Plant Microbiome Webinar
11 April 2024
09:30-11:15
Welcome

• Please put any questions in the Q&A box

• Use the chat box to network and for any technical difficulties

Pedro Carvalho
Plants and Crops
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<table>
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<tr>
<th>Time</th>
<th>Event/AGENDA</th>
<th>Speaker/Institution</th>
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<tr>
<td>9:30</td>
<td>Introduction to the Event</td>
<td>Pedro Carvalho, IUK Business Connect</td>
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<tr>
<td>9:40</td>
<td>IUK Business Connect Microbiome Innovation Advisory Group (MIAG)</td>
<td>Andrew Morgan, IUK Business Connect MIAG Chair and Professor in Practice at the University of Exeter</td>
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<tr>
<td>9:50</td>
<td>The Importance of Microbes for Sustainable Crop Production</td>
<td>Sharon Zytynska, BBSRC David Phillips Research Fellow at the University of Liverpool</td>
</tr>
<tr>
<td>10:05</td>
<td>Microbial Discovery Platform for biofungicides and biostimulants</td>
<td>Vijayalakshmi Gunasekaran, R&amp;D Lead at FA Bio</td>
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<tr>
<td>10:20</td>
<td>Guided Biotics® for Crop Health &amp; Nutrition</td>
<td>Jason Vincent, Chief Development Officer – AgTech at FOLIUM Science (Flourish is a FOLIUM Science business)</td>
</tr>
<tr>
<td>10:35</td>
<td>Microbiome engineering via M genes</td>
<td>Tomislav Cernava, Assoc Professor in Plant-Microbe Interactions at the University of Southampton</td>
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<tr>
<td>10:50</td>
<td>Q &amp; A</td>
<td>Gabriela Juárez Martínez and Caroline Griffin, IUK Business Connect</td>
</tr>
<tr>
<td>11:05</td>
<td>Funding Opportunities and Close</td>
<td>Pedro Carvalho, IUK Business Connect</td>
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About Us

Innovate UK Business Connect exists to connect innovators with new partners and new opportunities beyond their existing thinking – accelerating ambitious ideas into real-world solutions.
We have deep expertise in AgriFood

Livestock & Aquaculture

Plants and Crops

Food & Drinks
How we can help

- Make powerful connections
- Secure funding
- Get expert insight
- Keep up to date
IUK Business Connect
Microbiome
Innovation Advisory Group (MIAG)

Dr Andrew Morgan
IUK Business Connect MIAG Chair and
Professor in Practice at the University of Exeter
IUK Business Connect
Microbiome Innovation Advisory Group (MIAG)

Dr Andrew Morgan, Chair

April 2024
VISION:
UK to be recognised as a world leader in microbiome research and innovation.

GOALS:
- Developing a proactive, self-sustaining microbiome community
- Raising the visibility of the UK’s world leading microbiome science
- Enabling microbiome innovation: entrepreneurs, start-ups, scale-ups & industry partnerships
- Enhancing access to and investment in UK microbiome science & innovation

https://iuk.ktn-uk.org/agrifood/microbiome/
IUK Business Connect MIAG – *outputs so far…*

**WEBINARS**

**Microbiome Landscape Map**

**Microbiome One-Health Conference**
Glasgow  
23 & 24 March 2023

**Human Intestinal Microbiome Therapies and Diagnostics**
The Science, Opportunities and Challenges
The Importance of Microbes for Sustainable Crop Production

Dr Sharon Zytynska
BBSRC David Phillips Research Fellow at the University of Liverpool
The Importance of Microbes for Sustainable Crop Production

Dr Sharon Zytynska
BBSRC David Phillips Fellow, Lecturer
Dept of Evolution, Ecology, and Behaviour

@SZytynska
Rhizosphere microbes for crop protection

Trivedi et al. (2020) Nat Rev Microbiol 18:607

Rhizosphere bacteria can increase crop yields

Li et al (2022) J Sust Agri Environ 1:216

7 meta-analyses on plant effects (2017-2023)


microbe

crop

Yield

location

greenhouse (n=45)
field (n=66)

