Transdisciplinary Solutions to Meet the UK Food System Challenges

Inaugural Conference 23rd November 2023

ProFSET

Professional Food Science, Engineering and Technology Group

Thanks to IOP for hosting us today

82 registered delegates

Opened by John Bows

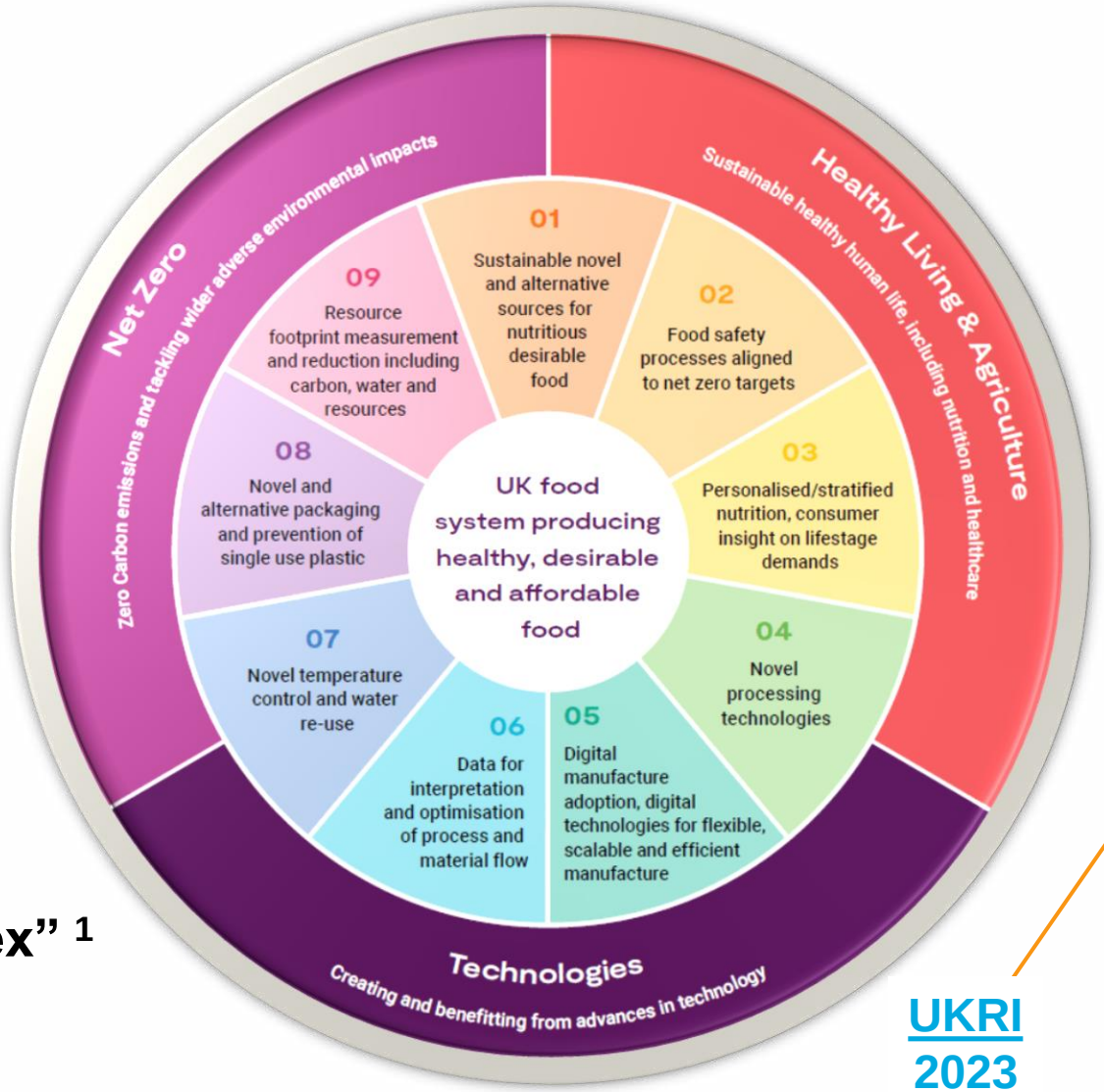
Food sector needs an independent, scientific voice

Food Sector is #1 UK manufacturing sector

- **One third of all food is wasted**
- **Major challenges and headwinds …**
- **Only 2% of EPSRC 2024 iCASE Vouchers allocated to food companies [2]**

But

- **We know food industry needs & priorities**
- **UK ranked #1 globally "Citable documents H-index" [1]**
- **ProFSET has just launched to provide this Voice**



UKRI 2023

[1] Global Innovation Index 2023 – H-index … Journal & Scientists scientific productivity and scientific impact, [2] UKRI.org

10 Food & Drink Groups represent >12,000 scientists, engineers & technologists

ProFSET

Professional Food Science, Engineering and Technology Group

Institute of Food Science + Technology ifst

IAgrE

IOP Institute of Physics Food Physics Group

RSC INTEREST GROUP FOOD

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

Institution of MECHANICAL ENGINEERS

SCI where science meets business

Applied Microbiology International

SDT Society of Dairy Technology Passion for Dairy

THE NUTRITION SOCIETY Advancing Nutritional Science

ProFSET was set-up to identify and propose actions in Science and Technology, to meet the future needs of an efficient UK Food Supply Chain in the rapidly changing global situation

1. **A single, informed voice to influence and support government, media and the public**

2. **Providing opportunities for collaboration, knowledge sharing and cooperation across industry and academia**

3. **Promoting the industry as an exciting career path and supporting the development, education and training of professionals**

ProFSET Group

John Bows IOP 	Martin Whitworth IOP 	Natasha Medhurst IFST 	Peter Lillford IFST 	Cassie Ellis Nutrition Society 
Craig Duckham SCI 	Daniel Heftt IAgrE 	Jane Parker RSC 	Tim Foster RSC 	Lucky Cullen App.Microbiology Int'l 
Judith Evans IMechE 	Stacie Tibos IMechE 	Seamus Higgins IChemE 	Laura Malhi IChemE 	Marian Pusey Soc. Dairy Tech. 

Transdisciplinary Solutions to Meet the UK Food System Challenges
ProFSET Inaugural Conference 23rd November 2023

10:30 Welcome

10:40 Keynote from Kate Halliwell, Chief Scientific Officer at Food and Drink Federation

11:05 Keynote from Prof Gideon Henderson, DEFRA Chief Scientific Adviser

11:30 Perspectives on Creating a Sustainable UK Food System from the 10 ProFSET groups

12:30 Lunch

14:00 Panel Discussion facilitated by Ian Noble

15:00 Networking Buffet / 15:30 Close

Two awesome keynote speakers

Prof Gideon Henderson

DEFRA Chief Scientific Adviser

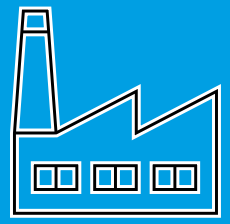
Kate Halliwell

Food and Drink Federation's
Chief Scientific Officer

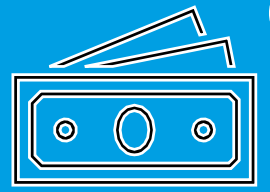
UK food manufacturing – driving change in the food system

Kate Halliwell, Chief Scientific Officer – Food and Drink Federation

Food and drink is the **largest** manufacturing sector in the UK



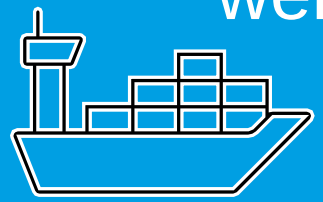
The industry contributes over **£33bn** to the economy



The sector provides over **450,000 jobs …**

… with **4 million more** across the farm-to-fork food supply chain

Food and drink exports were valued at a record **£25bn** in 2022



fdf

FOOD & DRINK POWERS OUR NATION

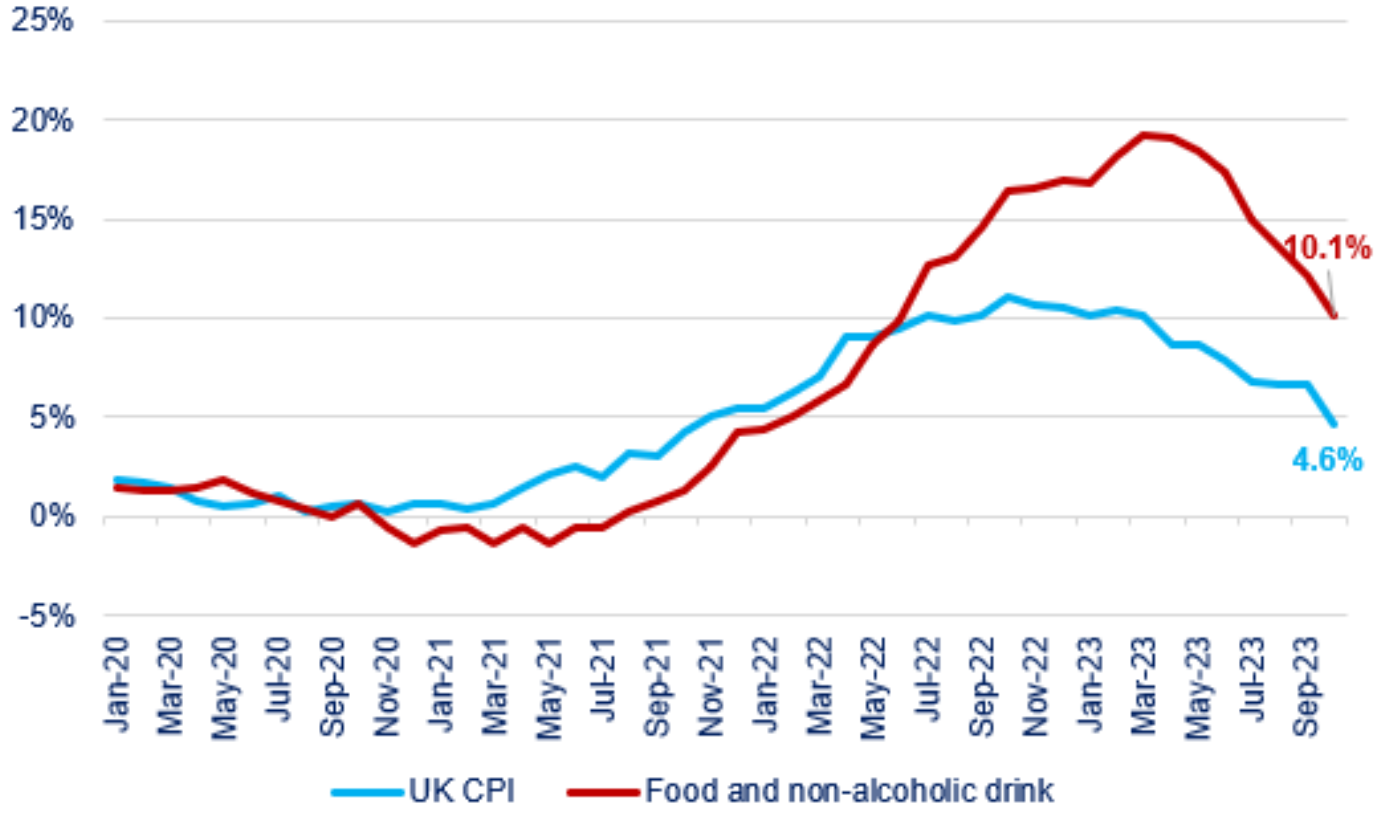
Key issues

Huge number of drivers changing our food system…

…all of which can have consequences

Food and drink inflation firmly in easing territory

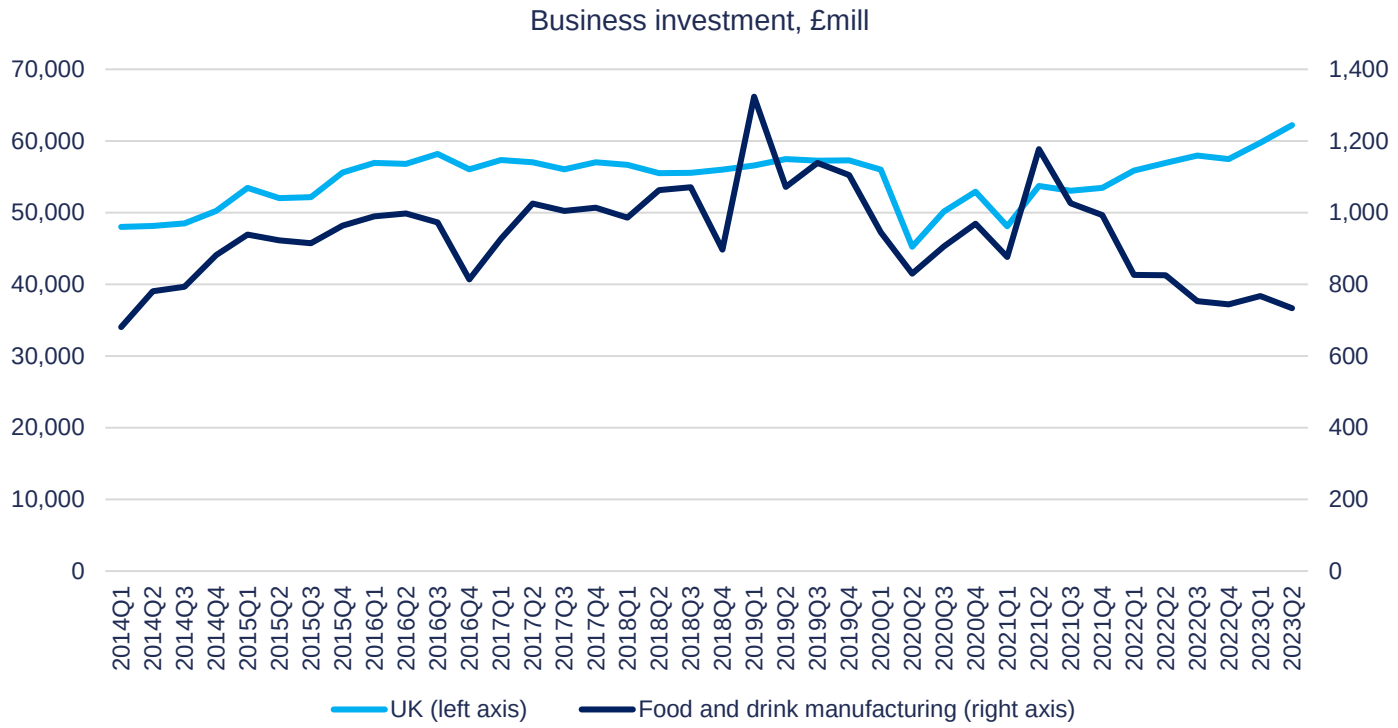
With annual inflation slowing for a seventh consecutive month in October



Source: ONS.

Business investment lower than four years ago

In sharp contrast with business investment in the UK as a whole



Growth

	Food and drink	UK
H1 2023 on H1 2019	-36%	7%
H1 2023 on H1 2016	-17%	6%

Source: ONS, Business investment, chain volume measures, NSA.

Labour and skill shortages

Vacancy rate in UK, manufacturing and food and drink manufacturing
(vacancies per 100 employees)

Source: FDF State of Industry Survey and ONS

- Vacancies across all types of roles and skills levels
- Shortages are holding back productivity improvements and growth in the sector.

- Employers are attracting and retaining talent by:
  - **Increasing wages**, average pay in the sector grew by 4.1% and is expected to rise by a further 5.4% over the next year.
  - **Introducing flexible working** such as shorter shift patterns and working from home.
  - Investing in **Apprenticeships**
  - Creating the **Food and Drink Careers Passport** – an industry-led pre-employment training programme to help people into the industry

- We support the recommendations of the Independent Review in Labour Shortages in the Food Supply Chain, and are calling on the government to:
  - Reform the Apprenticeship Levy
  - Incentivise the adoption of automation

EU Exit

Our (*complex*) regulatory landscape

European Union (EU)

Northern Ireland
FSA in NI

Republic of Ireland
Food Safety Authority of Ireland (FSAI)

Great Britain (GB)

Scotland
Food Standards Scotland (FSS) & Scottish Government

Wales
Food Standards Agency (FSA) in Wales & Welsh Government

England
Department for the Environment, Food and Rural Affairs (Defra), Food Standards Agency (FSA), Department for Health and Social Care (DHSC), Health and Safety Executive (HSE), …

United Kingdom

Food Standards Scotland

Department of Health & Social Care

Food Standards Agency

Department for Environment Food & Rural Affairs

European Commission

✓**Cross-regulator cooperation**

✓**Strive for a 4 nation UK approach**

Sustainability

Sustainability Theme	Scope
Net Zero	2040 farm-to-fork ambition & emission reductions, scope 3 accounting, supply chain collaboration, reporting frameworks
Nature restoration	Contribution to Nature Positive by 2030: nature restoration and biodiversity, including water and regenerative agriculture
Sustainable commodities	Environmental foot printing, sustainable procurement, forest risk commodities
Food waste	Reducing food waste in manufacturing and across supply chain, in line with SDG 12.3
Packaging	Extended Producer Responsibility and Deposit Returns Scheme

Net Zero

SUMMARY OF ACTIONS

Carbon offsets
Carbon offsets can compensate for unavoidable emissions in the value chain, once all feasible emissions reduction actions have been implemented. Companies should only use high-quality offsets certified by an independent scheme.

Ingredients & imports*

- Understand your ingredient emissions
- Procure lower carbon ingredients
- Reformulate products to reduce emissions

Packaging

- Assign internal responsibility for packaging emissions
- Set company policy on packaging sustainability
- Engage packaging suppliers to find low carbon options

Manufacturing

- Improve energy efficiency
- Decarbonise electricity
- Decarbonise process heat
- Shift to sustainable refrigerants

Distribution & Storage

- Embed climate performance into logistics services
- Shift to electric vehicles for light goods vehicles
- Optimise your HGVs

Customers & Consumers

- Understand customer expectations on climate
- Capitalise on growing demand for lower carbon products
- Engage consumers on climate issues and waste reduction

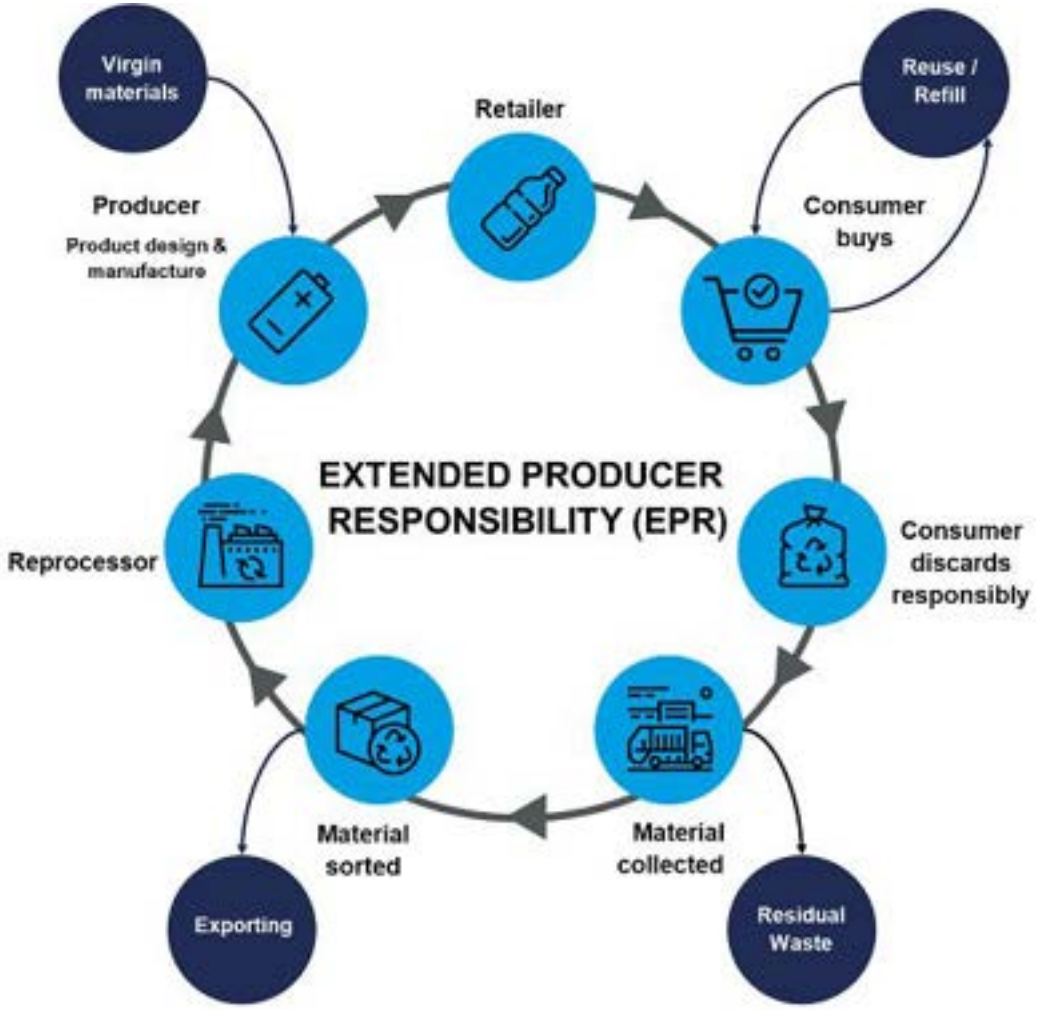
Food and Drink **Net Zero Handbook**

*This category includes emissions related to production of UK ingredients (agricultural emissions), as well as emissions embedded in imported ingredients, animal feed and finished goods (production, packaging and transport to the UK).

