



University of
Nottingham
Future Food

Exploring new ways of feeding the world

Future Food
Beacon of Excellence





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We bring together researchers from across disciplines to collaborate on the challenge of feeding a growing global population in an era of climate change.



Introduction

By 2050, there will be an additional two 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, is the changing climate. The Future Food Beacon is an integrated open-research platform that brings together researchers from different disciplines to collaborate on global food challenges. Our aim? To deliver food systems that are sustainable, equitable and provide nutritional security.

To find better ways to understand our food systems through transdisciplinary research, we have invested in additional world-class researchers and purchased key cutting-edge equipment to drive our work.

We have projects around the world, with specific collaborations in China, Brazil and the African continent. We cover four key areas:

- Future-proofing agricultural systems
- Food for sustainable livelihoods
- Food for health
- Smart manufacturing for food

We are committed to knowledge sharing and capacity building through schemes such as the Graduate Centre for International Agriculture, which brings scholars from the Global South to undertake PhD research jointly at the University of Nottingham and Rothamsted Research.

We have successfully won 24 grants, worth nearly £10 million, with a further 52 awaiting decisions. Our researchers have published 38 papers and, together with our wider network, have published 87 papers in quality peer-reviewed journals.



820 million people suffer from malnutrition.
672 million are obese.
We need to rectify this imbalance within our food systems, while simultaneously ensuring we are planning for the future of both the population and the planet.



Overview

Globally, we need to find sustainable, ethical, healthy ways that are mindful of traditional foodways, cultures and identities to feed 10 billion people.

Today, 820 million people suffer from malnutrition, while 672 million are obese. We need to rectify this imbalance within our food systems, while simultaneously ensuring we are planning for the future of both the population and the planet.

To address this challenge, we focus on the synergies developed through transdisciplinary research. We bring together soil science, genome-enabled plant and animal sciences, nutritional science, food processing and manufacturing. We also harness the power of digital technologies – all informed by an understanding of the economic, legal, social, cultural, historical and ethical issues that underpin and shape food systems.

This year has seen the start of our Innovation Challenge projects, with appointments of PhD students and postdoctoral fellows for both the Future Protein Platform, and Palaeobenchmarking for Resilient Agricultural Systems. These scholars are drawn from all over the world and bring with them expertise in a variety of disciplines including archaeology, genetics, mathematics and biosciences.

Dr Andrew Clarke, previously of the University of Cambridge, will set up an ancient DNA lab at our Sutton Bonington campus. Dr Carlos Lopez Viso will explore the use of molecular techniques to enhance the quantity and quality of novel sources of protein. Dr John Ferguson will establish a multiscale trait discovery pipeline. We have appointed Dr Tristan Dew, joining us from Manchester Metropolitan University, as Associate Professor in Molecular Phenomics.

The Future Food Beacon is a gold sponsor for the Nottingham Good Food Festival, organised by the Nottingham Good Food Partnership, helping build strong links with our local community. The festival took place over summer 2019, beginning with the Neighbourhood Food Growing festival and concluding with the symposium on urban greening.



Pictured: Dr Guillermina Mendiando, Future Food Fellow in Crop Molecular Genetics (second right) with members of her lab.

Snapshot of achievements

108 grants submitted
(totalling £88m)

29 grants awarded
(£10.9m)

46 grants awaiting outcome
(£29.2m)

113 papers published
(since July 2017)

58 papers published
by new staff appointed by the Beacon

11 papers reviewed as 4*

360+ stakeholders

2 senior group leaders hired

1 junior group leader hired

6 Nottingham Research Fellows

5 post-doctoral researchers

4 technologists

5 PhDs in the Graduate Centre for International Agriculture, further five to commence in October 2019

12 Innovation Challenge PhDs – two based at our Malaysia Campus

Equipment

£2.1m spent on 23 items of equipment

£1.6m committed for new equipment and new facilities

- liquid chromatography – mass spectrometry
- gas chromatography – mass spectrometry
- dual carbon isotope analyser
- soft contact tribology – mini traction machine
- critical point dryer

7 doctoral prizes awarded
(£168k)

6 Future Food Fellows awarded

16 Innovation Fund proposals awarded
(£354k)

6 projects partnering with EMBRAPA – Brazilian Agricultural Research Corporation
(£124k)

11 Partnership Fund proposals awarded
(£101k)



Fighting antimicrobial resistance



As part of our engagement with China, we have developed a Sino-UK AgriFoodTech Innovation Hub. This will act as an incubator for innovation, an accelerator for industrial engagement, and create training opportunities for leaders and scientists.