P=0.7909

30.42%
33.51%

wheat (n=36)
vegetable (n=15)
maize (n=16)
legume (n=14)
fruit (n=8)
P<0.0001

27.53%
68.93%
22.5%
58.06%
36.87%

Serratia sp. (n=8)
Pseudomonas sp. (n=21)
Mesorhizobium sp. (n=7)
Enterobacter sp. (n=13)
Bacillus sp. (n=32)
Acinetobacter sp. (n=8)
P<0.006

14.25%
49.94%
15.73%
27.55%
25.66%

Effect size

0.0
0.3
0.6
0.9
1.2

microbe–assisted
conventional

Agrochemical inputs

@SZytynska
Insects as crop pests

Intensive farming, monocultures, low-diverse crops
= perfect insect feeding conditions

Overuse of chemical pesticides:
- pesticide resistance / resurgence of insect pests
- elimination / disruption of the food web
- environmental toxicity
- eventual reduced yields
Microbial inoculation of plants on insects

(a) Chewing insect traits
- attractance
- feeding
- survival
- development
- body size
- fecundity
- lifespan

(b) Insect family
- Chrysomelidae
- Lepidoptera Spodoptera
- Lepidoptera Plutella
- Lepidoptera Other

(c) Host plant family
- Brassicaceae
- Poaceae

Microbial inoculation effect on insect traits (hedges g)

Bacillus spp
Pseudomonas spp
Others
Microbial inoculation of plants on insects

(a) Chewing insect traits
- Attractance
- Feeding
- Survival
- Development
- Body size
- Fecundity
- Lifespan

(b) Insect family
- Chrysomelidae
- Lepidoptera Spodoptera
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- Lepidoptera Other

(c) Host plant family
- Brassicae
- Poaceae

Rhizobacterial inoculation effect on insect traits (hedges g)

@SZytynska

Zytynska, Parker, Sanchez-Mahecha (in prep)
**Acidovorax radicis N35** — Betaproteobacteria, Comamonadaceae

First isolated from wheat roots in 2011, promotes root growth of wheat and barley

Colonises barley plants by forming biofilm-like structures on the roots

*A. radicis* produces AHL signalling molecules

- bacteria-bacteria communication
- plant-induced defences
A. radicis reduces aphid survival and reproduction
Primting and induction of plant defences

Transfer of knowledge to the field

Meta analysis of rhizobacteria effects (1997-2023)

**Bacillus** inoculants

- Pot: n=24
- Field: n=22

Other inoculants

- Pot: n=9
- Field: n=3

Multi-genus Field: n=6

Rhizobacterial inoculation effect on insects (hedges g)
From the lab to the field
Field inoculation has community wide effects

C: Control
Ac: Acidovorax radicis
Bs: Bacillus subtilis

Plant belowground microbiome
Development of microbial synthetic communities


Zytynska et al. (unpub)
Summary

• Rhizosphere bacteria are recruited by plants to enhance growth and defence
• Microbial strains can be isolated and inoculated to deliver key plant benefits
  - For plant growth and insect defence, often both simultaneously
• Level of success dependent on microbe type and strain
  - Reduction of insect feeding behaviour and fitness (survival, growth, reproduction)
• Variability in field trials highlights context dependency
  - Need consistency to exploit full potential of microbes in agriculture
• Designed SynComs aim to use stable functional networks of microbes for enhanced effect across variable environments
Inoculating crops with beneficial bacteria can promote plant yield and health

Thank you!

Xinqiang Xi
Crispus Mbaluto
Megan Parker
Edward Cairns
Andrea Ceribelli
Harri Walters
Daniel Leybourne
Sophie Blenkinsopp
Milo Henderson
Jen Banfield-Zanin
Joe MacLeod
Sara Adam

Oriana Sanchez
Robin Heinen
Sarah Sturm
Wolfgang Weisser
Sophia Klink
Mike Rothballer
Microbial Discovery Platform for biofungicides and biostimulants

Dr Vijayalakshmi Gunasekaran
R&D Lead at FA Bio
Microbial Discovery Platform for biofungicidies and biostimulants

