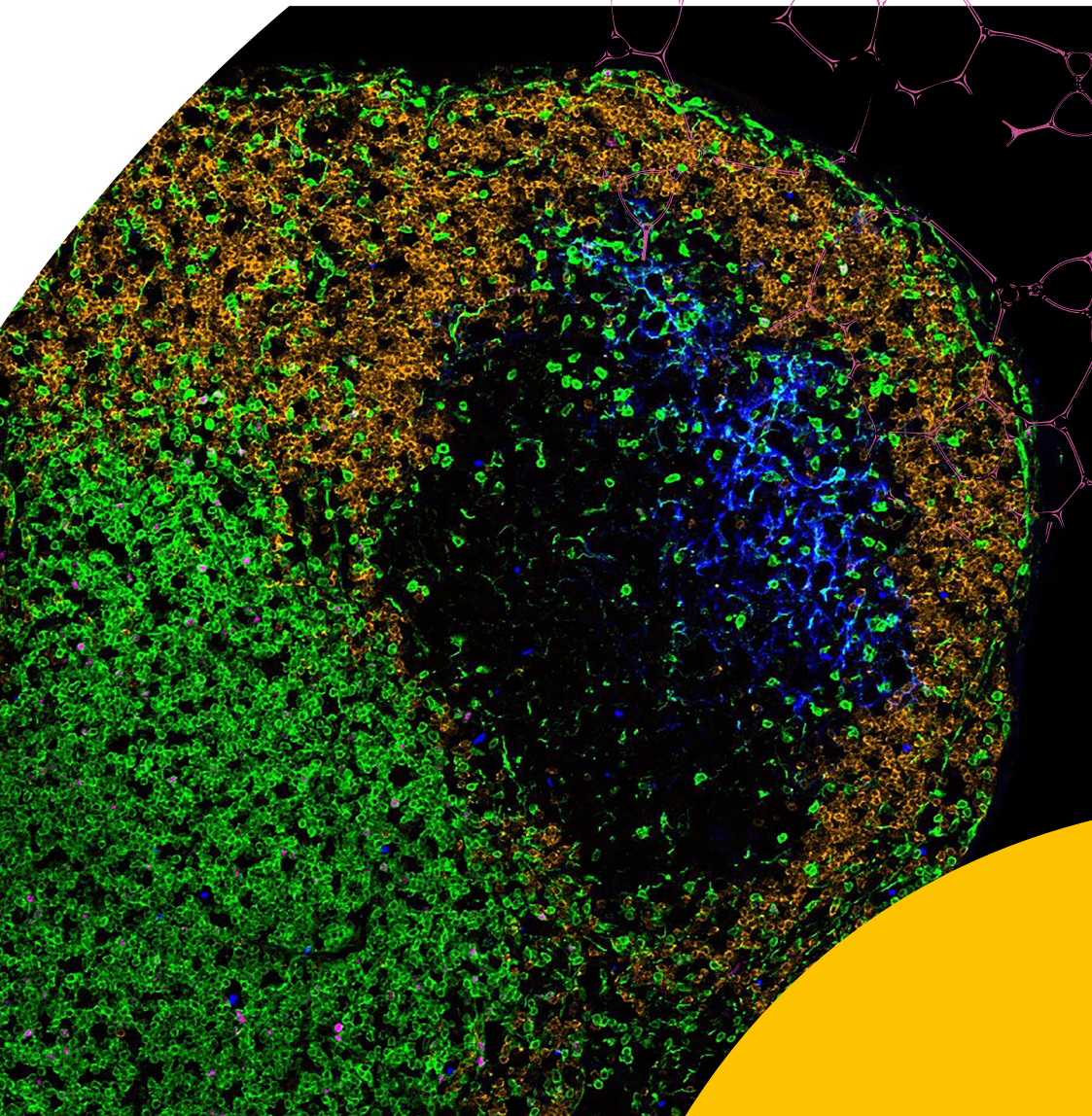
Biotechnology and Biological Sciences Research Council

Impact Showcase 2020

BBSRC's impact in the biosciences



Investing in world-class bioscience

BBSRC's investments help bioscience to deliver world-class outputs, outcomes and impacts to society and the economy. Each year, BBSRC's investments in research and innovation total over **£330m**, spanning the themes set out in our Forward Look for UK Bioscience:

66%
of investment addresses one or more strategic challenge:

Bioscience for sustainable agriculture and food
Delivering more productive, healthy, resilient and sustainable agriculture and food systems.