Innovate UK has awarded funding for two key projects. Research into fighting antimicrobial resistance is urgent, particularly in the rearing of livestock for consumption. We are leading research in this area to support the Chinese agrifood sector.

Farmwatch: Fight antibiotic resistance with machine-learning and sensing technologies

Led by Dr Tania Dottorini, School of Veterinary Medicine and Science

Antibiotics are used extensively in Chinese poultry production because demand has increased dramatically. But this use has resulted in increased antibiotic resistance and zoonotic transfer to humans via direct contact, environmental contamination and food consumption. This project will develop molecular markers for the rapid and effective diagnosis of infection in farmed chickens, decreasing the need for antibiotics. The aim is to use deep learning, large-scale data collection and statistical modelling that can both detect and predict bacterial infections.

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Research and develop alternative feeding antibiotic products from herbs

Led by Professor Serafim Bakalis, Department of Engineering

This project explores the possibilities of traditional Chinese herbal and botanic medicine in the effective rearing of livestock. It concentrates on sustainably reducing and/or preventing infectious diseases in pigs and poultry, by exploring antimicrobial compounds in alternative plant sources. Animal health and welfare, alongside minimising environmental impact, is a key aspect of the future of Chinese animal agriculture.

Science on Tap lecture: Future Farms: Feeding a Hungry Planet

In March, as part of our commitment to further developing relations with China, Professor Zoe Wilson, Dr Levi Yant and Dr Kate Millar delivered a UKRI-China Science on Tap lecture at the Chinese Academy of Agricultural Sciences in Beijing.

This fun and informative lecture walked the audience through a journey of more than 11,000 years of agricultural resilience. The academics talked about how our knowledge and understanding of the past, together with modern science and cutting-edge tech, can help develop a resilient future. The ethics of science, and bioscience in particular, formed a key part of the message delivered by Dr Millar. The audience was encouraged to participate through a voting system, and the event was livestreamed to more than one million viewers across 32 provinces in China.

Science on Tap highlighted University of Nottingham and Future Food Beacon strengths in agritech research and innovation, and showcased existing UK-China partnerships. The presentation was covered by China's mainstream science media outlets.

Commitment to communities

Our aim is to improve lives among the most vulnerable populations, drawing on food systems scale thinking and expertise across the two organisations.

We have signed a Memorandum of Understanding (MoU) with the Food and Agriculture Organization (FAO) of the United Nations, which sets out an ambitious plan of action for tackling the issue of food deserts in Latin America.

Food deserts are spaces with limited or no access to healthy foods, an issue that particularly affects low-income families. By collaborating with the FAO, our aim is to improve lives among the most vulnerable populations, drawing on food systems-scale thinking and expertise across the two organisations. Dr Tereza Campello is well-versed in the challenges facing ordinary citizens; she is an economist and former minister of Social Development and Fight Against Hunger in the Brazilian government (2011-2016). As Senior Future Food Visiting Fellow, she is leading the research.

The work with the FAO draws on our interdisciplinary expertise. Dr Markus Owen (Mathematical Sciences) is developing a model of food deserts in Latin America, while Dr Anne Touboullic (Business School) brings her expertise on sustainable supply chains and engaging with local stakeholders and policymakers. The team will work with communities to develop locally appropriate interventions to increase food access, using the model to help policymakers understand the effectiveness of these efforts.

The importance of working directly with communities to reveal hidden stories is at the heart of Dr Karen Salt's project. Her work in Africville, Nova Scotia, reveals a new narrative based on the centrality of food in community survival. This approach to understanding food culture for resilience gathers recipes, food stories, agricultural practices and food preparation activities from elders in the community to frame the story as one of adaptation and knowledge.

Festivals and outreach activities

We took 'Corrupt Kitchen' – a virtual reality (VR) activity from a project led by Dr Richard Hyde (Professor of Law) – to the Sutton Bonington Agricultural Show and the Workop Fun Palace. The game shows how easy it is to slip into bad kitchen hygiene habits and the compromises people make around cleaning, contamination and food.