Dr. Vijayalakshmi Gunasekaran  
Research and Development Lead  
Plant Microbiome webinar  
April 11, 2024
FA-Bio’s Mission

To increase crop yields sustainably whilst reducing agriculture’s environmental impact by discovering superior microbial active ingredients for the development of robust bioproducts.
OUR JOURNEY to OUR MISSION

- Founded FungiAlert Ltd
- Initial funding
- Set-up own lab and office @ Rothamsted Research
- IUK grant awarded (I)
- Additional funding
- MVP validated
- Patent granted
- Team growth
- Commercial field trials using SporSenZ
- Sales SporSenZ microbial analysis service
- ISO9001:2015
- 2 patents national phase + 1 PCT stage
- IUK grant awarded (II)
- Launch Microbial Discovery Platform
- Patents granted
- Rebrand to FA Bio
- Pre-Seed Round closed
- Biofertiliser & biocontrol product developments
- 3 partnerships for product development
- Winner of Radicle Growth Diversity & Inclusion Challenge
- Product development of biofertilizer & biocontrol leads
- Commercial license signed
- Team growth
- IUK grant awarded (III)
- Fermentation, stable formulation, seed coating
- UK wheat field trials
- EU maize trials

2015 2016 2017 2018 2019 2020 2021 2022 2023 2024...
Where do we make a difference

In the past 50 years, **70% of biodiversity was lost**, a **leading cause of soil degradation**.

Between 2015 and 2019, at least **100 million hectares of productive land** were degraded every year, affecting food and water security globally. The loss is equivalent to twice the size of Greenland.

One of the factors affecting soil degradation

- **Usage of synthetic fertilisers, pesticides, herbicides**

**Conventional Agrochemical Market:**
- Global market value of $250 bn, 4.3% CAGR

We make a difference through the **Discovery & development of effective microbial biocontrol, biostimulant & biofertilizer products**

**Biopesticides, biostimulants, biofertilisers**

**Sustainable Biologicals Market:**
- $10.6 bn, 15% CAGR.
KEY DRIVERS OF REGENERATIVE AGRICULTURE

- Regulations
- Consumers
- Health
- Environmental
The SporSenZ is a unique tool to decipher soil microbes.

How does it work?

- Sporsenz attracts active dominant microbes in field
- Has components that mimics plant root exudates
- Target geographies: USA, UK, Europe, LATAM

Targeted SporSenz sampling

- Target crops: cereals and horticultural crops
Microbial Discovery Platform
WE CAN CUT THE DISCOVERY PHASE FROM YEARS TO MONTHS

- SporSenZ Microbial Sampling Campaigns
- Genomic and Bioinformatic Studies
- In vitro studies and early scalability trials
- Glasshouse trials
- Fermentation & Formulation studies
- Field trials, & regulatory applications

9 months from Soil to Plant Studies

Success Rate

| 6% | → | 25% |

Timeframe

| 5 years | → | 18 months |
THANK YOU

Dr. Vijayalakshmi Gunasekaran
Research and Development Lead

Revolutionising REGENERATIVE agriculture with the DISCOVERY of superior microbes
Microbiome engineering via M genes

Dr Tomislav Cernava
Associate Professor in Plant-Microbe Interactions at the University of Southampton
Microbiome engineering via $M$ genes

Tomislav Cernava
11 April 2024

Plant Microbiome Webinar
hosted by Business Connect

@TomiSci1
The plant microbiome is under genetic control of the host.

Host genetic variation is reflected in the microbiome whenever $M$ genes are involved.
Microbiome genes – $M$ genes
Microbiome genes – $M$ genes

- The term was recently introduced to highlight the intrinsic link between plants and their microbiome.
- This link is key for plant health and productivity.
- A framework for $M$ gene breeding is being established.
Healthy soils harbour highly diverse bacterial and fungal populations. Plants can actively recruit beneficial microbes from them. **We are beginning to understand the underlying principles.**
Soil-plant microbiome interface

Plant leaves are colonized by microbes that are selected and enriched via host metabolites and play a pivotal role in protection against phytopathogens.

