University of Nottingham
Future Food

Exploring new ways to feed the world

Future Food

Beacon of Excellence

nottingham.ac.uk/future-food

PICTURED: The University's £6m Centre for Dairy Science Innovation at Sutton Bonington Campus was officially unveiled in May 2018.

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To achieve our Future Food Beacon ambitions, we are investing in both people and technologies.

PICTURED: Professor David E Salt, Director of the Future Food Beacon

Foreword

It has been an extremely busy inaugural year for the Future Food Beacon of Excellence but I am really pleased with the foundations put in place and excited about the excellent research we hope to deliver in the next few years.

We have recruited two world-class group leaders in Professor Murray Lark (Geoinformatics) and Associate Professor Levi Yant (Evolutionary Genomics) and we expect to recruit a third group leader in the coming months. In addition to Murray and Levi, the Future Food Beacon has appointed six fellows through the highly prestigious Nottingham Research Fellowship scheme:

- Dr Guillermina Mendiondo – Crop Molecular Genetics
- Dr Gabriel Castrillo – Plant Microbiome
- Dr Michael Pound – Computer Vision
- Dr Sally Eldeghaidy – Sensory Science
- Dr Sina Fischer – Functional Genomics
- Dr Rahul Bhosale – Crop Functional Genomics

These fellows are the next wave of researchers who I hope will become the new global leaders in their fields. The scientific research they have already produced is excellent with papers in high-ranking journals such as *Nature, Nature Communications, PNAS (Proceedings of the National Academy of Sciences in the USA),* and *Current Biology*.

The final two fellows will be appointed, in Predictive Modelling and Human Nutrition, over the next few months.

I am pleased to welcome Dr Jon Atkinson as the Beacon's technologist specialising in phenomics, who will be managing the new Future Food Beacon makerspace facility to deliver nimble design and build capabilities for the Beacon. Welcome also to Dr Michael Wilson who has joined the Beacon as a technologist in bioinformatics and computational biology hosted within the Advanced Data Analysis Centre (ADAC). We plan to hire a genomics technologist within the next few months, to be hosted within the University's Deep Seq genomics facility.

The recruitment of support staff is crucial to the effective running of the Future Food Beacon and so I am delighted to welcome Simon Ridgway (Head of Operations); Joanna Smuga-Lumatz (Administrator); Dr Lexi Earl (Outreach and Engagement Lead), and Peter Noy (Grant Development Lead), who will be starting in October.

I'm also extremely pleased that we are purchasing cutting-edge equipment to underpin the work of the Beacon, and which is also available to all staff at the University.

We have got off to a running start in our first year with success in both winning grants and publishing high-impact papers. Five grants have been awarded bringing in over £5m, and 62 papers published in prestigious, peer-reviewed journals. Internationally, we are working closely with our colleagues at University of Nottingham Malaysia and University of Nottingham Ningbo China, and are developing strong research networks in China, Brazil and Africa.

On a personal level, I would like to offer my sincerest thanks to everyone who has supported the Future Food Beacon on its journey from inception in December 2016 to the completion of its first successful year of operation, especially Professor Shearer West, Professor Dame Jessica Corner, Professor Kevin Shakesheff, Professor Simon Langley-Evans and the hard working members of the Leadership Team drawn from eight schools across the Faculties of Science, Medicine and Health Sciences, Social Science and Engineering. I would also like to thank Professor Bob Webb for kindly agreeing to chair our External Advisory Board.

Professor David E Salt
Director of the Future Food Beacon

By 2050, there will be an **additional two billion** people on the planet.

The Future Food Beacon is one of six Beacons of Excellence invested in by the University of Nottingham to tackle significant global challenges. The mission of the Future Food Beacon is to deliver world-class research to help address the challenge of providing sufficient quantities of nutritious and palatable food to a growing world population within a changing environment.

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, 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 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.