Bioscience for renewable resources and clean growth
Transforming industries through bio-based processes and products in a new low-carbon bioeconomy.

Bioscience for an integrated understanding of health
Improving animal and human health and wellbeing across the lifecourse.

34%
of investment relates to understanding the rules of life:

Understanding the rules of life
Promoting creative, curiosity-driven frontier bioscience to address fundamental questions in biology.

19%
of investment relates to transformative technologies, which cuts across the whole remit:

Transformative technologies
Developing the tools, technologies and approaches that enable researchers to push the boundaries of scientific discovery and stimulate innovation

High-level key themes:	Tackling strategic challenges	Advancing the frontiers of bioscience discovery

Cover image credit: Sigrid Fra-Bidó

Executive Chair's foreword

Enabling and supporting impact is one of the top priorities for UKRI, as outlined in the UKRI Strategic Prospectus which sets out UKRI's commitment to further developing the UK's knowledge-driven economy.

The power of biology impacts all of our lives and this publication aims to provide you with a flavour of just some of the many and varied impacts arising from BBSRC investments in world-leading research and innovation.

Impact can arise from everything BBSRC invests in, including research addressing our strategic challenges, the curiosity-driven frontier bioscience which helps us to understand the rules of life, and the development of transformative technologies that push the boundaries of scientific discovery.

The variety of impacts that we see is testament to the determination of our community to realise the benefits of their research. As part of UKRI, BBSRC plays an important role in enabling researchers to partner with businesses and other stakeholders, supporting the translation of research into tangible impacts for the economy and society.

Professor Melanie Welham
Executive Chair, UKRI-BBSRC
August 2020

Addendum: During the Coronavirus pandemic, BBSRC-funded bioscience is playing a major role in helping the UK and other countries respond to the challenges. Our impact on this life-saving work will be the focus of future publications and reports.

Smooth sailing thanks to biofilm research

A new device for studying slime growth is accelerating the research and design of ship hull coatings.

Biofilms are sticky layers of microorganisms, which form slimy coatings on wet surfaces such as ship hulls. They cost the shipping industry and naval fleets billions of pounds each year in cleaning costs and extra fuel due to increased drag.

Researchers at International Paint Ltd and the University of Southampton developed a device to help understand the drag caused by biofilm growth on ship hulls, using funding from BBSRC and Innovate UK. The marine biofilm flow cell is used to see how different surface coatings, such as antifouling paint, affect how biofilms grow and cause drag.

The flow cell is being used by International Paint Ltd, part of AkzoNobel, to speed up the testing of new antifouling coatings for ship hulls.

Image credit: Dirk Dallas, Flickr

The sweet spot for apple storage

A system to reduce spoilage during long-term apple storage could save the fresh produce industry £6 million per year. After harvest, apples are kept in controlled atmosphere stores for up to 12 months. Low temperature, low oxygen and high CO_2 stop them over-ripening, but they can also spoil with insufficient oxygen.

The SafePod system, built by Storage Control Systems with scientific support from the University of Greenwich's Natural Resources Institute, finds the perfect storage conditions by monitoring apples' respiration during storage. It detects if the apples become stressed and require more oxygen, and indicates when they have reached the end of their storage life. This reduces waste via spoilage and allows apples, and potentially a range of other fresh produce, to be stored for longer.

SafePod was developed using AgriTech Catalyst funding in collaboration with Sainsbury's PLC, AC Goatham & Sons and Avalon Produce Ltd, and is now being trialled by apple growers in the UK and North America, with more than 200 units sold or leased in 2019.

Bioplastics from paper waste

BBSRC funding has enabled the production of bioplastics from lignin, a structural material in plants and a by-product of paper pulp production. The building blocks of lignin have a range of potential uses. However, lignin itself is difficult and expensive to break down, so waste lignin is usually burned as fuel.

Professor Timothy Bugg at the University of Warwick used a BBSRC Integrating Biorefining Research and Technology Club grant to identify a bacterial enzyme which breaks down lignin without using high temperatures and acid.

The research led to a collaboration with bioplastic developers Biome Bioplastics to turn the extracted chemicals into bioplastics. The team are now demonstrating that the process works on a commercial scale for sustainable bioplastics production.