Page 8

Collection and packaging reforms

- Producers pay the full net costs of packaging waste they produce
- Reduce ‘excessive’ packaging
- Packaging recyclability increased
- More packaging gets recycled
- Increased quality of material for recycling
- Less packaging is littered



High in Fat, Sugar or Salt (HFSS)

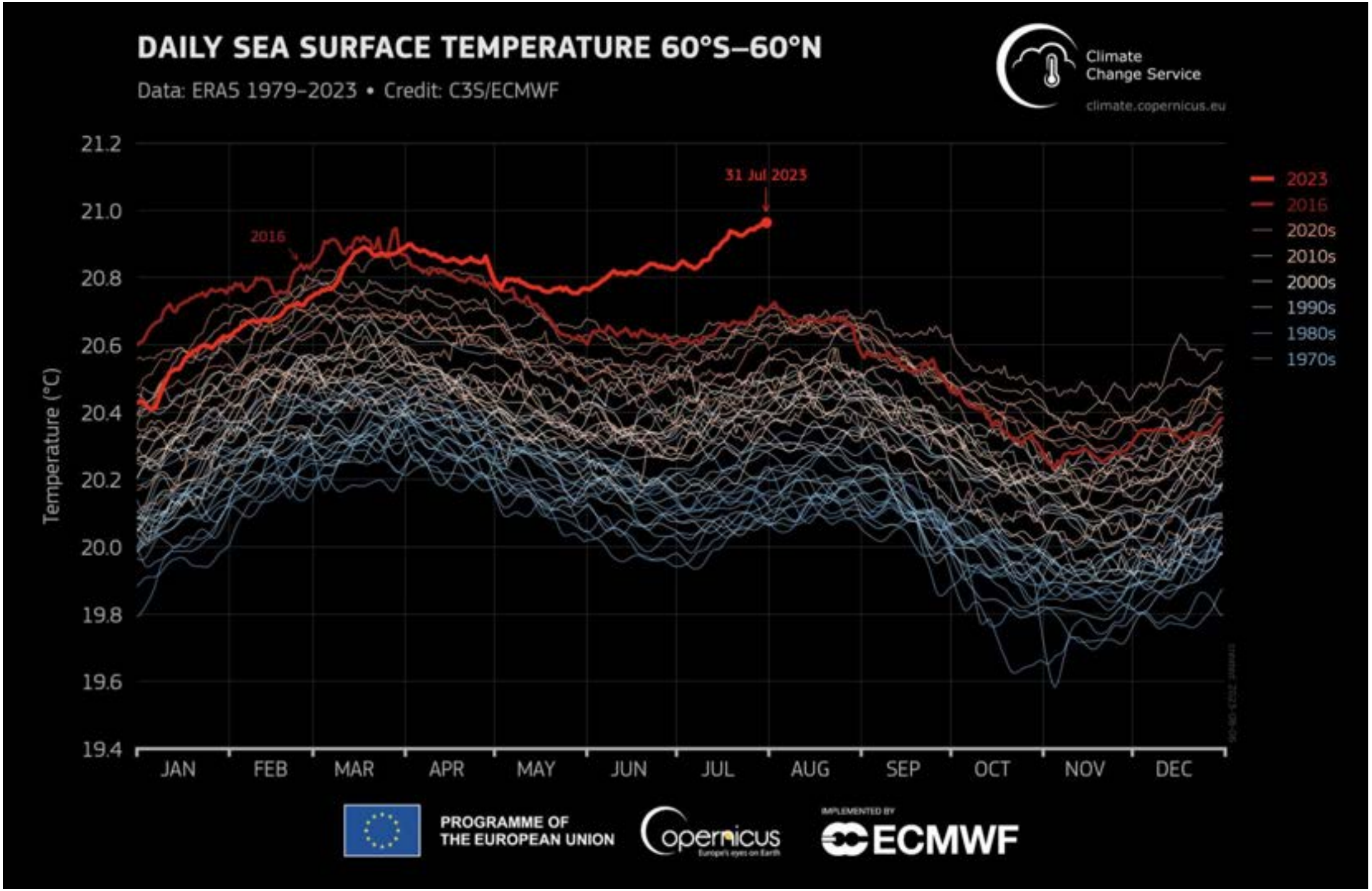
Driving change in the food system

Feeding a growing population affordably in the face of health, climate, and biodiversity challenge

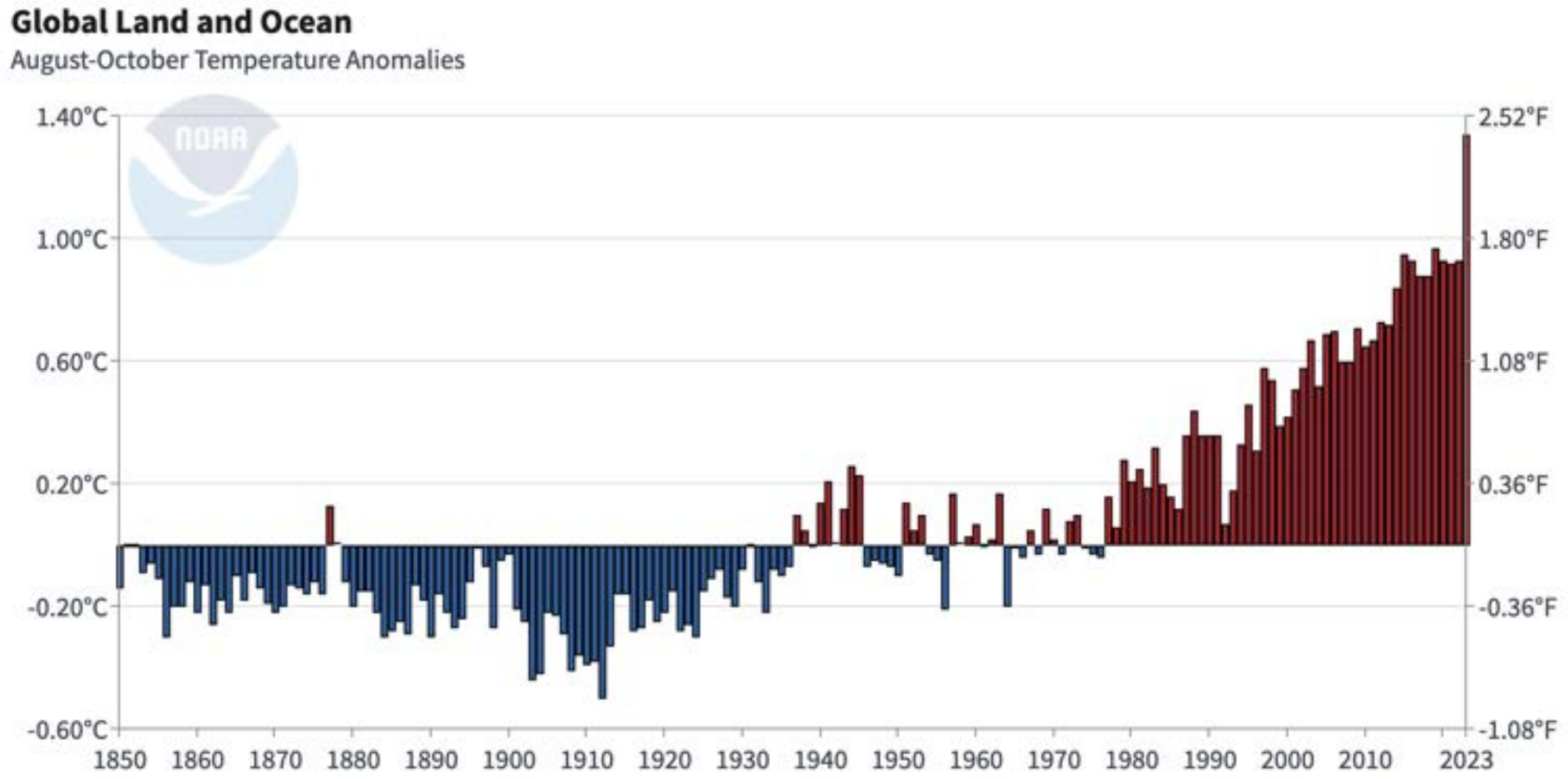
Prof. Gideon Henderson
Chief Scientific Advisor, Defra

23-Nov-2023. ProFSET meeting.

Department for Environment Food & Rural Affairs


DAILY SEA SURFACE TEMPERATURE 60°S–60°N
Data: ERA5 1979–2023 • Credit: C3S/ECMWF
Climate Change Service
climate.copernicus.eu
21.2
21.0
20.8
20.6
20.4
20.2
20.0
19.8
19.6
19.4
Temperature (°C)
31 Jul 2023
2016
2023
2016
2020s
2010s
2000s
1990s
1980s
1970s
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
PROGRAMME OF THE EUROPEAN UNION
Copernicus
Europe's eyes on Earth
IMPLEMENTED BY
ECMWF

Global temperature - September



Plotted relative to 20th average (13.9°C) which is 0.2°C warmer than preindustrial
https://www.ncdc.noaa.gov/cag/

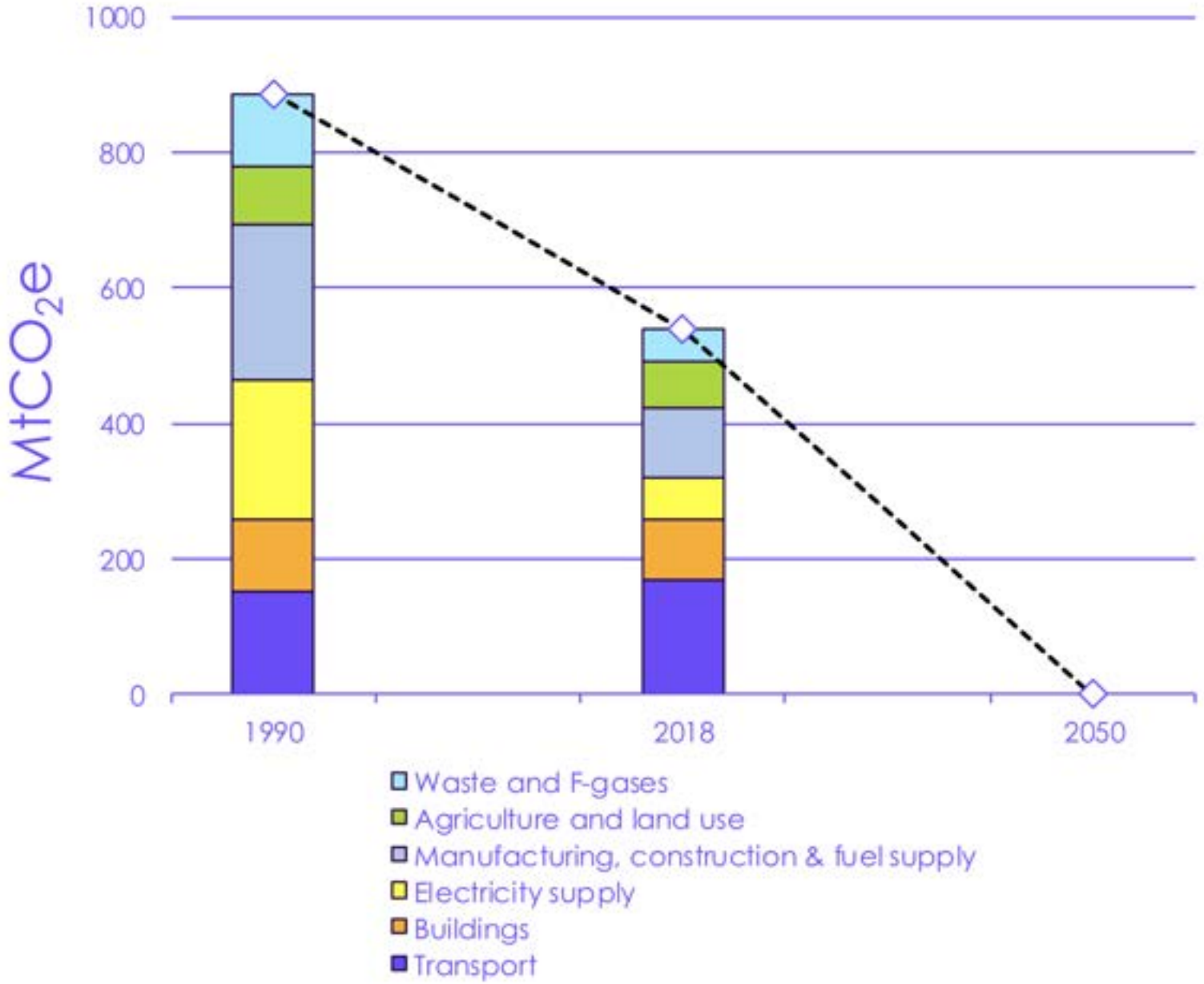
Climate change: Rise in Google searches around 'anxiety'

21 hours ago

Climate

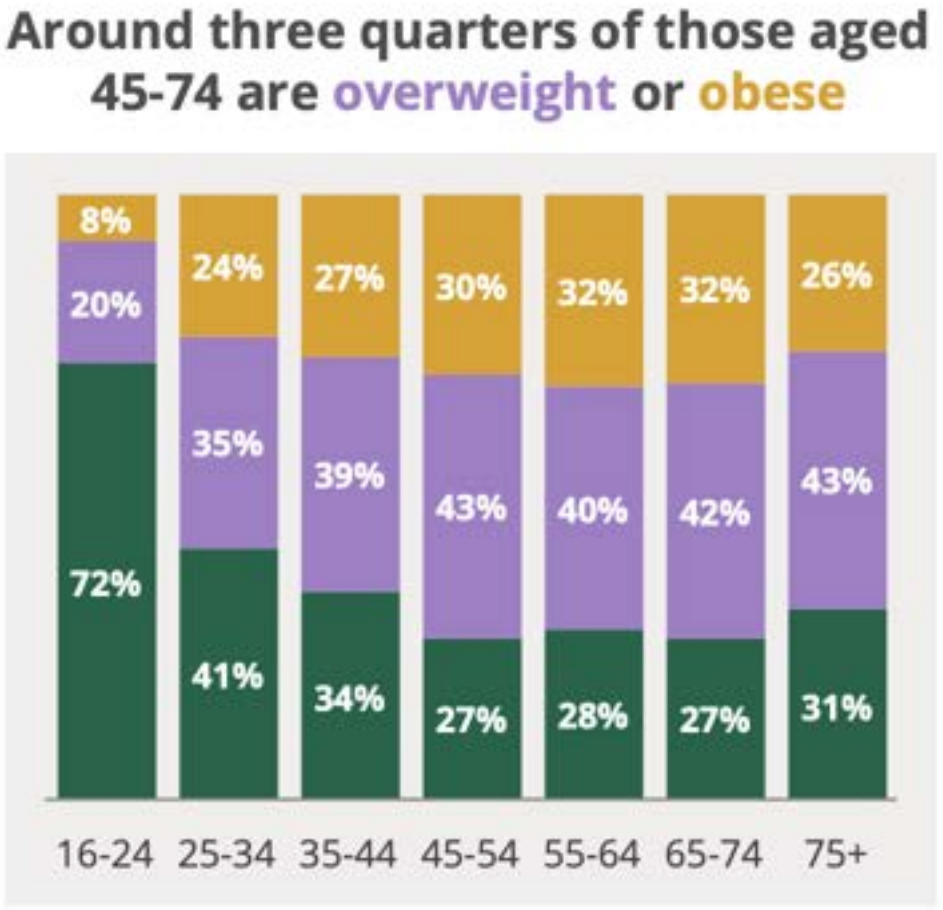
Climate anxiety is a term that describes distress at the impact of climate change on the planet and human existence