The Future Food Beacon is targeting six of the major challenges to ensure global food security:

1. **Soil challenges:** reducing soil erosion and improving soil fertility
2. **Water challenges:** improving water conservation through crop resilience and irrigation systems
3. **Production challenges:** maximising yields, stabilising yields in the face of climate uncertainty, minimising waste and improving access
4. **Nutrition challenges:** improving the nutrient density of staple and processed foods
5. **Protein challenge:** providing alternative and palatable proteins for human and animal diets
6. **Climate challenges:** developing robust food systems that are able to cope with climate uncertainty

Future Food Beacon researchers will develop solutions to these challenges, working with practitioners and policymakers, through two key research strategies: improving agricultural resilience, and enhancing nutrition for health and healthy aging.

To achieve these ambitions, we are investing in both people and technologies. New appointments in key areas of informatics, evolutionary and functional genomics, phenomics, geoinformatics, plant microbiome, crop molecular genetics, predictive modelling, computer vision, sensory science and human nutrition will strengthen critical scientific expertise within the University. Pioneering funding schemes, like the Innovation Challenge, have brought together over 160 stakeholders from across multiple disciplines and the commercial sector to generate inventive interdisciplinary research projects addressing our two key research strategy areas.

The Graduate Centre for International Agriculture (GCIA) is a joint initiative between the Future Food Beacon and Rothamsted Research to develop world-leading research in the field of International Agricultural Development. This funds 25 four-year PhD studentships over the five-year period of the Beacon, and contributes to the Lawes Trust International Fellowship scheme which will increase the number of early career researchers from the Global South working in this field.

The Future Food Beacon is capitalising on cutting-edge technologies to enable researchers across a wide array of disciplines to make important scientific leaps. We are investing in increased digital capability, genomics equipment, facilities for animal and plant phenotyping, and new equipment to characterise the nutritional content and physical properties of food. This will best equip our researchers to make ground-breaking scientific discoveries.

With our colleagues at University of Nottingham Ningbo China and University of Nottingham Malaysia we are investing in developing sustainable partnerships in China, Brazil and Africa to build an international platform to allow the Future Food Beacon to truly deliver global impact.

Snapshot of achievements

49 research proposals submitted

7 research proposals awards totalling over **£5m**

37 research proposals awaiting outcome totalling **£30m**

62 papers published since July 2017

21 papers published by new staff who have been appointed through the Beacon

Papers published in journals such as: **Nature Communications, Nature Plants, PLoS Biology**

214 stakeholders directly involved in the Beacon

Recruitment

2 Senior Group Leaders
Murray Lark (Geoinformatics), Levi Yant (Evolutionary Genomics)

6 Nottingham Research Fellows
3 females and 3 males

2 Technologists
supporting phenomics and computational biology

5 PhD Studentships
(joint initiative with Rothamsted Research) from Malawi, Zimbabwe, Ethiopia, Bangladesh, India

20 Positions still to recruit
1 Senior Group Leader
2 research fellows
5 post-doctoral researchers
10 PhD studentships
2 technologists

Equipment

£930,000 spent:
9 pieces of equipment covering: genomic data collection, high throughput phenotyping, and a nutritional analysis handling robot

- Chromium 10X for single cell genomics
- Nanopore GridION for long read sequencing
- BioNano Saphyr optical mapper
- Mosquito Nanolitre liquid handling robot
- ICP-MS with various sample introduction systems, including single-cell
- Laser Ablation Tomography (funded through BBSRC)

£2m still to be purchased
for field scale and high throughput phenotyping

4 Doctoral prizes awarded
£96k
each recipient receives a £24k stipend to fund a 12-month impact fellowship

3 Future Food fellows awarded
£58k
Two senior fellows from Brazil and one early career fellow from Ecuador

6 Innovation proposals awarded
£128k

9 Partnership proposals awarded
£24k

Case study

Mapping global food futures

We have spent the first year striving to create global networks to help imagine new sustainable food futures and the road map to achieve these goals.