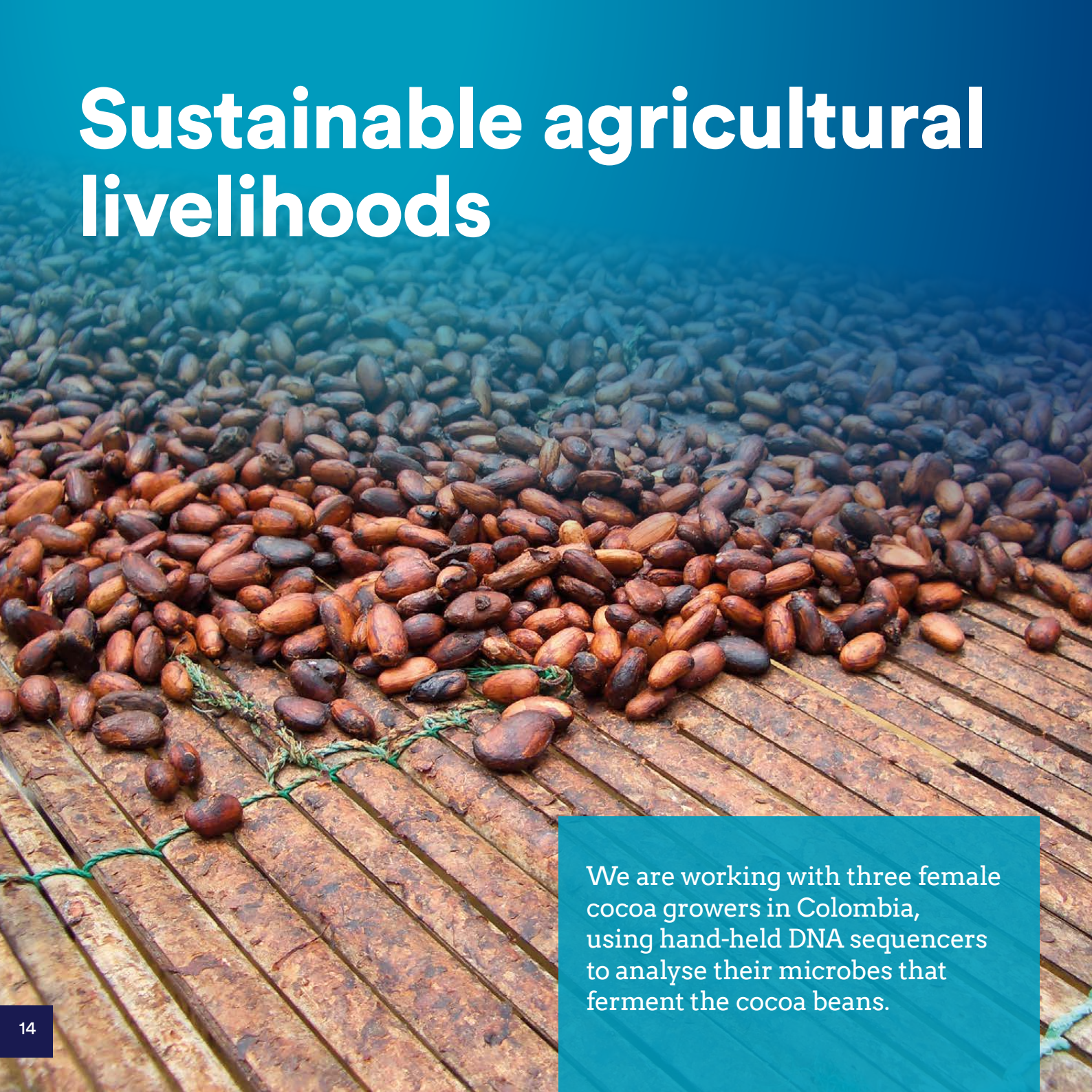
We attended Science in the Park. Our Lego DNA sequencer, designed by Beacon bioinformatician Dr Michael Wilson, allows children to choose different genetic markers that they can then string together. When fed into the new sequencer, their DNA code generates an image of the plant.

Beacon Fellow Dr Sina Fischer designed a stressors experiment to show how scientists research plant stresses like drought. Children were invited to prepare seeds for growing in cotton wool, but to then add additional elements – like ketchup or vinegar – to see if there was any effect on seed germination and growth.

In 2019, we took part in Wonder, the University's main public engagement event. Dr Anne Touboullic asked 'do you know where your bananas come from?'. We challenged visitors to share £1 across five elements of the supply chain, which inspired conversations about fairness – many young people argued that farmers should be paid the most as they do all the hard work!

We also hosted 'Food Tales', which asked visitors 'can you tell me a food story?'. It encouraged people to think of a favourite recipe, a list of favourite foods, a drawing or a story (real or imagined). We are collecting these stories to publish together in a zine.