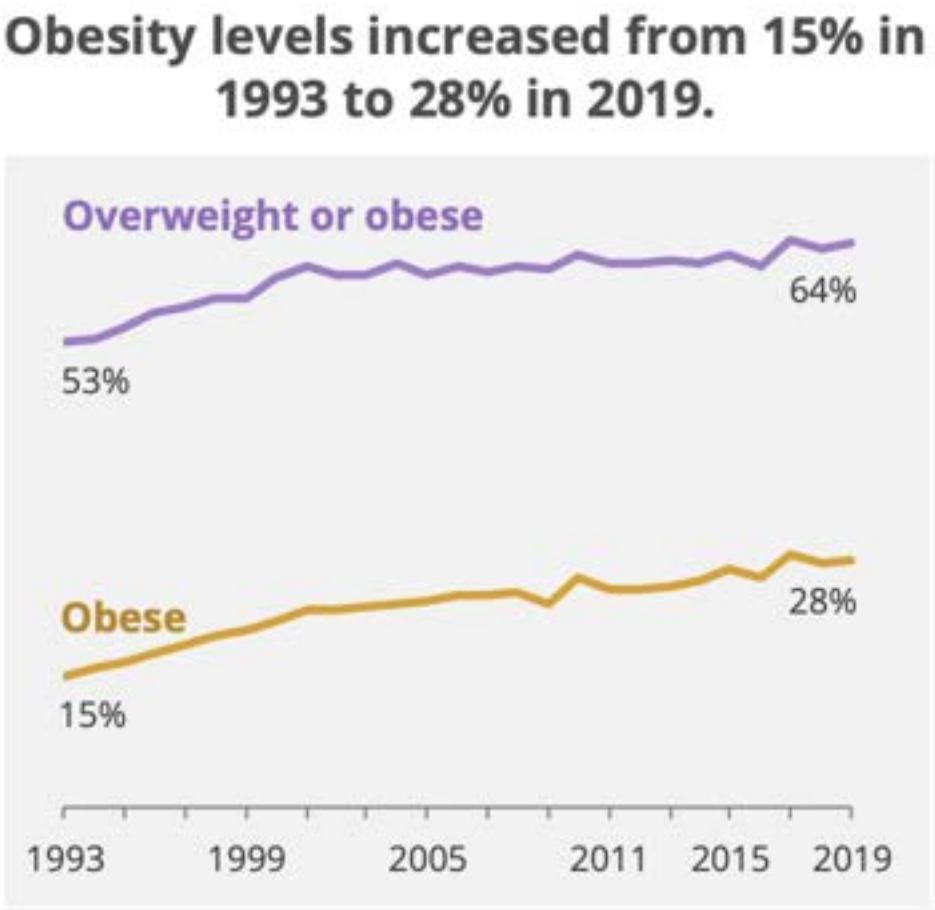
The scale of the net zero challenge



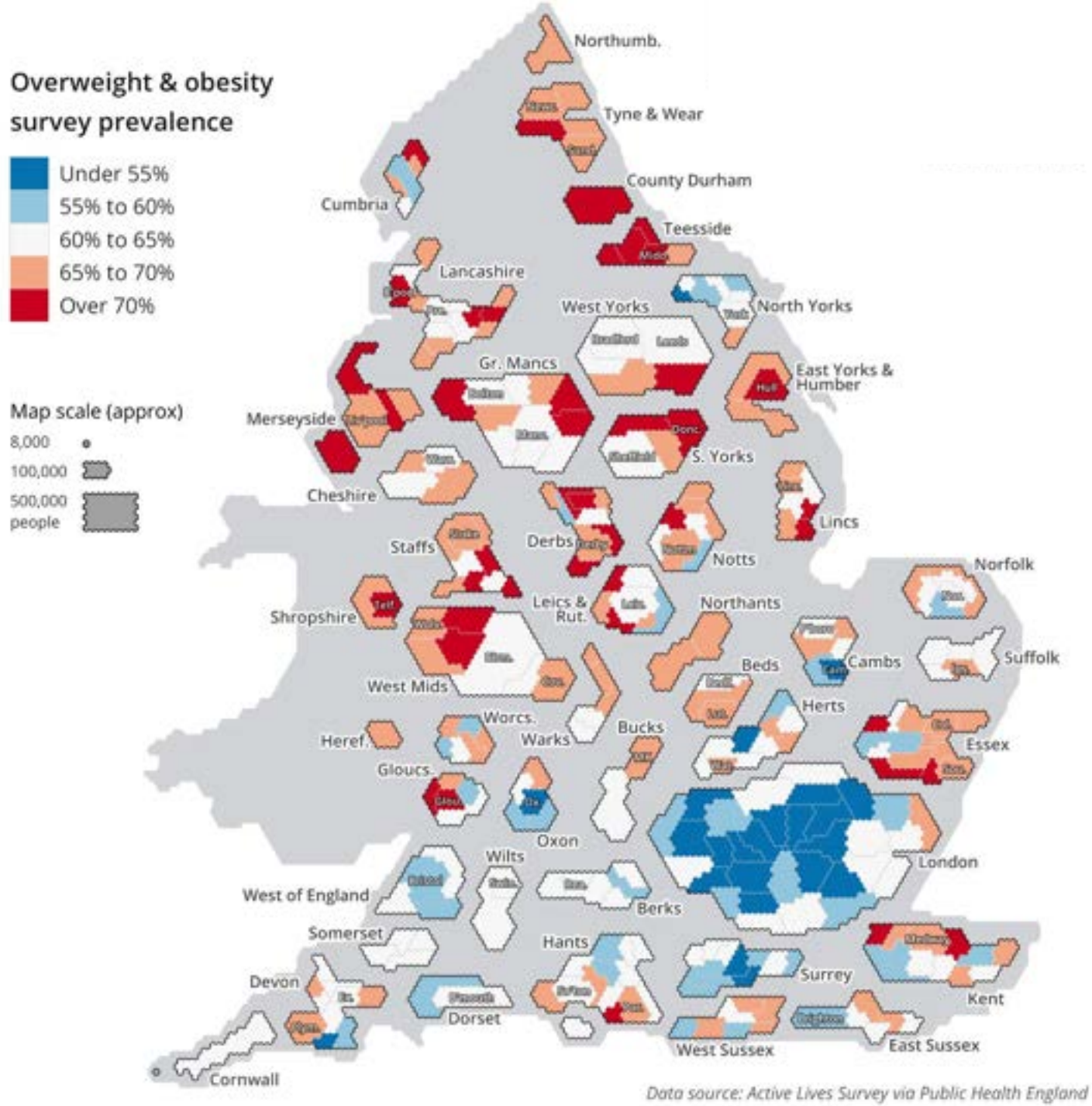
CCC CB6 Report

We are eating too much food



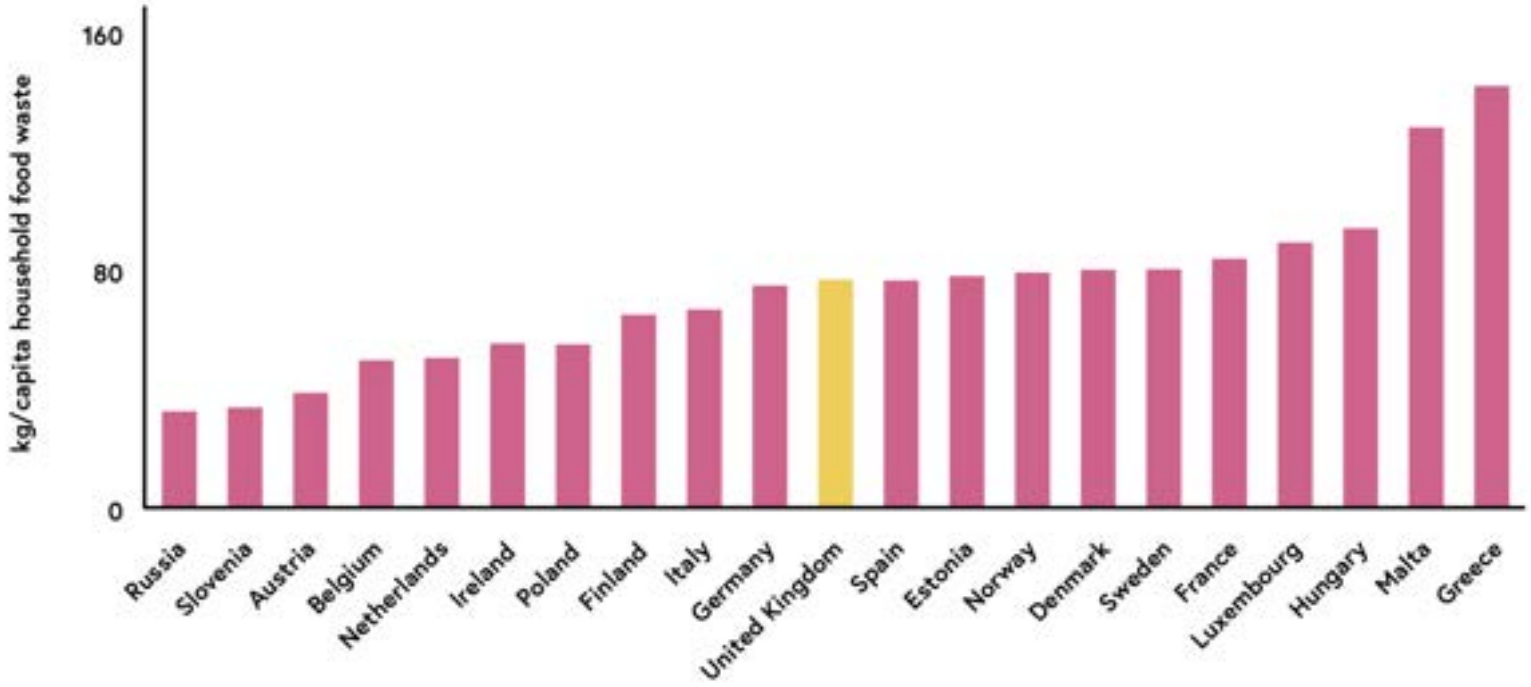


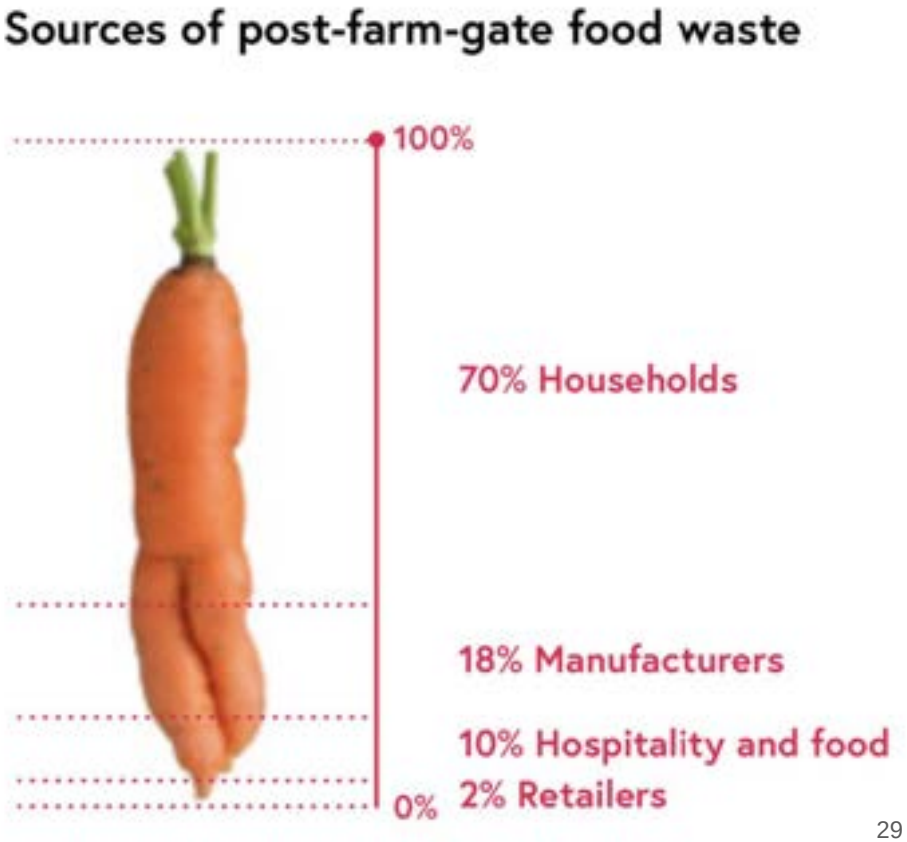
House of Commons Obesity Statistics. January 2023


Overweight & obesity survey prevalence
Under 55%
55% to 60%
60% to 65%
65% to 70%
Over 70%
Map scale (approx)
8,000
100,000
500,000 people
Northumb.
Tyne & Wear
County Durham
Teesside
Cumbria
Lancashire
West Yorks
North Yorks
Gr. Mancs
East Yorks & Humber
Merseyside
S. Yorks
Cheshire
Lincs
Staffs
Derbs
Notts
Norfolk
Shropshire
Leics & Rut.
Northants
Suffolk
Beds
Cambs
West Mids
Herts
Worcs.
Bucks
Heref.
Warks
Essex
Gloucs.
Oxon
London
Wilts
West of England
Berks
Somerset
Hants
Surrey
Devon
Kent
Dorset
West Sussex
East Sussex
Cornwall
Data source: Active Lives Survey via Public Health England

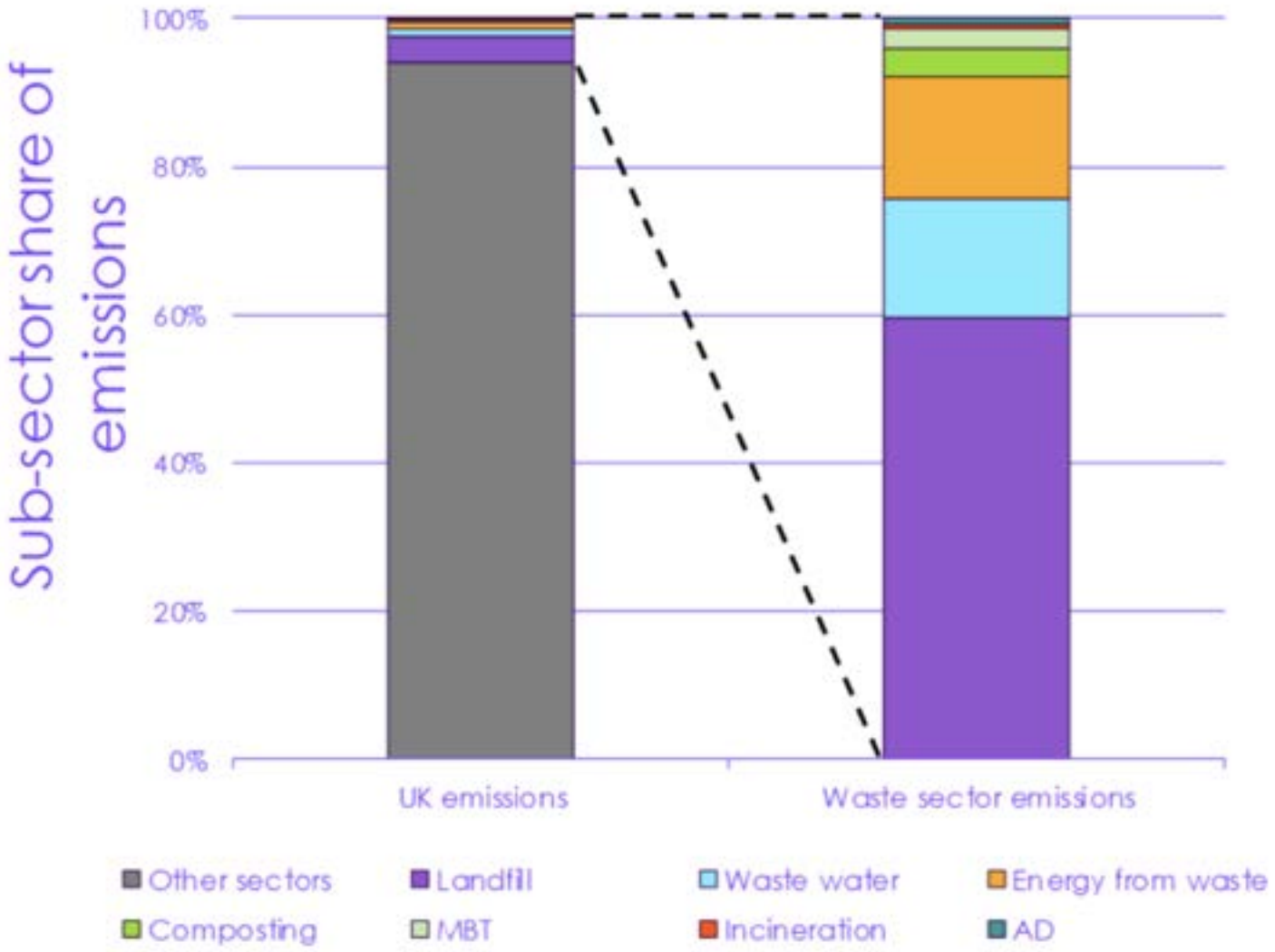
We throw too much food away

9.5 million tonnes of food wasted in the UK per year (WRAP)
= 16% of food purchased by households is wasted
Value of £19bn per year. Associated with 25 Mt CO_2e emissions per year





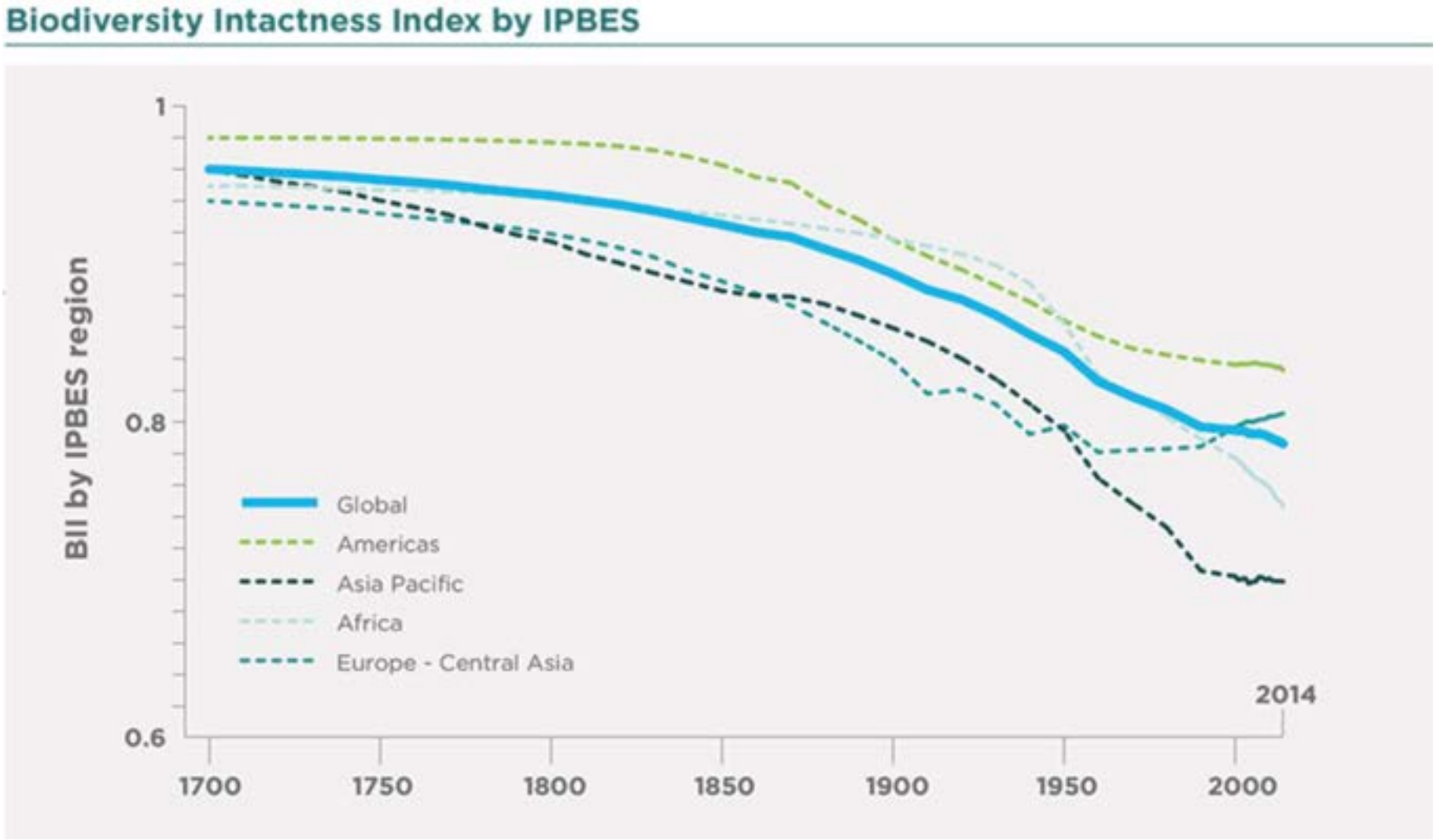
Emissions from waste



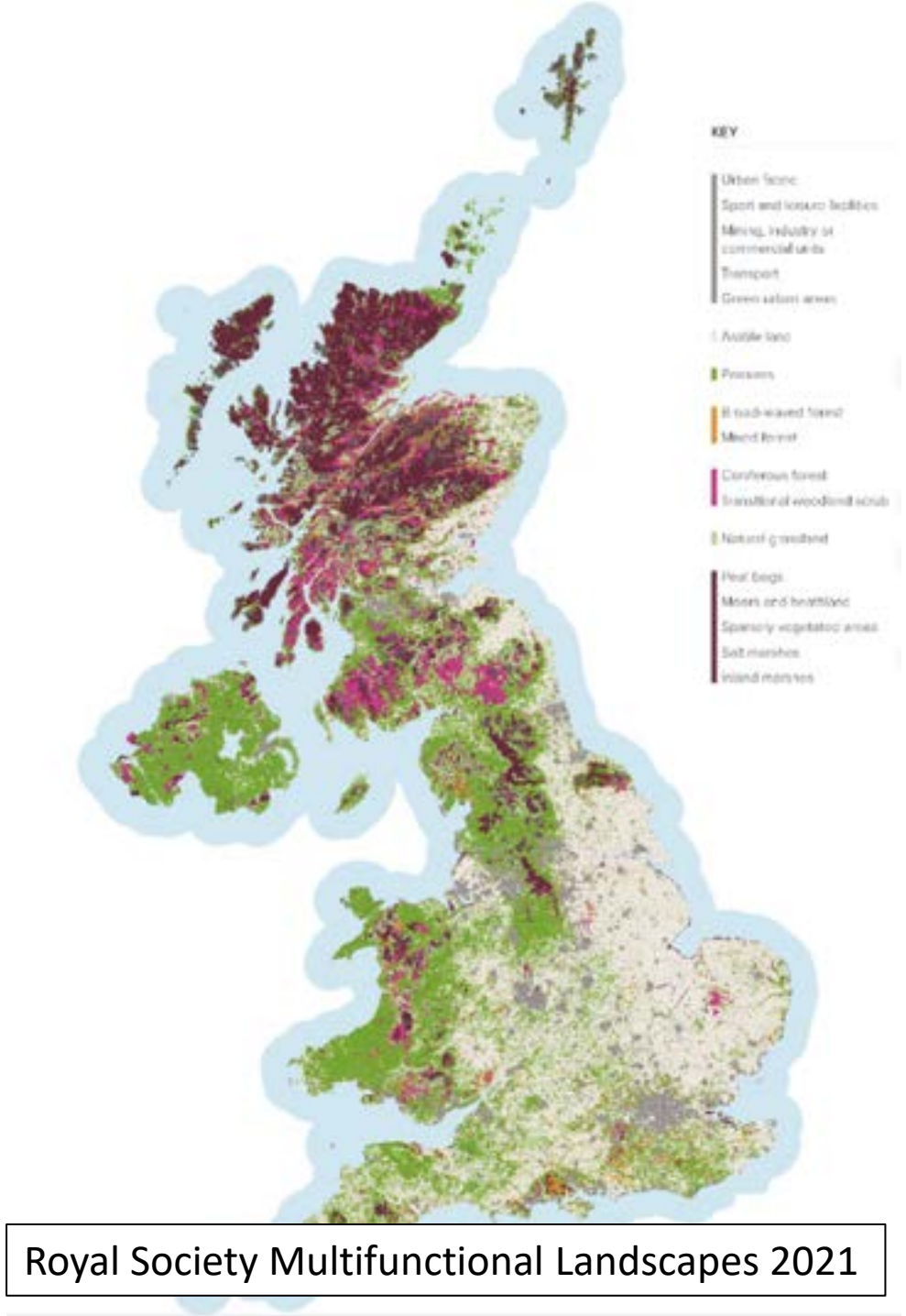
"…we are bringing forward £295m… allow local authorities in England to prepare to implement free separate food waste collections for all households from 2025"

Net Zero Strategy

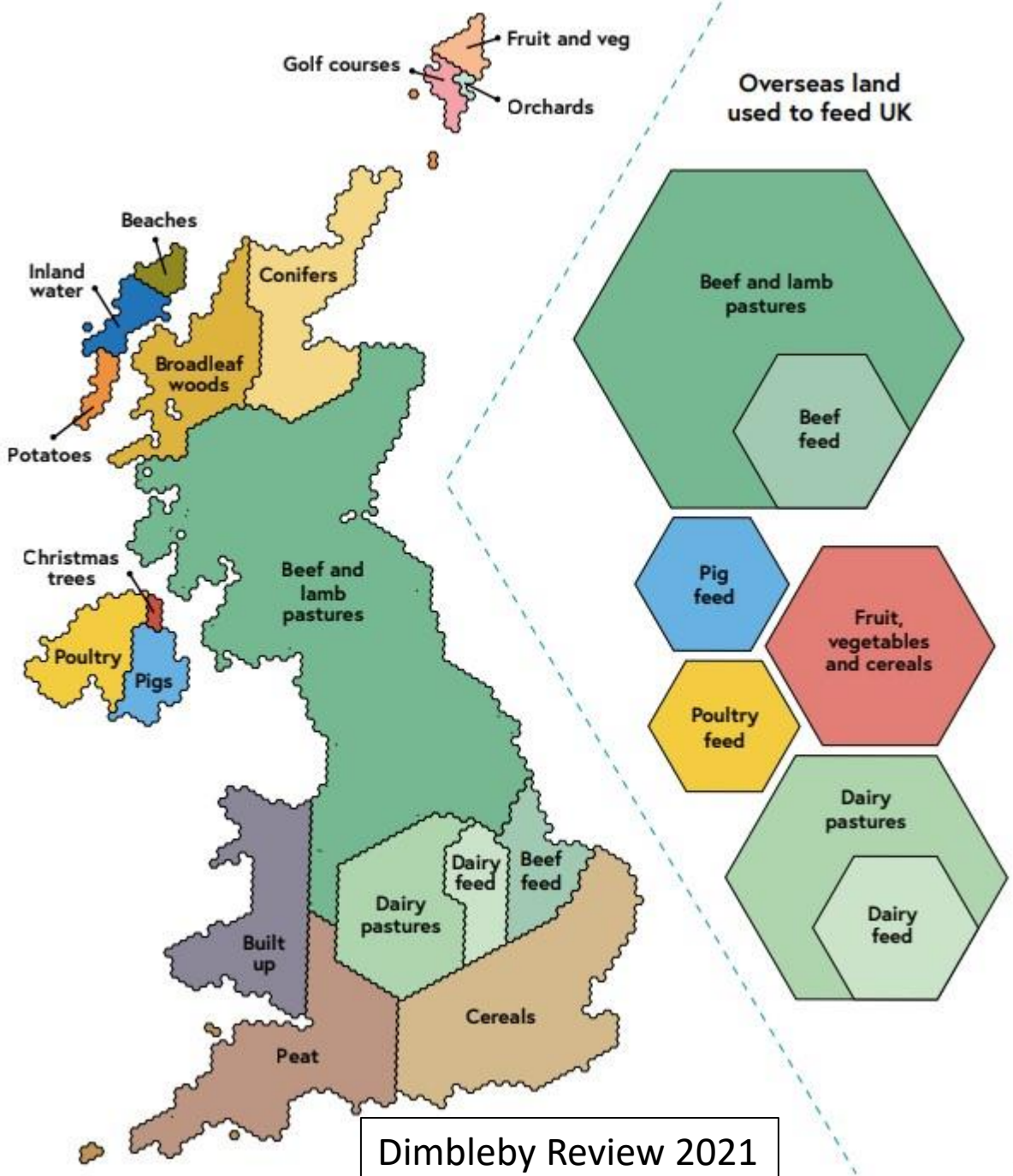
Agriculture is the single biggest cause of biodiversity loss