We are pleased to welcome Dr Tereza Campello as a Visiting Fellow to the Future Food Beacon for 2018/19. Dr Campello was the Minister of Social Development and Fight against Hunger for the Brazilian Government, from 2011-2016. Dr Campello formulated and coordinated the Brazil without Extreme Poverty Plan, which was created to lift 22 million people out of extreme poverty. She coordinated the Food and Nutrition Security National Policy, which saw Brazil's removal from the UN World Hunger Map in 2014. Dr Campello is the author of *Faces of inequality in Brazil: a look at those left behind*. While in Nottingham she will be working on issues of food justice and equitable development. She was part of the judging panel for the Future Food Innovation Challenge and will continue to participate in Beacon activities during her time with us. Dr Campello is hosted in collaboration with the University's Rights and Justice Research Priority Area co-lead, Dr Karen Salt.

In Brazil, our focus has been to engage the Brazilian Agricultural Research Corporation (EMBRAPA) in a long and sustainably mutual relationship focusing on key research areas that play to the strengths of both the School of Biosciences and the School of Veterinary Medicine. These areas are: soils, animal production, livestock infectious diseases and crop quality. The Future Food Beacon is committed to knowledge exchange with academics in Brazil. To this end in 2018 a team from the School of Biosciences led by Dr Marcos Alcocer delivered a one-week intensive food safety course at the Institute of Food Technology (ITAL) in Campinas, Brazil, as well as a one-day visit to the School of Medicine/Nutrition, the University of São Paulo, Botucatu. Students from the UK and Brazil attended the course, providing an excellent opportunity for networking as well as learning.

> The Future Food Beacon is committed to knowledge exchange with researchers, practitioners and policymakers in Brazil.

This course is now part of the annual curriculum of the three institutions; University of Nottingham, ITAL and Unicamp (University of Campinas).

The Future Food Beacon is developing partnerships with key players in the cocoa industry, building relationships with Fedecacao (National Cocoa Federation) and Casa Luker in Columbia, and the Cocoa Research Centre in Trinidad. We are working with an SME in Nottingham, Luisa's Artisan Chocolates, to connect commercial chocolate makers with chocolate growers in Columbia and other cocoa producing countries. This project aims to develop individual small-holder on-farm processes to optimise cocoa fermentation for improved chocolate flavour and quality. The Future Food Beacon are excited to host David Gopaul, a post-doctoral researcher at the Cocoa Research Centre, University of the West Indies. David's research focuses on mitigating cadmium bioaccumulation in cocoa. His visit to the Future Food Beacon is funded through a Commonwealth Science Conference Follow-on Travel Grant, supported by the Royal Society and the Queen Elizabeth Diamond Jubilee Trust. David will be conducting research while with us, and will be further developing collaborative links between the Future Food Beacon and the Cocoa Research Centre.

The Future Food Beacon has also fostered a relationship with the University's Rights and Justice Research Priority Area, supporting the work of Dr Karen Salt and her colleagues from the Centre for Research in Race and Rights. The Future Food Beacon supported research in Africville, Nova Scotia, in July 2018. Dr Salt and her colleagues were invited to attend the 35th anniversary celebrations of the founding of the Africville Genealogy Society where they were able to continue research begun under an AHRC Networking Grant titled Geographies of Black Protest. A key aspect of this research is food justice, and Dr Salt and her team are actively documenting the past and current food practices and traditions of Africville, in order to redress questions of justice, development and survival within marginalised communities. Their aim is to shift the stories told about communities like Africville to centre on innovation, adaption and knowledge, rather than those regularly told about such communities being spaces of dispossession and abjection.

Case study

International agricultural development

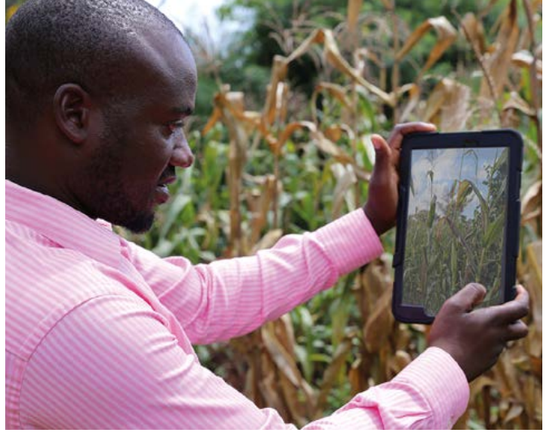
The Future Food Beacon is focused on developing international agricultural research and initiatives, particularly through knowledge exchange.

