing a PhD?
To cope with the pressure, I like to work on my bullet journal as an artistic way to keep organised and to relax. I've filled my home with plants to make sure I have a relaxing space, and I enjoy the routine of caring for them as a way to reset. When someone has a bad week, myself and the girls from my office like to go and get a ridiculously large coffee and slice of cake and either talk through work problems or just chill for a while.

Featured Research

Studying food safety in Brazil

The Food Safety in Brazil course is a second year module offered to Biosciences students at the University of Nottingham, funded by the Future Food Beacon. Established in 2017, the Food Safety course offers students the opportunity to travel to Brazil for a week to learn about contemporary issues in food safety. The course draws on expertise from UoN, ITAL, UNICAMP and UNESP. Students are given lectures on a range of topics from different academics and researchers, are taken on tours of facilities, and are able to experience life in Brazil too. UK students are provided the opportunity to learn from health professionals and students working with underprivileged communities in poorer areas of Brazil.

Each day of the one week course focuses on a different aspect of food safety. In 2019, the course included lectures on developing food ingredients from fruit processing residue, the microbiological safety of meat and meat products, the health benefits from Brazilian fruits for people with obesity, the application of metabolomics to personalised medicine, food allergies, nutrition and bioactive substances, and sports nutrition for high performance.

Students attending the course were invited to provide responses to their experiences, some of which we have highlighted below.

"As an agricultural student, it was interesting to see a different side of the food production chain. […] Personally, I feel it is important to understand all aspects of the food production chain in order to understand the food products consumers are interested in […]."

"Our first day was organized by ITAL, the Brazilian food technology institute. The very first presentation was about utilising leftover mango peels for extraction of edible mass full of nutrients which can be ground to mango flour and used to enrich confectionary products to become healthier. I absolutely loved the idea and immediately asked Jo [Dr Jo Gould] if I could do something like that for my 3rd year project".

"One of my favourite topics during the entire seminar was the development of by-products of fruits and vegetables into consumable food to avoid food losses. The lecture showed that certain fruits varieties, such as the 'Ubá Mango' can have at least 40% of the fruit disregarded as they include the seed and the peels, which usually are not consumed. Surprisingly, the peels have the highest nutrient contents, even more than the pulp itself. They have a project called 'ByProFood', which develops products from coffee, banana and coffee residues. […]".

"I was mostly amazed by the visit to the Synchrotron and the SIRIUS. Visiting these two particle accelerators located in the Brazilian Synchrotron Light Laboratory was an overwhelming

experience. I have never seen a particle accelerator or was even aware of the uses of these machines to research in physics, chemistry, material science and life sciences. This experience has broadened my views of how the different sciences are all connected".

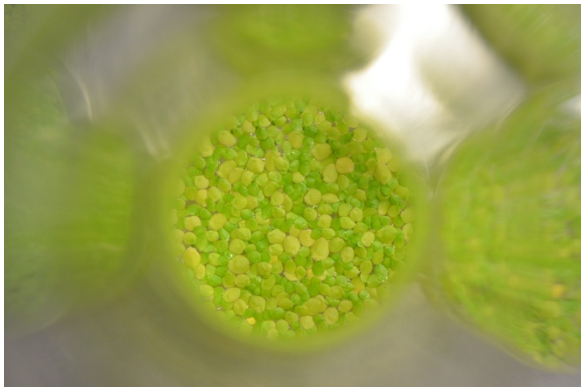
"On 25 April, we went to UNICAMP and this day was my favourite as I got to know so many interesting researchers. 'Processing food by high pressure technology' was my favourite. This technology is very beneficial to the food product as it will not have an effect on nutrients, flavour, and colour. […] I found it very fascinating that so many works need to be done for each food and drink product in order to make it safe and good quality for consumers".

"On 25 April a lecture was delivered on 'Bioactive compounds nutrition and health'. This was my favourite lecture delivered throughout the whole five days as it addressed the gut-brain axis and its relation to food and cognition. Specifically, the correlation between obesity and the onset of Alzheimer's disease. So much so that Alzheimer's disease is thought to be possibly Type 3 diabetes. I found this extremely interesting as I have never thought that such a correlation existed. Obesity produces specific biomarkers that can be used to identify the early onset of Alzheimer's disease. Noticing these biomarkers can potentially slow down the onset of Alzheimer's and therefore dementia. I also thought it was miraculous that in the studies presented to us by UNICAMP that these biomarkers were considerably reduced when the mouse test subjects were given fruit; specifically, Jabuticaba. This drew to the conclusion that even if a person was obese with the proper intake of fruit, they can improve their biomarkers presented as well as cognition. This was utterly fascinating and I though Jabuticaba should be named a miracle fruit".

"I really enjoyed taking part in the Food Safety in Brazil module and think it was a highly valuable experience. The opportunities which the module provided me in relation to lectures and the field visits, but also in terms of travelling to a new country, experiencing a different culture and meeting new people are irreplaceable. I think that I have come away from Brazil with a new understanding of the impact and importance of research within the area of Biosciences and more specifically food science, as well as a new appreciation for the issues being faced by a developing country (for example, the impact of reduced access to gyms or nutritious foods on the health of poorer communities)".

"I also feel this experience has opened my eyes to a vast range of opportunities and careers which are possible with a Food Science and Nutrition degree, that I hadn't previously considered. […]".

Duckweed: plant for the future!

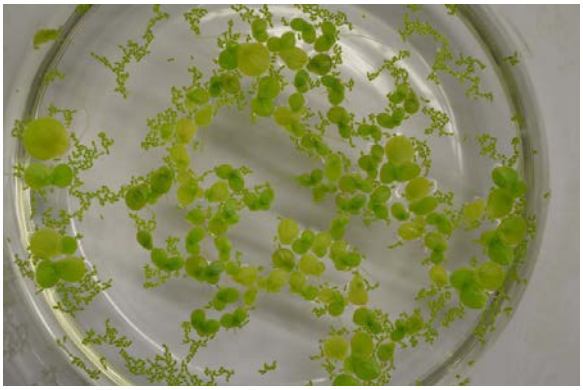


One of the wonderful things about science is the sense of exploration into the expanse of the unknown. Finding future food sources, particularly protein, outside of livestock, is becoming increasingly important, for both human and animal diets. It is easy, despite the myriad of possible research avenues, to become stuck down a single trajectory, chipping away at a single research area and making small but incremental advances. Sometimes it is necessary to step back, and explore a problem from an entirely different angle in order to make step-changing progress.

It is with this in mind that a group of Future Food Beacon researchers have begun new projects examining a very small plant with big potential impact: duckweed. What on earth is duckweed and what does it have to do with the future of food, we hear you ask? Let us explain…

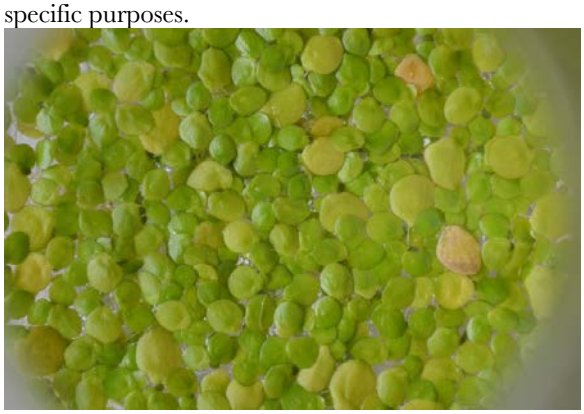
Duckweeds are small, floating aquatic plants. They are mostly found in still or slow-moving bodies of water (like your garden pond!). Duckweeds grow very rapidly, and reproduce clonally. They are able to absorb excess nutrients because they grow so quickly. These features mean that duckweeds are increasingly being used for a variety of applications, including biofuels, bioremediation (to clean up toxic sites), and as a protein source. Importantly, duckweeds are very high in protein – approximately 50% by weight—and while they are an appreciable part of human diets so far only in Southeast Asia, they hold massive potential for human consumption, animal feeds, and as a plant alternative to whey proteins.

Duckweeds can also be a great source of mineral nutrients. They possess the ability to accumulate very high quantities of different mineral nutrients such as iron, zinc, or copper, that are essential for good health. Malnutrition due to mineral deficiencies is a worldwide problem, particularly affecting children. Duckweeds therefore hold the potential to address this malnutrition issue.



Researchers at UoN are studying the ionome (the elemental composition of the organism) of different duckweed species and accessions to identify which duckweeds might be the best source of mineral nutrients for humans and animals. Dr Paulina Flis manages the ionomic facility within Plant Sciences at UoN, and has been driving the duckweed agenda forward. Dr Flis commented, "elements, along with nucleic acids, proteins and various metabolites are the essential building blocks of the living cells. They are involved in a myriad of processes happening in each organism. Ionomics help us to understand how mineral nutrients are managed within the organism which ultimately leads to the identification of genes involved in this mineral nutrient management. Our knowledge about duckweed is limited at the moment. Therefore, studying the duckweed ionome and how it differs among different species is a sensible step to understand better how this tiny plant works and how we can exploit its potential as a great source of mineral nutrients as well as proteins." Visiting PhD student from Chengdu University Min Zhou is studying natural variation in ionome profiles from across all duckweed diversity as a foundational study for work in Associate Professor Levi Yant's lab to determine the genomic basis of this diversity. Given duckweed's small genome and outstanding experimental tractability, this work aims in the longer run to take a synthetic biology approach to engineer duckweeds with 'boutique ionomic profiles' for

specific purposes.

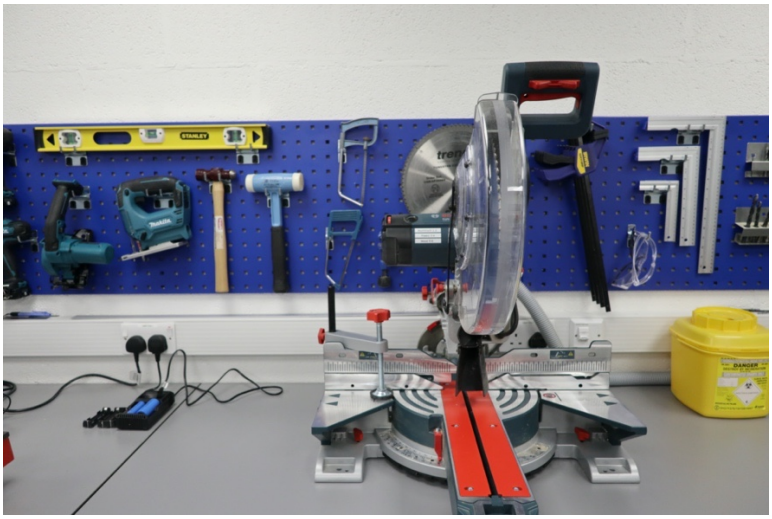


Dr Britta Kuempers and Dr Randa Darwishare are going deeper into the potential translation of this to human diets. By examining the nutrient content available to humans after consumption rather than simply studying the total nutrient content, researchers are able to pinpoint which species might be best as a potential food source. This involves studying the effect of gut enzymes on duckweed, in lab conditions. The nutrient content after this simulated 'food digestion' will provide important information for future proteins.

Beyond the interest in natural ionomic variation and nutrient bioaccessibility above, duckweeds have also caught the interest of evolutionary biologists who study large scale morphological transitions. These plants may look simple, but they have evolved relatively recently from land plants. Other plants in the same family, such as the peace lily, have a body plan much more typical of an advanced plant. As duckweeds have adapted to the aquatic environment they have lost several key structures and, in some species, have evolved to be completely rootless. Dr Anthony Bishopp has recently obtained a grant from the Leverhulme Trust to investigate the evolution of rootlessness in duckweeds, and hopes that this research can inform evolutionary biologists more generally about how structures can be lost.

Duckweed is a small plant with a big, promising future.

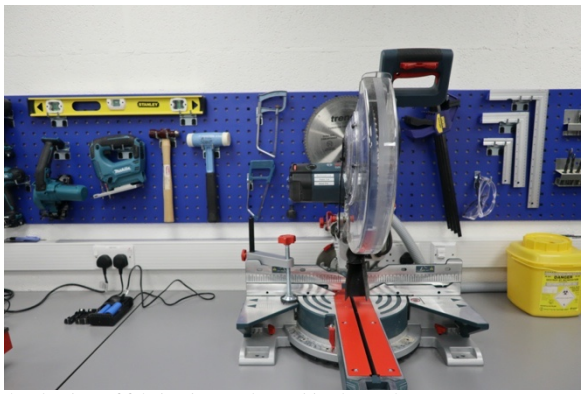
The Future Food Beacon MakerSpace



We spoke to Principal Research Fellow Darren Wells, Dr Jonathan Atkinson, and Dr Michael Wilson about the new MakerSpace, located in the Plant Sciences building here on Sutton Bonington campus.

Tell us about the MakerSpace…

The Future Food Beacon MakerSpace is an innovation hub established to support experimental and outreach activities in Biosciences and elsewhere. It is a fabrication suite and workshop used to design, prototype and build small- to medium-sized experimental equipment, primarily supporting the integrated plant phenomics programme. We are open to supporting researchers across faculties in need of assistance.



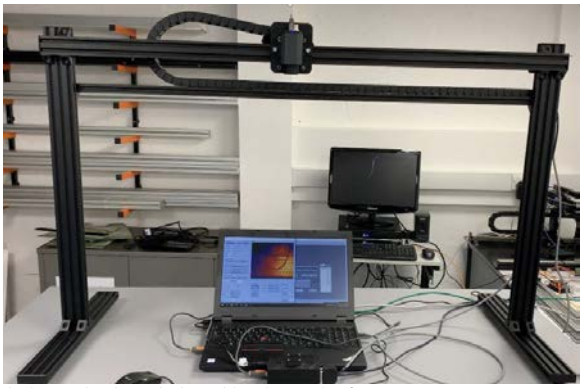
A selection of fabrication tools used in the makerspace

What kinds of equipment do you use/have?

The MakerSpace houses the existing workshop tools and equipment from the Wells Group at Sutton Bonington, and a range of new equipment funded by the Beacon, including 3D printers, hand and bench tools, and an electronics workspace. We also write software for robotics, data acquisition and sensor logging.

What sorts of things do you make?

Projects to date have included camera positioning systems, phenotyping robotics, wireless environmental sensors, outreach displays and microscope systems. We are open to all staff and students.



A thermal robot, designed by the MakerSpace

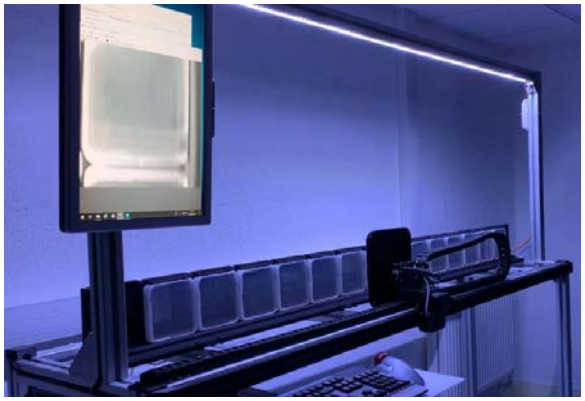


Plate robot, designed by the MakerSpace

How do the things you make feed into research?

Experiment-driven research often requires bespoke equipment matched to particular experimental needs. Designing the equipment as part of the experimental plan allows for more efficient use of (often) limited funds and increases the chance of useful data being generated. For example, we recently worked with a PhD student to design a microfluidic device to fit on a microscope and deliver precise volumes of media to growing plant roots.

What is the value of having this type of space in a Biosciences setting?

Using plant phenomics as an example, genetic studies require large numbers of measurements of plant traits, often images. Using robots to move either the cameras or the plants allows many more images to be taken per experiment. Custom-building the automation systems has two advantages: the kit is designed to generate exactly the data required, and the cost savings means that a larger proportion of the budget can be spent on the sensor systems, leading to higher value data.

3D printed nylon adapter for an active vision robot allowing both camera and gripper to be mounted together

Could you explain the process of making something?

A researcher will come to us with an idea for something that either doesn't exist or is too expensive to purchase or commission. We will advise on feasibility and required resources and go through several brainstorming sessions to come up with a plan for a prototype. Depending on the complexity, we will build the final design based on the collaborative sessions, or advise on using the facilities for the researcher to build it themselves.