IPBES 2019



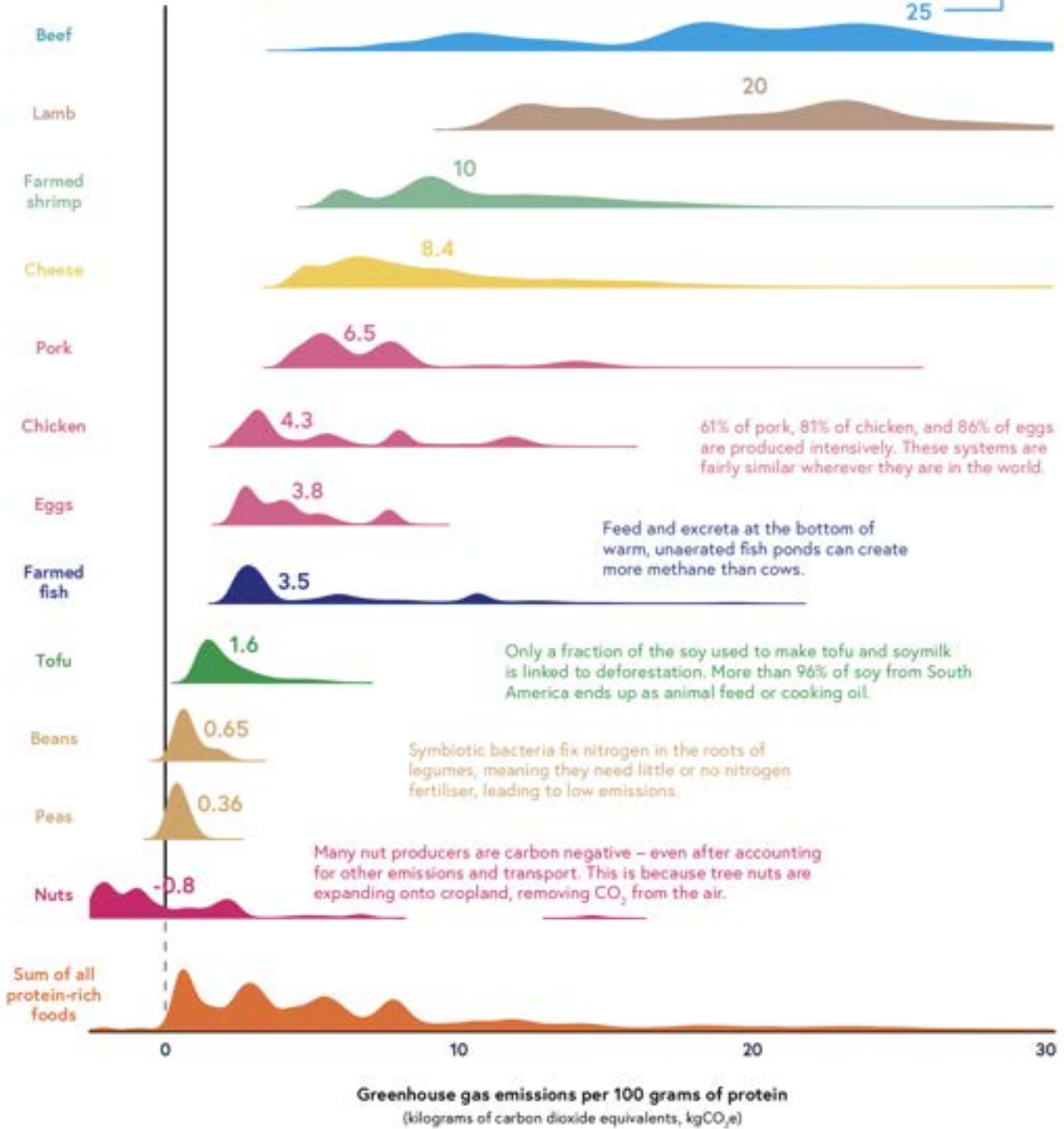
Royal Society Multifunctional Landscapes 2021



Dimbleby Review 2021

Sutainable proteins

Emissions by protein source



Dimbleby Review 2021

New environments; new crops

Palludiculture: bilberry, celery, cranberry, nettle, sedge grains, sweet grass grains, watercress, and fibre crops (e.g. for thatch)

£5m Defra fund for 'Paludiculture Exploration' launched in Sept 2022

Could growing celery in rewetted peatland help fight climate change?

A trial is farming crops that can tolerate high water levels on bogland, and prevent carbon being released

Celery plants in a wet farming trial in Greater Manchester. Photograph: Lancashire Wildlife Trust

Could celery help fight climate change? Peatlands in lowland Britain have been drained for agriculture and releasing carbon for years,

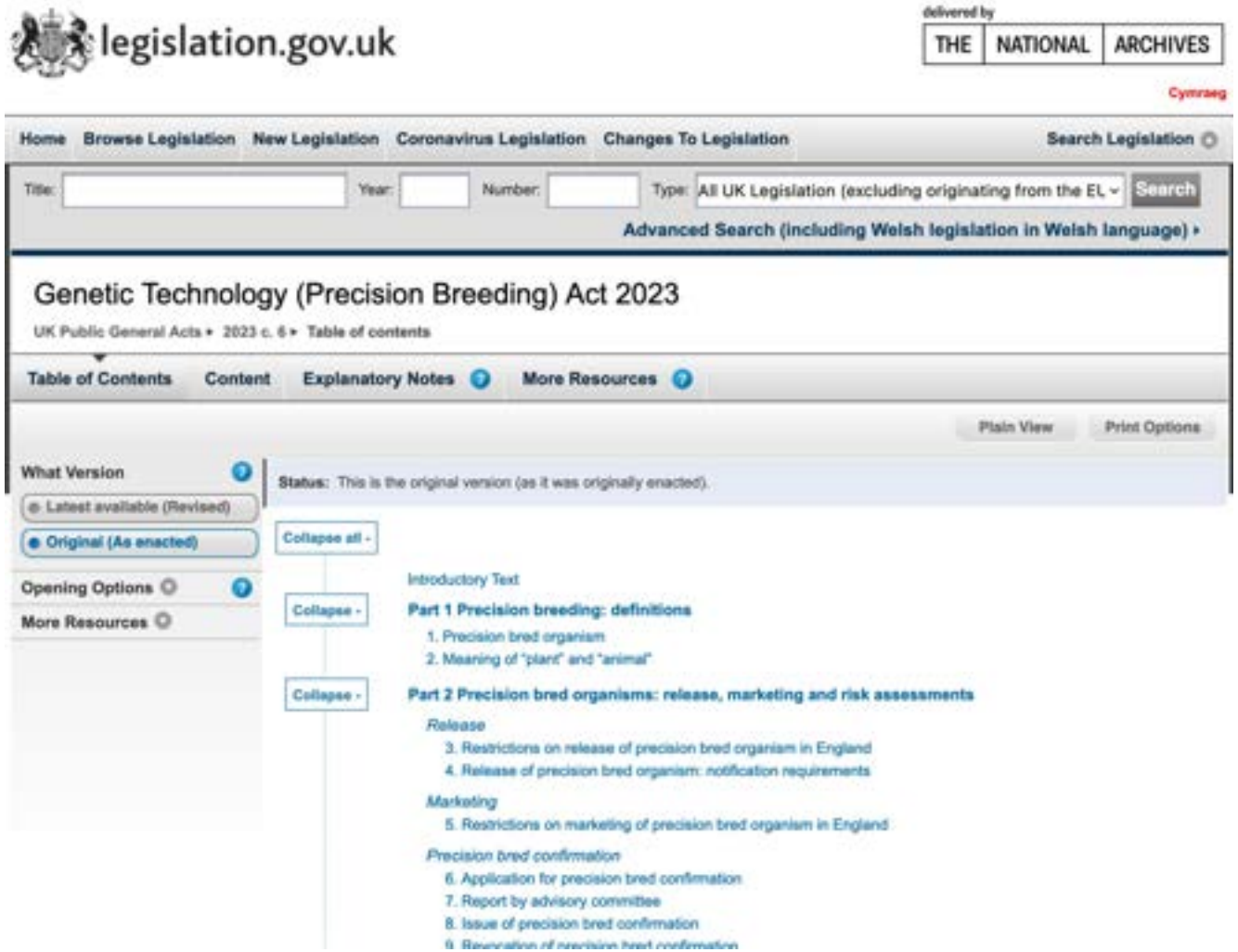
Millets: A focus in India

Broader range of protein sources

Genetic Technology (Precision Breeding) Act

The Precision Breeding Act is a major step in unlocking growth and innovation in technologies like gene editing. It supports Defra's efforts to reinforce food security in the face of climate change and ensure England becomes a world-leader in agri-food innovation.

Jan 2021: Launched consultation
Sept 2021: Gov response to consultation
May 2022: First reading in the Commons
June 2022: Committee stage
October 2022: Passed third reading in Commons
Nov 2022: First reading in Lords
Dec 2022: Committee stage
March 2023: Programme motion and consideration of ammendments
March 2023: Royal Assent



Some examples of precision breeding

Disease resistance and reduced agro-chemical use

Powdery Mildew resistance in tomato (Sainsbury Lab)
Panama Disease resistance in banana (Tropic Bioscience)

Climate and food security

High yielding heat-resilient wheat (John Innes Centre)
Enhanced nitrogen use in wheat (NIAB)
Drought tolerant soybean (approved for use in US, Argentina, and Brazil)

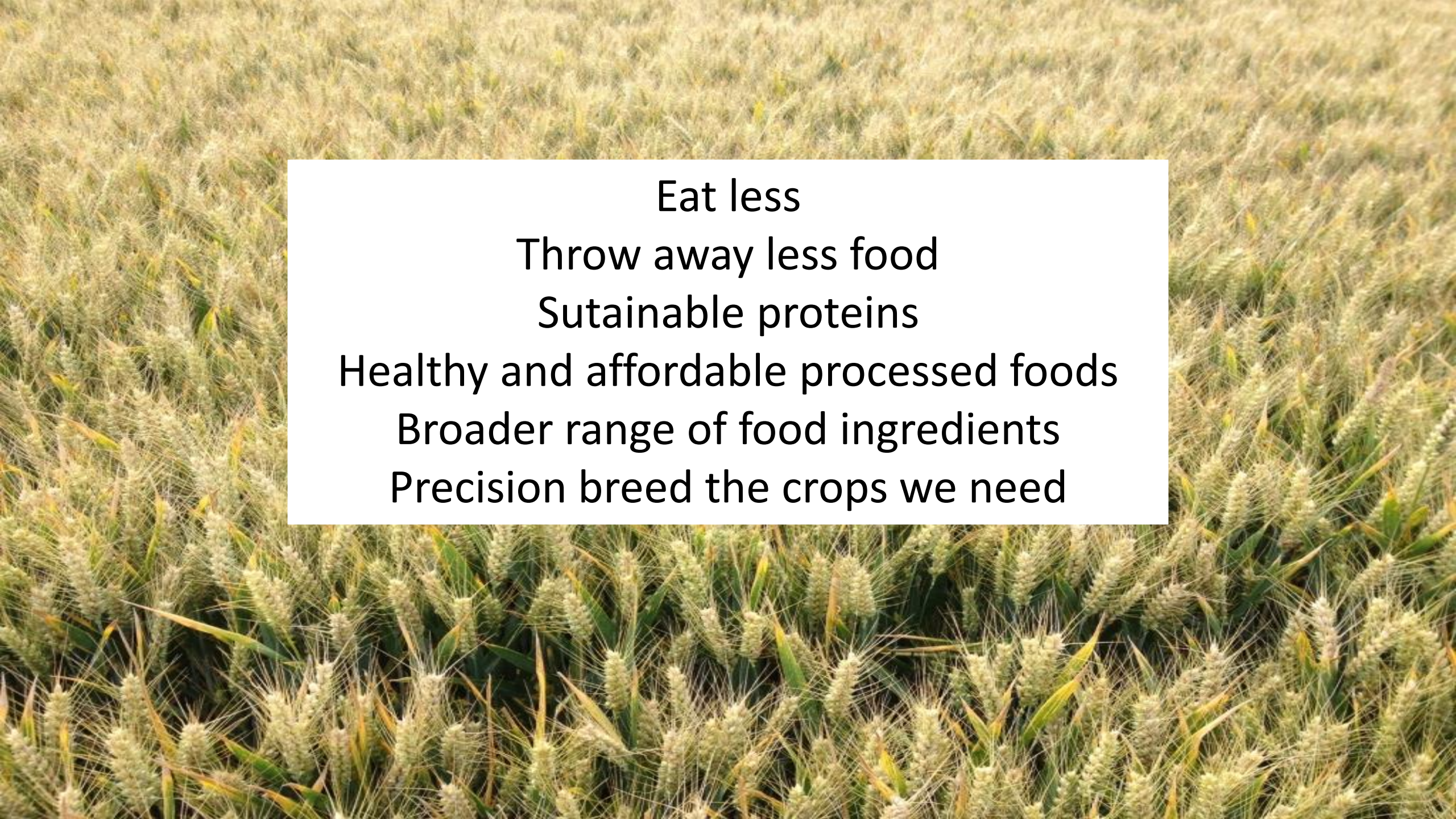
Public health

Low acrylamide wheat (Rothampsted)
Tomatoes biofortified with vitamin D (John Innes Centre)
Coeliac-safe wheat (NIAB and Wageningen)

Less bitter mustard greens (Pairwise; on sale in USA from May 2023)

Climate resilience?

German spruce under threat from drought and bark bettle


Eat less
Throw away less food
Sutainable proteins
Healthy and affordable processed foods
Broader range of food ingredients
Precision breed the crops we need

Ian Gordon

SDT Purpose

To advance professional development and recognition through knowledge transfer and networking.

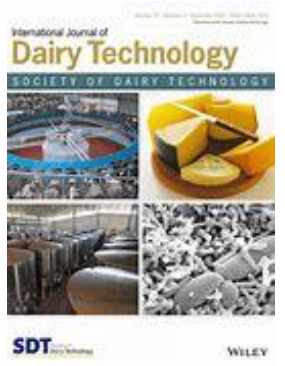
SDT Society of Dairy Technology
Passion for Dairy

The Society of Dairy Technology

- Founded in 1943
- 500 + members from the dairy industry and related industries
- Recognised professional body fostering scientific and technological developments in the dairy industry

SDT Society of Dairy Technology
Passion for Dairy

The Society of Dairy Technology



- Journal : ***International Journal of Dairy Technology***, (Wiley), publishes peer reviewed, original papers. The leading dairy processing journal published worldwide with an Impact Factor of 4.286
- 2022, 89 papers from 62 countries
- Top 5 India, Turkey, China, Iran and Brazil

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Other SDT Outputs

- Regional and National Conferences
- Networking and Mentoring opportunities
- E-learning training modules
- Dairy Technology Technical book series
- Site visits, regular Newsletters

SDT Society of Dairy Technology
Passion for Dairy

Dairy, Agriculture and Healthy Living

- The Society arose from the Milk Marketing Board and the desire to improve all aspects of Dairy in mid war
- The changes have been enormous since 1943

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Agriculture, England and Wales

- 1943 Cows/farm UK average **16**
- 2022 Cows/farm average **200+**
- 1943 Milk output for sale/cow **3kl**
- 2022 Milk output for sale/cow **8kl**
- 1943 share of TT herds **7%**
- 1960 share of TT herds **98%**
- Deaths England Bovine Tuberculosis, 1923 **1100**, 1960 **none**

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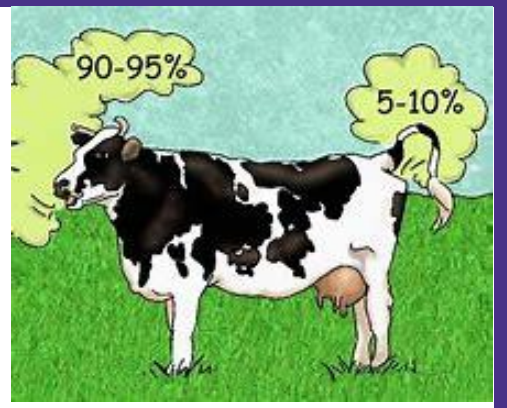
Dairy and Environmental Issues



- Cows and Methane: 35% fewer cows produce twice as much milk (1943-2022)
- Effluent, managed by careful processing, even used as feedstock for biogas generation
- Silage feed and self service systems reduce damage to grass crops
- High level of sterility through during processing means much less product spoilage

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Cow Milk Production

- 1943: Milk worldwide largely consumed as is, or converted into SMP or other medium/long lasting fractions, refrigeration very limited

- 1943: UK production 6 mioT, 87% liquid
- 2022: UK production 14.2 mioT, 43% liquid

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Milk and Healthy Living

- Milk and milk fractions
- Yogurt and similar fermented products
- Cheeses
- Whey and whey fractions

Not further considered today:

- Other milks (sheep , goat, camel, buffalo, horse..)
- Cream and Butter

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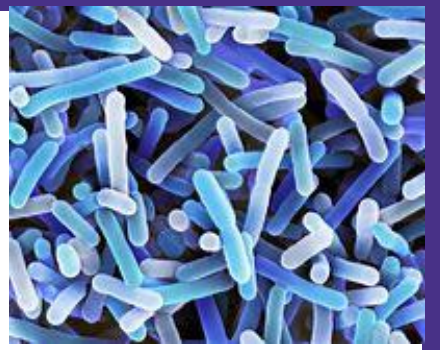
Yogurt and Healthy Living



- Yogurt (or Yoghurt) has been long recognised as a safe milk derivative with medium term shelf life, world consumption ca 70 million tonnes 2022
- The fermenting organisms have many health claims – especially probiotics fermented with *L acidophilus* and Bifidobacteria
- Claims already in Japan in 1929

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Cheeses and Healthy Living

- High nutrient density, long shelf life without refrigeration
- UK production 1943 25kT, demand 250kT
- UK production 2022 512kT, demand 740kT, value c. £15bio

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Milk Protein Concentrates 42/85 and Healthy Living

- MPC 42/85 2022 in Europe, value €0.5bio, demand 20kT
- Use 80% in food
- 20% Sports, Infant and Adult nutrition
- World 280kT, $2.7bio

Source: Giract: Global markets for Milk Proteins 2022-2027

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Milk Protein Conentrates 85+ and Healthy Living

- MPC 85+ 2022 in Europe, value EUR 0.4bio, demand 35kt
- 95+% Sports, Infant and Adult nutrition
- World 75kt $0.8bio

Source: Giract: Global markets for Milk Proteins 2022-2027

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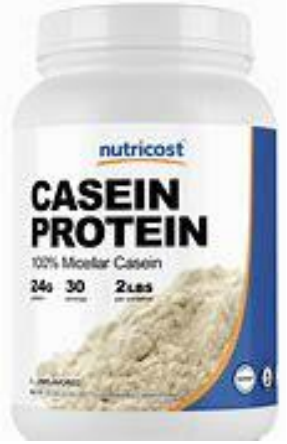
Casein/Caseinate and Healthy Living



- Casein/Caseinate 2022 in Europe, value €1.5bio, consumption 103kT
- Use 75% in food
- Sports, Infant and Adult nutrition 25%
- World, 330kT, $2.6bio

Source: Giract Global markets for Milk Proteins 2022-2027

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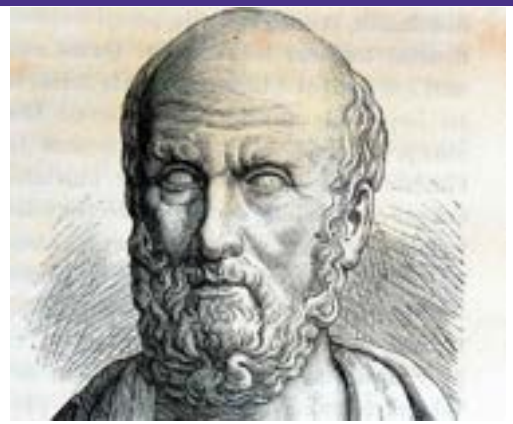
Whey and Healthy Living



- Hippocrates 2400 years ago prescribed it!
- Uses include, humanised baby formulae, sports and adult nutrition
- Whey 1943 virtually all as by-product to pigfeed
- Whey powder world production 2022 1.9bioT
- 2022 WPC's valued high level protein ingredients, and isolates also sought after

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Demineralised Whey Powder

- Europe 2022, value €0.6bio, demand 220kT
- Use 25% in food
- 75% Infant nutrition "humanising" cow milk
- World 520kT $0.8bio

Source: Giract: Global markets for Whey Proteins/Lactose 2021-2026

SDT Society of Dairy Technology
Passion for Dairy

Whey Protein Concentrates <90% Europe

- WPC 35-49% largely in standard foods and calf feeds c.100kT
- WPC 50-89% demand 110kT, value €0.8bio
- 40% Sports nutrition
- 45% Infant and Adult nutrition

Source: Giract: Global markets for Whey Proteins/Lactose 2021-2026

SDT Society of Dairy Technology
Passion for Dairy

Whey Protein Isolate and Fractions Europe

- WPI demand 2022, 35kT €0.4bio
- 15% Sports nutrition
- 85% Infant and Adult nutrition
- World 75kT $0.8bio

Source: Giract Global markets for Whey Proteins/Lactose 2021-2026

SDT Society of Dairy Technology
Passion for Dairy

Basic Dairy Products and Nutrition RDA%

Nutrient	2% Fat Milk	Cheddar Cheese	Yogurt
Calcium	31	28	26
Phosphorus	28	22	26
Protein	14	15	13

One serving about ¼ RDA Ca and P

SDT Society of Dairy Technology
Passion for Dairy

Dairy and Healthy Living

In conclusion:

- Milk and many milk fractions may be seen to contribute to Healthy Living, notably in infant, adult and sports nutrition
- Thank you for your Attention

  (Sources: SDT archive, Giract, Dairy UK, ADHB, Statista, FAO)