Image credit: Getty Images

The Fruit Fly Brain Observatory

A virtual fruit fly brain is helping researchers and students understand brain function and disease. The Fruit Fly Brain Observatory is an open software platform that enables researchers around the world to build, simulate and visualise a virtual model of the fruit fly brain.

Funded by BBSRC and the National Science Foundation in the US, the software was developed by researchers at the University of Sheffield and Columbia University, New York, with support from NVIDIA, the company that pioneered GPU computing.

The fruit fly *Drosophila melanogaster* is one of the most popular organisms to study neural computation and the relationship between brain structure and function. The fruit fly brain has just 135,000 neurons, compared to around 86 billion in the human brain, and poses a far less formidable computational challenge.

Many genes and proteins in the human brain are also found in the fruit fly brain, so the virtual fruit fly brain can help improve understanding of diseases such as Parkinson's or motor neurone disease as well as help identify potential new drug targets.

Image credit: Oregon Department of Agriculture, Flickr

Improved food safety through policy change

Food safety advice from BBSRC-funded research has informed international laws on acrylamide.

Acrylamide is a probable carcinogen which forms in foods made from potatoes, cereals and beans (including coffee) when they are cooked at temperatures over 120˚C.

Professor Nigel Halford and Dr Tanya Curtis at Rothamsted Research, an institute strategically funded by BBSRC, used a series of BBSRC grants to study acrylamide formation. The research involved industry collaborations including with Kellogg's, Nestlé and Tesco, and informed the European Commission's regulations for acceptable levels of acrylamide in food and practices for reducing acrylamide formation

A BBSRC Follow-on Fund Pathfinder award supported the establishment of start-up company Curtis Analytics Ltd in 2017, enabling Curtis' transition from researcher to company director. The company now employs seven people and provides an asparagine testing service for food manufacturers to ensure their products meet food safety standards.

Images credit: Curtis Analytics

2002
Year acrylamide was first reported in cooked foods

120˚c
Cooking temperature over which acrylamide forms

£1.3m
BBSRC funding awarded to Halford's team, including LINK and Follow-on funding

2017
Year start-up company Curtis Analytics was established

> **Without BBSRC I don't think I would have achieved any of this. It's been vital for the existence of Curtis Analytics.**
>
> Dr Tanya Curtis

From PhD student to company director

Dr Tanya Curtis has been supported by BBSRC since her days as a PhD student. She started researching acrylamide in 2006, with Professor Nigel Halford at Rothamsted Research and Professor Donald Mottram at the University of Reading on a HGCA*/BBSRC-funded studentship. She continued in Halford's team as a postdoctoral researcher on his BBSRC LINK project studying the acrylamide-forming potential of wheat.

BBSRC Pathfinder funding helped Curtis establish start-up company Curtis Analytics in 2017 to help food manufacturers reduce acrylamide in their products.

*Home-Grown Cereals Authority, now AHDB

The Healthspan Machine: Using worms to tackle ageing

Researchers at Durham University are using worms to unlock the secrets of ageing. They discovered that worms wriggle less with age, and have harnessed this knowledge to start a spin-out company that tests the effectiveness of healthy ageing compounds.

Caenorhabditis elegans is a simple nematode worm which lives for a few weeks and is a model organism used to study ageing. Using BBSRC Responsive Mode funding, Dr David Weinkove found that feeding *C. elegans* different mutants of the bacteria *E. coli* could significantly alter the worms' lifespan. For example, worms fed on bacteria which produced less folate both lived and kept moving for longer, indicating that they were remaining healthier for longer; a concept known as healthspan. This discovery, that gut microbial activity influences ageing, means that researchers could develop therapeutic compounds to target human gut microbes and reduce the effects of ageing.

Supported by the BBSRC Tools and Resources Development Fund, Weinkove's team then developed an automated method to monitor worm movement over time. By looking at movement rather than at lifespan, the 'Healthspan Machine' can be used to test compounds that promote healthier ageing, not just a longer life. This led to the establishment of spin-out company Magnitude Biosciences in 2018, who use their worm-based technology to provide contract research services, including testing compounds which could help keep people healthier for longer.