Michl et al. (2023) Environmental Microbiome
Host regulation of *Pseudomonas* in the rice phyllosphere microbiome

Pseudomonadales (mainly represented by *Pseudomonas*) abundance differs between indica and japonica rice sub-groups.
Genome-wide associations between rice host and microbiome

More than 300 metagenomes were implemented to identify rice genome loci associated with specific bacteria. Implementation of a GWAS-based approach with SNP resolution.
One biosynthetic pathway in rice included multiple GWAS hits

Lignin biosynthetic pathway

Typical lignin content in plant dry mass: 5 - 35%
One biosynthetic pathway in rice showed multiple GWAS hits
Two prevalent *OsPAL02* haplotypes occur in rice

Prevalent *INDICA* haplotype

Prevalent *JAPONICA* haplotype
Phyllosphere microbiome engineering via *OsPAL02* mutants

*OsPAL02* knockout mutants resulted in reduced *Pseudomonadales* abundance.

Overexpression mutants resulted in an enrichment and increased host resistance against *Xanthomonas oryzae*.

Su et al., Nature Communications (2024)
Importance of *Pseudomonas* in the rice phyllosphere microbiome

Application of *Pseudomonas* SynCom in WT and KO plants substantially reduces bacterial blight symptoms in rice.

WT phenotype can also be restored by external application of synthetic p-coumaric acid.

Su et al., Nature Communications (2024)
Importance of *Pseudomonas* in the rice phyllosphere microbiome

Disease-susceptible plants

Resistant plants

Application of *Pseudomonas* SynCom

Su et al., Nature Communications (2024)
**M** gene-based regulation of fungal communities – to be confirmed

- Phyllosphere microbiomes of rice cultivars with differing resistance towards *Rhizoctonia solani* were profiled
- *Aspergillus* was found to be enriched in resistant rice cultivar TQ

Fan et al., under revision
Interference is based on small molecule produced by *Aspergillus*

- The phyllosphere colonizer *Aspergillus cvjetkovicii* interferes with sclerotia formation of the pathogen *R. solani*.

- The small molecule 2,4-di-tert-butylphenol was identified as the bioactive compound.

Fan et al., under revision
Proposed mode of action

• 2,4-DTB interferes with ROS-dependent activation of transcriptional regulator

• Reduced formation of sclerotia

• Involvement of \( M \) genes in \textit{Aspergillus} enrichment?

Fan et al., under revision
Funding Opportunities

Dr Pedro Carvalho
Innovate UK Business Connect
The Farming Innovation Programme (FIP)

- Part of Defra's Agricultural Transition Plan
- £270M of grant funding for R&D through to 2028/29
- To enhance productivity, environmental sustainability and resilience in England’s farming sectors
- Funding is awarded on a competitive basis to high quality, innovative projects
- Collaborative projects must benefit farmers, foresters, and growers in England
The **Farming Innovation Programme** offers a range of opportunities for farmers, growers, businesses and researchers to collaborate on industry-led research and development:

- **Small Research Starter Projects** where farmers, growers & foresters can explore a new idea, or **Projects to Accelerate Adoption** (ADOPT coming soon) where farmers and growers can trial new innovation on their farms.

- **Feasibility projects** where businesses can check if a research idea works in practice.

- **Small/Large Partnership Projects**, where businesses can further develop a new farming product or service towards commercialisation.

- **Themed competitions** (Farming Futures R&D Fund), where businesses and researchers can work on longer-term innovation focussing on issues like: Climate Smart Farming, Sustainable Farm-based Proteins, Automation and robotics, Environmental Resilience.
# Farming Innovation Programme: Competition Schedule

<table>
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<tr>
<th>Competition name</th>
<th>Opens</th>
<th>Closes</th>
<th>Status</th>
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<tr>
<td>Farming Futures R&amp;D – Nutrient Management, Part 1</td>
<td>Spring 2024</td>
<td>Spring 2024</td>
<td>Upcoming</td>
</tr>
<tr>
<td>Farming Futures R&amp;D – Nutrient Management, Part 2</td>
<td>Autumn 2024</td>
<td>Autumn 2024</td>
<td>Upcoming</td>
</tr>
<tr>
<td>Small R&amp;D Partnerships (round 4)</td>
<td>Autumn 2024</td>
<td>Autumn 2024</td>
<td>Upcoming</td>
</tr>
<tr>
<td>Feasibility Studies (round 4)</td>
<td>Autumn 2024</td>
<td>Autumn 2024</td>
<td>Upcoming</td>
</tr>
<tr>
<td>Farming Futures R&amp;D – Net Zero Farming</td>
<td>Autumn 2024</td>
<td>Autumn 2024</td>
<td>Upcoming</td>
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</table>