MakerSpace electronics: This project uses "internet-of-things" technology to modify laboratory balances for automated weight monitoring in long-term experiments. These low-cost devices are also being used to develop wireless environmental sensor networks

Have you had any disasters or particular successes?

To date, no real disasters – that's the main advantage of low-cost prototyping – if the first version doesn't work, the next one (or the one after that) will. A challenge is maintaining the balance between collaborative work and our own research programmes. Hopefully as more people use the MakerSpace independently, that balance will shift.

Measuring carbon and water cycles in crop resource-use efficiency research

This post is written by Erik Murchie, Lorna McAusland, and Georgina Barratt

Plants are active day and night, performing myriad processes in metabolism, conducting environmental sensing and responding to stimuli. The processes that draw carbon and water from the environment and into the plant and that shift oxygen and water out of the plant (photosynthesis, respiration and transpiration) might not be visible to the eye but they are major physiological events on which our lives depend. Plants are some of the most sensitive organisms to changes in local conditions and climate. They have also been important factors in shaping crop adaptation and evolution to diverse environments during the last 10,000 years.
There is consensus that improved photosynthesis and efficiency of use of water, light and nutrients must underpin and drive yield improvements. This recently has driven the search for genetic variation in our crops. In turn, this has led to a renaissance of the demand for their measurement and innovation in instrumentation. The University of Nottingham has historically been a leader in research into crop resource-use efficiency and this continues today. Previous alumni of Sutton Bonington in this area includes John Monteith who co-developed the Penman Monteith equation used by the Food and Agriculture Organisation, to estimate global release of water from soil, plant canopies and water sources,and Roger Slack, co-discoverer of C4 photosynthesis.

Infrared gas analysis (IRGA) and chlorophyll fluorescence (CF) are the most published methods in plant physiology and over the last 30 years have transformed our understanding of how photosynthesis works. They have developed into highly sophisticated probes for plant physiological activity and health – they are portable and instantaneous. The Future Food Beacon have been using the latest version of one such 'workhorse' for this: the Licor 6800 (Li6800). We were delighted that three of these machines have been purchased to support crop resource use efficiency research across the School of Biosciences. With the Li6800, we can measure with great precision the rate and efficiency of carbon uptake and water loss. Moreover, we can tease apart the multitude of processes that drive photosynthesis and gas exchange, such as electron transport, enzyme activities and gas diffusion. The Licor6800s have so far been very busy with applications on several high-profile projects and we anticipate they will play a critical role in developing the field phenotyping capabilities of Nottingham and the Future Food Beacon in the coming years.

How is the Li6800 used?
The infrared gas analyser measures the exchange of both CO2 and water. This means the Li6800 not only measures the flux of CO2 for photosynthesis and respiration, but also the water released from the plant via its stomata. The Li6800 is invaluable in assessing the dynamic photosynthetic carbon uptake during the day (and respiratory loss at night) while also measuring the water loss, both during the day and at night. This has been useful for analysis in projects aiming to improve wheat, rice and sugar beet.
For example, the Li6800 has helped us characterise novel wheat lines for changes in photosynthetic CO2assimilation compared to modern, elite varieties. In addition, the Li6800 machines have helped us

identify wild relatives of wheat with higher rates of CO2 uptake than their modern equivalents. These species could be used as potential candidates for introduction into modern crossing programs with the aim of improving photosynthesis. Below we showcase three case studies, all using the Li6800, to illustrate how equipment like the Li6800 adds to different projects.

Scientists receiving training on how to use the Licor6800 from Ian Smillie of Licor

Case study: Exploiting night-time traits to improve wheat yield and water use efficiency in the warming climate of northern Mexico.
This project is funded by a Newton UK-Mexico scheme grant. Decreasing yield has been linked to increasing nocturnal temperatures in north-western Mexico. This project led by Assoc Prof Erik Murchie, with postdoc fellow Dr Lorna McAusland, seeks to determine whether some wheat varieties are better adapted to increases in nocturnal temperature and if so, why? Traits such as hydraulic conductance, respiration and nocturnal stomatal conductance may all contribute to nocturnal temperature resilience.

Case study: The International Wheat Yield Partnership (IWYP) and BBSRC project "Wider and Faster: high-throughput phenotypic exploration of novel genetic variation for breeding high biomass and yield in wheat".
This is a project (value £1.3m) run with The Nottingham BBSRC Wheat Research Centre which has developed novel wheat lines containing segments of DNA from wild, related species. These transferred segments introduce genetic variation into modern varieties with the aim of producing high yielding lines that are resilient or resistant to biotic and abiotic stress. Improvements in leaf-level photosynthetic carbon dioxide (CO2) uptake can be translated into improvements in whole plant biomass and, ultimately, grain yield.

Case study: Sugar Beet research at Nottingham.
Sugar beet is a spring crop of great economic importance in the UK and the rest of Europe. The storage root of the beet is processed to produce white sugar, which is sold to the consumer solely under the Silver Spoon brand in the UK. With water being an increasingly limited resource, research into water use efficiency (WUE) is critical as sugar beet often wilt freely even when water is available in the soil. Led by Prof Debbie Sparkes, this research group is looking into soil-plant interactions to improve sugar beet productivity in partnership with the British Beet Research Organisation (BBRO). Researchers such as Georgina Barratt have been using the Li6800 to determine how sugar beet WUE is affected by water availability, in response to multiple water stresses, different lengths of water deficit, and how varieties recover.

Eating chocolate in the name of science!

The Future Food Beacon is currently leading a Prosperity Fund/Innovate UK funded project titled Controlling cocoa bean fermentation for enhanced chocolate flavour. The project draws together Colombian female farmers with a Nottingham bean-to-bar chocolate maker, Luisa's Vegan Chocolates, working alongside our researchers to improve the flavour of chocolate.

The first harvest of cocoa took place in Colombia in May. Our farmers fermented the cocoa beans and surrounding pulp, and then dried them on the farms. Scientists, Dr Christopher Moore and Dr David Gopaulchan sampled the fermenting beans on the farms in Colombia, and are in the process of understanding what microbes are present in the fermentation, and what they do. Sacks of beans from each of the three farms were then shipped to the UK, arriving in Nottingham in September.

Harvesting cocoa pods in Colombia

The beans from each farm have produced chocolate that is distinct in flavour, just like a fine wine. Luisa uses the same recipe, fineness of grind, and percentage of cocoa solids in each chocolate made from the three different farms, so that they can be compared for taste and flavour notes. The farms are situated in different locations in Colombia, with different *terroirs* but similar growing practices and fermentation processes. It is the distinctive terroir, alongside the fermentation process, that gives the chocolate its unique flavours. If we are able to control the fermentation process, we will be able to enhance the flavours that speak to the region where the cocoa is grown. In this way customers are able to detect citrus notes, florals like lavender or rose, smokiness, or tartness in these chocolates.

Colombian cocoa beans freshly arrived in Nottingham

Checking the beans for quality of the fermentation.

Finished chocolate bars, their beans and the cocoa nibs

The next harvest is currently underway, our scientists are out in Colombia this week to sample the fermentation and the new harvest beans will be shipped to Luisa to make into chocolate too. We will then be able to compare the flavours of the chocolates from the different harvests.
On Friday October 18, customers in Nottingham were able to get a first taste of the Colombian chocolate. Luisa has been making 66% chocolate with the beans from the different farms and these are now ready to try (and purchase!) Over 60 people attended the tasting, which took place at Minor Oak and Luisa's shop in Sneinton Market. Tasters were able to sample the three different chocolates, and then write their notes on tasting sheets provided. Each of the three chocolates has distinct flavours that tasters were able to notice, and this helps us profile these chocolate bars against future editions.

The farmers from Colombia and the chocolate bars

Prof David Salt introducing the chocolate project

Dr David Gopaulchan talking to the audience about the science

Having members of the public taste the chocolates, and provide feedback, is hugely useful for our research. Our tasters give us a benchmark against which we are able to measure future chocolate profiles. In doing so, they contribute to our research findings and intervention plans. This is why citizen science is so important.

Funders, chocolate makers and researchers join forces to improve chocolate flavour! (From L-R: Jonathan Shore (UK Prosperity Fund), Luisa Vicinanzi-Bedi (Luisa's Vegan Chocolates), Catherine Pye (UK Prosperity Fund) and Prof David Salt (Director, Future Food Beacon, Uni of Nottingham))

Our Future Food research team. (L-R: Dr David Gopaulchan, Dr Christopher Moore, Prof David Salt, Ms Naailah Ali)

Nottingham Good Food Partnership: making food accessible to all in Nottingham

Nottingham Good Food Partnership is a not for profit organisation committed to transforming our local food system, to make it fit for purpose for the next generation. NGFP is a member of the international network of Sustainable Food Cities and represents over 60 organisations, all committed to realising a sustainable food future. It is the lead organisation for all things local food.We spoke to Penney Poyzer, NGFP chair, and Shona Munro, coordinator about the purpose of NGFP, their current projects, and their vision for Nottingham.

Tell us about the Nottingham Good Food Partnership. Why did you set it up? How did it begin?

Nottingham Good Food Partnership (incorporated 2018) emerged from the food sub-group of Nottingham Green Partnership. The Green Partnership was Nottingham City's overarching environmental strategic group made up of senior representatives from local authority, business, universities and community. The food sub-group, which comprised city council officers and community food representatives, provided the grass roots local food movement with a voice at the top level table – this was an enormously important step forward. After much discussion, Nottingham Green Partnership ratified the food sub-groups suggestion that the City should join the highly influential Sustainable Food Cities Network as the most the suitable, proven methodology to transform local food systems. This description makes it sound a bit dry, but it was an exciting, progressive period for grass roots food activists.

We are member 53 of the Sustainable Food Cities network, which is a partnership programme run by Sustain, the Soil Association, and Food Matters. The Sustainable Food Cities approach involves developing a cross-sector partnership of local public agencies, businesses, academics and NGOs committed to working together to make healthy and sustainable food a defining characteristic of where they live. The network helps people and places share challenges, explore practical solutions, and develop best practice on key food issues.

What is the purpose of NGFP?

The purpose of NGFP is to enable, facilitate and empower the citizens of Nottingham to shape the food future of their city and to make it fit for purpose for the generations to come.

What are the aims of NGFP?

The aims of NGFP are stated in the 6 key themes set out by the Sustainable Food Cities network which we have adapted to reflect our locality:

- Commit to eradicating food poverty and diet-related ill health by increasing citizen's access to affordable, healthy food through socially innovative growing and eating programmes
- Promote the importance of healthy and sustainable food to our diverse communities
- Build on the historical wealth of community food knowledge, reclaim lost skills and revitalise undervalued assets
- Catalyse a vibrant and diverse sustainable food economy that expands local food production and shortens supply chains
- Transform the relationship between catering and food procurement that prioritises local supply
- Work towards a circular food economy, radically reduce the ecological footprint of the food system and aim for zero edible food waste.

Tackling food poverty is our priority theme: it is vital that we create a fair local food system. This system would ensure surplus food is redistributed to where it is most needed through the rapidly expanding network of social eating spaces. We need to radically increase access to affordable, locally grown food and to eradicate the injustice of hunger. Nottingham has the youngest and poorest population in the UK so our priority must be to create a food system fit for the purposes of the next generation.

What sorts of projects are you working on at the moment?

The range of projects are incredibly diverse, and it can be a challenging balancing act to keep everything going especially with funding routes being chased by so many organisations all doing great things. At the moment the focus is on developing a ground-breaking piece of planning guidance – the Wellbeing Design Guide which will come into effect in January 2020. This piece of work has transformed how planning guidance is developed and is believed to be a UK

first. The consultation and development has come up right from the grassroots – starting with the city's first urban greening conference back in February 2019 at which Prof David Salt was our keynote speaker. The world café setting was exactly the right forum to stimulate debate and was an ideas engine. The most striking thing that came out of the world café was a unanimous call for action not words. The ideas were collated and key points formed into a citizen's survey. The aim of the survey was to gather opinion on how future housing developments should take account of wellbeing using food growing, nature and community gathering spaces . The survey was taken out onto the road to community events, engaging people face to face. Eight months on, over 300 surveys have been completed and the results are currently being written into the Wellbeing Design Guide. NGFP would like to acknowledge the role of the Future Food Beacon's financial support in this: the summer long programme of events for the Nottingham Good Food Festival enabled us to reach out to communities and engage them in the survey. We simply could not have achieved what we did with the Beacon's support.

Other key NGFP projects include:
Carbon Neutral Kitchens (CNK) – we launched this in October and were delighted to have the City Council's Deputy Leader Cllr Sally Longford there to give the welcome address. CNK is a programme designed by NGFP and delivered in partnership with the City Council, Robin Hood Energy and D2N2. The aim is to provide a free support package and quarterly events for the city's thriving indie food scene, which generates around £9m for the local economy. However, it is also a major contributor to emissions arising from food waste and is an intensive energy user. NGFP approached the City Council's Carbon Neutral 2028 team and proposed the concept of CNK as a route to support food businesses. At the first event we signed up 20 businesses to access free grants. We also did a demo on how to make a simple worm bin which was snapped up by Biocity!
Nottingham's Urban Food Plan 2020-2028 – NGFP approached the Future Food Beacon discuss how we could join forces to lead on the development of an ambitious carbon neutral, urban food plan for Nottingham. Nottingham City Council was the first city in the UK to pledge to Carbon Neutrality by 2028: it is logical that we should aim for the Urban Food Plan infrastructure to be in place and for scaling of projects to be properly established.


Neighbourhood food growing festival in the Arboretum in June 2019

How did you come together to form NGFP?
The gathering together of interested parties was organic and rapid: the local food system community is very close, interacting all the time, creating valuable social capital that enables short-cuts because everyone is interconnected.
Penney has been an active member of the local food scene since the mid-1980s, and has worked in the environmental sector for many years, including a stint as a TV presenter for BBC2. Shona has both owned her own food businesses and been a business advisor to food production companies. Shona was working at Groundwork, leading on Notts Nosh – a programme designed to increase the visibility of local food producers – when she invited Penney to chair NGFP. Since then, we have worked together on a variety of projects. Our combined knowledge of local food has meant we had a lot of connections throughout the food system. We do not work alone though. Our governance structure means that a broad range of advisors from across the city, guide and direct our work. Our board is very active and supportive and nothing we do could be achieved without them.

Children's veg power festival, August 2019

What kinds of success stories do you have?
The Good Food Festival this summer has been a great success – community action and engagement generates so much energy and brings new relationships. Our first Neighbourhood Food Festival at the Arboretum was extremely well received – we hope to make this an annual fixture.
Last year we ran two pilot food and activity programmes for children to tackle the scourge of holiday hunger. We used surplus food to make hundreds of lunches, engaged and trained volunteers, worked with the business community and most importantly provided local kids with a good meal and some great activities – including reading. Food insecurity is a very big deal in Nottingham and it's not improving anytime soon. We must do what we can to alleviate families and communities of this burden.
Another success has been creating a network to bring together community eating space organisers, who had been largely operating in isolation. It has been immensely useful to understand the common problems affecting this largely voluntary but crucial service. A really important relationship has been forged with the Future Food beacon: to have access to a circle of academic experts who are not only world leaders in their field but personally committed to their local community is an amazing opportunity and we look forward to developing many exciting projects.

Why is food so important in Nottingham?
Nottingham is almost a tale of two cities – on one hand we have £2 billion worth of investment in new development; on the other we have a picture of grinding food poverty. The challenges of Universal Credit, generational worklessness, social isolation and diet-related ill health may well be further compounded by Brexit. Tackling food poverty is our overarching aim.
We have a thriving food and beverage scene, multi millions spent on catering by universities, the city council and the NHS, yet less than 5% is locally sourced. This is a missed economic opportunity and one that could create long-term, meaningful jobs. It has been calculated that around 250,000 people are engaged in food growing in Britain. We need closer to three million to uplift food production. Potentially, the local food system could be our own local new green deal – transforming local supply, reducing greenhouse gas emissions and creating new jobs. We all need to eat and to eat well and that is especially true for children and young people. Nottingham has the youngest population in the UK and one of the poorest: good nutrition and access to affordable fresh food is fundamental to life chances and long-term health. We simply cannot afford, as a society, for young people to be robbed of achieving their potential.