1,000
Number of *E. coli* mutants used to test anti-ageing effects in worms

£375k
Total value of private investment received by Magnitude Biosciences

2018
Year Magnitude Biosciences was founded

6
Number of people employed by Magnitude Biosciences

Images credit: Getty Images

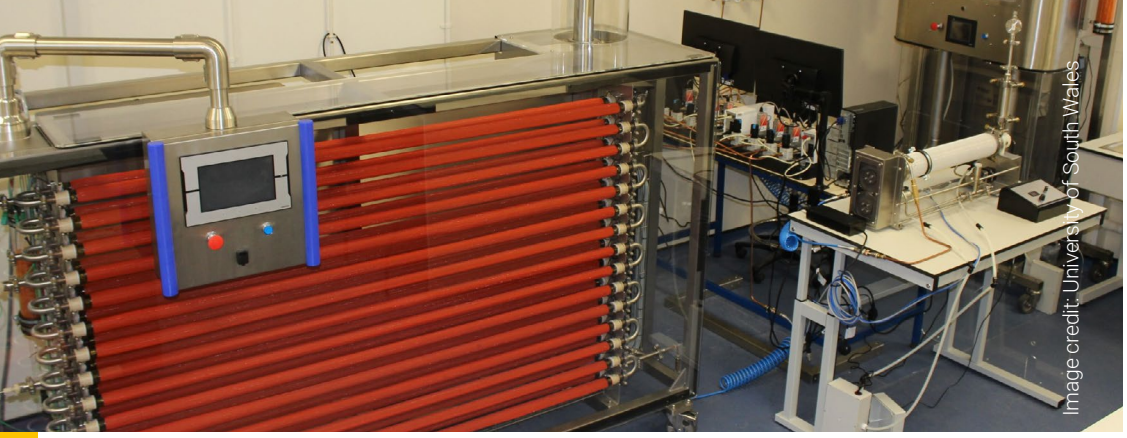


Image credit: University of South Wales

Green energy from industrial waste gases

BBSRC has supported research to manufacture sustainable fuels from industrial waste gases, reducing emissions and enabling renewable energy storage in the gas grid, which could be used for power, heat or as transport fuel.

Researchers at the University of South Wales developed a gas conversion technology using microbes, which they improved using BBSRC funding to develop a new bioreactor system, which turns H_2 gas and waste CO_2 into low carbon methane and carboxylic acids. Professor Sandra Esteves and her team collaborated with reactor specialists NiTech Solutions to develop the more efficient energy conversion system. The new bioreactor application has enabled NiTech to secure increased investment and hire more staff.

The collaboration was established using Industrial Biotechnology Catalyst funding from BBSRC and Innovate UK. The research has led to further technology developments targeting the production of alkane gases, carboxylic acids and biopolymers, supported by BEIS, Welsh Government and BBSRC, with further support from project partners TATA Steel, Wales & West Utilities and Flogas Britain.

> **The ability to biologically produce green methane from renewable hydrogen and excess carbon dioxide has the potential to make a step change in the way energy grids across the world are operated.**
>
> Professor Sandra Esteves, University of South Wales

New bio-inspired materials created using bacteria

Researchers are using an innovative synthetic biology approach to produce entirely new peptide-based materials. The team were inspired to create bio-based adhesives by marine mussels' ability to cling to rocks.

The new technology, called Zentide, uses bacteria to produce peptides. Zentide's unique selling point is its ability to build peptides without the limitations of chemical methods, meaning researchers can produce difficult peptides at a lower economic and environmental cost.

Zentide was engineered by researchers from BrisSynBio, the University of Bristol's Synthetic Biology Research Centre, using Industrial Biotechnology Catalyst funding from BBSRC and Innovate UK. Early products included an adhesive for the Defence Science and Technology Laboratory, and the team are now creating surgical and dressing adhesives for healthcare.

Further BBSRC funding supported commercialisation of the technology, leading to the establishment of spin-out company Zentraxa in 2017. Zentraxa have since secured a total of £500k private investment.

£208k
Investment from BBSRC and Innovate UK

98%
Reduction in environmentally-damaging waste products compared to existing methods

£500k
Private investment received by Zentraxa

Image credit: Andreas Trepte

MARPLE: the real-time cereal killer detective

Researchers led by Dr Diane Saunders at the John Innes Centre have created an advanced plant disease diagnosis system to help protect Ethiopia's wheat crops from wheat yellow rust fungus.