[https://farminginnovation.ukri.org](https://farminginnovation.ukri.org)
Summary:
These grants are focused on providing groups of farmers, growers and foresters in England with support to conduct on-farm experiments and trials.

ADOPT will help de-risk farmers’ participation in research and innovation.

There will be a total of £45 million grant funding available up until 2028/29.

Dates:
Coming in summer 2024.

https://defrafarming.blog.gov.uk/2024/03/12/grants-available-in-2024/
BridgeAI

£100m Innovate UK funded programme to encourage AI innovation and adoption in UK business over the next 2 years.

Mission statement

To empower businesses in high-growth sectors within the UK, including agriculture, construction, creative, and transport industries, to harness the power of AI in a responsible and ethical manner, driving productivity and unlocking their full potential.

https://iuk.ktn-uk.org/programme/bridgeai/
BridgeAI: Opportunities

**BridgeAI Standards Community**
- **Open:** 06/02/2024
- **Close:** 31/03/2025
- Harness the power of AI responsibly through standards support.

**BridgeAI: Introduction to Transparent Machine Learning | The Alan Turing Institute**
- **Open:** 01/05/2023
- **Close:** 31/12/2024
- Learn to implement transparent machine learning systems and processes in a real-world setting with The Alan Turing Institute’s free and open-source self-paced...

**BridgeAI: How Data Lies | The Alan Turing Institute**
- **Open:** 01/05/2023
- **Close:** 31/12/2024
- Gain practical, actionable support to identify and address data issues, while becoming an expert data scientist in AI with The Alan Turing Institute.

**BridgeAI: Feasibility studies for Artificial Intelligence solutions: Series 2**
- **Open:** 27/03/2024
- **Close:** 06/05/2024
- UK registered businesses can apply for a share of up to £5m to use Artificial Intelligence (AI) to address business challenges and opportunities.

**BridgeAI: Bespoke AI and Data Science Advice for SMEs from The Alan Turing Institute**
- **Open:** 18/10/2023
- **Close:** 31/03/2024
- Get personalised AI advice for your small to medium-sized business from The Alan Turing Institute's team of independent scientific advisors.

**The Turing Way Handbook | The Alan Turing Institute**
- **Open:** 01/05/2023
- **Close:** 31/12/2024
- Discover The Turing Way Handbook on data science, an innovative UK BridgeAI programme resource. The project offers a series of openly developed online...

**Turing Way Practitioners Hub – become an Expert in Residence**
- **Open:** 15/03/2024
- **Close:** 30/06/2024
- The Turing Way Practitioners Hub is inviting Expressions of Interest to join their second cohort of Experts in Residence.

**BridgeAI: Live course: Assessing and mitigating bias and discrimination in AI**
- **Open:** 03/02/2024
- **Close:** 28/05/2024
- Join our live training course to explore the impact, legislative contexts, and practical mitigation of bias in AI development across the agriculture, construction,...

**Live course: Operationalising ethics in AI**
- **Open:** 04/01/2023
- **Close:** 23/05/2024
- Join our live training course on operationalising ethics for AI in transport, agriculture and construction.

**BridgeAI: Discover Digital Transformation Training Programme**
- **Open:** 03/02/2024
- **Close:** 28/05/2024
- Explore the potential of your business with the Discover Digital Transformation Training Programme by STFC Hartree Centre.

**BridgeAI: AI Adoption Assessment Toolkit from Digital Catapult**
- **Open:** 07/01/2023
- **Close:** 31/01/2024
- If your organisation is diving into AI adoption but feels uncertain, our toolkit is your guide.