SDT Society of Dairy Technology
Passion for Dairy

Microbial Synergy for Sustainable Agriculture and Health

Diane Purchase

Professor of Environmental Biotechnology

Middlesex University

ProFSET

Professional Food Science, Engineering and Technology Group

Applied Microbiology International

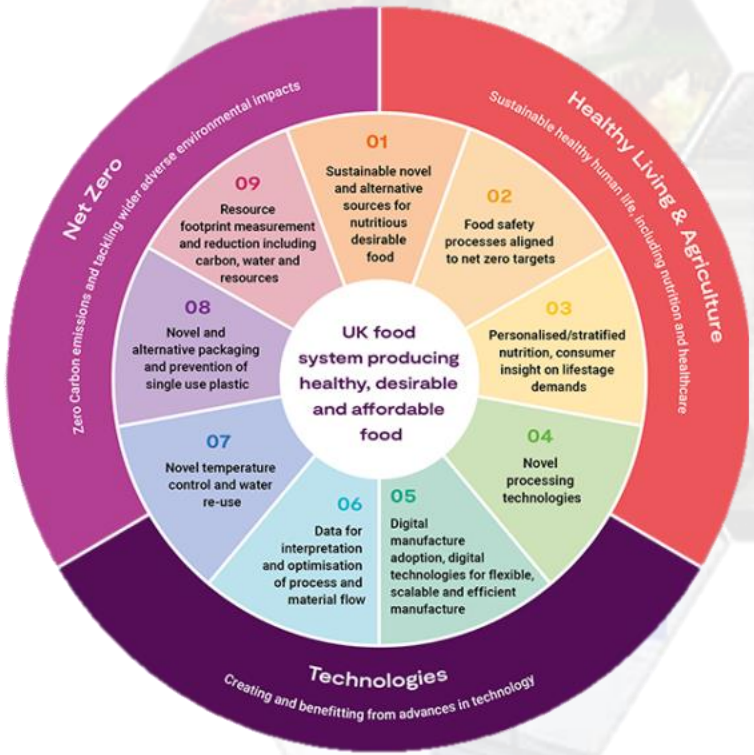
About Applied Microbiology International

Applied Microbiology International

- Formerly the Society for Applied Microbiology
- The oldest microbiology society in the UK founded in 1931
- Solving the world's greatest challenges by bringing the applied microbiology community together, across borders and disciplines, to enable meaningful collaboration that delivers scientific impact
- AMI Advisory Groups. E.g.,

Healthy food, people and planet

UKRI



European Green Deal

Microbial Synergy

- Co-operative interaction between different microorganisms (e.g., bacteria and fungi) where they collaborate to create a synergistic environment that achieves greater benefit for the consortium
- E.g., compost microbial community

Microbial Synergy in Sustainable Agriculture

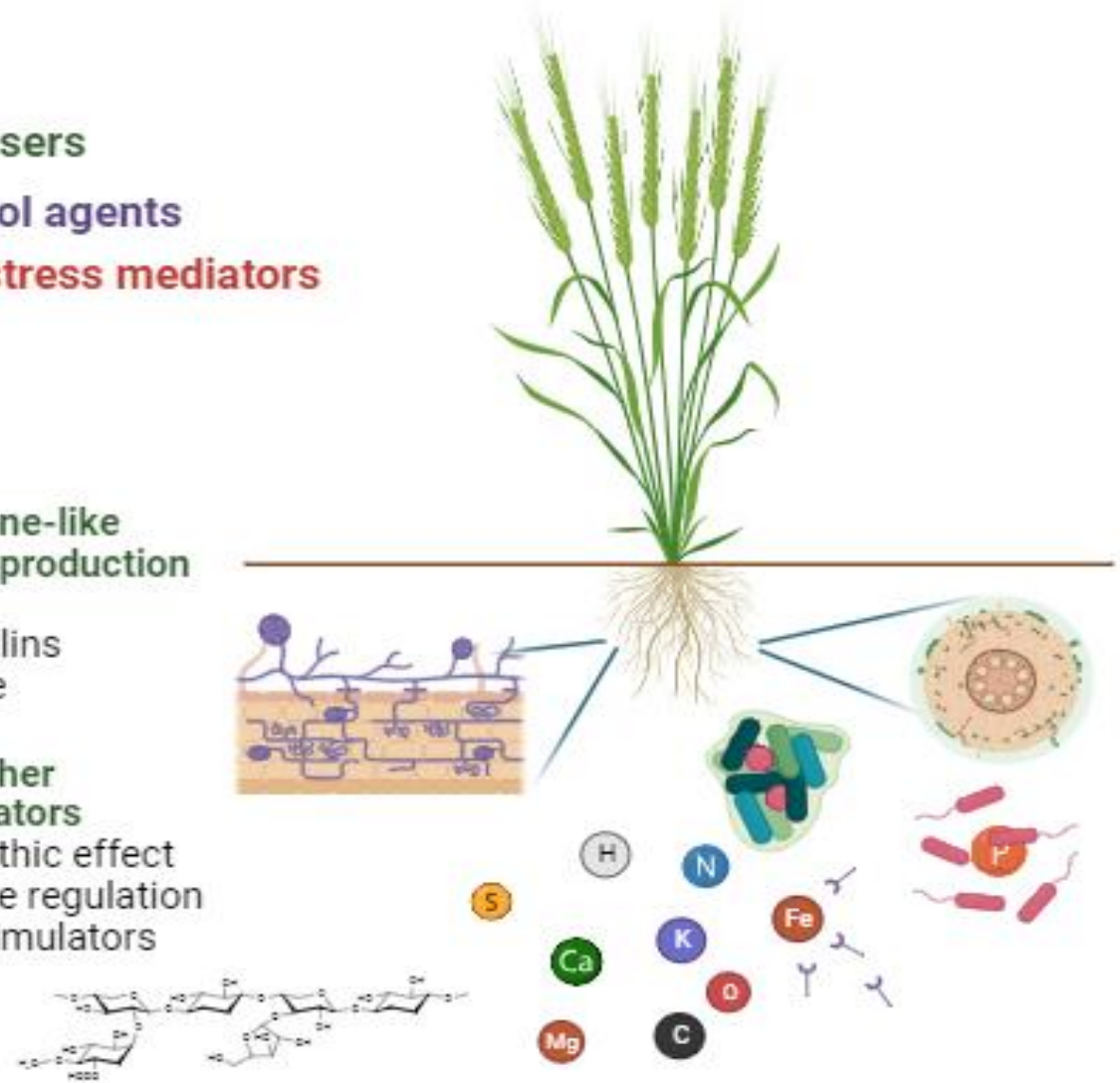
Biofertilisers

Biocontrol agents

Abiotic stress mediators

Phytohormone-like compounds production
- auxin
- gibberellins
- ethylene

Volatile & other phytostimulators
- allelopathic effect
- hormone regulation
- phytostimulators



Abiotic stress:
- redox regulation
- drought tolerance
- hormone regulation
- detoxification

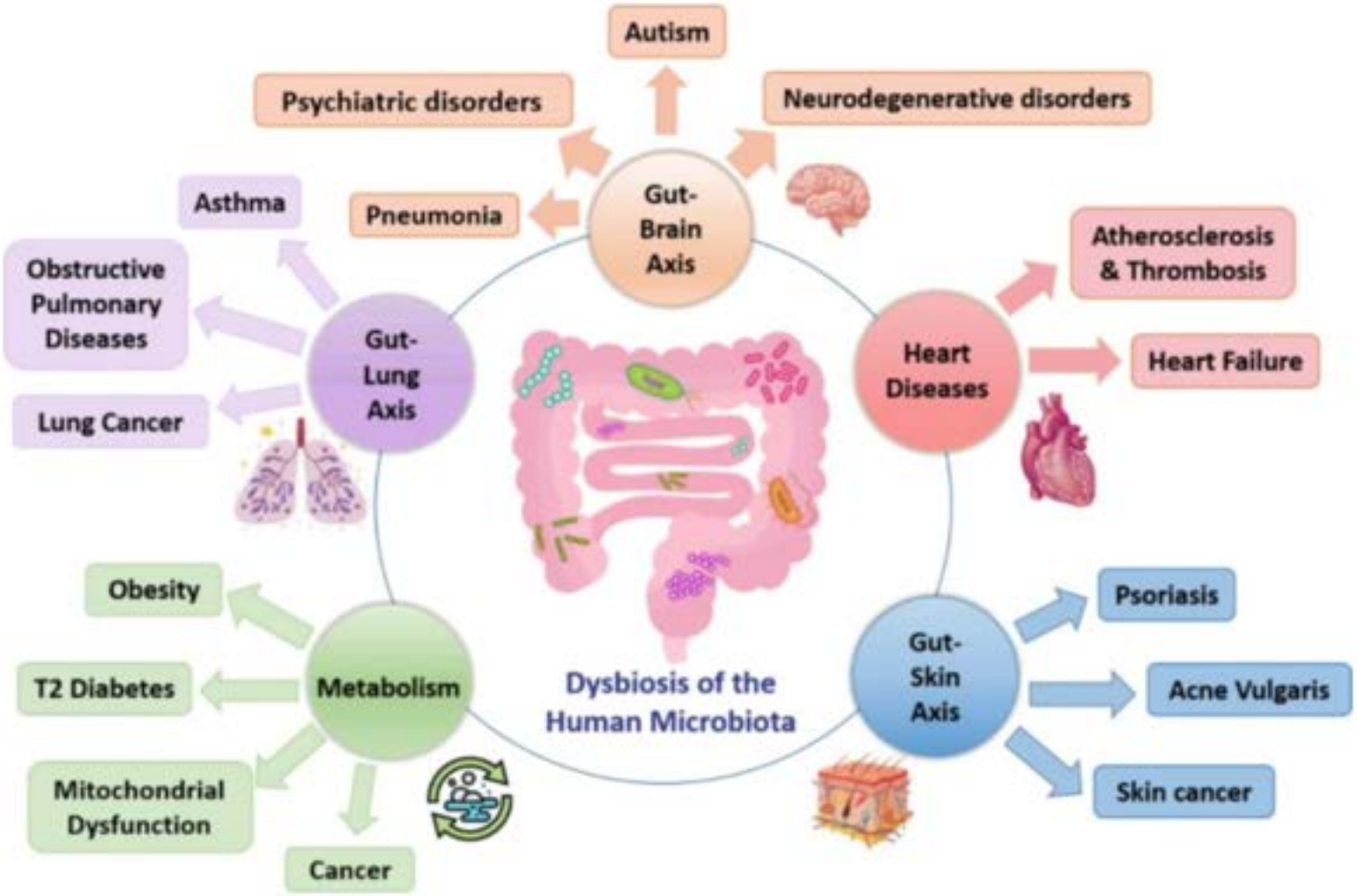
Pathogen protection:
- antibiotics
- quorum quenching
- ISR

Enhanced nutrient uptake
- biological nitrogen fixation
- phosphate solubilisation
- iron uptake

Microbes on Your Plate

- As a protein source – e.g. *Fusarium*
- In the form of fermented foods - e.g. yoghurt, kefir, kimchi, tempeh and sauerkraut
- As probiotics – e.g. *Lactobacillus* and *Bifidobacterium*

The importance of microbiome and well-being

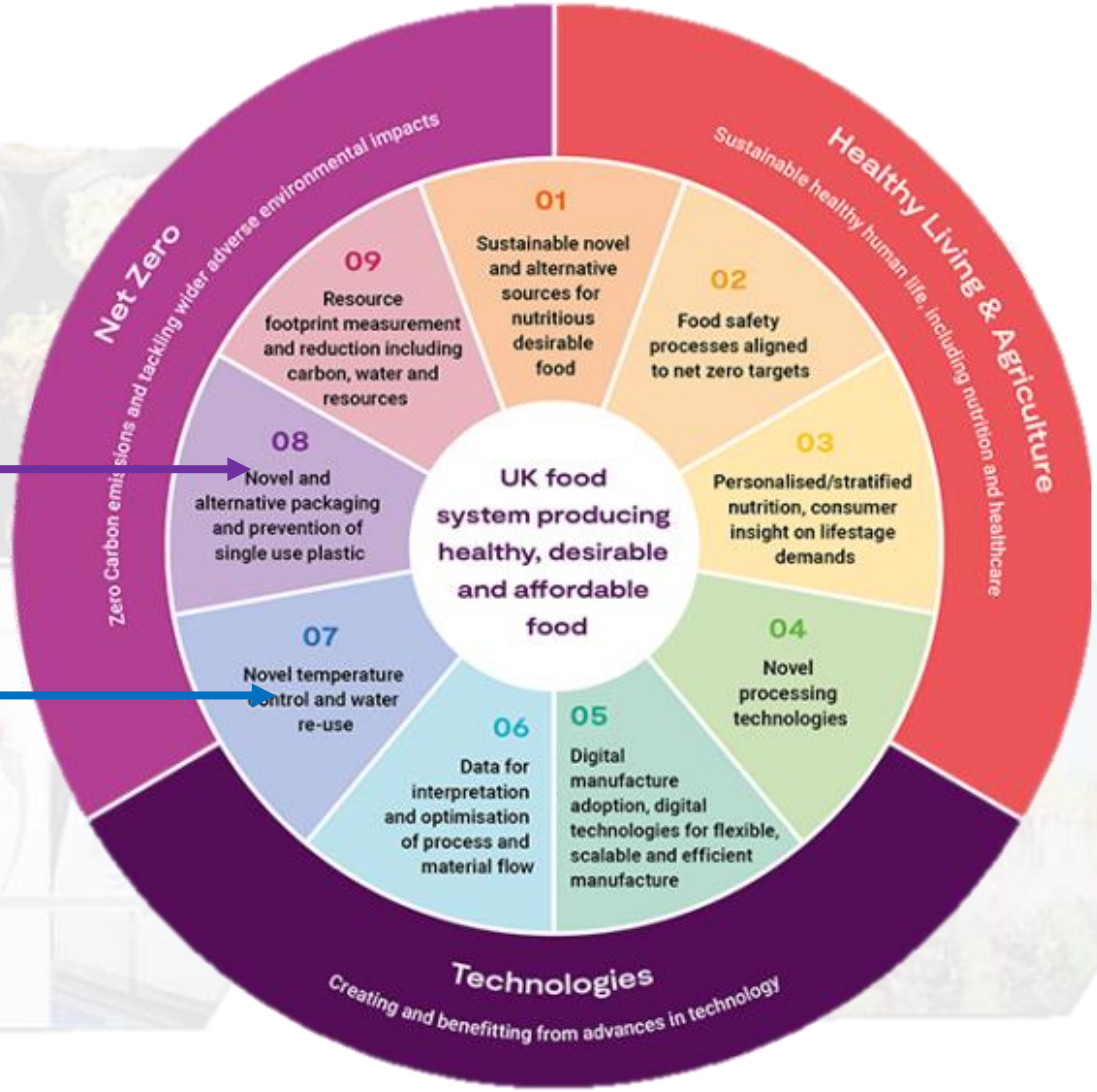


Gebrayel, P., Nicco, C., Al Khodor, S. *et al.* Microbiota medicine: towards clinical revolution. *J Transl Med* **20**, 111 (2022). https://doi.org/10.1186/s12967-022-03296-9

Microbes beyond Health Living & Agriculture

Biobased polymer
e.g. PHA, PLA

Wastewater reuse
e.g. Membrane Bio-reactor filtration



In summary

In agriculture

- Soil health
- Plant health
- Disease suppression
- Biological control
- Reduce the reliance of inorganic fertilisers and pesticides

On our plate

- Fermentation
- Probiotics
- Food preservation
- Gut health

Microbial Synergy and Transdisciplinary Solutions

- Break down disciplinary barriers
- Provide an integrated approach to sustainable agriculture
- Support healthy soils and human well-being
- Be part of the solution to enhance ecosystem resilience, adaptability and sustainability
- Contribute to policy development


Thank you for
listening

Novel processing technologies to deliver positive consumer food choices

John Bows – PepsiCo R&D (Leicester, UK)

IOP Institute of Physics
Food Physics Group

ProFSET
Professional Food Science, Engineering and Technology Group

PepsiCo R&D

The views expressed in this presentation are those of the author and do not necessarily reflect the position or policy of PepsiCo, Inc.
John Bows is an employee of PepsiCo, Inc.

PepsiCo is a global beverage and convenient food company with a portfolio of trusted brands

Net Revenue

More than
$86 billion
in 2022

Operating Profit

More than
$12 billion
in 2022

Iconic

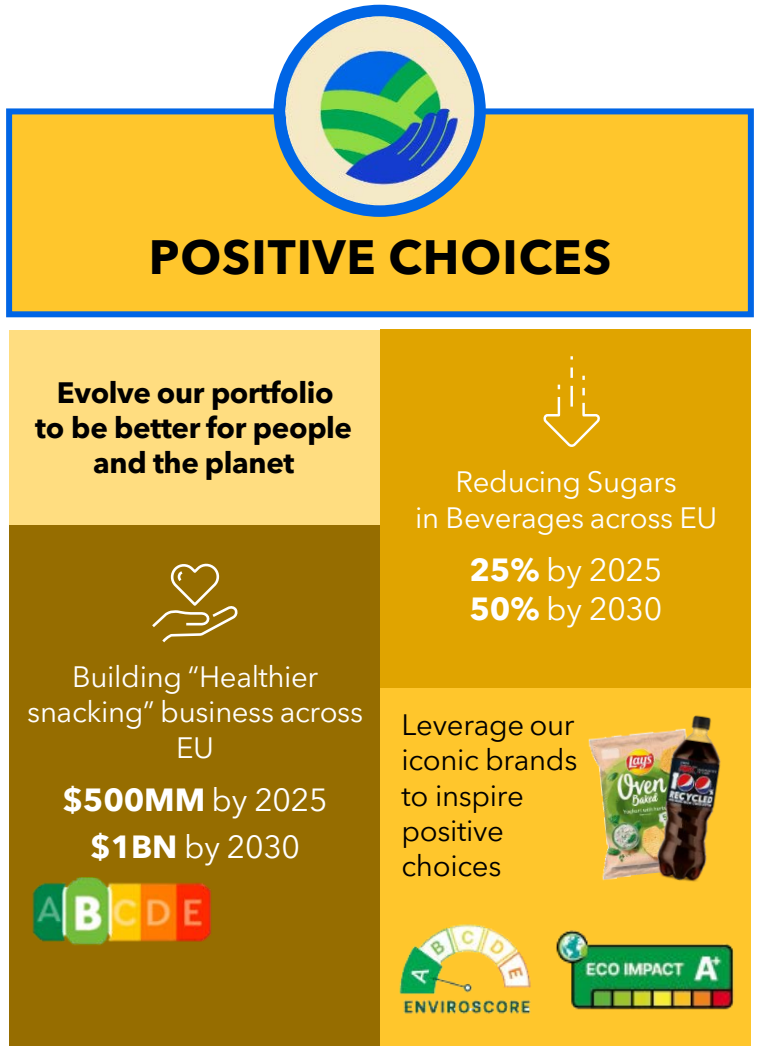
23 bn-dollar
brands sold in over 200+ countries and territories

Purposeful

pep+ pepsicopositive planet + people

Creating growth and value

Food process technology can unlock positive consumer food choices committed by PepsiCo pep+



Nov 2023

… **"diverse ingredients,"** which we define as food groups and ingredients – such as legumes, whole grains, plant-based proteins, fruits and vegetables, nuts and seeds – that people don't consume enough of in most countries. By 2030, we aim to **deliver 145 *billion* portions of diverse ingredients annually in our global convenient foods portfolio.** Each portion will provide approximately 10% of the suggested daily amount of the relevant ingredient

https://www.pepsico.com/who-we-are/our-commitments/pepsico-positive

Microwave drying unlocks nutrient retention from high moisture fresh vegetables as it's rapid, gentle and low temperature

Hybrid Baking Process

Rapid Microwave Drying → Rapid Hot Air Impingement Drying → Slow Hot Air Convective Drying

Fresh mashed potato blended with chopped fresh vegetables (70% m/c)

Deposited as a disc with large in-tact vegetable pieces

Dried snack retains nutrition value of vegetables pieces

Impact of Pre-Processing and Food-Processing Technique on the Phytochemical Content of Vegetable Baked Snacks (2023). Langston et al. Food Bioscience

Baked vegetable snacks made on a novel Hot Air Baking process* demonstrated in *clinical trials* equivalent bioaccessibility of phytochemicals compared to fresh cook control.