The portable device, called MARPLE (Mobile and Real-time PLant disEase) diagnostics, uses a new technique called field pathogenomics to detect which strain of the fungus pathogen is infecting a wheat crop. It yields results in just two days, so users can make fast decisions to control the disease and protect harvests.

The MARPLE kit is designed for use in the field – it fits in a suitcase and does not need any additional laboratory equipment. Previously, infected samples were sent to specialist labs for testing, which took many months.

Ethiopia is sub-Saharan Africa's largest wheat producer and is considered a gateway for new rust pathogen strains entering from Asia. In 2019, Dr Diane Saunders won the BBSRC Innovator of the Year Award for International Impact in recognition of MARPLE's impact.

2

Number of days MARPLE takes to diagnose the pathogen strain infecting a crop

5

Number of research hubs in Ethiopia using the MARPLE kit

10-70%

Proportion of wheat yield which may be lost due to yellow rust

"It's such a revolutionary technology. In Ethiopia we've now got one of the most advanced [crop] disease forecasting systems anywhere in the world."

Collaborator Dr Dave Hodson, The International Maize and Wheat Improvement Center.

Images credit: Matt Heaton, JIC

MARPLE's unique portability is thanks to the team's decision to use a minION nanopore sequencer to carry out their field pathogenomics technique. The minION sequencer is a portable, rapid DNA sequencer which plugs into a desktop computer. It was developed by Oxford Nanopore Technologies, a spinout company that benefitted from BBSRC investment.

Oxford Nanopore Technologies' while-you-wait sequencing has revolutionised how DNA sequencing is performed, opening it up to new environments and applications. The minION sequencer had previously been used for small viral genomes, so using it for large, complex fungal genomes was a major scientific breakthrough for the MARPLE team.

Finding the source of bovine TB on farms

BBSRC-funded researchers are working with Defra and UK farmers to identify sources of bovine tuberculosis (bTB) on farms. Earlier research found that cattle can catch bTB from badgers, and vice versa. However badgers rarely come close enough to cattle to transfer the disease directly, so how do they pass it on to cattle?

Using advanced DNA sequencing techniques developed during the project to detect the pathogen, the researchers, led by Professor Elizabeth Wellington at the University of Warwick, studied 20 farms in Cornwall where bTB was present. They found that bTB could survive in the farm environment. In particular, the bacteria were present in badger and cattle faeces, as well as in manure, slurry and water troughs. These are a previously unrecognised source of the disease, which can cost the UK £70m per year.

Wellington and team are now working on a field or penside test to detect the bovine TB pathogen to help farmers protect their herds.

£34k

Average cost of controlling a bovine TB outbreak on a farm

10,000

Number of samples processed during the project

£938k

Value of BBSRC funding for the research

Image credit: Marc Pell, Unsplash

Image credit: Susan Elizabeth, Flickr

Soil microbe research influences crop growing practices

Research into the impacts of soil surface microbes on agricultural soils has informed practices for growers associated with UK supermarket Waitrose.

Researchers at Cranfield University, the University of Nottingham and Swansea University used funding from BBSRC, NERC and Defra to develop a new method based on CT scanning to visualise and measure the structure of the top 1-2mm of arable soil. This helped them understand how rainfall and microbes interact to affect the formation of soil crusts. They found that microbes play a major role in soil structural dynamics in this surface zone, especially affecting water filtration, soil erosion and seedling emergence.

Growers in the Waitrose Agronomy Group are using this information to adapt their soil management practices to minimise soil disturbance and encourage surface microbiota development, leading to better quality soils and improved growing success. Much other research is also showing that minimising physical disturbance to soils via no-till or reduced till practices has additional benefits to soil health.

95%

Proportion of our food directly or indirectly produced from soils

1-2mm

Depth of soil surface studied with the new method

1bn

Number of microbial cells per typical teaspoon of topsoil

£385k

Value of BBSRC Responsive Mode investment for the project

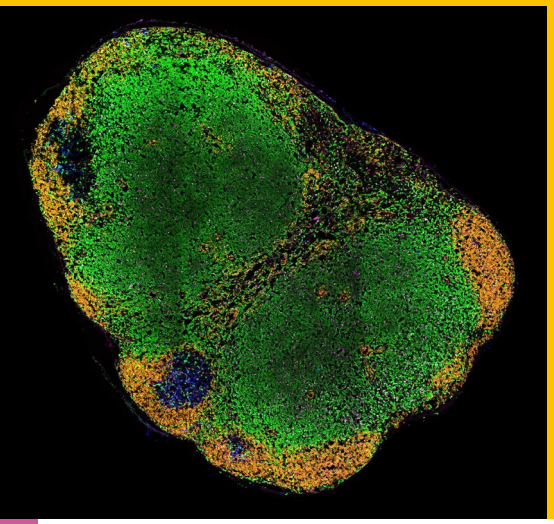
Boosting immune response to vaccines in older people