What food issues do you think should be prioritized at the local government level? And at the national one?
Locally, there are two issues that could make an enormous difference: to invest in expanding the network of social eating spaces to tackle social isolation, provide nutritious low cost meals, and reduce food waste. Secondly we need to identify land that can be purposed for community scale urban agriculture. It is imperative that we knit together the issues of food waste and local food production and aim for a circular food economy.
Nationally? We are really encouraged that a national food strategy is being led by Henry Dimbleby who is hugely respected. We want to see our government follow the lead of France and legislate against edible surplus food entering the waste stream. We need to see the government reinvesting in our food system at a local level and for soil health to be seen as a critical path.

What is your vision for Nottingham?
Our vision for Nottingham is to be the UK's first forest garden city by 2028, using agroecology and permaculture principles to create a carbon neutral food city fit for purpose for forthcoming generations. It is a huge vision encompassing a wide partnership of actors and a city-wide programme of engagement and action. We are absolutely confident in the expertise and passion of the partnership to achieve this. Nottingham's greatest asset lies in the warmth of our community and our ability to work cooperatively. NGFP was born out of interpersonal relationships, and shared sense of identity, a shared understanding of the need to reshape our food system, shared values when it comes to the need for a just food system that provides nutrition for all citizens, trust in each other, cooperation and reciprocity – a cascade of positive actions driving the foundation of a truly sustainable food city.

Understanding more about oil palm farmed by smallholders

During a recent trip to Malaysia, including visits to the University of Nottingham Malaysia campus, Dr Thomas D Alcock and Dr Lexi Earl stopped by some smallholder oil palm plantations to get a feel for production practices. This is what they found.

This post is written by Dr Thomas D Alcock and Dr Christina Vimala Supramaniam

Our journey to visit Sungai Gulang-Gulang Estate at Tanjung Karang, Selangor, Malaysia, took around two hours. Along the way, we saw countless oil palm plantations of varying degrees of maturity, demonstrating the popularity of this crop among growers in Malaysia. Indeed, according to data from FAOSTAT, almost 60% of arable land in Malaysia is used for growing this one crop, and around 35% of total palm oil production is from Malaysia. We were joined by Dr Christina Vimala Supramaniam, Associate Professor at University of Nottingham Malaysia, and Director of the Nottingham Centre for Sustainable Palm Oil, and two of her students, Nur Izzati Ridzuan and Khoo Chee Chang.

Dr Thomas D Alcock (far left) and Dr Christina Vimala Supramaniam (second right) with researchers from UNMC and smallholder farmers

The farm we visited was fairly small, at approximately only 2 hectares. This reflects the situation of many oil palm producers in Malaysia, 60% of which are smallholders. The trees, which were 10-15 years old, were quite widely spaced to allow them to continue to grow as they mature. The oil palm usable life cycle is around 30 years, with the first fruits appearing around three years after planting, and production starting to drop off after around 25 years. Fresh fruit bunches can be harvested twice a month, all year round.

Fruits of oil palm

Whilst the farm looked much like a forest to us, the wide spacing and general lack of biodiversity hardly reflects a tropical rainforest. A recent study by Dislich et al (2017) found that 11 out of 14 ecosystem functions analysed showed a net decrease in level of function in oil palm plantations relative to natural forest. This is perhaps unsurprising, but worthy of mention. That said, there are many features of the production system we saw that seem to contrast with perhaps more damaging impacts of many other crops. The long production span of oil palm hugely reduces the regularity of soil disturbances compared to annual crops, such as wheat or soybean, thus reducing soil erosion. Soil health is further benefitted by the widespread practice of using a cover crop between tree rows. This works to maintain soil structure and prevents the soil from drying out. Some producers favour Mucuna bacteata, a legume species, which provides a further benefit as an organic source of nitrogen to the oil palm trees. Fallen plant matter, including palm fronds, are generally gathered and left to decompose in the field, which enables additional nutrient retention. As a large, tree species, oil palm also sequesters carbon throughout its life cycle, thus reducing its net greenhouse gas emissions. It should be noted however that deforestation to create new oil palm plantations emits large amounts of greenhouse gases which are unlikely to be balanced by those sequestered by oil palm trees during their life-cycle.

Scenes from a smallholder plantation

Tom Alcock also visited Havys palm oil mill in Pahang, in order to see downstream processing practices. The first sight in the mill area was a huge field of palm trees being pulled down. This is in line with the general practice to replace trees every 25-30 years, but still looked pretty devastating. On the plus side, much of the organic matter from the felled trees was left in the field in rows, with new trees to be planted in between. By the time the new trees are ready to harvest, this will have degraded and will help to maintain soil fertility.

Dr Thomas D Alcock visiting the mill

Almost all material received by the mill is used, even so far as spare fibres that are used for mattress filling! Organic fertilisers are also produced from empty fruit bunches, decanter cake and palm kernel shells. These are not suitable for palm oil on its own but can complement chemical fertilizers as they promote slow release of nitrogen, phosphorus and potassium. A further hugely interesting co-product of palm oil processing is methane. This is emitted from wastewater used in the sterilisation steps of palm oil production. If left to be released into the air, this is hugely environmentally damaging. However, if methane capture technologies are used, as they were in Havys mill, this can be burned as a biofuel in order to produce energy. This is sufficient to provide all the electricity required by Havys mill, with some left over that is sold to the grid.

Decaying oil palm within the plantation

Oil palm is the largest source of vegetable oil globally, closely followed by soybean. In line with demand, the quantity of palm oil produced has been steadily increasing over the last 20 years, at an average rate of around 7% each year. Its popularity among growers is surely linked with its highly productive nature, yielding around 20 tonnes of fruit and 4 tonnes of oil per hectare. In contrast, soybean yields around 3 tonnes of beans and only around half a tonne of oil per hectare. Palm oil's level of production has provided huge economic incentive to both large companies and smallholder farmers. However, the generation of new plantations has come at the global cost of deforestation of primary rainforest. For example, to this day, Indonesian producers are thought to be using slash-and-burn practices to clear land for oil palm, as well as other crops.There have been strong efforts in recent years to reduce the impact of palm oil production. For example, the Malaysian Sustainable Palm Oil (MSPO) standard, which will be made mandatory for Malaysian producers by the end of 2019, favours zero-burning practices and prohibits planting on land with high biodiversity value. This is following zero-burning or licensed burning policies that have been developed over the last 20 years. Governmental restrictions on burning also exist in Indonesia, but are infrequently implemented. What remains to be empirically deduced is whether or not greenhouse gas emissions and loss of ecosystem functions would have been worse, had the global demand for oil been met with an alternative crop with a greater land-use requirement. The Future Food Beacon will be investigating this and general sustainability issues surrounding oil crop production in a new project starting in early 2020. Watch this space.

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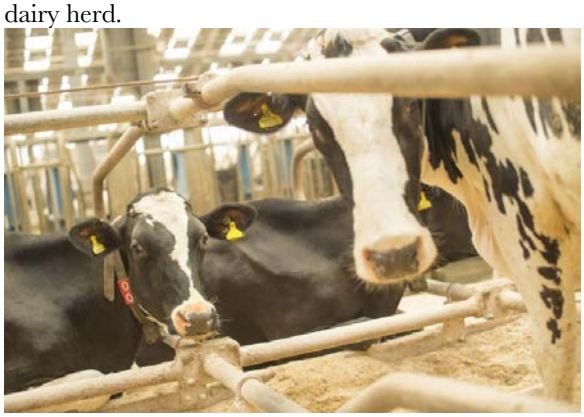
Genomic characterisation of the University of Nottingham dairy herd

This post is written by Dr Sarah Blott, Associate Professor in Animal Breeding and Genetics, in the School of Veterinary Medicine and Science.

Milk and dairy products are a significant source of nutrition in the human diet; the first evidence of dairy consumption dates back over 6,000 years, and today dairy farming is a global business. Europe is the leading producer of cow's milk in the world (with 39% of the global export market), followed by the USA and India (www.statista.com). In 2017/18, over $45 billion of dairy products were exported globally, with the UK contributing £1.9 billion of exports derived from the 1.9 million cows in the national dairy herd.



Cow health and welfare are of primary importance to dairy farmers. In the UK, the Dairy Cattle Welfare Strategy aims to reduce lameness and mastitis, improve survival and growth rate of calves and young stock, and help farmers manage cow body condition and fertility. The environmental impact of farming cattle is also a concern. Cattle production is a source of greenhouse gases (GHG) and dairy production contributes about 3% of all anthropogenic GHG emissions (www.fao.org). In the face of climate change, cattle producers will be under strong pressure to reduce emissions. The University of Nottingham Centre for Dairy Science Innovation(CDSI) is a leading centre for dairy research. The state-of-the-art facility houses 360 cows, enabling detailed study of health, nutrition and welfare and facilitating the translation of research into practical implementation. The Future Food Beacon is funding the genomic characterisation of the CDSI herd, to help elucidate the understanding of fundamental biological processes such as host-pathogen interaction, fertility, soundness, metabolism, nutrition, behaviour, and environmental emissions. Understanding of these processes will be key to further innovations in improving health and welfare, and reducing environmental impact.

Genomic characterisation of the herd enables all genetic variants in the DNA of the cows to be identified and compared. Nanopore DNA sequencing (with the PromethION) at the University of Nottingham sequencing facility has been used to generate whole genome sequence for two cows, which have several sisters and daughters within the herd. The nanopore technology gives ultra-long sequence reads, which has enabled de novo assembly of the two cow genomes by the School of Veterinary Medicine and Science Bioinformatics group to provide a representative 'UK Dairy Cow Genome'. The remainder of the herd has been genotyped for 777,962 single nucleotide polymorphisms (SNPs) using the Illumina Bovine HD Genotyping BeadChip. By using the whole genome sequence to 'fill in the gaps' the genotyping data will be used to impute up to 27 million variants in the genome of each individual cow with 95% accuracy. This will ensure that the majority of causal variants in the genome are identified, and will increase the power of gene mapping analyses carried out on the herd.

The genomic characterisation of the CDSI herd will support several innovative research applications in the Ruminant Population Health group and the

Pathogen Functional Genomics groups in the School of Veterinary Medicine and Science, and the Divisions of Nutrition and Animal Sciences in the School of Biosciences. These include investigating:

- host-pathogen genome to genome interactions, focusing on infection by the bacterium Streptococcus uberis, the leading and poorly controlled cause of clinical mastitis in the UK. Mastitis impacts on sustainability of the dairy industry through loss of milk production, inefficient use of resources, non-productive emission of greenhouse gases, reduction in the welfare of farmed animals and increased use of antimicrobials. The high-density genomic data which has been generated will be used in a host-pathogen genome-wide association study (GWAS) to identify regions of the cow genome which are associated with regions of the bacterial genome controlling the bacteria's ability to colonise the mammary gland;
- the relationship between lameness and metabolism (fat deposition). Lameness is a significant issue in dairy herds around the world, in the UK the prevalence (based on mobility scoring) is between 25-37%. Morphological hoof traits, such as the thickness of the digital cushion, are known to influence susceptibility to non-infectious foot lesions and have a heritable basis. Previous studies have suggested links between hoof morphology and body condition, and differences in digital cushion thickness may be related to changes in fat metabolism. Analysis of the CDSI genome data will aim to identify genomic regions associated with digital cushion thickness and to estimate the genetic correlation with metabolic traits;
- the relationship between genetic variation, environment and fertility. Selection for high milk yield over the years has resulted in a decline in cow fertility. Several candidate genes for fertility have been identified by previous GWAS studies and it is known that environmental factors play an important role in moderating fertility. The CDSI data will be used to further investigate interactions between genetic variants and environmental factors affecting fertility;
- the interaction between the rumen microbiome and host genome. Variation in environmental emissions between cows arises through a combination of the rumen microbiome composition and genomic differences between the cows themselves. Understanding the nature of this combinatorial effect will be important in the quest to reduce greenhouse gas emissions from cattle production;
- inter-cow differences in milk composition. Fatty acid and protein percentage in milk are important traits in dairy production, as they influence the quality of products such as cheese and cream. The percentage of fatty acids in the milk is linked to metabolism and, potentially, disorders such as ketosis. Investigating correlations between milk composition and disease susceptibility will bring new insight into the competing demands made on dairy cow metabolism;
- the resilience and welfare of cows and calves, including studies of their behaviour, response to heat stress, longevity within the herd and resistance to respiratory disease.

The work will complement ongoing phenomic studies to identify novel traits measured using state-of-the-art sensors. Better understanding of the biological mechanisms underlying these traits will facilitate the development of new therapeutics and management strategies, leading to more sustainable approaches to global dairy farming.

Doing science in the field: stories from our Colombian cocoa project

Dr Christopher Moore and Dr David Gopaulchan travelled to Colombia together in May 2019 to carry out scientific sampling of the cocoa fermentation process on different farms. David recently travelled back to Colombia for the second harvest, to conduct further sampling, in November and December 2019. We spoke to David and Chris about the experiences, and the challenges of doing science in the field.

Tell me about your first impressions of Colombia?

Chris: I had never been to South America before so it was all quite new. I think when you go anywhere new, you are always a bit cautious but all the people were incredibly friendly and you felt very welcomed, both on the individual farms but also in the cities.

David: I felt the same way because I didn't know what to expect. However, during the trips most people did their best to help us, such as taxi drivers and even the average person on the street. Even though we couldn't speak their native language, Spanish, if they spoke a bit of English, they would try to chat with us and if they didn't know English, they used their phones and used Google translate!

Tell me about the first trip…

Chris: We had a few days in Bogota to recover from the flights and then we flew out to Neiva, which would be our base for the next week. There we were met by Raphael who was the head of FEDECACAO for the region. Everyday he drove us up to Carmen's farm in his own car, up this dirt track mountain road. It was a two-hour journey there and a two-hour journey back. However, we always stopped off half way in the square at Palermo for a quick coffee, and to meet up with Armando (a FEDECACAO technician), who would also accompany us to the farm. From Palermo onwards, the road deteriorated, but the scenery was amazing. It was mainly forested mountain sides shrouded in wispy clouds. Every now and then you would pass a small farm where they would be growing cocoa, coffee or fruits.

What were your first impressions of Carmen's farm?

David: When we got to the estate, we were surrounded by towering mountains with lush, green vegetation all around. In the distance there was a little, rustic house where Carmen and her family stayed. We had to walk about 10 minutes to get to the house, which included hopping over some rocks to cross a small stream and a short climb up a hill. We were first greeted by the family's large, but very friendly dog 'Bruno' which became the morning routine for the rest of the trip.

Chris: Carmen and her family were very welcoming. On our arrival we were told that we were having breakfast and inside the house there was food laid out.

David: Every day they offered us either breakfast, lunch or both, as well as a lot of coffee.

Chris: Also delicious handmade hot cocoa!

Tell me about what you were doing on the farms

David: When we got there, Carmen's partner (Victor) and his workers, were cracking cocoa pods, and collecting the beans to fill the fermentation boxes. So, we used this time to explore the farm. We documented the different varieties of cocoa they cultivated; that is something we are also interested in because depending on the varieties grown, you can have differences in flavours. We also collected swab samples of microbes on the farm.

Chris: We took microbial samples from the leaves, the pods, the surrounding soil, trying to understand where the microbes in the fermentation were coming from and how they vary between the farms.
Most importantly we also collected microbial samples of the fermenting beans over five days. In addition to the microbial samples, we also took the daily pH and temperature measurements of the fermenting beans to monitor the progress of the fermentation.

David: Furthermore, we assessed the beans using the cut test method, which involves cutting several beans and recording the degree of fissuring within their structure. The more fissuring there is, the further along the fermentation.

Chris: Both Carmen and Victor were really interested in the work we were doing and were keen to learn. So, we showed them all the things we were doing and they wanted to have a go.

Fermenting cocoa beans

Fermentation of the beans being assessed through a cut test

Had you ever done any of that on-farm work before?

David: I had.

Chris: I hadn't. When I was doing my degree, I always thought I'd end up doing ecology and working out in the field but in the end I chose a different path, so it was really interesting to be doing field work. I hadn't seen a cocoa tree before this trip: so it was great to see the trees, the pods and the beans. I even got a chance to try some of the raw pulp. It was sweet but also quite acidic. I really liked it, but it tasted nothing like chocolate.

From Carmen's where did you go next?

David: After collecting the samples at Carmen's farm, we flew back to Bogota and then to Bucaramanga, a large city in the north. From there we took a car to Rionegro, where Martha's farm was located.