PICTURED: Researchers in Malawi taking soil and crop samples as part of the GeoNutrition project.

We have built a relationship with Rothamsted Research to support doctoral training in agriculture and biosciences, led by Professor Martin Broadley, and specifically aimed at building research capacity in the Global South. Known as the Graduate Centre for International Agriculture, PhD candidates spend two years at Nottingham or Rothamsted, and two years at partner universities such as those in Ethiopia, Malawi, Zimbabwe, Bangladesh and India, focusing on issues in International Agricultural Development. The Future Food Beacon has also developed a Rothamsted International – University of Nottingham Fellowship scheme to support early-career researchers. This scheme will support four fellows per year, for fellowships up to 12 months. Fellows will work with supervisors at Nottingham and Rothamsted to co-develop projects. The scheme further promotes the exchange of vital agricultural research skills between the UK and scientists from low- and middle-income countries.

The Future Food Beacon has welcomed Professor Murray Lark to the team, as Professor of Geoinformatics. Professor Lark brings soil science expertise to the Beacon, as well as experience of working in Zambia, Malawi and Zimbabwe. His current UKRI GCRF grant examines conservation agriculture in three sites in those countries, designing strategies for crop management. The project focuses on building research capacity and partnerships in the three countries, so that findings from the project can be integrated into practice where they will be most useful. Professor Lark is passionate about ensuring research findings are taken up 'in the field' so that cutting-edge research can be used by farmers and others working in agriculture. He therefore focuses his energy on ensuring research findings and statistics can be communicated in a way that they can be understood by people at the source. Professor Lark joins us from the British Geological Survey.

We are also working with Professor Martin Broadley, Professor of Plant Science at the University of Nottingham. Martin was the recipient of a £4.4m Bill and Melinda Gates Foundation grant for the GeoNutrition project. Working with project partners – including University of Nottingham, Lilongwe University of Agriculture and Natural Resources, Addis Ababa University, governments in Malawi and Ethiopia, the International Maize and Wheat



PICTURED: Cuthbert Mambo, a member of the GeoNutrition research team in Malawi.

Improvement Centre, the International Crops Research Institute for the Semi-Arid Topics, the World Agroforestry Centre, Rothamsted Research, London School of Hygiene and Tropical Medicine, and the British Geological Survey – Professor Broadley aims to help alleviate the problem of hidden hunger in Malawi. Mapping the country through crop and soil samples from some 2,000 farms, the project will identify nutrient deficiencies in the soil, and thus the crops. Such deficiencies put children at particular risk of infection and developmental problems.

The project is interdisciplinary, using research expertise from people such as Dr Kate Millar of the Centre for Applied Bioethics, to examine the ethical and socio-economic issues of adding minerals to the food chain via fertilisers or enriched food. The knowledge gained in Malawi will be used to inform geospatial mapping in Ethiopia and has the potential to influence public health interventions across the region.

Key to the project's design is the development and support of PhD candidates within sub-Saharan Africa. Investment is focused on training, including technical specialists and equipment. Sub-Saharan Africa is at the epicentre of the global challenge for nutritious food for growing populations and thus training agricultural scientists in the region is key to overcoming these challenges.

Our growing Future Food Beacon team

Professor David E Salt
Director of Future Food Beacon
Professor of Genome Enabled Biology

Professor Murray Lark
Future Food Beacon
Professor of Geoinformatics

Associate Professor Levi Yant
Future Food Beacon
Associate Professor in Evolutionary Genomics