**BridgeAI: High Performance Computing (HPC) Innovation Voucher**
- **Open:** 18/10/2023
- **Close:** 30/04/2024
- Gain access to £5,000 vouchers for the Hartree Centre’s powerful high-performance computing (HPC) platforms. Explore faster simulations, efficient projects...

**BridgeAI: Access to Hartree Centre Training Portal from Science and Technology Facilities Council**
- **Open:** 04/09/2023
- **Close:** 31/01/2024
- Accelerate your digital expertise with the Hartree Centre Training Portal as part of Innovate UK’s BridgeAI programme.

**BridgeAI: Turing Commons | The Alan Turing Institute**
- **Open:** 01/05/2023
- **Close:** 31/12/2024
- Learn how The Alan Turing Institute’s ‘Turing Commons’ can guide you in designing, developing, and using data-driven technologies responsibly...

**BridgeAI: Assessing and Mitigating Bias and Discrimination in AI | The Alan Turing Institute**
- **Open:** 01/05/2023
- **Close:** 31/12/2024
- Register for the BridgeAI self-paced e-learning course on assessing and mitigating bias in AI with The Alan Turing Institute. Learn about multiclass...

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https://iuk.ktn-uk.org/opportunities/?_sft_areas=bridgeai
BridgeAI - Feasibility studies for Artificial Intelligence solutions: Series 2
Opens 27th March 2024 - Closes 8th May 2024

UK registered businesses can apply for a share of up to £5m to use Artificial Intelligence (AI) to address business challenges and opportunities.

- **Sectors:**
  - Agriculture and food processing
  - Construction
  - Creative industries (*excluding marketing and advertising*)
  - Transport, including logistics and warehousing

- **Project size:** £25k to £50k
- **Project length:** 4 to 6 Months
- **Carry out its project work in the UK**
- **Intend to exploit the results from or in the UK**
- **Start by 1 October 2024/ End by 31 March 2025**
- **Lead:** Micro, SME
- **Partners:** Micro, SME, Academic

https://apply-for-innovation-funding.service.gov.uk/competition/1864/overview/ce313d66-4481-4aaa-af0a-34928aa0ad05
Other Funding opportunities

**Innovate UK SMART Grants: January 24** (opens 18 Jan 2024 - closes 24 Apr 2024)  
Smart is Innovate UK’s responsive grant funding programme. It supports SMEs and their partners to develop disruptive innovations with significant potential for rapid, economic return to the UK.

**Innovation Loans Future Economy: Round 14** (opens 7 Mar 2024 - closes 1 May 2024)  
Loans to micro, small and medium-sized enterprises (SMEs), to support innovative projects with strong commercial potential to significantly improve the UK economy.

**Knowledge transfer partnerships (KTP)**  
Partnership between a business and academic partner, with knowledge transfer via a recent graduate.
The conference, will bring together academics, industry scientists, entrepreneurs and funders interested in microbiome research and innovation from a wide range of sectors including human, animal, plant and environment.
AgriFood Funding, Events & News

A journey through urban innovation and circularity
We have brought together a group of innovators from across the urban supply chain to develop a Circular Action Plan for urban waste. Find out about innovative uses for waste.

Q&A - Farming Innovation Programme - Small R&D Partnership Projects R3
If you have a new farming product or service that could improve farming methods and help the environment and you want to find out about funding to develop it, watch our Q&A on replay.

Driving innovation in industrial biotechnology and engineering biology
We explore the role Industrial Biotechnology and Engineering Biology can play in moving towards producing chemicals and materials from alternative, sustainable biomaterials.

Boosting productivity in AgriFood using AI - Take our short survey
Innovate UK is seeking new ideas to improve productivity using Artificial Intelligence in a range of sectors including AgriFood, as part of the Thriving AI project.

Sign up for IUK KTN AgriFood newsletters and funding alerts:
https://r1.dotdigital-pages.com/p/2VFU-7B5/agrifood-mailing-list
Find out more

https://ktn-uk.org/
https://ktn-uk.org/agrifood/

Pedro Carvalho
pedro.carvalho@iuk.ktn-uk.org

Why not get the Innovate UK Business Connect AgriFood Newsletter each month?

https://iuk.ktn-uk.org/