Chris: Martha's farm was much bigger than Carmen's. They had higher production and had different crops – there were avocados, bananas, and citrus as well as the cocoa. Their fermentation setup was bigger too. It was a purpose-built room with fermentation boxes. Martha was not living on the farm, but she had a farm manager who oversaw the day to day running of the farm. However, Martha had an apartment on the farm, which she kindly let us stay in while we were carrying out the sampling. It was an amazing opportunity to stay in a beautiful location. During our stay at the farm we also had a visit from Hugo Olarte from CasaLuker (a chocolate company in Colombia and a collaborator on the project). He was very knowledgeable about cocoa production in the region and Colombia in general.

David: We also visited the FEDECACAO office in Rionegro. They showed us their warehouse with bags and bags of cocoa beans. The beans were bought from farmers in Rionegro and stored there before

being sent to larger storage facilities and eventually to buyers.

Is it only the fermentation that affects the beans or are there other factors in play?

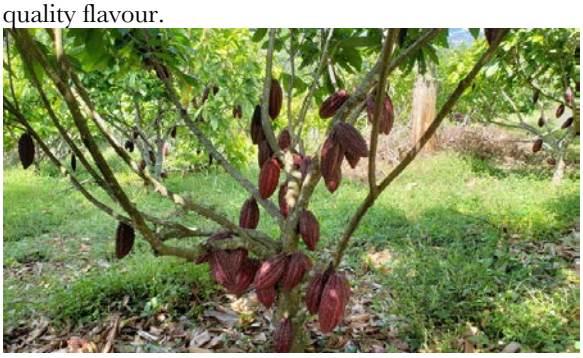
David: Fermentation plays a big part but the drying is also important.

Chris: They do test the moisture content of the beans on the farm while they dry, because too much moisture makes them likely to rot.

David: I think they aim for 7% moisture. That is a quality control step.

Chris: The different farms also have different varieties of cocoa which David was looking at because some are better for flavour and others are good cash crops where you produce a lot more.

David: Usually pale coloured beans indicate better quality flavour.



Cocoa pods on a cocoa tree

How do you prepare for these trips?

Chris: It is quite difficult because you have to plan all the experiments in advance, and ask yourself what exactly would I need? Then you make sure to ship the items to the location and/or take it with you. If you don't, you can't just pop into a store or a neighbouring lab and go, "oh I need a few more of these". So we have to plan exactly how much of everything each experiment takes. It is tricky and a bit nerve wracking as well because we don't want to be out there and run out of anything. It is not a trivial thing to do. In a trip in August, we sequenced the DNA from the microbial samples at CaserLuker in Bogota. However, in November last year (2019) we did our first on-farm DNA sequencing of the microbes involved in fermenting the cocoa beans. This proved to us that it was feasible to use this technology to monitor cocoa fermentations in real time in the field.

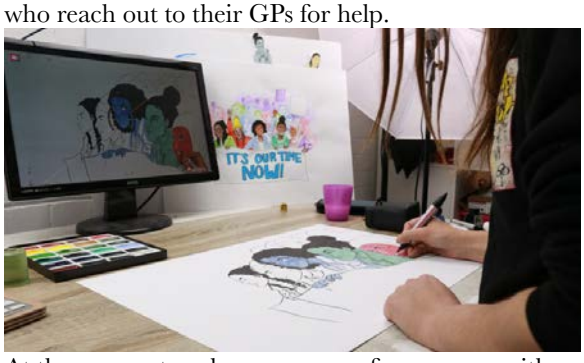
A Creative Approach to Engaging with Male Eating Disorders: Animating the Patient-Doctor Encounter in Clinical Settings

This post is written by Dr Richard Vytniorgu, Impact Research Fellow, School of Cultures, Languages, and Area Studies.

To animate something means to give shape to that which is hidden, inert, silenced. To be animated is to demonstrate movement rather than rigidity, a liveliness in place of absence.

Together with the animation studio Woven Ink, Dr Heike Bartel and her team are developing an animation that seeks to give voice to the lived experiences of men now in recovery from eating disorders. In a previous post Dr Bartel explained in an interview with Dr Lexi Earl how she came to develop her interest in the experience of food and how, from a literary perspective, she is now branching out into innovative interdisciplinary terrain in the field of health humanities.

The AHRC-funded 'Hungry for Words' project is about articulating, communicating, and understanding issues around food, particularly in a clinical setting where GPs may not be aware of the dimensions of male eating disorders that require their own particular response. The aim is to equip GPs with the knowledge and skills necessary to improve the experience of men and boys with eating disorders who reach out to their GPs for help.



At the moment we have a group of seven men with lived experience, all in recovery, and all talking openly about their struggles. We are working together with an animation team called Woven Ink, who have done work in the field of eating disorders before, and we are currently translating those experiences of men into a training animation for GPs. Questions we put to these men were:

- Why was it so difficult to disclose to the GP or practice nurse what you thought or guessed was wrong with you?
- What would have helped?
- What definitely did not help?

Once we had responses to these questions, we analysed them for common themes and distinctive experiences and began to create the ingredients for a short video which would animate these authentic voices and give life to them in visual and narrative form.

As Una Foye, Co-I on the Hungry for Words project explains:

A big part of the process for me was spending time reading the content multiple times, each time taking notes and making memos and highlighting the words that pop out of the page and things that keep coming up. As a visual person I usually do this on physical paper with lots of coloured pens with each colour representing similar themes or key points. It was important for us to keep the men's own words and experience in mind while working with the transcript from these interview days. I could often hear the voices as I read back and remember how it felt on the day which is why it was right for us to work with verbatim transcripts to pull out quotations rather than rephrasing or scripting something ourselves, as this would lose that real authentic voice that makes this work so genuine and different.

Once the transcript was turned into a script for the animation, we passed the baton on to Woven Ink, who took charge of turning our materials into a powerful animation, with the help of animator Mathilde Laillet.

Jess Harvey and Isolde Godfrey at Woven Ink explained to us:

It's always very humbling to be approached to work on a project of this nature, to be invited in, and entrusted to be part of holding and creating the space to amplify the voices and experiences of the men we've been working with; especially when the experiences they're sharing, are so deeply personal.

And to be able to work alongside such passionate, dedicated, knowledgeable collaborators like Heike, Una and the rest of the team, only adds to the nourishment of working on a project like this.

We aim to avoid being didactic in how messages are put forward in the animations we produce. So for this project, with GPs being our primary audience, our aim is simply to provide a space, in which they can access these real men's' lived experiences, and to take from it anything they may feel is helpful or useful when working with men they may encounter in their surgeries in the future.

(We are obviously quite biased), but we feel animation as a medium, is an incredibly powerful tool, for sharing narratives like this, elements around anonymity and safeguarding definitely come into to the mix, but in being outside the constraints of real life, we have the freedom to create and explore metaphors, and mix between the literal and abstract, to help portray and represent these men's experiences. We hope it proves helpful and insightful.

It's our expectation and hope that the animation will help GPs enter into the lived experience of the people they are likely to meet in the course of their surgeries. Rather than restricting our intervention to recommendations, an animation brings the subject into the aesthetic realm, where feelings and experiences become animated in tangible characters with stories to tell. What we then understand about a set of issues becomes more holistic, intimate, and less abstract.

As researchers, the experience of channelling research in the health humanities into an aesthetic medium has been eye-opening. We look forward to exploring the benefits of this intersection between the arts and sciences in the months to come.

The animation will be launched to an audience of GPs and beyond in late January 2020. Watch this space!

Richard Vytniorgu is Impact Research Fellow in the School of Cultures, Languages, and Area Studies at Nottingham, focusing on developing impact in the school, especially for REF. As a literary scholar he has interests in life writing, aesthetics, and wisdom. His monograph on literary experience and wisdom is now out in paperback.

Using eating together to think: reflections on doing research at public mealtimes

This post is written by Marsha Smith.

Marsha Smith has ten years' experience working in award-winning community food initiatives. She contends that public meals at mealtimes, using surplus foods are a response to food insecurity and food wastage, but may also be understood as a new form of commensality, or group eating practice. Marsha is currently undertaking a PhD in social eating at Coventry University, she is a Visiting Fellow at Nottingham Trent University and an academic advisor to FoodHall in Sheffield.

Is there something special that happens when we eat together in groups?

This post looks at an emergent form of group eating initiatives and explores some ways of doing research with, and about, the customers and producers of these eating events. Community-based forms of group eating practices are trying to address serious issues of our current food culture such as the coexistence of food insecurity and food waste. In doing so, these community groups are prompting researchers such as myself to consider different ways of seeing the potential of this everyday practice to do much more than feed us. This post looks at what commensality is, why it is important and how it might generate new ways of doing research.

Group eating practices or eating and drinking together in a common social or physical setting is known as **commensality** in academic parlance (Chou, Kerner, and Warmind 2015). Commensality is described as a potent symbol of everyday life, marking some of our most important life transitions such as marriage or death, as well as providing structure and rhythm to our daily schedules (Brannen, O'Connell, and Mooney 2013; Valentine 1999). Commensality is common in all Western cultures and is often seen as the social 'glue' that strengthens family and group bonds, and as a site where social roles, norms and values are transmitted and reinforced (Bourdieu 1984; Chou, Kerner, and Warmind 2015). Indeed, not only can commensality be seen as a microcosm or an engine of social life, a recent report of eating habits in the UK stated that 'taking the time to sit down together over a meal helps create social networks that in turn have profound effects on our physical and mental health, our happiness and wellbeing, and even our sense of purpose in life.' (Dunbar 2016:1).

A shared meal, made from surplus food

Social eating spaces

There is an emergent form of commensality which takes the sociality of the family dinner and sets it loose in 'everyone-is-welcome' public spaces. **Social eating** or public mealtime events are emerging in the East Midlands, particularly in Nottingham, and may be thought of as homemade meals eaten in public places. Here, people choose to eat together in groups, to foster new social connections and support community togetherness, and to make good use of the food surpluses supermarkets do not need. Social eating explicitly encourages the participatory aspects of commensality and offers an alternative to services such as commercial cafes or food banks that are based on eligibility and economically-mediated need. In framing social eating as a positive, public activity, a non-stigmatising approach to eating affordably in groups has been developed by communities.

In social eating spaces, the public is invited to share a meal, not as part of a festive occasion or to mark a life transition, but as a regular alternative to an evening meal which may be a takeaway, eating in restaurants or home-cooked food. Social eating spaces that are open weekly or monthly for example, to members of the public who might want to access a social meal for a variety of reasons, appear to be a pragmatic way of

leveraging the power of commensality to do more than feed people.

The opportunity to share food with friends and with strangers at public mealtimes can create exciting spaces which allow us to begin thinking about the organisation and transformation of society in conjunction with the public. Commensality, or eating in groups, is the subject of much anthropological and sociological research, often viewed through an ethnographic lens in an effort to produce knowledge that is rich in cultural meanings and reflections. However, commensality has not been widely explored through empirical work on food insecurity.

Research methodologies

In some approaches to studying society, the eating and sharing of food is also used as a means of doing research: not just by studying how and why people eat together, but by *using eating together to support the creation of data.*

Eschewing the regular types of research approaches such as surveying, using public mealtimes as a research resource and eating together with participants can create intimate, convivial and equalising ways of co-producing data. Additionally, current empirical research on food insecurity has tended to employ approaches that are *methodologically individualist*, or which focus on the individual, such as interviewing. Yet commensality is a group activity and a fundamental one at that. There is space here then, for exploring food insecurity as it is expressed through, and by, groups.

This approach opens up space to engage in *group methodologies* beyond the use of focus groups. For example, to go further than elicit opinions or reactions about an item or issue, but instead to endeavour to involve groups in the creation, coding and analysis of data. This co-production approach is exemplified in the methods of 'community-based participatory research'.

It seems clear when we reflect, that commensality is a primarily social activity and that this sociality could be embraced by researchers to generate unique research opportunities. This overall approach to doing research on issues such as food insecurity *with* invested stakeholders rather than *for* them, has the potential to generate new insights and forms of knowledge that occur uniquely because of group deliberations and discussions. Additionally, I argue that groups who eat together could and should be the creators of knowledge, policies and interventions that concern them.

Group eating practices such as the ones unfolding in social eating spaces challenge the idea that food is 'merely something inert on the plate' and instead convey how 'influential, symbolic, powerful and transformative food can be' (Coveney 2013:2).

Eating in groups is a social activity that involves resources, equipment, timings and rhythms, and arrangements of spaces, as well as sequences and timings of behaviour; all of which contribute towards the setting and reinforcing of social customs. Social eating spaces are rich sites of sociological interest that have the potential to offer up novel ways for producers and consumers to participate in consumer research that can be used to shape services and strategic plans. Of course, we have other precedents for using food and group eating practices as a research resource (see, for example, Burges Watson 2016 on using specialist food experiences for engaging with cancer-survivors, or Pettinger 2017 on engaging with 'harder to reach' service-users).

Participants reading post-it notes for research on social eating

Community-based participatory research

Now we may consider how using public mealtimes to engage in research might fit into a methodological approach called 'community-based participatory research' (Westfall et al. 2006) which is used by community groups to create and test their service-provision, as well as by academics such as myself. Social eating creates and facilitates a special type of research experience that immerses researchers in the intersections between the domestic and social worlds, between the producing and recording of data, and this changes the power dynamic between researcher and researched. It became apparent, through my experiences of social eating spaces, that whilst I was recognised as an academic, the research environment created through a shared meal diminished the difference between researcher and participant. However, using group eating practices as a research resource within community-based participatory

research approaches has not been widely explored. So, what is **community-based participatory research**? And how can eating together be used in community-based and influenced research?

Food and the eating of food can facilitate one of the creative kinds of empirical research that are described as 'community-based participatory research' (CBPR). CBPR moves beyond 'traditional research approaches that assume a phenomenon may be separated from its context for purposes of study' (Holkup et al. 2004:162). CBPR in its commitment to involve communities in the research process, may employ a diverse and creative methodological approach to better understand complex problems and find solutions or points of intervention for participants, using both logic and systematic thinking as well as intuition and imagination (Heck et al. 2018). Sociology is the study of the development, function and structure of society and the study of problems within society. Community-based participatory research can be understood as a practical synthesis between community work and sociology.

Methods used in researching social eating – post-it notes with participant thoughts

CBPR is particularly useful for 'applied research that seeks to understand people's engagements with objects, systems and services, better engage publics and other stakeholders, work towards social change, and identify and intervene in futures' (Lupton 2017:1). CBPR centres the creative, ground-up processes intended to ensure interventions and services fulfil their intended aims and produce their intended impacts. What is also useful in this approach is the curious, open nature of the process where problems and failures are embraced and positioned as further opportunities to refine and redevelop services. Through close attention to, and involvement with, users and their ideas, skills, habits, desires or plans, a range of entry points for transforming social practices emerges. Using public eating spaces to engage participants creates a focus for, and rhythm to, dialogue. Sharing food with participants creates convivial conditions where emotions are stirred, reminiscences are recollected and where new relationships can begin to form. Community 'design' approaches are primarily practice-oriented; focusing on how social processes are enacted, how they emerge, change and are performed, so food and eating could form part of a researcher tool-kit, offering creative ways of stimulating the production of answers to researchers' questions.

The rhythmic dialoguing over dinner creates space for data to assemble, and it creates an emotional and affective environment that is different from conventional interviewing. Eating food together creates a special type of conversational, participatory research environment. It creates new ways for researchers and participants to relate to each other as co-producers of knowledge. Participants immersed in that special environment develop connections alongside researchers according to their priorities and interests rather than pre-determined research agendas.

Eating food together as a form of CBPR offers an alternative approach to interaction beyond the tendency of researchers to report insights about participants rather than treat participants as co-producers of knowledge. Even more than this, the CBPR approach takes the rich insights gained through ethnographic and participant observation research and adds a practical dimension of user-involvement. It takes eating together to be a creative 'material' that plays an essential part in the shaping of new services. The power of commensality is not positioned as the backdrop to research, but it is highlighted as a force that can potentially transform services and the social structures they are part of. To paraphrase Levi-Strauss (1962), research methods using commensality as a resource are useful to researchers, not just because they are good to eat, but because they are good to think.

Some of the material used in this post was originally published on the Coventry University CURB blog.