75g Baked snacks = 460g fresh cook veg mix

Used from Freeze Dried

Used from Frozen

Glucoraphanin *β-carotene* ***Quercetin*** ***Apigenin***

Also exhibited equivalent bioavailability (how much the body absorbs)

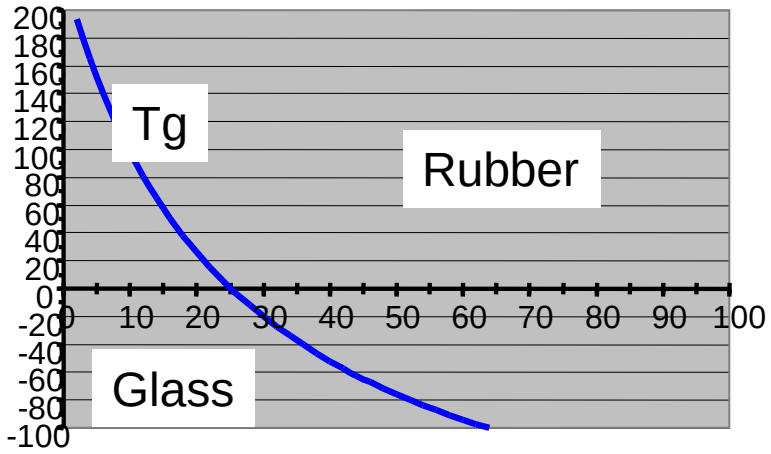
Research led to publications and patents

- Patent GB 332748 filed 7-Jul-2017, WO 2019008088 filed 5-Jul-2018
- Paper on clinical trials published in Journal of Functional Foods (2018)
- Further publications by PepsiCo-funded PhD on nutrient retention from baked snacks (Langston)

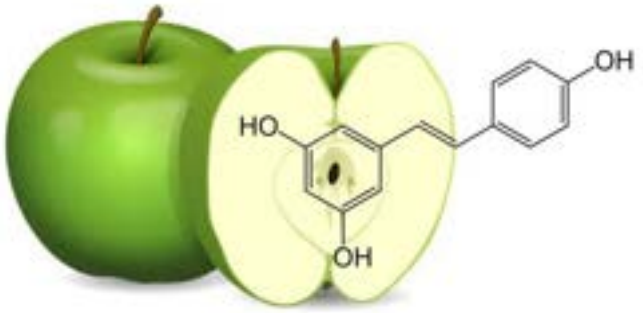
* Project Oliver (2012-14) was a UK Government co-funded TSB project between PepsiCo, Quadram and Uni. East Anglia

Understanding snack production through lens of Soft Matter Physics, Field Physics & Flavour Chemistry can unlock great tasting healthy snacks made from fresh-only ingredients with purposeful choice of process technologies

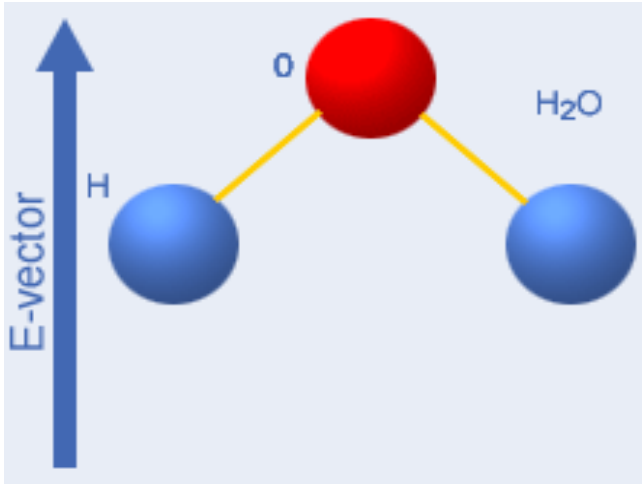
Soft Matter Physics



Flavour Chemistry

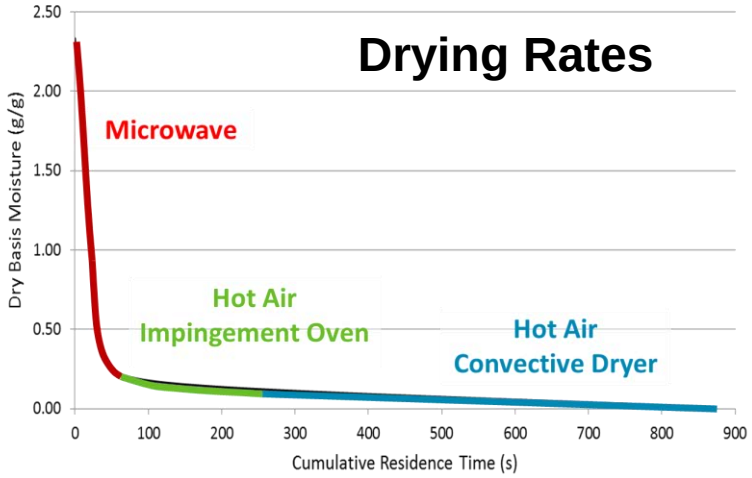


Field Physics



Gentle Ingredient Handling

Drying Rates



Dielectric Theory

$$\nabla \times H = \sigma E + D/t$$

$$\Delta T / \Delta t \propto f E_m^2 \varepsilon'' / \rho C_p$$

$$\varepsilon^* = \varepsilon' - j\,\varepsilon''$$

Without fully understanding the complete ingredient transformational physics, simply replacing frying with microwave drying has met with limited consumer success

c. 2010 (US)

re-launch 2012 (US)

Discontinued 2018

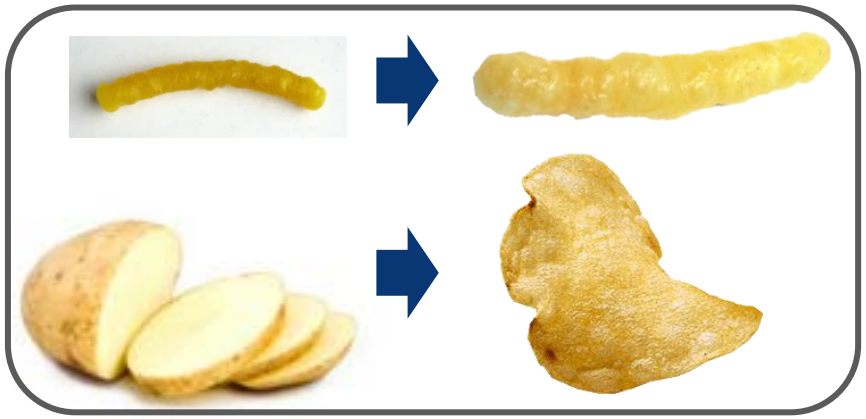
Launched 2014 (UK)

Discontinued

M&S “Count on Us”
UK, 3% fat

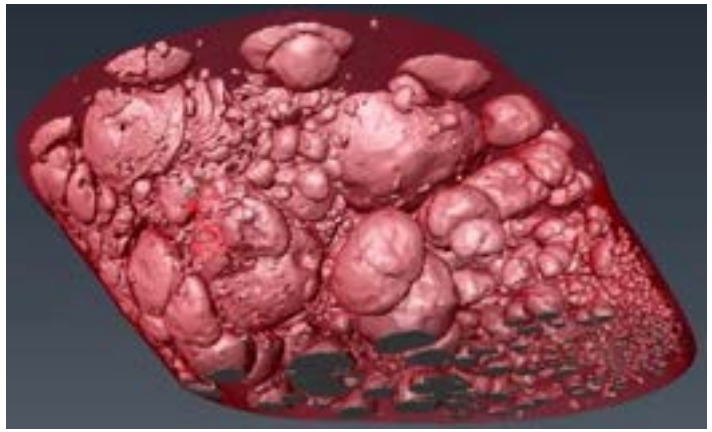
“Novel processing” technologies can deliver positive consumer food choices with natural ingredients

Understand ingredient to product transformation (texture, flavour, appearance)



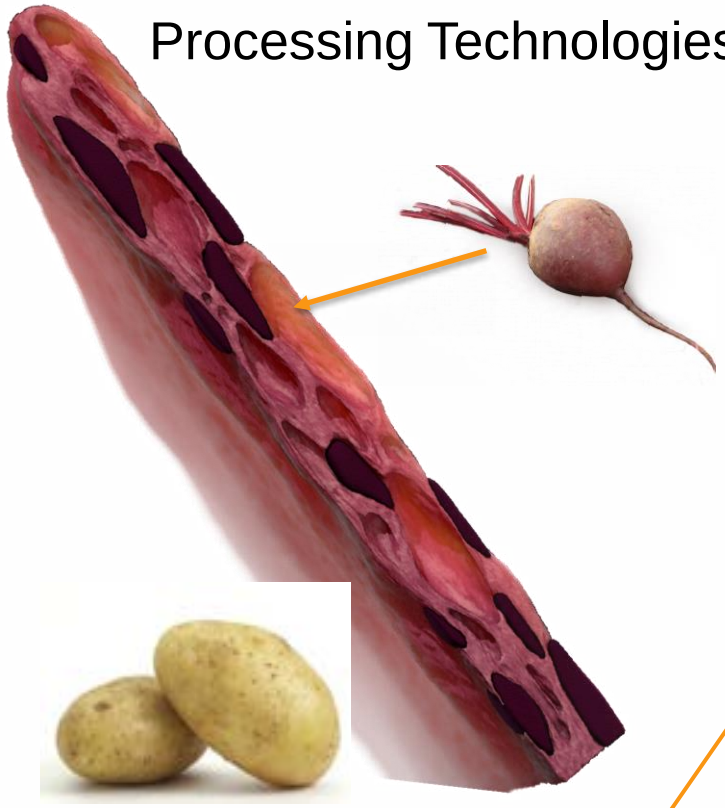
Agri Science to Soft matter physics

Quantify Transformations
(Imaging, Measurement, Analytical, Sensory and Virtual First Capabilities)



X-Ray 3D imaging of expanded snack showing air pores and cell walls

Deliver transformation through Nutrient-Retention Gentle Processing Technologies



In-tact microstructure of vegetable inclusions in fresh mash potato snack

Net zero and our needs as an industry

Dr Laura Malhi *PhD AMIChemE CEng*

Food & Drink Special Interest Group

www.icheme.org

ProFSET

Professional Food Science, Engineering and Technology Group

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

Dr Laura Malhi – A little about myself

Food & Drink
Special Interest Group

www.icheme.org

IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

ProFSET Mission. Identify and propose actions in Science and Technology, to meet the future needs of an efficient UK Food Supply Chain in the rapidly changing global situation

Focus Areas

1. **A single, informed voice to influence and support government, media and the public**
2. **Providing opportunities for collaboration, knowledge sharing and cooperation across industry and academia**
3. **Promoting the industry as an exciting career path and supporting the development, education and training of professionals**

"A single, informed voice to influence and support government, media and the public"

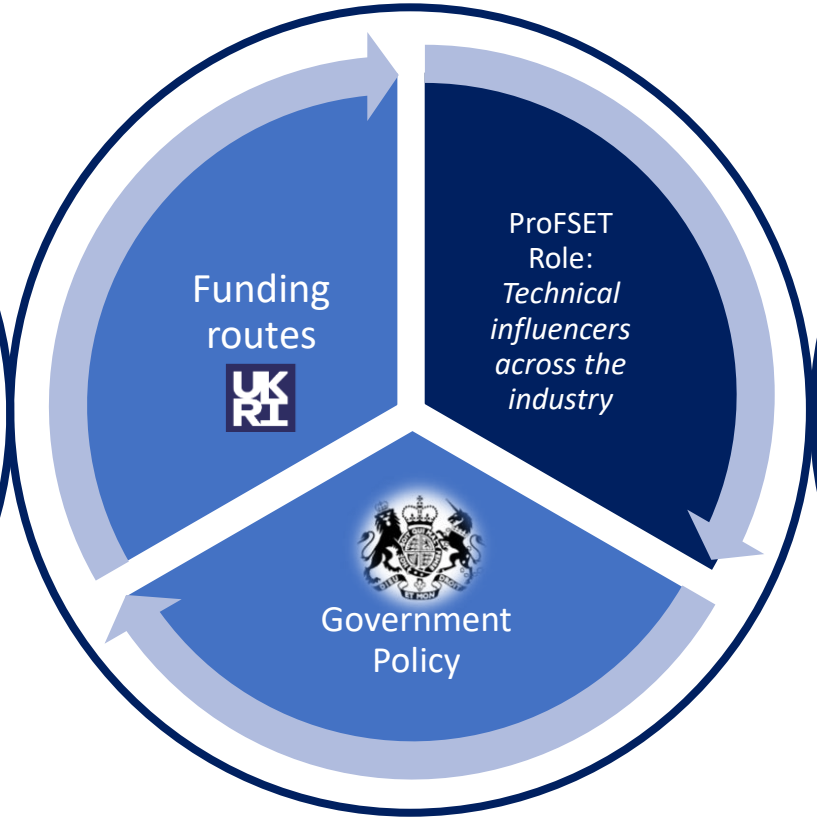
ProFSET
Professional Food Science, Engineering and Technology Group

WHY ACTION IS NEEDED:

The Agri-Food industry is the largest in the UK generating £128b GVA, accounting for 20%[2] of the manufacturing industry though 98% of the companies are SMEs.[1] This leads to estimated emissions of 150 Mt of CO2e in 2019.[3]

Communicating the needs of the breadth of the industry with 'one voice' is vital to ensure sufficient funding is invested to achieve net zero targets & promote economic growth.

PROFSET ROLE:



WHAT WE WILL DELIVER:

We will take a strategic lead in liaising with UK government & academia on scientific & technical demands from the industry.

Short term deliverable:
Support academic / industry partnerships bidding for UKRI funding
(e.g. 2022/23 - £12m EPSRC funding to establish a food manufacturing hub).

Longer term goal:
Maintain network across the professional bodies & industry to influence funding.

1. https://www.gov.uk/government/statistics/food-statistics-pocketbook/food-statistics-in-your-pocket. 2. https://www.fdf.org.uk/fdf/business-insights-and-economics/facts-and-stats/
3. https://wrap.org.uk/taking-action/food-drink/actions/reducing-greenhouse-gas-emissions

Today's talk: Purpose

Share our vision for ProFSET's role: Technical input

Celebrating the wheel with ProFSET member feedback

Technical inspiration from the 'Net Zero' section

Representing 10,000 members in total!

Approaching our members for feedback on the wheel

Nov 2022 – shared a survey with our members
Asked our members to vote on areas
that require increased funding.

Disclaimer!
The following results are some of the areas that were voted highly for needing increased funding, and does *not* cover *ALL*!

Approaching our members for feedback on the wheel

Solutions for turning current waste streams into useful cost neutral or higher value commodities.

- Exploiting under-utilised crops that suit UK agronomy under changing climatic conditions.
- Approaches that improve nutritional composition including increasing fibre and micronutrient content whilst reducing fat/salt/sugar.

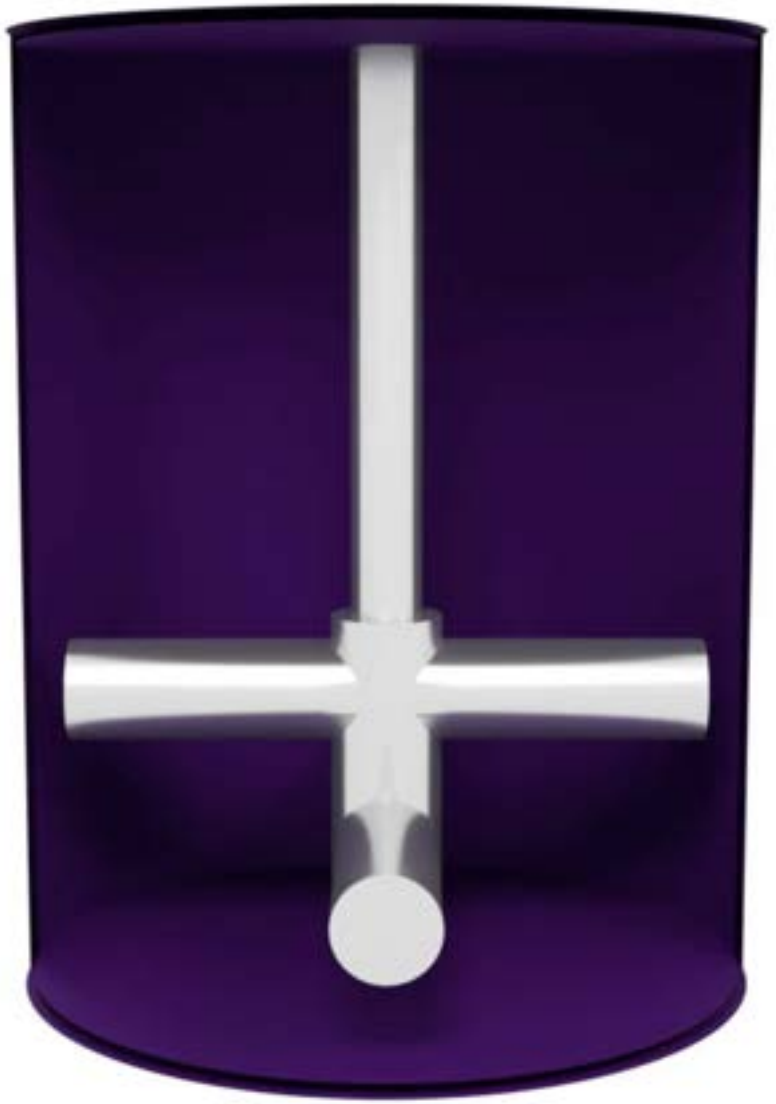
- Advanced mono-materials that facilitate (onsite) recycling or increased biodegradability.
- Increase recycled content of packaging, cut virgin plastic use.
- Re-usable packaging solutions.

Improve resource efficiency with reduced greenhouse gas emissions in reimagined food processing

Evolutionary Optimisation “Reimagined food processing”

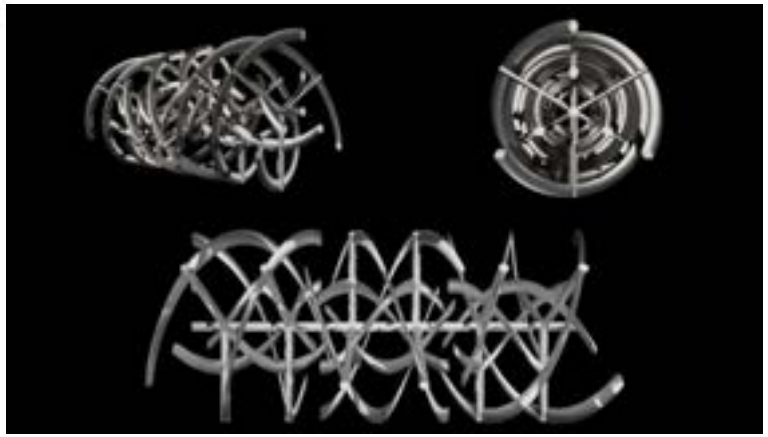
Milling:

- >3% of **global energy**
- Often <1% efficient
- “Classical” trial-and-error optimisation slow & expensive
- **How to improve sustainability in a tractable manner?**



Evolutionary Optimisation “Reimagined food processing”

EvoPhase+



Ref: Christopher Windows-Yule

Today's talk: Summary

Shared our vision for ProFSET's role:
Technical input
Celebrated the wheel with some
ProFSET members feedback

Improve resource efficiency with reduced greenhouse gas emissions in reimagined food processing

DECARBONISING HEAT IN THE FOOD SECTOR – EXAMPLES & FUTURE PERSPECTIVES

Institution of MECHANICAL ENGINEERS

23 November 2023

Elliot Brown
Project Engineer
Element Digital Engineering Ltd

Improving the world through engineering

PRESENTATION AGENDA.

01 Introduction to Element Digital Engineering

02 Modelling & Simulation: Decarbonising Heat

03 Future Opportunities

04 Conclusions

WHO ARE ELEMENT DIGITAL ENGINEERING

An engineering consultancy company formed as Norton Straw in 2011 and a business unit of Element Materials Technology since 2022.

Deep specialists in the use of numerical analysis to support design, operational and safety challenges in high-hazard and capital-intensive industries.

Active participants in nationally-funded R&D programmes and collaborators with major software companies in developing new methods and techniques.

Developers of specialist software solutions for analysis and assessment problems that cannot be addressed with commercial codes.

PREVIOUS PROJECTS DELIVERED FOR…

Solar Turbines
A Caterpillar Company

ABB

SIEMENS
Ingenuity for life

PEPSICO

Rolls-Royce®

Schlumberger

UK Atomic
Energy
Authority

Allseas

Mondelēz
International

wood.

MEGGiTT

OneSubsea
A Schlumberger Company

MAGTEC
HYBRID & ELECTRIC VEHICLE DRIVES

WHY MODELLING & SIMULATION

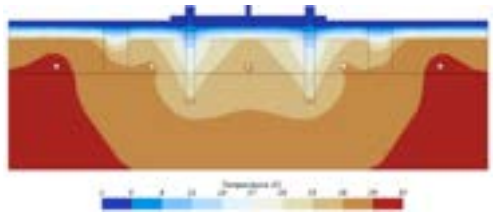
- Rapid assessment of design options without the need to build prototypes
- Understand systems over time (high cycle fatigue or thermal stresses)
- Gain insight to underlying physics phenomena
- No downtime required for production lines
- Assess dangerous systems without human risk

REFRIGERATED ROOM

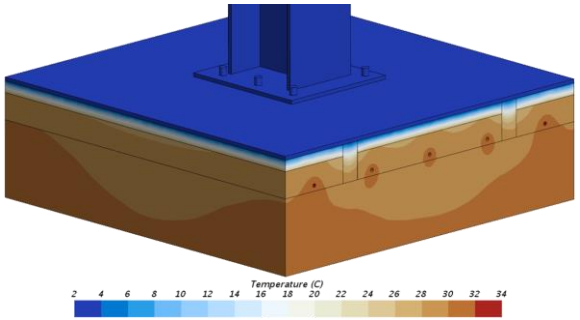
Challenge

Our client was installing the floor for a refrigerated room.

Heat transfer through the floor was allowing excess heat into the cooled room from the ceiling below.



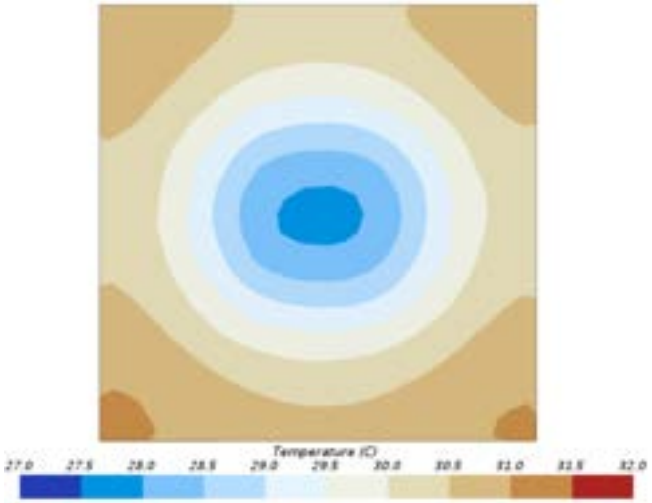
Model section temperature gradient



Model temperature gradient

Approach

We applied our knowledge of heat transfer mechanics to construct and simulate thermal models using an iterative approach to reach a converged heat transfer coefficient.



Ceiling temperature gradient

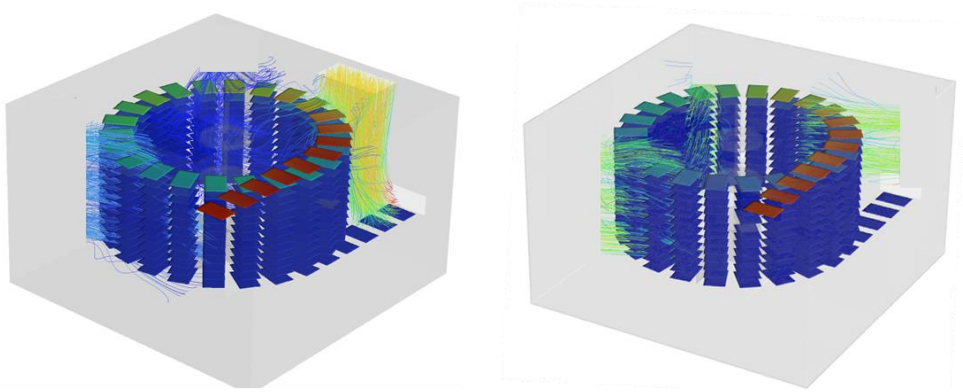
Outcome

Optimised design reduced heat leak into the cooled room, and reduced energy requirements for cooling by 50%.