Immunology researchers at the Babraham Institute, which is strategically funded by BBSRC, have made important progress in tackling ageing of the immune system. The research could help to tailor vaccines for older people.

As we age, deterioration in our immune system makes us more susceptible to infection and less able to develop protective immunity after vaccination. With an ageing population, finding ways to improve vaccine efficacy in older people is an important global challenge.

Research led by Dr Michelle Linterman found older mice and humans have problems with two specialised immune cells essential to the immune response and antibody production. However, they found that applying an existing topical antiviral cream to the vaccination site boosted the number and fixed defects in those immune cells in mice.

This is an encouraging indication that age-related defects in the immune system are not irreversible, opening up possibilities for new vaccine formulations to improve vaccine responses in older people.



“Older members of our families and communities are at higher risk of serious illness from infectious diseases, so it is imperative that we understand how their immune system works and explore how we might be able to boost their immune responses to vaccines.”

Dr Michelle Linterman,
The Babraham Institute.

Image above: The formation of germinal centres, which produce antibody-secreting cells, in a lymph node in response to vaccination. This process is impaired in older mice. Image credit: Sigrid Fra-Bidó

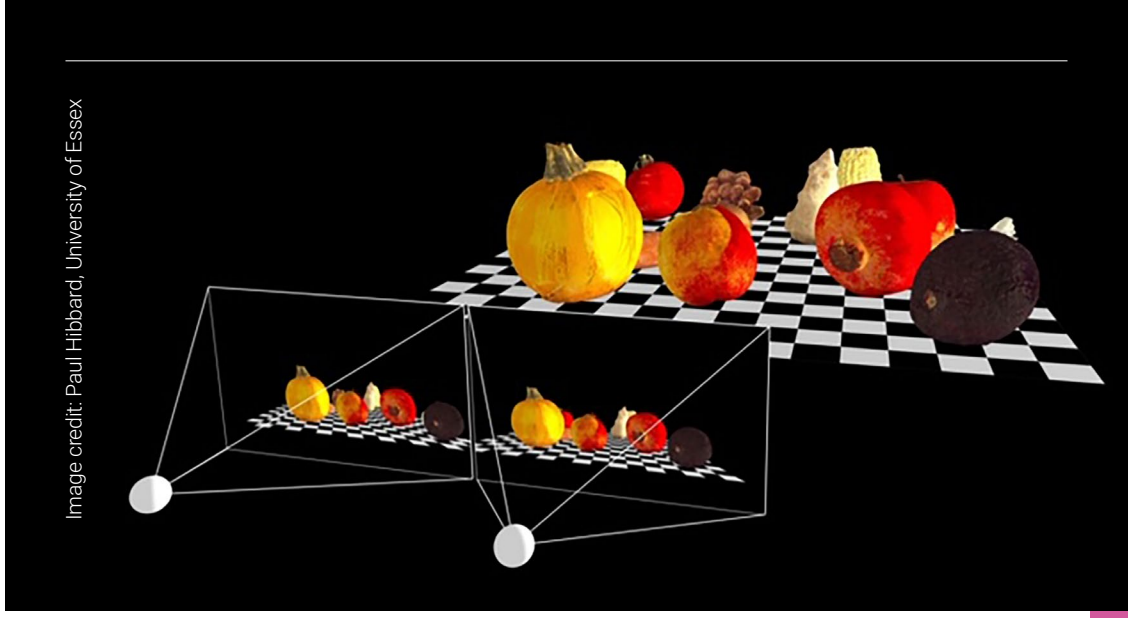


Image credit: Paul Hibbard, University of Essex

Virtual reality technology aided by binocular vision research

BBSRC-funded researchers at the University of Essex are collaborating with researchers at Facebook Reality Labs to study how people judge distance, which will help researchers develop and refine virtual reality technology.