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The new agricultural bill: soils, sustainability and farming

It may have already left your news feed, but a few weeks ago a new agricultural bill was presented in parliament. We spoke to some of our local soil and plant scientists, Prof Sacha Mooney, President of the British Society of Soil Science, and Prof Malcolm Bennett, and Prof David Salt on what the new bill means for the UK, for farmers and for universities.
One of the most important aspects of the new agricultural bill is the focus on soil, and specifically soil quality. The reasons for the inclusion of soil in an agricultural bill are multiple, but soil scientists have been lobbying for its inclusion for a long period of time. A government enquiry on soil health two years ago focused people's attention on the need to conserve soils.

The farm at our Sutton Bonington campus

Prof Mooney explained, "the big shift is, we are changing from farming that has been focused on maximising production to one that is seeking to improve sustainability. At the heart of this is the recognition that we lose soil faster than we form it. Soil takes a long time to form, in some cases it can be decades or hundreds of years for thin layers of soil to form. But we can lose significant quantities in just one afternoon through soil erosion with a heavy rainstorm or under poor management. If you are continuously net losing soil, eventually you will run out, and that will have a devasting impact on our ability to produce food".

Conserving our soils is important for the future of food.

The new agricultural bill is part of a series of changes that the UK will need, now that the exit from Europe is finalised. The UK will no longer be tied to EU agricultural policies (including CAP), and so the way farming is financed and managed in the UK is going to change. The new agricultural bill moves to paying farmers for being environmental land managers, rather than just as food producers. Given the change in public mood around the climate crisis in the last year alone, the time is right for a new way to think about farming and agriculture.
The priorities of food security and environmental protection are at the heart of the new agricultural bill. Farmers will no longer just be responsible for the production of food, but will also provide public goods – including clean air and clean water. As Prof Mooney told us, "One thing that I've certainly noticed in the last few years, working with farmers, is just how many progressive farmers there are, who are already doing many of these things: maintaining hedgerows, reducing tillage, minimising traffic, using cover crops to minimise erosion, and there is a significant movement of farmers who are right at the cutting edge of it. And actually, some of them are way ahead of the scientists".
Such a change in approaches to farming are driven by environmental awareness and a long-term view of the purpose of farming. Some farmers are more accepting of potential reduced yields by minimising cultivation, because it improves the health of the soil. Over time, as the natural structure of the soil evolves, developed by the microbes and organisms that live within it, the soil quality will be improved and therefore will support better crop production. But this is a long-term commitment. Farming is a business, and economics are always going to be important, but as Prof Salt pointed out, "when we think about wine makers for example, we immediately don't think that all they are after is profit. We think they are very cultured, they take care of their vines, the land, the terroir but farmers are just the same, regardless of

what they are growing. We shouldn't be thinking about them in a different way at all".

Vineyard in Tuscany

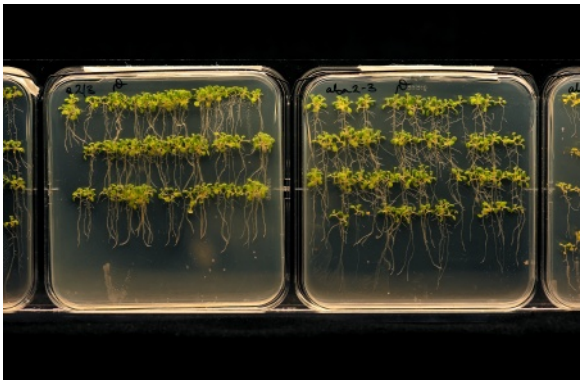
A new agricultural bill focused on soil health and long-term environmental sustainability also has implications for the research in institutes and universities. Farmer will need to be supported by universities and institutes who are undertaking research in soil science. There are several urgent research questions such as which cover crops work best, what crop grows best under different environmental conditions, how can we optimise the growth of crops such as wheat in compacted soil or when the soil is too wet or dry, this information needs to be shared to best support farmers. Greater openness and collaboration will need to be embraced by both scientists and farmers.

Traditionally, many plant scientists and soil scientists have considered that they work in different fields, with little collaboration. But greater integration is going to be necessary as we move towards creating a more sustainable world. As Prof Salt explained, "people interested in the evolution and adaptation of plants, and people interested in mechanisms are starting to merge and I think that is a really good sign because it's saying that people are interested in the interaction between the soils and the plants and ultimately, that is the key because soils depend on plants for organic matter, plants depend on soils for nutrients. You can't have one without the other really."

How do plant roots branch towards water?

Plant roots need to forage for water and nutrients in the soil. These key resources are not distributed equally through the soil so plants therefore have to send their roots towards the best available sources of water and nutrients. If plants couldn't flexibly adapt to changing conditions in their environments, they would struggle to thrive and reproduce. We know that roots preferentially branch towards water availability. But how do plants know where to send their roots?

A new paper, published in Nature Plants, helps to explain how root branching works. The research, led by Dr Daniel von Wangenheim and Prof Malcolm Bennett of the University of Nottingham School of Biosciences and the Future Food Beacon, grew Arabidopsis roots on agar plates to see how early lateral roots develop. One side of the root was exposed to the air, while the other was in contact with agar. They noticed that these new branches reoriented their growth in the direction of water, even if the new roots were initially formed on the air side. If they grew roots surrounded by water, no bias in root branch angle was observed. They concluded that the angle lateral roots grow is far more flexible than previously thought, as the plant attempts to steer root growth preferentially towards available water sources in the soil.



Prof Bennett explained, "Our work shows that plants are able to adapt flexibly to their surroundings, spreading roots in all directions but, when faced with a choice, have mechanisms that can direct new root branches towards the best available water and nutrient sources. This also means plants are able to adapt to changes in their environment, ensuring their survival, even when distribution of water and/or nutrient sources change."

Information on roots, and how they forage for nutrients and water in the soil, is critical for future food security. Developing crops with roots able to find more reliable water sources is important given future climate scenarios which will include periods of drought. Similarly, developing crops able to forage more efficiently for nutrients is essential for making agriculture more sustainable given over 50% of nutrients like nitrate-based fertilisers are currently not taken up by crop roots.

You can watch how this occurs on this informative video!

Plants for future food security: the case of Bambara groundnut

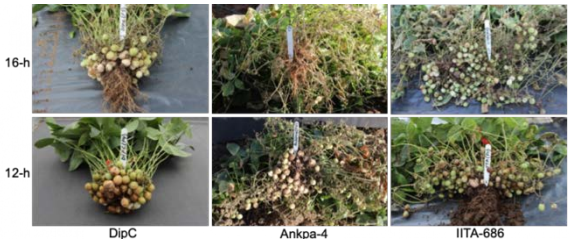
Future Food Beacon researchers in Malaysia and UK are working with partners in Africa and Asia to help secure the future of our food supply. They are doing this by exploring the wider use of crop diversity to fill food production and nutrient gaps, making a diverse range of food crops available and accessible to all.

Bambara groundnut growing in fields

One of our flagship projects (BamBREED) is focused on Bambara groundnut or bambara nut (Vigna subterranea), a protein rich legume of African origin. Bambara is known to be drought-tolerant, with good nutritional composition and capable of fixing atmospheric nitrogen. It is the third most important of cultivated legumes in Africa, next to groundnut and cowpea. Because of its inherent tolerance to stressful environments and the ability to produce some yield in soils that are too poor for cultivation of drought susceptible species such as peanut, bambara groundnut has the potential to help secure our future food and nutritional needs in the face of climate change, as part of a more diverse and resilient agriculture.

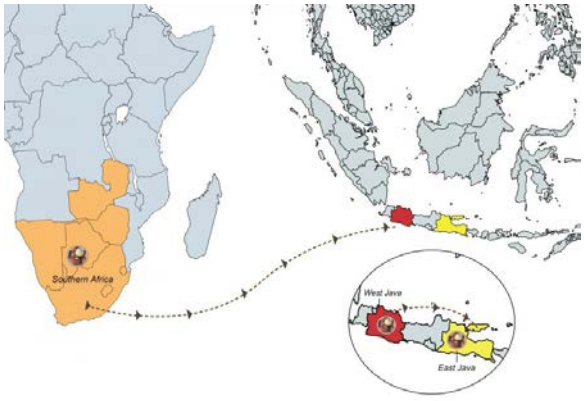
Bambara groundnut: flower, pod, and seeds

This project builds on previous work at the University of Nottingham and Crops for the Future in Malaysia and aims to complete the translation of over 20 years of research on this crop at Nottingham and with partners world-wide, stretching from basic genomics through to field testing and, soon, the growing of new varieties in farmer's fields.



Variation in pod set of Bambara genotypes

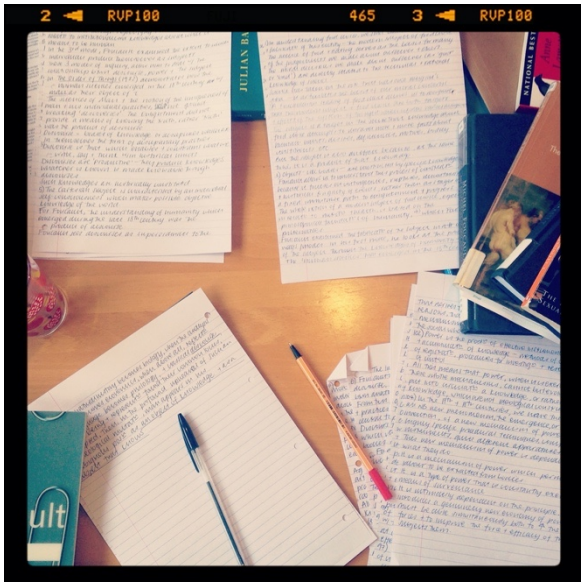
To date, there are no registered or improved varieties of Bambara groundnut. Farmers still use landraces which have been developed locally through seed selection over many generations. Some of these landraces carry important adaptive traits but overall, they are low yielding. An additional problem is that Bambara groundnut has the 'hard-to-cook' (HTC) phenomenon, which may provide some protection from storage pests, but requires often expensive and hard to obtain fuel to cook. The range of countries in which the crop can be grown is also limited in some cases by an unusual photoperiod requirement for pod development. Led by Prof Festo Massawe (University of Nottingham Malaysia) and Dr Sean Mayes (University of Nottingham, UK), the Future Food Beacon team is working with breeders, seed companies and farmers in Ghana, South Africa, Tanzania, Indonesia and Malaysia to develop and release new and improved varieties in order to realise the full potential of this important crop. We have focused breeding efforts and plans for variety registration in partnership with the University of Kwa-Zulu Natal in South Africa, and the Crops Research Institute in Ghana.



Bambara groundnut in Indonesia likely to have been introduced from Southern Africa. World map diagram from www.mapchart.net and Genome, https://doi.org/10.1139/gen-2019-0137.

The future of this project looks promising. First trials have shown good variation for traits in the field in four countries and the most promising lines are now being taken forward. Watch this space for more stories as the project develops!

Coronavirus and the food system: a reading list



Gardening and growing

- Growing and gardening while in isolation, by Mark Diacono (Facebook/Telegraph)
- Land available for allotment use has declined 65% since the 1960s (Institute for Sustainable Food, Sheffield)

Food supply chains

- The UK's food supply and a call for rational rationing, by Prof Tim Lang (The Conversation)
- Interview with Tim Lang, by Jay Rayner (The Observer)
- Stocking up and the supply chain, by Judith Evans and Jonathan Eley (FT)
- New legislation to support food supply chains, by Katy Askew (FoodNavigator.com)
- Countries hoarding food supplies (Bloomberg)
- Worried about gaps in supermarket shelves? You needn't be, by Manoj Dora (The Conversation)
- Shopping trends during March (Agriculture and Horticulture Development Board)
- Local supply chains in Scotland, by Pete Ritchie (Nourish Scotland)
- How the coronavirus disrupts food chains, by Marcelo Duhalde (South China Morning Post)

Changing business models

- Suppliers of London restaurants having to approach their business differently by James Hansen (Eater)

Farming and agriculture

- The need for additional labour on farms in the upcoming months, by Fiona Harvey (The Guardian) and Farmers fear they won't find enough workers to pick produce, by Steven Morris and Lisa O'Carroll (The Guardian)
- DEFRA responds to calls for food rationing (Defra Press Office)
- What you can do to support the fishing industry in the next few months (SustainWeb)

Ethics, food aid and food access

- Ethics in the food response to COVID-19 (Food Ethics Council)
- Food access and the wider food system, by Lawrence Haddad, Jess Fanzo, Steve Godfrey, Corinna Hawkes, Saul Morris and Lynnette Neufeld (GAIN – Global Alliance for Improved Nutrition)
- Millions will need food aid soon, by Felicity Lawrence (The Guardian)
- Chef Jose Andres and his World Central Kitchen respond to the pandemic (TIME)
- Who gets to have a voice within the restaurant industry? by Eric Rivera (Eater)

Food system concerns

- Consequences of Covid-19 on the food system, using Mexico as a focus (FoodTank)
- FAO policy briefs on Covid-19 (FAO)
- Covid-19 impacts on food security, by Suchith Anand (Open Access Gov)
- How is Covid-19 changing how we feed ourselves? (Food Foundation)
- Creating a fairer food system, by Sandra Laville (The Guardian)

Practical information

- A guide to storing leftovers by The Food Standards Agency
- How to clean your groceries, by Sarah Young (Independent)
- Food expiry dates, by J. Kenji Lopez-Alt (NYT)

Global food supply chains in times of pandemic

This post is written by Anne Touboulic, Lee Matthews, and Lucy McCarthy

The public health crisis unfolding before us is unprecedented, unimaginable and catastrophic. It will profoundly impact our values and lifestyles as it exposes the implications of national austerity measures on public services and the precariousness of our globalised production and consumption systems. Food supply chains are no exception. Public awareness of the interconnectedness our food supply chains has soared in recent weeks; despite being largely disregarded throughout Brexit debates. It is imperative we interrogate the global connections that our food supply chains rely upon and create, especially as the current global pandemic is but one of the threats to humanity as we know it.

The "globalisation" of food is not a new phenomenon and our global food supply chains have their roots in historical trading patterns. These trading patterns and our organisation of global food chains can be understood from the perspective of traditional (and flawed) economic models that underpin capitalism and are a product of colonial history.
Whilst this legacy must be challenged, one must

recognise that the mass availability of food and spread of food culture emerged from this global food system and the advent of the supermarket model in the 20thcentury. In fact, we take for granted that we can consume anything, anytime and cheaply. The average consumer has little to no sense of seasonality or the real value of food. The socio-environmental costs – but also the economic ones to the least powerful players (e.g. growers/small-scale producers) – are seldom considered as our choices and lifestyles seem resolute.

Yet as COVID-19 spreads and supermarket shelves are left empty, the fragility and unsustainability of global food chains is exposed. We depend on complex and extended networks to provide goods to our table. As a result of the pandemic, one can expect global freight to decrease, especially for less essential goods, leading to the slow disappearance of tropical or out-of-season fruits on UK shelves but also to impact the import of key ingredients for our manufactured food products (for instance stock cubes and soups). We must question how to transform our food system into a resilient and equitable one. Promoting local and seasonal as the new normal seems like a step in the right direction.

We must acknowledge the unsustainability of our current model as it promotes the exploitation of natural resources and people to satisfy the insatiable consumers in the global North. Some argue this is a key reason for the outbreak, as our production and consumption systems infringe on nature and other species' natural habitats. There is increasing recognition that human health cannot be understood independently of the health of the ecosystems, this relationship is being studied in a field of science called 'Planetary Health'. The destruction of ecosystems is leading to an increase of human exposure to previously unknown pathogens. This is being wrought through land-system change, driven by the expansion of global food systems, and the consumption of bushmeat by millions of the world's poor who are locked out of these food systems.
Will Covid-19 bring changes to our global food systems? This seems inevitable. But only if we become more informed about how supply chains work, the distribution of power within the system, and the alternative models for change.

To understand more about supply chains, we have pulled together the following resources:

- Worried about supermarket shelves being empty? There is really no need.
- A video to explain how supply chains work, from production to retailer.
- Understanding the effect of unexpected demand on supply chains.
- The global food system still benefits the rich at the expense of the poor

UK Plant Health Week: A conversation with a plant pathologist

2020 is the International Year of Plant Health and April 20-27 is UK Plant Health Week. We spoke to Dr Rumiana Ray, a Crop Pathologist, about the importance of plant health, and what you can do to support keeping plants healthy.

You are a specialist in crop pathology, what does that mean?