Dr Jon Atkinson
Senior Research Fellow and Technologist in Phenomics

Dr Mike Wilson
Senior Research Fellow and Technologist in Computational Biology

Dr Michael Pound
Nottingham Research Fellow in Computer Vision

Dr Guillermina Mendiondo
Nottingham Research Fellow in Crop Molecular Genetics

Dr Rahul Bhosale
Nottingham Research Fellow in Crop Functional Genomics

Dr Sina Fischer
Nottingham Research Fellow in Functional Genomics

Dr Sally Eldeghaidy
Nottingham Research Fellow in Sensory Science

Dr Gabriel Castrillo
Nottingham Research Fellow in the Plant Microbiome

Simon Ridgway
Future Food Beacon
Head of Operations

Dr Lexi Earl
Future Food Beacon Outreach and Engagement Manager

Joanna Smuga-Lumatz
Future Food Beacon
Administrative Assistant

The Future Food Beacon Leadership team

Chair, David E Salt
Biosciences

Richard Emes
Veterinary Medicine and Science

Matt Loose
Life Sciences

Tania Dottorini
Veterinary Medicine and Science

Graham Seymour
Biosciences

Tim Foster
Biosciences

Debbie Sparkes
Biosciences

Malcolm Bennett
Biosciences

Kate Millar
Biosciences

Andy Salter
Biosciences

Tony Pridmore
Computer Science

Markus Owen
Mathematical Sciences

Darren Wells
Biosciences

Martin Broadley
Biosciences

Richard Hyde
Law

Ramiro Alberio
Biosciences

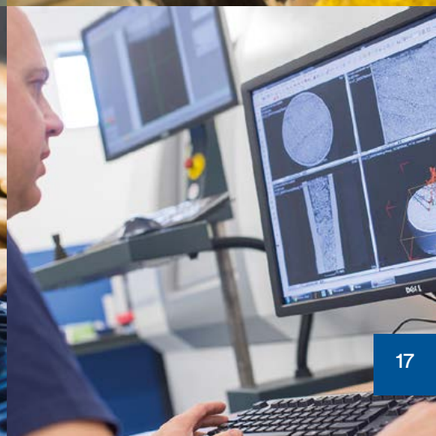
Anne Touboulic
Business School

Serafim Bakalis
Chemical and Environmental Engineering







Case study

Safe and healthy food supplies for China

A key focus area for the Future Food Beacon is collaboration with China. The University of Nottingham already has an established campus at Ningbo, and we are working to expand influence in the region, while ensuring a safe and healthy food supply for China.

Chinese agriculture needs to provide sufficient cereals, vegetables and fruits for its population, while also providing grain for livestock to meet growing demand for meat. Foods should be nutritious and free from harmful heavy metals. However, much of Chinese arable land has been polluted by heavy metals and although the Chinese government has attempted remediation of the soils, there is still risk of heavy metals in the food chain.

The main staple crop in China is rice, which contains low mineral nutrients. As such there is a real problem with hidden hunger in China. Chinese agriculture is further hampered by drought, causing crop losses of 10 million tons and salinization of soils. The UK has a long track record of excellence in research programmes focused on heavy metal accumulation and mineral nutrient homeostatis. In September 2018, the Future Food Beacon, in collaboration with colleagues from Nanjing Agricultural University, and Shanghai Institute of Plant Physiology and Ecology, held a workshop in Shanghai, bringing together 35 early career researchers from the UK and China to work on innovations in food, and food for healthy societies.

The workshop introduced early career researchers to mentors who are notable names in the agricultural/food fields, and provided opportunities for networking and initiating working relationships. This will develop an interdisciplinary network of UK-China researchers for a post-Brexit future. Mentors provided inspirational case studies of their own research and acted as guides to best practice at keynote lectures and masterclasses that focused on content and processes of research. Following the workshop, researchers had opportunities to share current research projects, and to work on new ideas for ethical and equitable solutions to global challenges in order to leverage their expertise into large multi-investigator projects. In the long term, these researchers will work on projects to increase the adaptive capacity of rice production systems to enable high, resilient, crop yields, and improving food security and food for health in the region. The workshop was funded through the British Council Research Links programme, the Newton Fund and the National Natural Science Foundation of China.

PICTURED: Future Food is helping address hidden hunger in China. The staple crop rice is low in nutrients and yields are also hampered by drought. Images ©iStock.

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