WAFER COOLER

Challenge

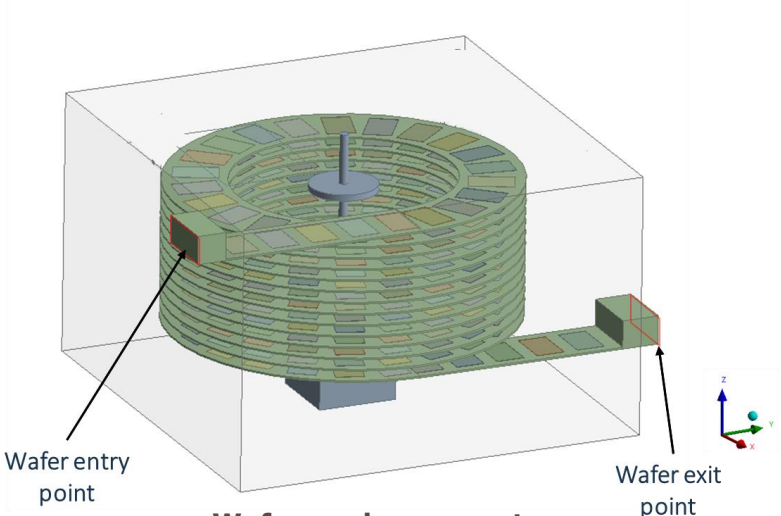
Our client was looking to increase throughput of a wafer cooling unit, while maintaining existing performance.



Computational Fluid Dynamics (CFD) results

Approach

We used a CFD model to assess the cooler and present potential design improvements. The preferred design was compared to the original cooler.



Wafer cooler geometry

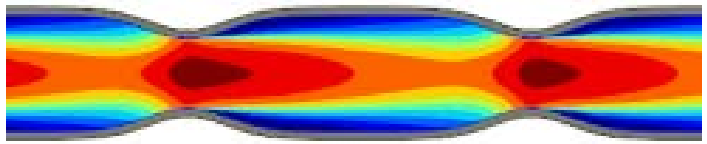
Outcome

Cooling of the wafers was improved leading to an improvement in throughput of 20% for the same energy costs.

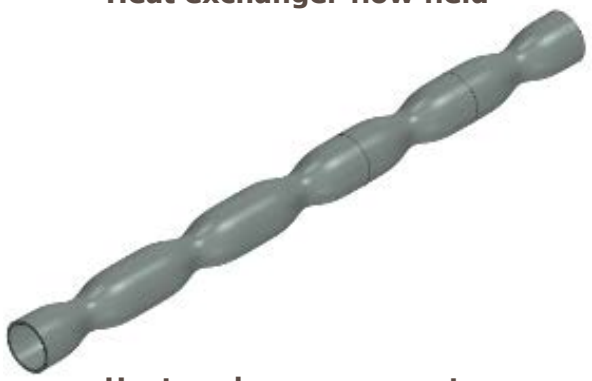
HEAT EXCHANGER

Challenge

Our client wanted support with optimization of the tube wall pattern of shell-and-tube a heat exchanger.



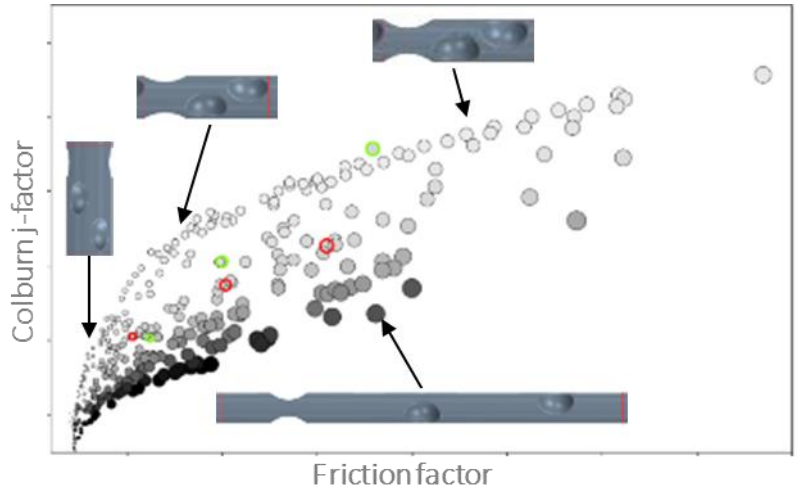
Heat exchanger flow field



Heat exchanger geometry

Approach

We used experimental data to validate our initial model, we then performed a design optimisation study to improve the heat exchanger performance.



Design study results

Outcome

We were able to demonstrate a 20% performance increase over the same pressure drop, and a 50% decrease in pressure drop for the same thermal performance.

FUTURE OPPORTUNITIES

- Increasing demand for engineering and data models of end-to-end processes
  - Optimisation of full production lines to reduce energy requirements
- Development of Reduced Order Models (ROMs) allows for condition-based monitoring and process optimisation
  - Reduction in reduction in production line waste and minimised maintenance burden
- Development of Apps
  - Democratisation of modelling & simulation to engineers close to the issues
- Materials modelling to validate suitability of new sustainable materials
- Data driven approaches to identify possible savings

CONCLUSIONS

- The digital space can lead to real world benefits
  - Modelling & simulation allows for valuable insights into the wide variety of physics that are encountered during food & drink manufacture
  - Understanding thermal characteristics of systems and processes can lead to a reduction in energy usage
- Digital engineering can be used in tandem with real world data to build robust models and validate them against real world data
  - This allows us to rapidly test new ideas and designs in the digital space before committing to implementation
- Insights from other industries can be used to drive emissions reduction in food and drink

FURTHER READING

- Report published September 2023 by the IMechE Food & Drink Engineering Committee (FDEC)

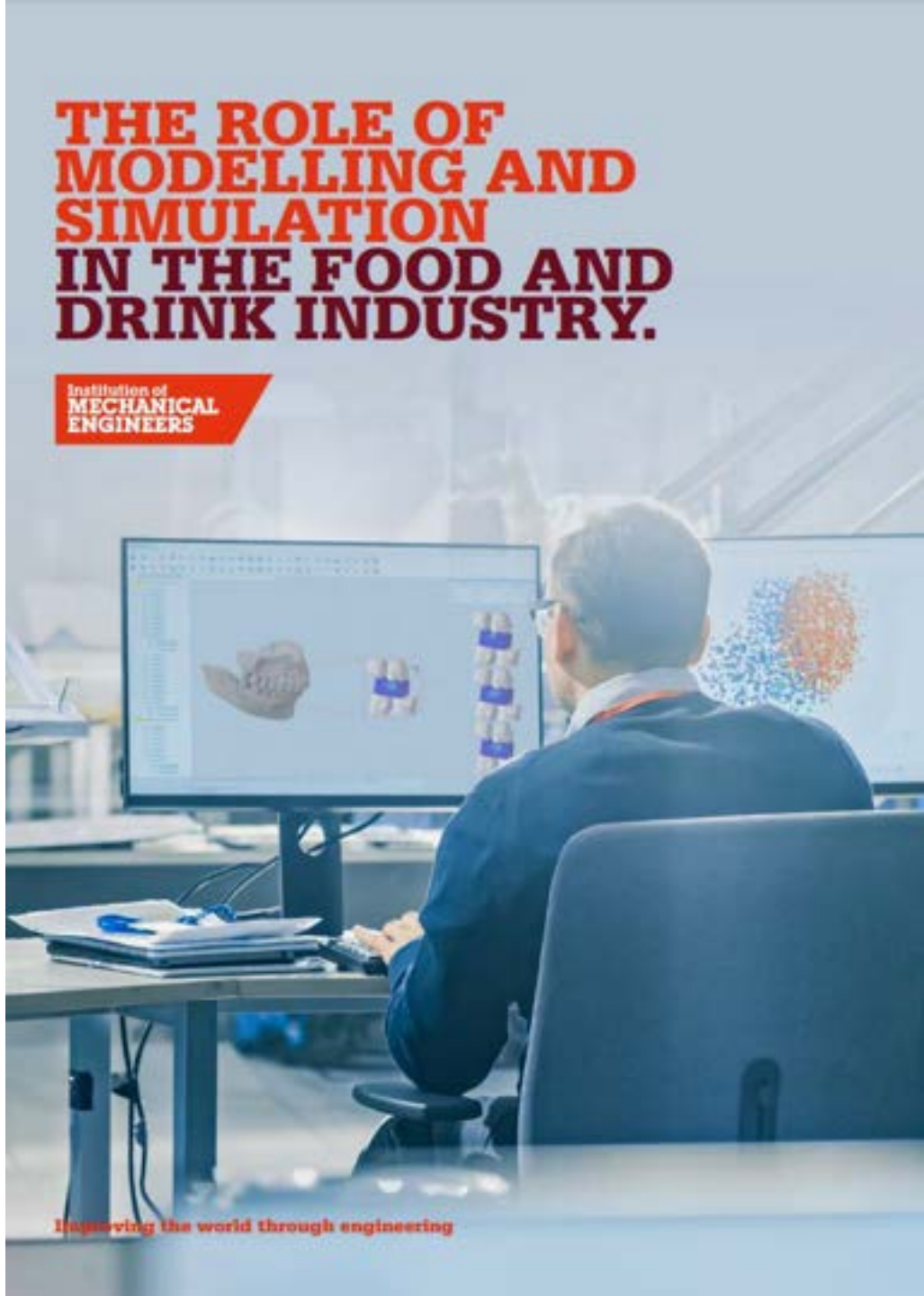
Homepage > News > Policy and press > All reports and policy statements > Report and policies detail

REPORT

THE ROLE OF MODELLING AND SIMULATION IN THE FOOD AND DRINK INDUSTRY

21 Sep 2023

This report, produced by the IMechE Food and Drink Engineering Committee, explores benefits of modelling and simulation in this important sector.



THANK YOU.

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element
Digital Engineering

Introduction to agricultural technologies and its potentials

IAgrE

Dr Mark Moore, Director Government Affairs, AGCO

The challenge

Food security vs Climate Change vs Profitability

How do we produce more food in a sustainable that allows farmers (and others in the supply chain) to make a living?

Food Security

Global population is expected to reach 9b by 2050

- FAO – by 2050 we will need to produce 60% more food
- World Vision – Hunger is worsening worldwide
- World Food Programme (WFP) – 258 million people across 58 countries faced crisis or higher levels of food insecurity

Sustainability (Climate Change)

One-quarter of the world's greenhouse gas emissions result from food and agriculture

Profitable (ROI)

The high cost of agricultural technology is a major barrier, followed by an unclear ROI

Agricultural technology is already making an important contribution

Auto Steer

– uses GPS signals to automatically control the tractor in seeding, spraying, fertilizer application and harvesting, reducing overlap of farming operations and leading to substantial fuel savings

Variable rate technology

– uses sensors or preprogrammed maps to determine seeding, fertilizer, crop protection application rates. Supporting technologies include variable rate controllers, GPS, yield monitors, crop sensors and soil sensors

Machine and Fleet Management

– time monitoring of equipment, providing information like GPS location, equipment idling, traffic control and route suggestions

Machine Section Control

– section control technology turns planter, fertilizer or sprayer sections on or off in rows that have been previously seeded/sprayed, or at headland turns, point rows and waterways

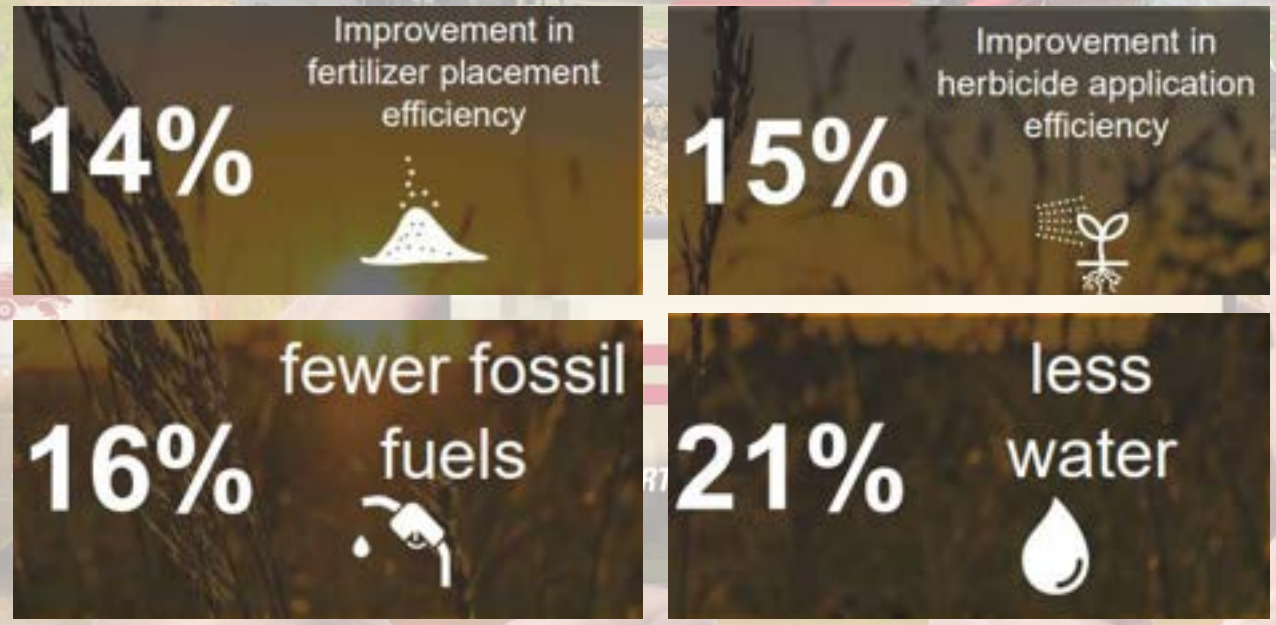
Precision Irrigation

– switch on/off apply and different amounts of water to different areas of the field. Focused on centre pivots

Agricultural technology – further potential

Annual crop production could increase a further 6% with a broader adoption of Precision Farming technologies

Wider adoption of precision ag technology has the potential to provide significant improvements



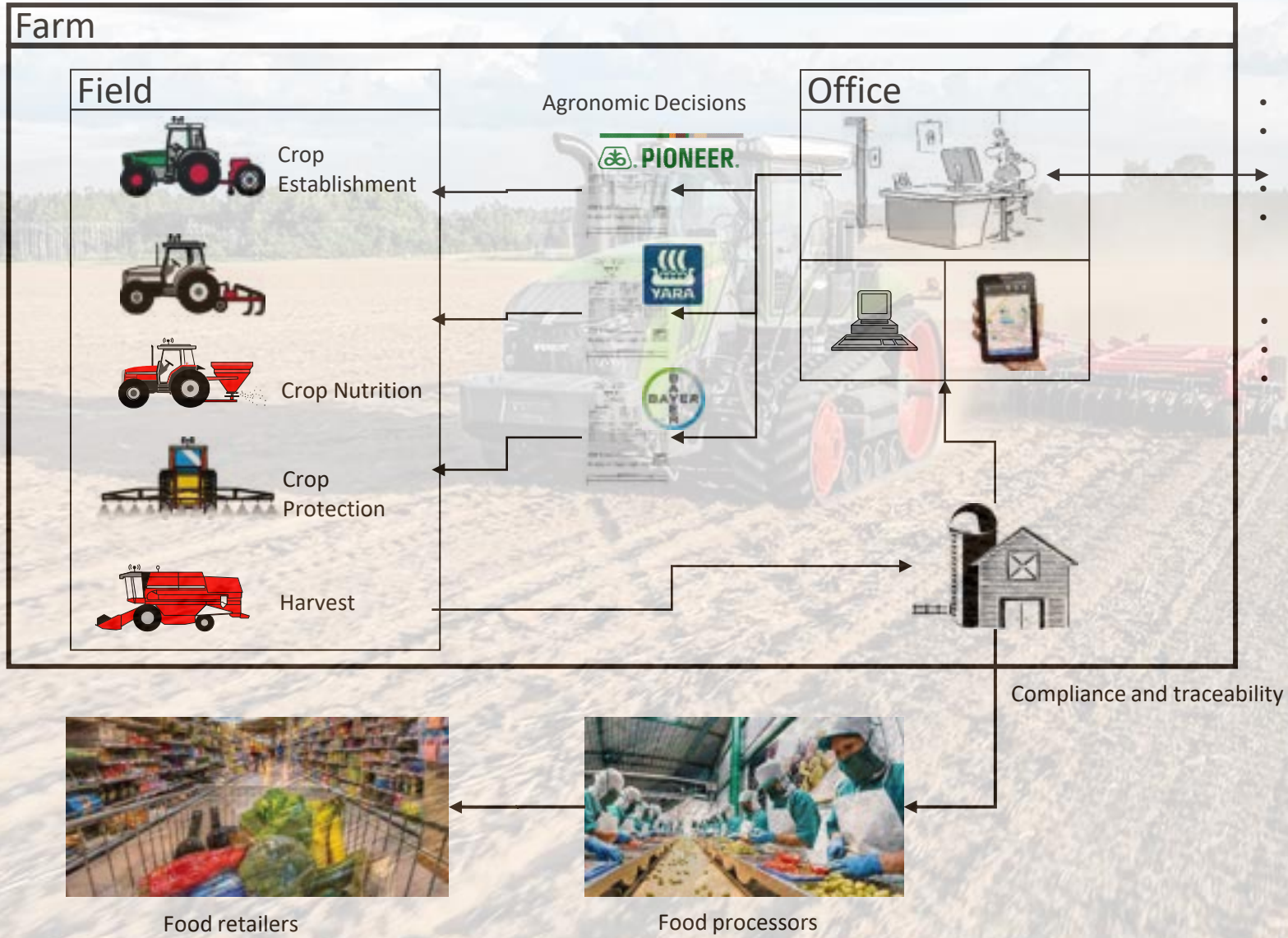
Source: AEM

Precision Ag products & services “touch” many parts of a food production system

Agricultural engineering has an overarching role within the food production system, but we don’t own it

We need to collaborate with others to ensure systems:

- Work seamlessly, and:
- Deliver value to all stakeholders



Summary

- There’s never been a more exciting time to be an agricultural engineer !
- The challenge is enormous – 60% more food by 2050 while reducing impact on the environment and maintaining profitability
- Governments recognise the aims of policies cannot be achieved without smart technologies and digital transformation
  - The expectation from policy makers is agricultural technology will enable sustainable food production while ensuring food security
- The agricultural machinery and technology sector has an overarching role across the food supply chain
- A systems approach is required to meet the challenge
  - Delivering useable systems with an obtainable ROI will increase adoption rate
- Collaboration across organisations will be required
  - We know working in silos limits the adoption of technology by farmers

Role of Thermal Processing in Waste Reduction of Pasteurised Foods

By Chris Holland FIFST, Food Processing Special Interest Group

Presented by:
Natasha Medhurst FIFST, Senior Scientific Affairs Manager

Institute of Food Science + Technology ifst

Special Interest Groups

Sensory Science	Food Regulatory	Food Science and Nutrition	Food Safety	Food Innovation (Product & Packaging)	Food Processing

Knowledge Hubs

COVID-19

Food Allergens

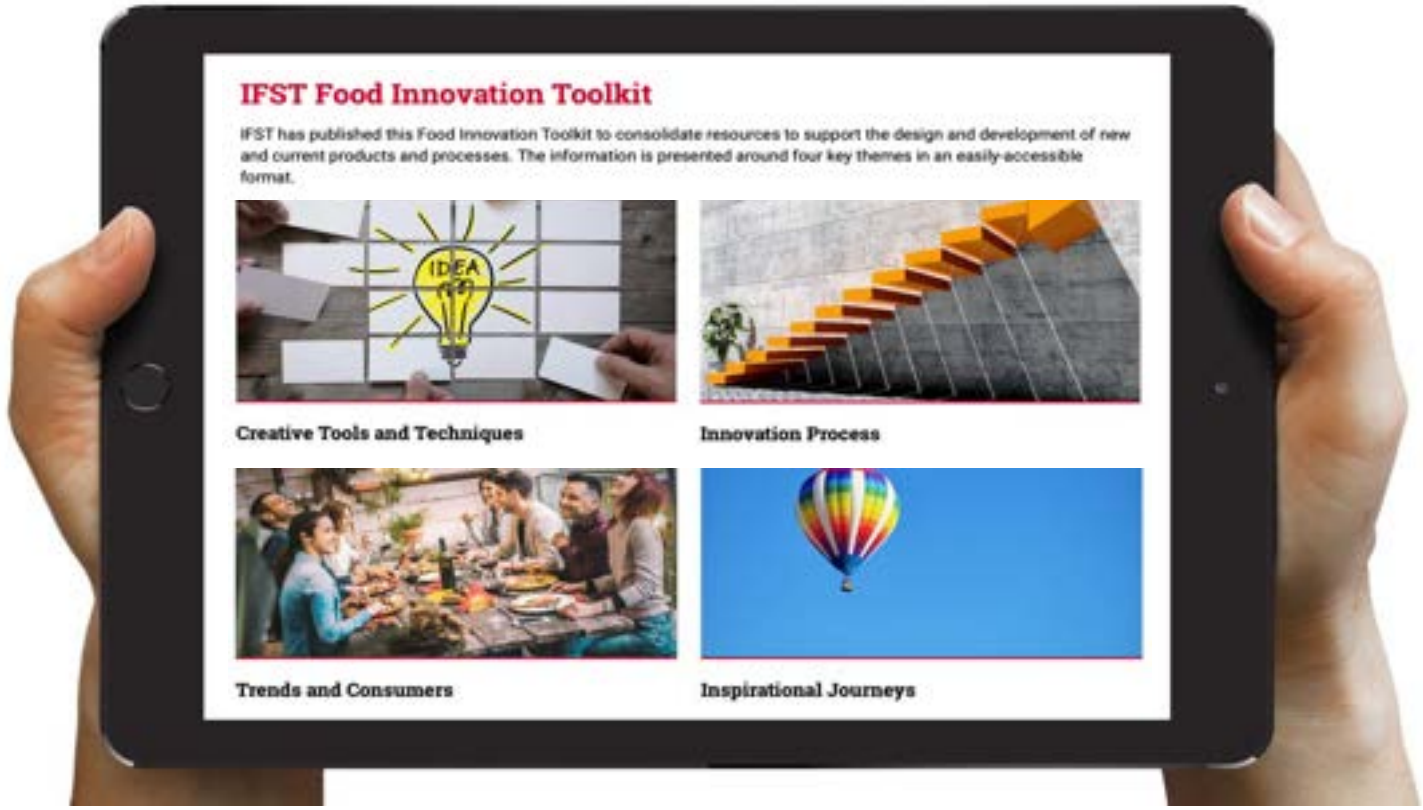
Sustainability

Food Safety

Food Processing

Institute of Food Science + Technology ifst

Food Innovation Toolkit – new!