Plant pathologists work on understanding how plant pathogens such as viruses, bacteria or fungi for example, cause diseases on plants and how can we effectively control them to minimise losses. My focus is on the protection of cultivated plants and crops, against diseases that threaten food security. Plant pathologists are interested in early disease prediction and disease epidemiology (how the environment, the host and the pathogen interact in time to explain the amount of disease).

Dr Rumiana Ray, with a colleague, testing wheat for disease

Tell us a little about what your job entails. What sort of projects do you work on?

I specialise in understanding diseases on plant roots, stems, foliage or reproductive organs, for example grain or seeds on Cereal and Brassica crops that are caused by pathogenic fungi. Severe diseases by these pathogens can develop into epidemics associated with devastating yield, quality or safety losses. Some of these pathogens, for example the *Fusarium* species that infect cereal crops, produce mycotoxins that can contaminate our food with harmful effects for humans and animals. My job is to develop and integrate effective methods for plant protection, ideally before crops are infected, but during their growth and development in field. These methods may rely on a single solution or maybe integrated to include varietal resistance, chemical, biological or cultural control. Therefore my projects span from molecular to applied and are performed in the lab, growth room and in the field. My projects focus on pathogen diagnostics/disease sensing, phenotyping and understanding the mechanisms of host resistance, fungicide action and even ecological interactions between co-occurring organisms on their shared host and how these influence disease development or control.

Testing wheat for disease

What do we mean by 'plant health'?
Plant health broadly refers to the normal physiological functioning of plants in the absence or under the minimised impact of physical, abiotic or biotic factors in the environment.

Why is plant health important?
Plant health is important for food security, plant diversity and our food supply. Let's not forget that many crops are also commodities and devastating plant diseases can cause excessive economic losses, in addition to contributing to human disasters, death and people's displacement. There are many examples in our history to give here, including the Irish famine which was caused by *Phytopthora infestans* infecting potatoes in Ireland and causing late potato blight. The blight epidemic resulted in more than 1.5 million people dying or emigrating from Ireland. The biggest threat to plant health thus comes from imported plant pathogens such as the potato blight pathogen which was not native to Ireland. Plant pathogens can be easily moved and spread by people or indeed other vectors such as insects. It is important that we don't introduce aggressive new pathogens into new environments where they will thrive, especially if there is no host resistance to them. One recent example is a devasting disease caused by the bacterium *Xyllela fastidiosa* vectored by insects. One of the sub species of the pathogen infects olive trees in Europe, killing them and leading to billions of Euro loss. In the absence of host resistance, without EU legislations for the eradication of the pathogen, severe outbreaks can potentially change the physical, cultural and economic landscape of Mediterranean countries. Thus, it is important that people are made aware of quarantine and legislative measures imposed by governmental plant protection agencies in the world to prevent the movement and introduction of invasive plant pathogens.

Our agricultural landscape is reliant on good plant health

FAO have declared 2020 as the International Year of Plant Health. What does this mean for you, as a scientist?
To me it means we need to raise public awareness of the effects of plant diseases and regulations on the invasion of plant pathogens and pests so that we can protect our landscape, crops and environment. We need to invest in research and development for better diagnostics and innovation into plant protection practices and technologies.

The term 'plant health' sounds quite scary in terms of scale, what can ordinary people do to improve plant health?
The simplest way of protecting native plants and the environment is to ensure people don't bring back any foreign plants/seeds, vegetables or flowers when they travel, as they may also bring back pests and diseases with them. If people are not sure they can contact PHA at DEFRA to check on phytosanitary control.

Tempting though it is, don't bring seeds back from your travels.

How can scientists make the public more aware of plants and their needs? What role should scientists play?

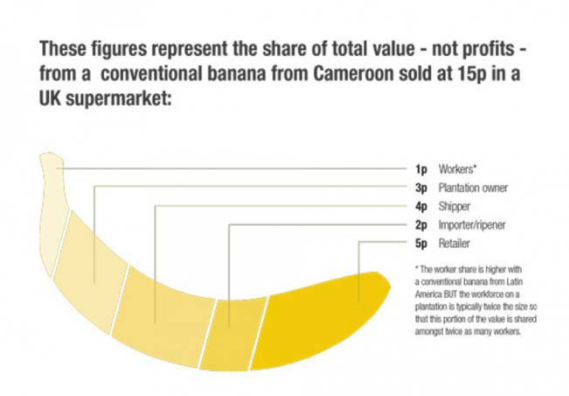
We are so used to our ecological and agricultural landscape that we often take plants/crops there for granted. However, we all have a role to play to ensure that our environment is friendly towards our diverse plant species and resources. Businesses and farmers have already moved away from single measures and practices; integrated management for both pests and diseases is now promoted by industry and practiced by farmers in field. This ensures a much more sustainable way of agriculture and diversifies the plant species within our environment. The role of a scientist in plant health is to ensure that we are prepared for future plant threats by increasing our arsenal in the fight with damaging pathogens and keeping one step ahead, whether it is going to be by increasing host resistance, improved diagnostics, novel chemistry or biological control agents. A key role here will be played by scientists by making their science more accessible to the public in order to raise awareness of plant health.

Global trading: the good, the bad and the essential

This post is written by Lucy McCarthy (QUB), Anne Touboulic (University of Nottingham), and Lee Matthews (University of Nottingham).

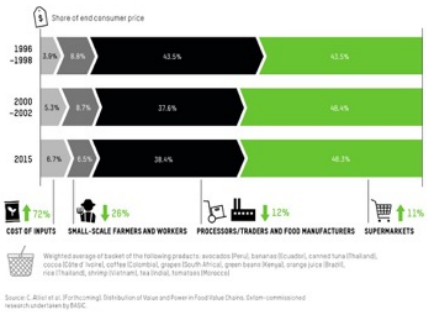
In our last post, we began our journey considering food supply chains in times of pandemic and we touched upon their history. Here, we further consider some of the flaws in our globalised food systems and the historical trading patterns upon which they are based, which have remained largely unquestioned for centuries. Food is essential but the way consumer demands have shaped our food systems through overproduction and consumption is not.

We find ourselves dependent on socially unequitable and environmentally degrading global supply chains. Not all supply chains are created equal and there is no denying that in this crisis we need to pull together to meet ventilator demand and that staying global could be vital. Yet when it comes to food supply chains we need to think differently. How did we get to system where a banana costs 15p? And why do those who labour the most receive the least?



Source: Fairtrade Foundation 2014; Banana Link 2015

The figure below shows how small-scale farmers and workers have been squeezed within food value chains in the last 24 years



Source: Oxfam Ripe for Change report, 2018 p. 18

Despite this clear inequality, we often justify these practices and prices to ourselves by considering them outside their context, disregarding their very real costs. Economically, these inequalities are justified by 'free trade'. Socially, we like to think that our consumption provides jobs. As Unilever describes it, by purchasing their products, they 'feed the farmers that feed us'. We are creating jobs, but what do we say to the 8 year olds that are picking our cocoa? Environmentally, our consumption patterns in the global North are changing the landscape for food producers globally. For instance, coffee growers are finding it increasingly difficult to grow their crops as global temperatures fluctuate. Those who can, move to find the 'right' conditions, those who cannot experience the first wave of climate apartheid and poverty.

Poverty is both a macro-economic and a micro-economic problem. Poverty in 'developing' countries cannot be understood without reference to the global political economy that is controlled by 'developed' countries. The exploitative relationship between the 'developed' and 'developing' countries is a major driver of poverty and hazard for the people of the 'developing' countries. The global supply chains of multinational companies are often the mechanisms through which this exploitation is organised. Our quests for new foods and superfoods, such as quinoa, has priced these developing nations out of their own staples.

Surely though, it must be better for local food producers in the UK? But increasingly, only large-scale producers are able to compete. And despite Brexit, and the push for local people doing local jobs, we are lacking essential food workers. This pandemic has highlighted our shortage of 'local' people to do manual jobs and the likelihood is we will once again have to import workers to do this essential work – we are even having to turn to volunteers for this essential work. And this isn't unique to the UK. The French government, for example, has officially called upon unemployed people to join the "army of agriculture" to feed the nation.

UK farmers are no strangers to exploitation either

Now, more than ever, is the time to reflect on our consumption patterns and think about what we are eating. We need to consider the real cost of food, and as food poverty spreads, we call for more inclusionary food systems for all, which we believe will help us to avoid future pandemics.

Genomic sequencing and Covid-19

Deep Seq, the University of Nottingham's state of the art high-throughput genomics facility, is currently part of the COVID-19 Genomics UK Consortium, mapping the spread of coronavirus. We spoke to Prof Matt Loose and Dr Christopher Moore, about the work, the equipment they use, and how they are adjusting to this new challenge.

Tell us about Deep Seq. What sort of work do you normally undertake?
Deep Seq is the University of Nottingham's high-throughput genomics facility. The projects that we carry out are very diverse and come from researchers across the University as well as from other institutions. In a single week, projects we are working on could include analysing the microbial species associated with a particular plant's roots, mapping genome rearrangements in human cancer cell lines, analysing gene expression changes in zebrafish blood stem cell development and sequencing the genome of an emerging crop. Researchers often come to us with a genomics research question, and as long as they can obtain the DNA or RNA from their model system of interest we can normally help them find an appropriate way to answer it with the technologies we have in Deep Seq.


The lab at Deep Seq

What kinds of equipment do you use?
Deep Seq has a range of equipment, each of which has its own individual strengths. These include Illumina short read sequencers, Oxford Nanopore long read sequencers, a Bionano optical mapper, automation robots and various other sample preparation and QC platforms. By not focusing too much on any one technology we have tried to make a broad range of techniques and services available to UoN researchers to enable their research. The Future Food Beacon's support has been crucial in allowing us to expand the diversity of technologies available within Deep Seq. An example of one of the Beacon's investments is the Oxford Nanopore GridION X5, which has rapidly become one of the most used pieces of equipment in the lab because of its versatility and convenience. It allows us to perform medium-throughput Nanopore long read sequencing with a powerful dedicated computer on board to process the data.

GridION


The GridION at work

How does this equipment work?
Oxford Nanopore sequencing technology is based on DNA passing through membrane-embedded

"nanopores" while a voltage is applied to the membrane. As the DNA passes through the nanopore there is a disruption of the ionic current across the pore producing a signal that can be detected by an underlying sensor array. The level of disruption in the current is determined by the combination of bases that are passing through the nanopore at any one time. The change in signal detected can be analysed by algorithms, which convert this into readable DNA sequences. Once this conversion has taken place the sequence data is available immediately for analysis, so unlike many other sequencing platforms it allows real time analysis of the data being produced. Each flow cell has a membrane, which has a possible 512 nanopore channels that can be sequencing at the same time. By using the GridION we can run up to five flow cells at once, meaning that we can be collecting and analysing sequence data from up to 2560 pieces of DNA at the same time, which is pretty cool.

A flow cell

What kinds of projects have you done with it previously? How does the GridION help the research?

One of the major advantages of Oxford Nanopore technology is that you can sequence really long pieces of DNA as single sequences. This makes the data really useful for assembling genomes. To use an analogy, it's like trying to do a 300 piece jigsaw compared to a 10,000 piece jigsaw: bigger pieces mean less pieces and make an easier jigsaw. We often use the GridION for sequencing relatively small genomes (<600 Mb) and metagenomics. Recent projects have included sequencing the genomes of bambara groundnut and mealworm as well as performing metagenomic sequencing on samples from cholera patients. The GridION has also been key to the Loose lab's work in developing and optimising "Read Until", a software based selective sequencing approach, which allows targeted re-sequencing of specific regions in a genome. Most recently the Deep Seq team has been using the GridION to help us with our work for the COVID-19 Genomics UK Consortium.

What are you doing now as part of the Consortium?

We are currently sequencing SARS-CoV-2 genomes from COVID-19 patient derived samples. These viral genome sequences that we produce feed into the consortium, which comprises of the NHS, Public Health Agencies as well as academic institutions. These data will help increase understanding of the dynamics of transmission in the UK and globally, especially as we closely monitor the waves that may emerge over time.

What are the logistics of working on Covid-19 & what challenges have you faced?

We have had some logistical challenges to overcome in terms of sample processing, ordering reagents and maintaining social distancing. We have been working closely with one of the UoN virology groups led by Prof Jonathan Ball and NUH Clinical Microbiology to obtain processed samples for us to sequence. The increase in testing in recent weeks means more samples are arriving at the hospital, which is bringing benefits and challenges. Our initial sequencing strategy had a modest throughput, however we are now looking at ways to scale this up while maintaining a minimal lab presence.

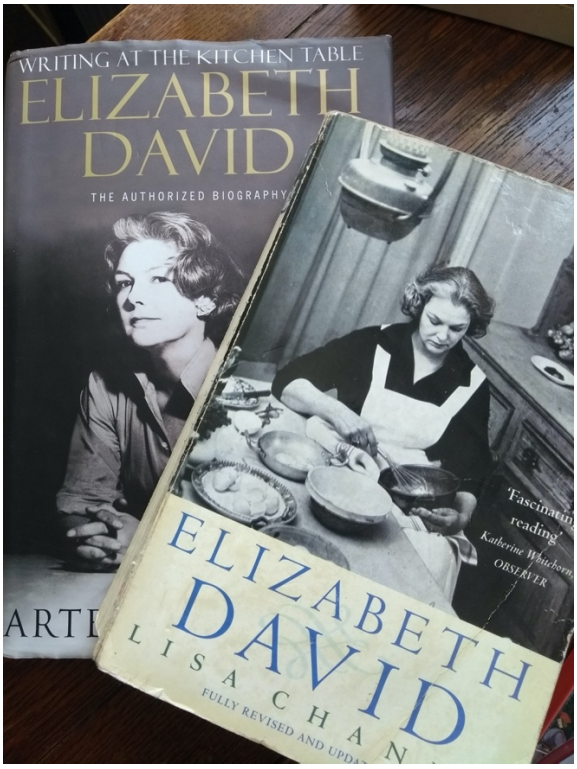
What have you learnt from this experience?

I think we've learnt a lot, particularly about how well we work as a team even in difficult situations such as this. We have worked together to adapt protocols, perform the sequencing, create bioinformatics pipelines and solve the logistical difficulties of ordering and delivery, all while maintaining physical separation from each other. It has also been great to see how other UoN researchers and the wider research community have been able to come together and pool resources on this project and others at such short notice.

Links:

- Artic Network COVID-19 sequencing protocol (that Deep Seq have based their sequencing approach on)
- Global Initiative on Sharing All Influenza (to which some of the data is being contributed)
- Nextstrain SARS-CoV-2 genome data visualisation

Elizabeth David on food and belonging: Keeping house during a lockdown



This post is written by Dr Richard Vytniorgu, Impact Research Fellow in the School of Cultures, Languages, and Area Studies.

The Challenge of Covid-19

For those of us who can, working from home has become the new normal, squeezing our entire lives into the four walls we call home. Inviting friends and family over for socialising has been banned, and even our diets may have changed due to the unavailability of certain kinds of food. As kitchen tables become desks and spare space is taken up with extra food supplies, 'the hearth of the home' is being radically re-purposed so that our homes, and being at home, are asked to do a lot more work for us than they previously did.

Before the lockdown, to speak of home may have tasted sweet or simply carried the savour of normalcy. Post-lockdown, the taste of belonging at home can be one of bitterness and sour resentment at the thing that has caused our homes to become our cells.

But I've been finding some comfort from the books of Elizabeth David (1913-1992) – perhaps one of Britain's most famous food writers of the twentieth century – whom I'm currently researching. David appeals to me as a literary scholar interested in how literature and culture, and the people who mediate these things, create and transmit traditions across generations. These traditions, which can come from anywhere, can help foster a sense of belonging somewhere, even in times of difficulty.

Elizabeth David and Inheritance

David saw herself as a writer rather than a cook, but by 1989 she had come to see that food was really at the basis of everything, in the same way that the American M F K Fisher believed that to write about food was really to write about our need for security and love. My own approach to David is to see her as a writer fascinated by the inheritance of culture: to see food practices and recipes as forms of knowledge inscribed by tradition, which are *received* by others and thus inherited. And it's this sense of having inherited something that contributes to our feeling of belonging somewhere.

I'm sure many of us only tend to think of inheritance in monetary terms. But we can inherit lots of things: DNA, some health conditions, tastes, religion, politics, interests, style, and many more. These things are passed to us, sometimes involuntarily but often freely given and freely received, and become an inheritance to the extent that 'it lives in me', as Roger Scruton has said in his meditation on belonging, *Green Philosophy: How to Think Seriously About the Planet* (2012).