The collaboration builds on research supported by BBSRC to understand how our brains learn to perceive the world in three dimensions. The secret to seeing 3D is the slightly different view seen by each of our eyes, known as binocular vision. The team used a 3D laser scanner to create images of everyday objects, which were shown to participants and used to understand which factors contribute most to our ability to perceive objects in 3D.

The team won one of just three awards from Facebook for vision research. The Facebook collaboration also led to the researchers' involvement in the creation of a VR experience to accompany a play, The Mystery of the Raddlesham Mumps, based on a poem by BBC poet-in-residence Murray Lachlan Young.

“Participating in collaborative projects with industry gives our research real-world application and impact.”

Emma Wakeling, Knowledge Exchange Manager at the University of Essex.

Machine learning saves gardeners' plants from pests

A service which predicts the arrival of insect pests is helping gardeners to protect their produce and reduce chemical pesticide use.

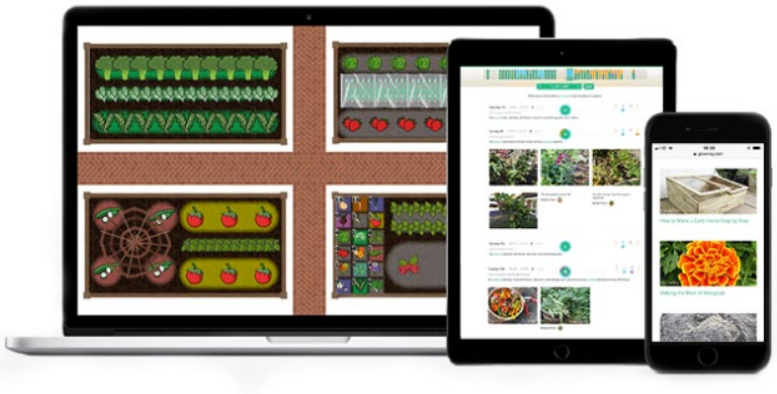
Gardening app developer Growing Interactive creates innovative gardening apps to help home-growers plan and grow edible crops, ornamental plants and annual flowers. They have incorporated a new pest prediction feature into their existing Garden Planner app and anticipate a 33-43% increase in revenue thanks to increased subscriptions.

The predictive model of insect migrations underpinning the service was developed by Dr Daniel Kudenko and colleagues at the University of York, using geographical and temporal data from the Rothamsted Insect Survey (RIS) and large-scale citizen science project The Big Bug Hunt founded by Growing Interactive. Using this model, the pest prediction service alerts users of predicted outbreaks, so gardeners have time to implement biological control measures in advance.

Rothamsted Insect Survey

Established in 1964, the Rothamsted Insect Survey is a series of insect traps across the UK. The traps attract and capture insects, which are counted and released daily, creating the world's most extensive long-term dataset of insect populations and migration over time. The RIS has catalogued more than 30m insects across the UK – information used by farmers and ecologists alike.

Since 2012, RIS has been funded as a BBSRC National Capability – an institute-based resource intended to benefit the wider scientific community. It provides a unique repository of data and expertise that can be used by scientists in the UK and across the world.



"We have been delighted with the enthusiastic response from gardeners around the world, and the partnership with the University of York through BBSRC and Innovate UK has enabled us to make the most of this extensive data."

Jeremy Dore,
founder, Growing Interactive.

Images credit: GrowVeg.co.uk

86%
Average prediction accuracy of aphid movements by the predictive model

£200k
Value of investment from BBSRC and Innovate UK

33-43%
Anticipated increase in revenue for Growing Interactive

About BBSRC

The Biotechnology and Biological Sciences Research Council (BBSRC) is part of UK Research and Innovation (UKRI), a non-departmental public body funded by a grant-in-aid from the UK government.

BBSRC invests in world-class bioscience research and training on behalf of the UK public. Our aim is to further scientific knowledge, to promote economic growth, wealth and job creation and to improve quality of life in the UK and beyond.

BBSRC invests over £450 million in world-class bioscience each year. We support research and training in universities and strategically funded institutes. BBSRC research and the people we fund are helping society to meet major challenges, including food security, green energy and healthier, longer lives. Our investments underpin important UK economic sectors, such as farming, food, industrial biotechnology and pharmaceuticals.