Sustainable agricultural livelihoods

A large pile of cocoa beans, ranging from light brown to dark brown, is spread out on a wooden surface. The beans are in various stages of processing, with some showing the characteristic cracked shell. The background is a solid blue gradient.

We are working with three female cocoa growers in Colombia, using hand-held DNA sequencers to analyse their microbes that ferment the cocoa beans.

Feeding the world in a sustainable, nutritious and equitable way is key to the Beacon's work. Here, we highlight three projects that could shape the future of food sources that meet these objectives.

Controlling cocoa bean fermentation for enhanced chocolate flavour

We have won an Innovate UK Agritech Catalyst Colombia grant for this research project, which draws together expertise in genetics and plant sciences, plant microbiomes, genomics technology, FEDECACAO (a federation of cocoa farmers in Colombia), and Luisa's Vegan Chocolates, a bean-to-bar chocolate maker based in Nottingham.

The cocoa market is split into bulk (95%) and fine flavour cocoa (5%). The latter fetches a premium price as, like wine, it has a range of complex tastes, from fruity to floral, to smoky, nutty and woody. It is used by bean-to-bar producers to create chocolate that speaks of the terroir in which it is grown. As the beans fetch a higher price, it improves the farmers' livelihoods.

A key aspect of chocolate making is fermentation. Occurring on the farm, this largely uncontrolled and spontaneous process lasts two to seven days, reducing bitterness and astringency, and stimulating the colour and flavour of the beans. However, quality and taste of the final product can vary. We are working with three female cocoa growers in Colombia, using hand-held DNA sequencers to analyse the microbes that ferment the cocoa beans. Luisa's Vegan Chocolates will transform these beans into chocolate, enabling us to track how this translates into flavour and quality of the end product, improve the chocolate-making process and enhance the livelihoods of the small-scale farmers.



Enhancing pearl millet productivity and marketability in sub-Saharan Africa

Pearl millet is a staple food for approximately 100 million people. 90% of it is grown by smallholder farmers in India, and in parts of northern and southern Africa. The gluten-free grain is high in protein, essential minerals and energy. Yet, increasing amounts of wheat are imported into countries where pearl millet is grown, to meet increasing consumer demand for wheat rather than pearl millet in their diets. This costs governments millions of dollars each year.

A new project, funded by The Global Challenges Research Fund (GCRF), draws together Senegalese and UK expertise in pearl millet, bread, nutrition and brewing science to discover how to add value to this important staple crop to enhance its commercial exploitation. With a specific focus on breadmaking, brewing, and nutritional benefits, the interdisciplinary research team is developing new uses for pearl millet, enhancing its value to both farmers and consumers. The project will promote economic growth in Senegal and the wider region.

By combining forces, this project draws on Senegalese expertise in pearl millet, and the UK's expertise in food and crop science. The project explores processing pearl millet into flours, malting pearl millet (for brewing), profiling seed nutrient content, and understanding pearl millet's possibilities as a novel food. Pearl millet grows well in a wide range of ecological zones and production systems, making it an excellent crop to improve small farmer livelihoods, and help reduce wheat imports in various countries.

Giant swamp taro (Cyrtosperma merkusii)

Rice, one of Indonesia's staple crops, is vulnerable to salinity and therefore cultivation is affected by sea incursions. A new project, funded by a Newton Institutional Link with Indonesia, aims to develop a food production model for giant swamp taro, a little-known but potentially vital crop found in the north Sulawesi region that could provide a new avenue for sustainable, future foods. As it grows in flooded, brackish conditions, it makes an excellent plant to cultivate in areas where the sea is spreading inland and increasing the salinity of the soils.

Giant swamp taro is not currently consumed as a staple crop, as we lack a basic understanding of where and how it grows. This project, led by Dr Sofie Sjögersten, Associate Professor in Environmental Science, and including Future Food Fellow, Dr Guillermina Mendiondo, together with partners in Indonesia led by Dr Jantje Ngangi of Manado State University, will collaborate with farmers to explore the growth habit and environmental tolerance of giant swamp taro. The team will develop cultivation systems that allow the plant to be grown as a sustainable food source, and will examine options for marketable food products.



The Future Food Beacon leadership team

Director of the Beacon and Leadership Chair, David Salt Biosciences

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Matt Loose Life Sciences

Tania Dottorini Veterinary Medicine and Science

Graham Seymour Biosciences

Tim Foster Biosciences

Debbie Sparkes Biosciences

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Tony Pridmore Computer Science

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Beacon executive team



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