For Elizabeth David, food, and especially cooking, formed a crucial part of a living inheritance at both the individual, personal level, and the national level as well. Her writing is also intensely autobiographical—not quite a 'foodoir', but nevertheless grounded in robust and sometimes painful personal experiences of belonging and the loss of belonging.

Keeping House

Of course, David didn't live through Covid-19, but she did live through the Second World War, when she left the UK in 1939 to sail around the Mediterranean with her lover, Charles Gibson-Cowan. David narrowly escaped more prolonged incarceration in Italy, and eventually settled in Cairo for the rest of the war. But before she settled in Cairo, she and Gibson-Cowan took a tiny cottage on the island of Syros in Greece, and it was here that she really learnt to cook and to 'keep house'—something immortalised in David's biographical entries to her books which proudly tell us that 'Mrs David lived and kept house in France, Italy, Greece, Egypt and India, as well as England'.

In 1940 Elizabeth and Charles arrived in Greece, but they had lost almost everything by then. And yet compared to British standards at the time, the couple had an abundance of food: eggs, tomatoes, onions, potatoes, aubergines, turnips, pomegranates, oranges, lemons, octopus, and chicken. While Charles taught English, Elizabeth pared back living and keeping house to their basics: the preparation of 'honest, sincere, and simple' cooking with what she had to hand, as she noted in *French Country Cooking* (p. 8).

In the volume of recipes which David wrote in 1947 in an attempt to remember what she cooked in the Mediterranean – *A Book of Mediterranean Food* (1950) – she set down what she had learnt while keeping house in times of difficulty. The recipes are frequently 'given' by others, or else they are created from an understanding of regional customs and practices. Her basic method is to record the essentials of a dish and then adapt, in the process creating a living inheritance which truly lived in her because she cooked what she wrote. This process of transmission, of inheriting ways of preparing and eating food and then adding to the basics, enabled David to belong anywhere at precisely the moment she was forced to belong somewhere very restrictive.

But it was more than just recipes that David inherited; it was a way of thinking about and living with food. 'Some sensible person', she quipped in *French Country Cooking* (1951), 'once remarked that you spend the whole of your life either in your bed or your shoes. Having done the best you can by shoes and bed, devote all the time and resources at your disposal to the building up of a fine kitchen. It will be, as it should be, the most comforting and comfortable room in the house' (p. 23).

Many of us I'm sure, have resorted to clean-outs of various kinds during the lockdown, and our kitchens-cum-offices are no exception. We are looking for the 'comforting and comfortable' in these difficult times, chucking the clutter, but focusing on *building up* as we're newly confronted with the somewhere of our homes. David tells us that 'As time goes on you accumulate your own personal gadgets, things which graft themselves on to your life' (p. 23).

As David discovered through her isolation at Syros, lots of things graft themselves on to our lives. They've been given to us by others and carried around with us

because we've had no reason to discard them. They matter; they flow from us like tendrils which bring us in touch with others outside, out there.

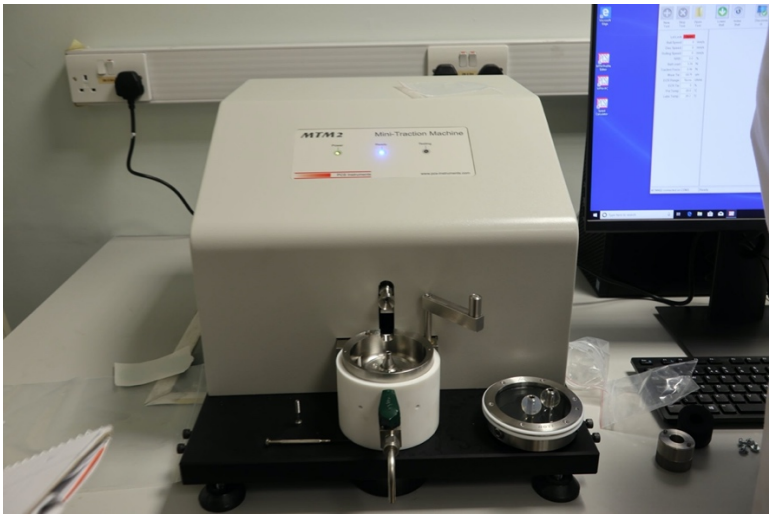
Belonging in a Lockdown

But a lockdown prompts us to re-think how we keep house, and how we use our time and resources to build up a fine kitchen, whatever that looks like. How do we avoid becoming resentful at being shackled to somewhere, not free to roam anywhere?

The author in their kitchen

The only way we can pare down to the essentials in a moderately conciliatory rather than resentful way is to work out what *already* 'lives in us' of the anywhere, in our approach to food and the design of the spaces in which we prepare and eat it. What have we inherited? How can we revive and add to the attitudes, perspectives, and habits we received once from a familiar face that 'flickers into focus' again now that the noise of the world outside has quietened? Maybe this will help us to feel a little more as if our homes are places where we freely belong somewhere, even if only at mealtimes, in our kitchens, where we really can belong anywhere.

Mini-Traction Machine (MTM-2): Tribometer / Soft Contact Tribometer



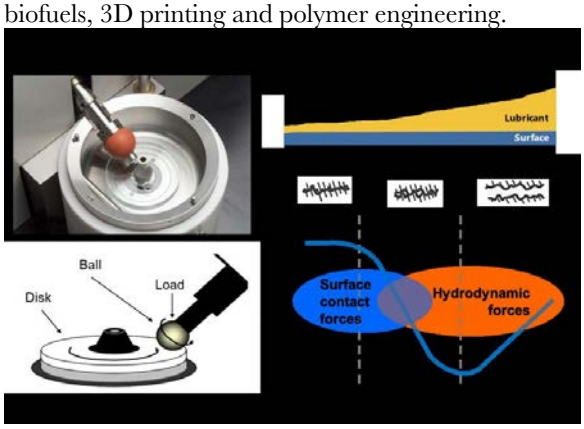
We spoke to Dr Gleb Yakubov about the mini-traction machine (MTM-2): tribometer used in Food Science for experiments and research.

Tell us about your research? What kind of things are you exploring?
In my group, we are interested in linking molecular and structural features of polysaccharides (polymeric sugars) with their functionality in foods, plants, and biomaterials. Despite ubiquity of polysaccharides, from cellulose and starch to complex hemicelluloses and pectins, little is known about their interactions at the molecular level. These molecular interactions lead to the most wondrous and economically vital sets of properties of polysaccharide assemblies. Unlocking the interaction mechanisms at the molecular level enables researchers to improve foods, enhance utilisation of biomass, and gain deeper understanding of plant physiology.
Currently, our main research focus is on understanding dietary fibre functionality in the gut and fibre interactions with the gut microbiome. In addition, through collaborations with industry, we utilise our expertise to investigate oral perception and oral processing of fibre-containing foods. We also contribute our expertise in structural characterisation to look at dietary fibre and constituent polysaccharides in their native state as part of plant cell walls and plant mucilages.


Dr Gleb Yakubov and colleagues at a training session for the tribometer

Tell us about the mini-traction machine? What does it do? How does it work?
MTM-2 enables measurements of lubrication, friction (tribology), micromechanics, and thin-film behaviour of polysaccharides and proteins. The unique adaptation utilised in our group is Soft Contact Tribology (SCT), a novel technique which compliments existing capabilities residing within the University of Nottingham in rheology (analysis of flow) and texture analysis, as well as enabling unique access to probing micro- and nano-mechanical properties of multi-phase complex fluids such as particle suspensions (e.g., ketchup, vegetable puree) and emulsions. At its core, the technique probes the friction between two soft surfaces separated by a layer of fluid. The use of soft surfaces mimics the oral environment where oral processing involves interactions with soft tissues such as that of the tongue. In addition to utilisation of SCT technique in

a wide range of food systems from beverages to yoghurts and potato crisps, the SCT can be successfully utilised to characterise suspensions of plant particles, milled flours and other paste-like systems. The technique can also be utilised to probe the lubrication behaviour of plant proteins, polysaccharides and food materials such as oils, starches and emulsions.
More generally, the field of tribology (friction, wear, lubrication) is an interdisciplinary area with applications across foods, material science, chemistry, biological sciences and engineering. The proposed SCT facility will provide world-class infrastructure to serve broad needs across the University of Nottingham, as well as opening new avenues for industrial engagement with applications as far ranging as the development of medical devices and biomaterials, drug delivery, purification membranes, biofuels, 3D printing and polymer engineering.



How does this help your experiments?
MTM-2 enables measurements of lubrication, friction, micromechanics, and thin-film behaviour of polysaccharides and proteins. This allows us to address a broad spectrum of problems in a unique way that cannot be accessed through other instrumentation. For example, SCT became indispensable in the analysis of oral processing of food and oral care products, as well as the interaction of foods/oral care ingredients with saliva that impact texture, in use performance and sensory perception, as well as to analyse molecular mechanisms underpinning biological lubrication in animals (articular cartilage lubrication) and plants (root penetration through the soil).

Can other researchers make use of this equipment? If so, how?
Currently, the equipment is accessible on a collaborative basis and is being promoted internally through UNICAS, NDDS, and Beacons. Once the support environment from the technical team is set in place, MTM-2 will be made available through the Kit-Catalogue and to M5 universities via the Midlands innovation website.

The Perfect Storm: Environmentally and Socially Unsustainable Seafood Supply Chains

This post is written by Lee Matthews, Lucy McCarthy and Anne Touboulic.

Seafood supply chains sustain three billion people nutritionally and also provide 10% of the world's population with employment, the vast majority of whom are small-scale fisher-people. Seafood provides access to safe protein for many of the world's most economically marginalised people but these supply chains are not sustainable in their current form. 90% of global fish stocks are either fully fished or overfished and numerous species are becoming endangered, for example: bluefin tuna.

Seafood supply chains are also blighted by many of the same problems explored in our previous blogs on

terrestrial food production, such as inequality, waste and poor governance. They are also marred by illegal fishing, fraud and modern slavery, with international crime organisations being key players in the industry. It is estimated that there is a one in five chance that when we buy seafood it has been illegally caught. This robs local fishing communities of their livelihoods and their food. Fraud is a key strategy for moving this illegally caught seafood through the supply chain to the consumer. For example, Russian waters are drained by illegal fishing operations and the seafood is processed in China so its provenance is hidden. In the worst cases, illegal fishing is even mislabelled as being responsibly sourced.

As fish stocks become depleted, fishing vessels need to travel further from the coast in search of fish. This, combined with the high levels of illegal, unreported and unregulated (IUU) fishing within the industry create ideal conditions for modern slavery. Forced labour and human trafficking are well-documented in the tuna fisheries of the Pacific but despite this, only 4 of the 35 leading tuna brands conduct due diligence on modern slavery within their supply chains. Violence against fisher people working in the Pacific is similarly well documented, with human rights abuses including beatings and murder, with dead bodies being thrown into the ocean.

While it is tempting to believe that technofixes, like blockchain, will save the ocean and the people who depend upon it, more fundamental change is required. But as so often with our food supply chains, the answers are as elusive as they are obvious. We need to return to local, community-based supply chains if the ocean is to continue to sustain a growing world population. COVID-19's impact on business as usual in this sector has provided a fertile ground for some community seafood systems to emerge in places like North America. Unfortunately however, the governance required to end IUU fishing, overfishing and destructive fishing practices, such as the use of Fish Aggregating Devices (FADs), would require a level of international cooperation that appears beyond our world's current leaders.

If we continue along our current path, more people globally will need alternatives to wild fish, such as farmed fish (aquaculture) and other potentially unsafe alternatives. Farmed fish is the fastest growing area of food production in the world and while it is presented as a sustainable alternative to wild fish, it is far from the panacea it may seem. Farmed fish are dependent on feed made from the very wild fish they are meant to replace and the poor conditions in which they are kept leave them vulnerable to disease and parasites, such as the sea lice infecting farmed salmon. Farmed seafood can have high levels of antibiotics, which may lead to antibiotic resistance, one of the greatest threats to human health today.

For the poorest people of the world that cannot afford farmed seafood, a glimpse of a possible future can be seen in West Africa. Subsidised large fishing vessels from the European Union have moved to the waters off West Africa and have depleted the fish stocks there. Seafood is the largest source of protein in West Africa and as fish stocks become depleted increased consumption of bushmeat is necessary. Eating certain wildlife is not only a driver of biodiversity loss but can be also be a source of zoonotic diseases, such as Ebola and coronavirus. More of us are starting to become aware that our own health depends on the health of the planet and that food supply chains can no longer be considered independently of planetary health.

A PhD placement with AB InBev in the USA

Jasmine Littler is a BBSRC-iCASE funded PhD candidate in the School of Biosciences. Her project is titled: Enhancing barley environmental stress tolerance through targeted mutagenesis. She is supervised by Dr Guillermina Mendiondo and co-supervised by Prof David Cook. As part of her PhD programme, Jasmine visited the AB InBev Barley Research Centre in Fort Collins, Colorado, USA, in early March, to undertake a PhD placement with AB InBev.

In this blog post, Jasmine recounts her experiences in the US, and shares some of the learning she took away with her.

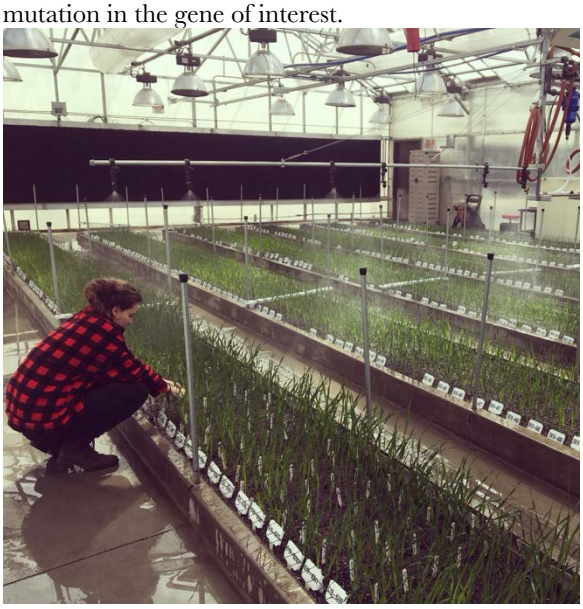
We arrived in Fort Collins, Colorado, amid a snowstorm warning, and the next day we met the team at AB InBev's Barley research centre. The research centre itself, situated almost in the shadow of the Fort Collins Budweiser plant, is made up of several labs, all committed to the different aspects of improving the brewing qualities. This is done by exploring better barley cultivars, and assessing their qualities within the agricultural and brewing industry.

Jasmine outside the Global Barley Hub research centre in Fort Collins, Colorado

AB InBev is dedicated to sustainability when it comes to their agriculture and processes. Worldwide, they are dedicated to improving crop yields and reducing the resources they use through research and development. At the heart of this initiative is the Barley Research Hub where I was based. My project focuses on barley growth in unfavourable conditions such as in drought, which links with AB InBev's goal of growing crops in conditions where water is not readily available.

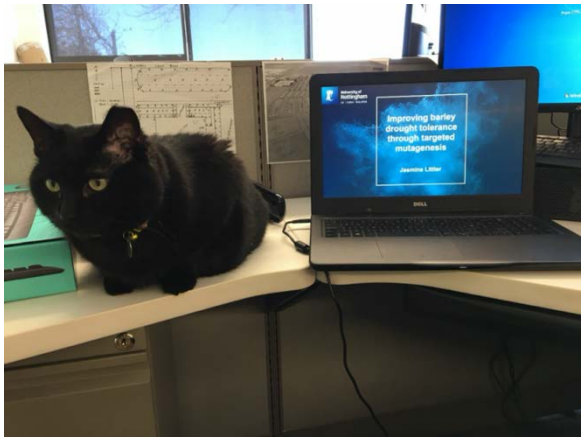
> *"We want to secure a resilient and high-quality supply of crops for decades to come." -ABInBev*

A tour of facilities started with the DNA lab and glasshouse area, where I would mostly be working, as well as the pathology and malting labs which are also crucial to testing new lines for suitability in the field. The DNA lab is a small lab working mainly on DNA extractions and genotyping. This will be used to genotype TILLING lines with known mutations in a gene of interest. The TILLING lines are being backcrossed by the team at Fort Collins, Audrey McDonald and Kate Rochenbach, to remove unwanted mutations from the lines, while keeping the mutation in the gene of interest.

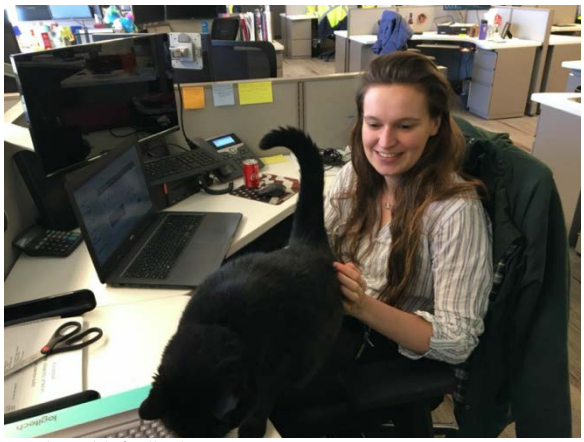


Jasmine taking samples in the facility's glasshouse, where TILLING lines were being backcrossed

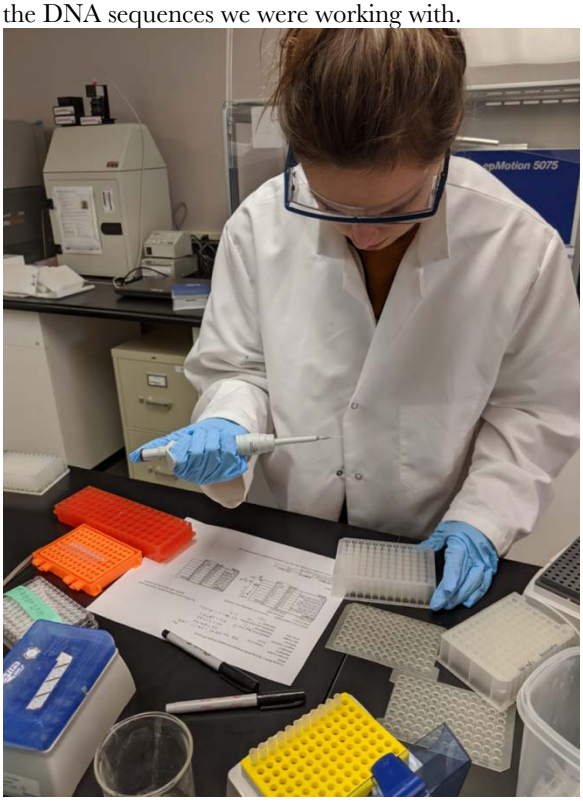
The glasshouses at the facility are mostly laid out in concrete crossing blocks, which are large sowing beds where seeds are directly sown, and where each plant can be identified by its row and column. The system has automatic overhead watering (as I learned whilst collecting samples) and the plants are grown without pots to simulate field growth.
There was also a very special member of staff to meet at the facility, who had authority in every department: Stella the cat. She was very useful in the meeting!



Stella the cat


Jasmine with Stella the cat

The main bulk of the placement was to be made up of training in the valuable protocols that Audrey and Kate at AB InBev had developed in terms of genotyping the plants in the TILLING lines for the mutation of interest. The mutation within the lines should enhance the survival of the barley under drought stress. TILLING then involves crossing these mutations with a commercial line of barley to breed out the negative mutations in other areas of the genome. Whilst some of the mutation targets had clear heterozygous and homozygous genotypes, which could be identified through measuring fluorescence, other genotypes had to be found using restriction enzymes. It was helpful to learn from the team how these steps had been developed when problems arose, which greatly increased understanding on how this could be developed for other projects further down the line. It was also useful to me to see the amount of resources and work required to breed these TILLING lines, as it highlights the importance of working efficiently and keeping resources to a minimum.
One of the most impressive things about the DNA lab was the amount of automated technology. Robotics were used to quickly and accurately move small samples and add reagents, which meant that it greatly improved efficiency for DNA extraction protocols and restriction digests. The number of samples used in this facility is far greater than my use will be when genotyping at the University of Nottingham, however the protocols used were all the same as would be done manually. It was interesting to see how technology like this can be programmed and used for such a wide range of protocols, and therefore technology can enhance the speed and accuracy we can work at.
It was also useful for both Kate Rockenbach and Audrey MacDonald and for me to see what software and programmes we use at UoN to visualise and manipulate genetics and data. It is interesting to get different insight into which programmes are useful for which projects, and I was able to introduce software that helps to visualise the genetic sequence. They also introduced me to other software which was used to easily annotate and manipulate data to find restriction enzymes and other features of interest in the DNA sequences we were working with.


Jasmine genotyping samples from the backcrossed plants to identify homozygous and heterozygous lines

Having meetings with AB InBev staff from a wide range of background including molecular biology, breeding, and commercial, gave me valuable insight into the business side of research, and the difficulty of connecting long-term projects with return and

investment. Meetings highlighted what information and quantifiable traits the company would find useful for attaching value to the project in terms of profits. This means that I can build experimental designs that include quantifications that could then be of interest to the company. The issue with long-term projects in breeding crops such as this one, is return and investment are seen over several years, which makes it more difficult to attach estimated profit. What is promising is the marketability of a stable barley under drought conditions, which could maintain a steady yield, which in turn creates stability for farmers.

The visit overall made me understand my role as a scientist on a larger scale. The work we are doing affects farmers, business and the sustainability of crops under climate change. The ethos behind AB InBev ensures that sustainability is at the forefront of their research, including a large drive on improving farmers productivity, profitability and their efficient use of natural resources, such as water. This includes the flagship platform SmartBarley:

"SmartBarley leverages data, technology and insights to help more than 5,000 enrolled farmers improve their productivity and environmental performance. Today, SmartBarley is present in over 12 countries across five continents."-ABInBev

I am excited to be a part of this project alongside the BBRSC and AB InBev because of the potential impact the scientific research has for farmers and business. I have seen first-hand the links between breeders and researchers, and it has highlighted the motivation behind academic research projects such as this one for future agricultural sustainability. I look forward to seeing how this project makes an impact on producing sustainable yields under challenging global environments.

Overall the whole team at the Barley research centre were so welcoming, and I would like to especially thank Kate and Audrey who made me feel at home out in Colorado!

Jasmine at AB InBev in Colorado

Changing commensality during the crisis: the Nottingham Social Eating Network and Covid-19

This post is written by Marsha Smith.

Marsha Smith has ten years' experience working in award-winning community food initiatives. She contends that public meals at mealtimes, using surplus foods are a response to food insecurity and food wastage, but may also be understood as a new form of commensality, or group eating practice. Marsha is currently undertaking a PhD in social eating at Coventry University, she is a Visiting Fellow at Nottingham Trent University and an academic advisor to FoodHall in Sheffield. Follow her on Twitter: @eatingonpurpose

The Nottingham Social Eating Network and its community food partners in the city mobilised to meet the rising demand for food aid support during the early stages of lockdown. In this post, I reflect on how the values of 'social eating' initiatives are being translated into emergent, localised food security practices.

Social eating

Luca et al. (2019) define social eating initiatives as 'community-based initiatives that provide an integrated model for recovering and using surplus food, localizing food and providing spaces of interaction'. In Nottingham there are around 15 identified social eating initiatives that are operating across most of the wards of the city. These public meal services address food insecurity, support health and well-being, and enable participants to develop what may be termed food social capital by increasing access to, and engagement with, a broader range of ingredients, cooking techniques and meal types.

My PhD research explores the various practices that constitute social eating, with a focus on how they are valued by participants. The practices that social eating participants say are valuable to them can summarised as: *commensality* (Chou et al. 2015) or group eating practices; *alimentary contribution* wherein community-based meal services require a whole range of mealtime helping-out activities (Pfeiffer et al. 2015), and *performances of care* (Van Esterik 1995) or activities that express caring and nurturance. Whether, through the collection, sorting and storing of foodstuffs, setting up the dining room so people can sit together in groups, or through the convivial conversations that transpire in the dinner-queue, social eating initiatives are suffused with opportunities to participate and get involved. Not only at the mealtime itself but before, during and after the eating event, people are able to derive value from the various participatory practices that make up a social

eating initiative.
This 'more than food' (Baron et al. 2018; Blake 2019) approach makes these initiatives particularly vital in urban contexts in the current milieu of austerity: food insecurity coexisting with food wastage.

The case of Nottingham

The lockdown therefore may have seemed disastrous for the Nottingham Social Eating Network. With paying customers now quarantined at home, and with the capacity to engage in public commensality now curtailed, how did these initiatives respond? Did social eating become obsolete?
Alongside my PhD research I am voluntarily coordinating two WhatsApp groups sharing information with multiple social eating groups and their partners about the reorganisation of their community food services. This unique insight has afforded the opportunity to consider social eating initiatives as the sites of dynamic translation between the broader challenges of feeding citizens during the pandemic, and how community initiatives themselves shape and construct these issues through the practices they engage in.
Instead of shutting down, the network redesigned their services and mobilised rapidly and effectively to produce and distribute thousands of meals across Nottingham. The values embedded in social eating could still be detected as groups sustained their meal services despite the operational challenges brought on by lockdown. Instead of becoming obsolete, these practices were transformed into a crucial feature of Nottingham's Covid-19 foodscape.

Community commensality

As the government left the market to balance need and demand (The BBC 2020), many people experienced food insecurity for the first time in the city. Shielding and unable to shop, with home delivery slots limited and oversubscribed, plus new redundancies and benefit-application backlogs, a referral line manned by Nottingham City Council saw numbers of requests for food aid rising. The surplus foods that the groups had access to through their social eating activities were redirected and shared across the city. In fact, as restaurants and catering businesses closed, record amounts of surplus hit the circuit and were safely and effectively used by groups to augment their meal offers (FareShare 2020).

Sharing food in times of Covid 19

Commensality took a new form; meals were boxed and bagged up for collection and delivery by low-risk volunteers in kitchens where the usual food hygiene rules were intensified to encompass new CV19 risks. Meals may not be being eaten at the same table, but food resources are being shared out by groups to both existing and new customers. Although not physically in the same place, the commensal ethos of the Nottingham network was sustained through these services.

Alimentary contribution

Surplus stock repurposed for community eating

Similarly, alimentary contribution, usually practiced during the set-up, service time and clear down of social eating initiatives, was enfolded into new practices of food collection, production and distribution. The expansion of food aid requests and

referrals joined up existing social networks of volunteers and customers with new partners to procure, process and provide meals. Multiple and diverse actors across the city converged to both receive and to contribute help. Taxi drivers became meal delivery services, carparks became socially-distanced food drop off spots where surplus milk, van loads of bacon and catering packs of grated cheese all interlinked to produce novel forms of localised alimentary contribution. At one point 15,000 short-dated sandwiches appeared, requiring immediate distribution, keeping the WhatsApp groups busy all weekend.

Performances of care

Perhaps the most striking practices that became co-opted into the pandemic responses were the performances of care articulated by the Nottingham Social Eating Network. Not only are they materially producing and distributing thousands of meals, but members are the human interface between vulnerable people and the food services that have sustained them. Door-knocking and waiting for a brief catch up chat, checking up on customers with phone calls, thanking and being thanked, putting extra food items in customers bags, paying meals forward and sharing spare food containers- are all examples of the myriad of caring competencies that the network and their partners have enacted across the city.

Conclusion

The values of social eating initiatives, expressed through the multiple, complex and dynamic practices are evidence of a potent local food security response that will retain its importance post-lockdown. Our broader food system is '*a stretched web of rubber bands which can unravel when splits occur*' (Lang 2020), and as such, it is crucial to consider how this network and its partners have formed an effective, localised response to renegotiate these upstream food security determinants.

The interruptions to the 'just-in-time', complex and internationally-distributed food supply affected temporary, localised scarcity in Nottingham. However, as social eating initiatives embraced social disruptions, invoked new partnerships and provisioning practices, they are operating as provisional bridging mechanisms between broader and localised food security practices.

Nottingham citizens have been fed and cared for not solely by globalised food chains but through practices underpinned by values that cannot be commodified. The values of sharing, social cohesion, care and mutuality were just as effective a means of protecting people from food insecurity than access to a commercial product or service, alone.

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Reflections On Public Engagement

Engaging with Engagement – Connecting Science, Public Engagement Masterclass at the Wellcome Genome Campus

This post is written by Dr Peter Craigon

Peter Craigon is a Research Fellow in Ethics, Legislation and Engagement and member of the Future Food Beacon, working with Dr Kate Millar and Professor Richard Hyde on developing tools to encourage ethical engagement and regulatory responsiveness for researchers working in food and agricultural innovation and beyond. He previously worked at the Horizon Digital Economy Research Institute at the University of Nottingham developing a tool to enable ethical design of IT based technologies and also at the University of Nottingham Veterinary School researching dog behaviour. Alongside this he completed a multidisciplinary PhD at the Horizon Centre for Doctoral Training also at the University of Nottingham exploring how social maps create knowledge about place. If you want to find out more about Peter's experience at the Wellcome campus please email: Peter.Craigon4@nottingham.ac.uk

At the beginning of July I visited the Wellcome Genome campus south of Cambridge to attend the 'Public Engagement Masterclass' put on by the Connecting Science project supported by the Wellcome Trust (https://coursesandconferences.wellcomegenomecampus.org/our-events/pem2019/). Whilst I felt like I had an understanding of the role of public engagement in research, gained through my work and experience, I didn't know exactly what to expect. One thing I thought might happen was that I would be surrounded by 'pure' scientists used to spending all their time in a lab, looking for ideas about how to engage the public with detailed, hard to understand science. As a researcher whose research to date has involved a considerable amount of engagement with people and groups as research participants, I wondered how I would fit into the course. On arriving I was pleasantly surprised to find that the group of people in attendance was much more diverse, with a much wider range of experience and interests in public engagement than I expected. The attendees came from disciplines ranging from the humanities and performing arts to earth sciences and social sciences and psychology which ensured that the perspectives of the masterclass were much broader than I had initially expected.

Over the course of the two and half days we undertook a deep dive into public engagement and its role within research through presentations, demonstrations and case studies from experts, participants and different groups with an interest in public engagement. Over the course, public engagement was shown to be a vital part of research. It can inform and engage 'the public' with the work that their money is often funding and improves the quality of the research, by creating a dialogue with the society it serves, enabling them to participate in the research process. This was contrasted with older conceptions of deficit models whereby 'the public' were seen as 'lacking' or unable to understand the nature of science and research thereby rendering efforts to engage with them futile or a waste of the time that could be spent on research.

Our LEGO sequencer being used at the Festival of Science and Curiosity

Varied sessions of the masterclass focused on different sections of 'the public' as audiences; from education and third sector organisations, to city and regional areas – interestingly for me, focusing on Nottingham and example ideas of pop-up science 'shops' and science festivals. From these discussions, lessons were drawn about the expectations and difficulties of working with groups of 'the public' to help us to develop successful mutually beneficial partnerships with different organisations. Drawing on the expertise in the masterclass we were also able to gain advice for our own work, for example, holding one to one mentoring sessions. I particularly enjoyed a discussion about the ethical limits of engagement that provided useful grounding and context for the sessions. We were encouraged to use what we learned and develop our own public engagement plan for our research. To help us think about this we used a 3 'p's approach to consider the Purpose, Process and People involved in our public engagement at all stages of a research process whilst evaluating our activities throughout.

Food Tales asks visitors to contribute a food story, memory, picture or recipe that is added to the collection on the board.

The most fascinating element of the course was meeting the range of people that the masterclass brought together and getting to know a little bit about their research and experience of public engagement. I had many memorable conversations over the three days with people working in such a wide range of areas. I came to learn about Marsquakes (like earthquakes but on Mars); virtual reality simulations of bullying to investigate psychological resilience; whether poo from plankton sinks or floats and the effect this has on the environment; making birthday cards to engage school students with the contents of a historical archive; engagement materials on the scientific basis of forensic evidence to aid deliberation by judges and juries in court room situations; and theatre and performance to engage audiences with the experience of growing up in care.

Experimenting with plant growth and stress

I came away from the course with a broader appreciation of the context of public engagement with research and a multitude of creative ways of embedding engagement throughout research projects. Whilst I didn't have a specific research area or project to focus my learning about public engagement on, I am keen to apply the ideas and approaches that I gained from the course to my work with the Future Food Beacon and to share it with my colleagues, so if you would like to know more then please get in touch.