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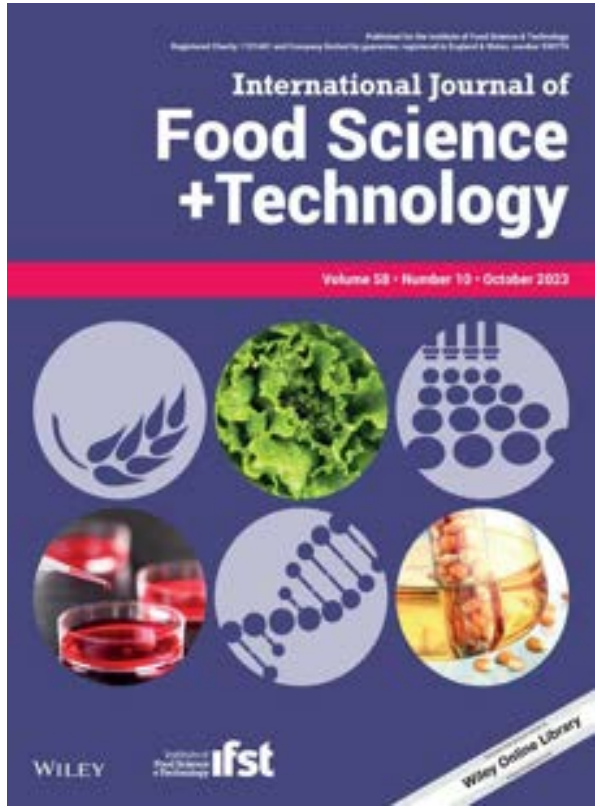
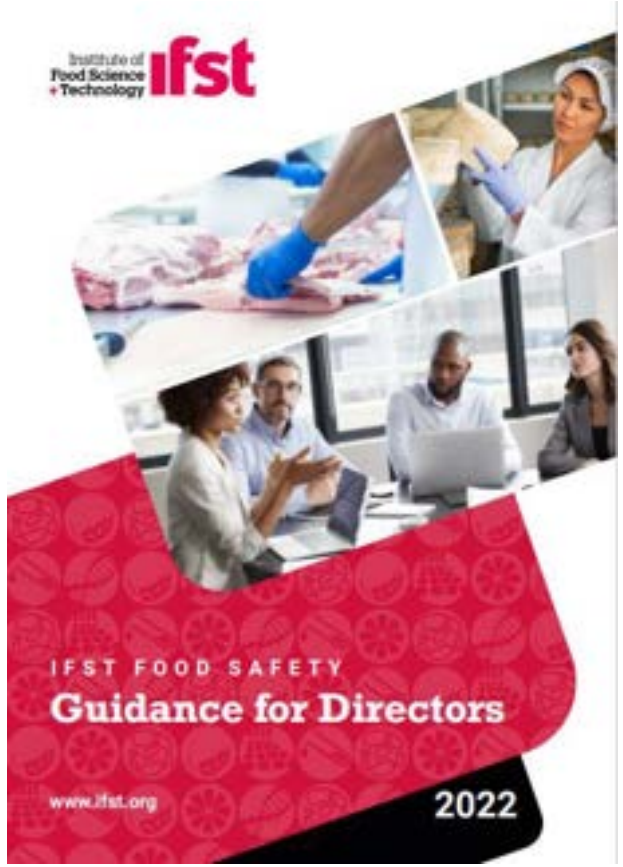
Publications





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Setting the Scene

Source: WRAP 2019

APPROXIMATELY 1/3RD

of all purchased food ends up in landfill

Around 4% of recipe dish products are

WASTED IN-STORE

Over 2 million

ready meals per week never leave distribution

The food and drink sector is responsible for approximately 35%

OF THE UK'S CARBON FOOTPRINT

10% of this is from processing

Why is this happening? Manufacturing focus:

- Overproduction – industry wide disconnect between retail orders and manufacturing timelines
- Product recalls
- Packaging damaged in transit
- Consumer preferences
- SHORT SHELF LIVES
- CONSUMER DEMAND FOR PERFECTION

Institute of Food Science + Technology ifst

“Thermal processing delivers waste reduction and a sustainable solution for the future as it has in the past”

Holmach Ltd
Enabling State-of-the-Art Manufacturing

Chris Holland, Managing Director, Holmach Ltd

What is Thermal Processing?

Defined as the application of **heat** or **cold** to achieve property change in a consumable product

May be an enzymatic reaction, gelling or crystallisation effect; more commonly a **time/temperature equation** to apply a log reduction to microbial flora

Put simply: **PASTEURISATION** & **STERILISATION**

Breaking down the myths relating to processed food

Right thermal process will retain nutritional value of raw ingredients.

Recent study (*Food Science & Nutrition* journal*)* found vitamin C not destroyed/ reduced during thermal processing

Studies have shown that vitamin C levels in fresh vegetables can drop by <=75% within 7 days of harvesting. Some thermally processed foods can retain nutrients for the duration of their shelf life

Breaking down the myths relating to processed food

Thermal processing removes need for extra salt and sugar etc. - preservatives and the right process can enhance flavours without using unnecessary flavour enhancers

Shelf Life Extension

Retorting

- Gentle cooking process retains organoleptic properties of food
- Cooking in the container reduces overall cooking time and enhances flavours - same way as ‘double cook’ phenomenon
- No preservatives required e.g. high levels of salt / sugar / citric acid
- For chilled ready meals: can obtain additional shelf life of up to 28 days

Subject to packaging integrity, products reaching end of shelf-life can be retorted / re-retorted. May lose some commercial value during second cook but can still be safe and tasty for distribution via food waste initiatives e.g. food banks

Shelf Life Extension

High Pressure Pasteurisation (HPP)

- Pasteurises fruit, vegetables, fish and meat gently, without heat or need for chemicals
- Food subjected to 6000 bar – approx. pressure at 60 km below water; high enough to neutralise germs and bacteria
- Products processed in final packaging; texture, appearance, taste and nutrients remain intact.

Shelf-life is up to 10 times longer after the preservation process

Consumer demand for perfection

ISSUE:

UK throws away c.1.4 million tonnes of edible fruit and vegetables p.a due to cosmetic imperfections = £2.1 billion (WRAP)

PART OF SOLUTION:

ugly fruit and vegetables can be saved from waste by being used in thermally processed products e.g. ready meals, soups, juices, smoothies

Consumer demand for perfection

ISSUE:

industry loses £440 million p.a. due to the disposal of discoloured beef (BRC)

PART OF SOLUTION:

High Pressure Pasteurisation can improve colour of fresh and cooked dark-cutting beef

Effects of high-pressure processing (HPP) on surface color of dark-cutting beef on day 1 of display.

Consumer demand for perfection

ISSUE:

c.1.3 million tonnes p.a. chocolate (10% of all produced) thrown away worldwide due to chocolate bloom* - International Cocoa Organization (ICCO)

**white/greyish discoloration on surface - not harmful but looks unappealing*

PART OF SOLUTION:

some manufacturers retemper chocolate with thermal processing technology solutions, then repackage - safe and quality retained

Summary

- Based on a 21-day shelf-life, at least 10 days on shelf can eliminate 4% wastage instore. Still allows 11 days for distribution.
- Shelf-life on most foods can be increased without consumer resistance
- The narrative needs to change. Processing plays a significant part in the global battle against food shortages and waste
- Thermal processing is an ideal solution to food waste caused by cosmetic imperfections
- Retailer buyers need to be more sensitive to the valuable resource of food

60th Jubilee 2024

How has food science and technology changed our lives in the last 60 years?

Driving young people into rewarding and inspiring careers in the food sector

Advances in Food Chemistry: Solving issues spanning the Food System

Professor Tim Foster, FRSC, FIFST

(Creating Food Meteorites Ltd)
(Associate Editor of Food & Function (2012-2018))

What is RSC's skin in the game?

- RSC Interest Group **FOOD** whose aims are to promote the role of chemistry in food and enable transfer and sharing of information and networking between academia and the food industry in a way to enhance sustainability and food & nutrition security:
  - foster an awareness of the importance of chemistry in the food chain
  - encourage interactions between scientists and technologists engaged in food R&D
  - help transfer such scientific research from ideas to applications

  And whose scope is: Analytical, biochemical, chemical, physical, nutritional and toxicological aspects of food & ingredients and the composition and relationships between structure and functionality throughout the entire food chain
- Two **FOOD** journals: 'Food & Function' and 'Sustainable Food Technology'

Food (micro)constituents and their relation to health and/or nutrition by describing (the):

- **Physical properties and structure of food**
- **Chemistry of food components**
- **Biochemical and physiological actions of food components**
- **Nutritional aspects of food**
- **Toxicological responses to food components**
- **Clinical and population studies using food or food components**

Novel green strategies applied to both crops and animal foods from every step of the food chain, “from farm to fork”: farming, harvesting, processing, packaging, storage, distribution and control.

Circular bioeconomy strategies, from those adding value to food by-products to those focused on the appropriate reuse of food waste

Alignment with the KTN Wheel

Circular strategies for adding value to food by-products and food waste (recovery and valorisation)

Molecular properties and physiological effects of food components / Novel and sustainable food resources and food ingredients

Green active and intelligent packaging and storage systems

Sustainable intensification of food production and processing requiring less energy and water consumption

Nanotechnology and biosensors in food processing, packaging and safety

Effects of food contaminants - including toxicology and metabolism

Efficacy and mechanisms of bioactives in the body

Food fortification

Chemistry and physics of food digestion processes e.g., nutrient release and uptake

Emerging food preservation techniques: non-thermal processes, bioactive compounds

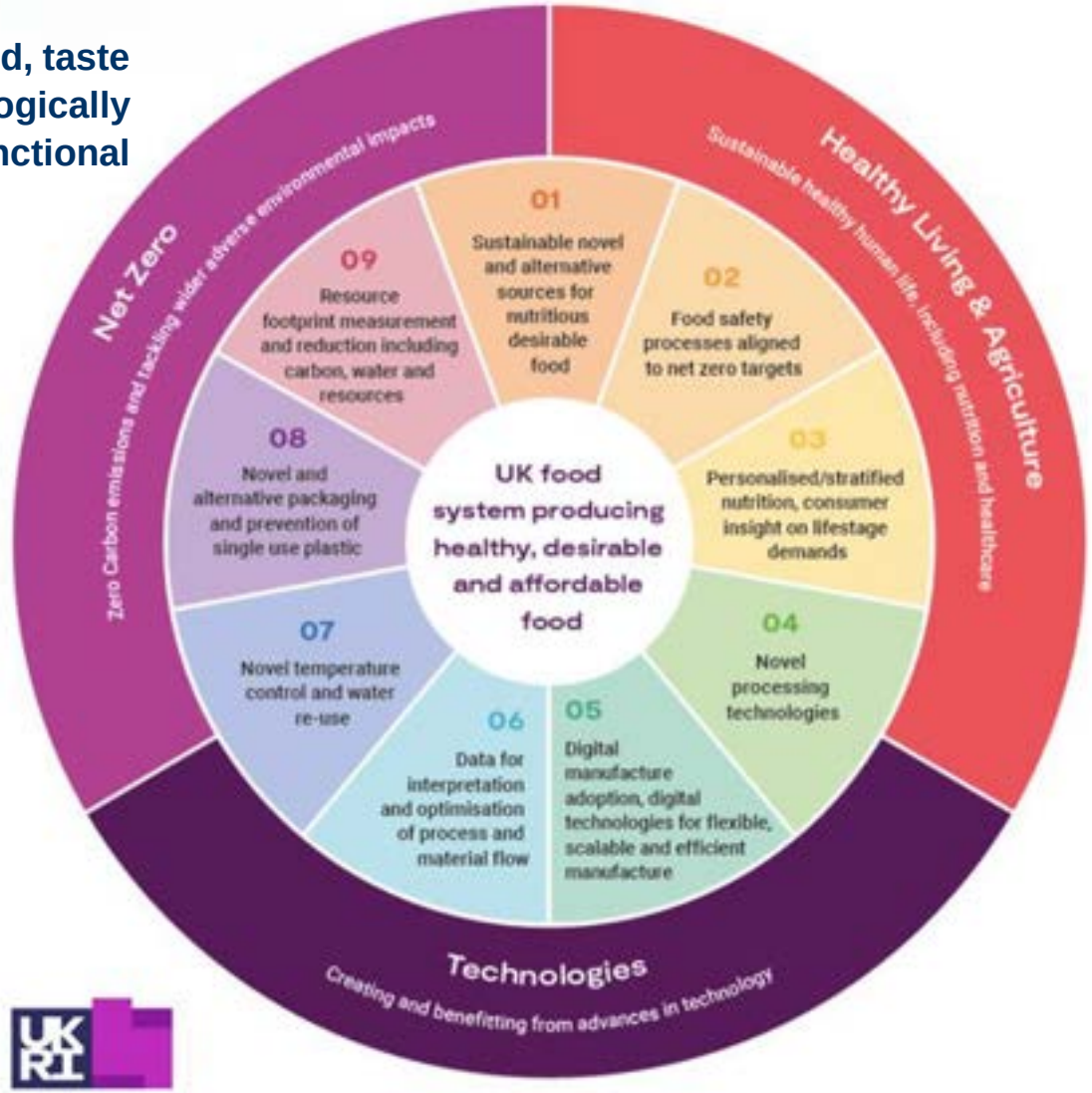
Data harmonisation, digitalisation and artificial intelligence to assist food production and control

ROYAL SOCIETY OF CHEMISTRY

Innovate UK

Alignment with the KTN Wheel

Alternative Proteins – minimal processed, taste optimised, physically and physiologically functional



Food fortification – increasing the nutritional profiles of food (macronutrients: protein / fibre / fats; micronutrients: zinc / iron) and their interactions

Lab Grown – ingredients, matrices, structures and products

RSC Education Programme – Example Activities

Schools Outreach

Practical kit and demo – flavours within chocolate flavour

Schools' poster competition – "Food, the Vital Ingredient"

Events

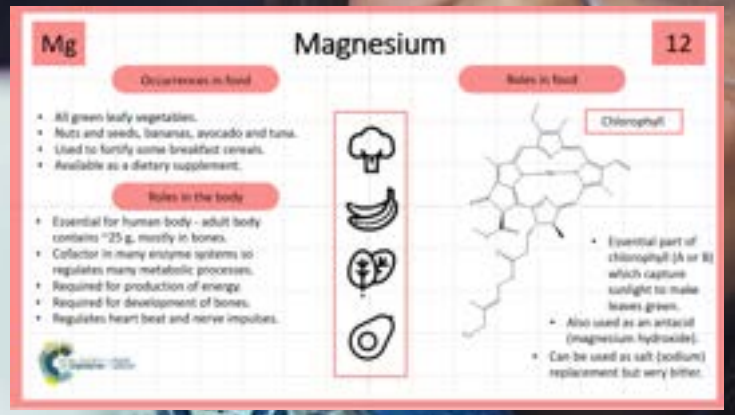
Advances in the Chemical Analysis of Food – conference series

"Natural" ingredients conference

Publications

Food science "Mythbusting" book in preparation

Interactive Food Periodic Table of Elements



Medals and Awards

Early Careers Medal

Open Medal

Conclusions

Advances in Food Chemistry not only span the food system but both the academic and industrial landscapes.

A discipline synergistic with physics, nutrition, toxicology, clinical and emerging AI / modelling capabilities.

Providing educational stimulus for the next generation.

SCI Food Group

Where Science Meets Business

Breaking Down Barriers to Open up the Science-Business Interface: Microencapsulation as a case study

The ProFSET Conference
23rd November 2023

SCI
where science
meets business

Barriers to Innovation in the Food System

Communication

- Culture
  - ‘Not-invented here’
  - Reluctance to change
- Language

Existing barriers to communication

- Academia-industry
- Large and small businesses
- Between disciplines
- Scientists and non-scientists

Limited access to investment

Short-term R&D planning

Regulatory

About SCI

Vision

- To be '*where science meets business*'

Identity

- Unique, independent multidisciplinary community
- Supporting innovation from chemistry and related sciences in sectors including Energy, Environment, AgriFood, Health and Materials

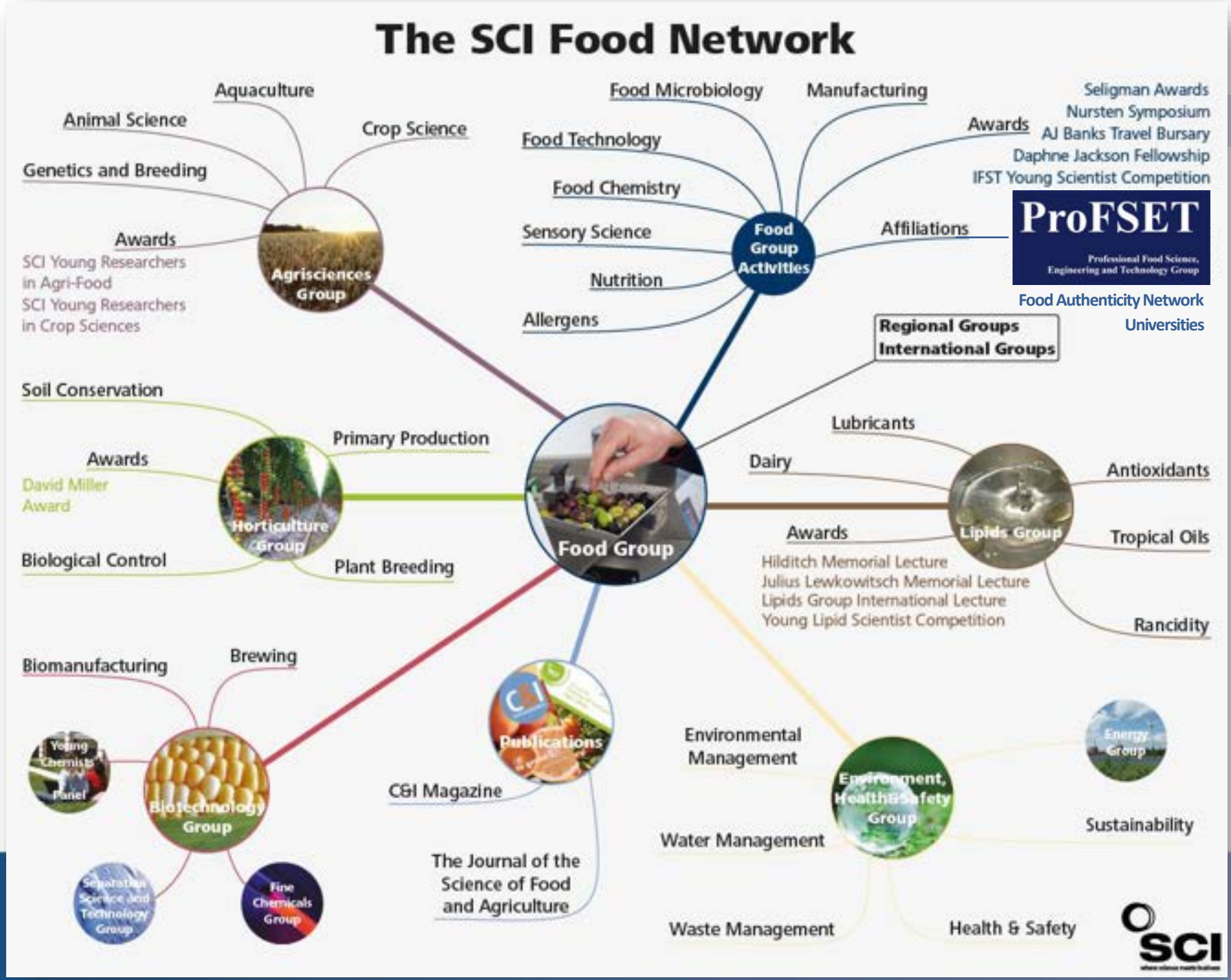
Mission

- Encourage networking and distributing knowledge
- Support members' careers in business and academia
- Contribute to public understanding of science

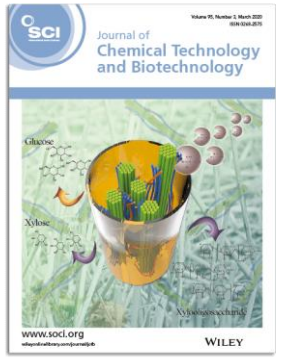
Foster innovation
The commercialisation of science via new products and processes

The SCI Agri-Food Hub

A Long-Term Collaborative Network



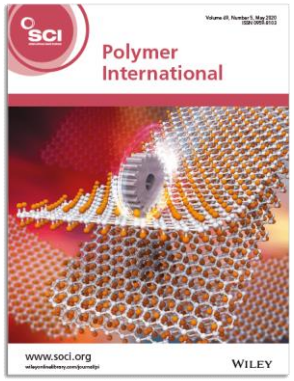
Communication



Journal of Chemical Technology and Biotechnology

Journal of the Science of Food and Agriculture

Pest Management Science

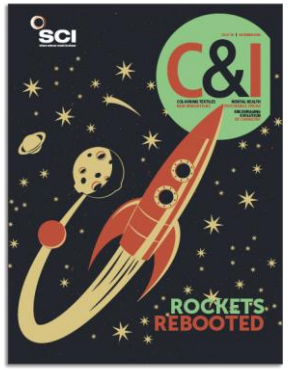


Polymer International

Biofuels, Bioproducts & Biorefining Journal

Energy Science & Engineering

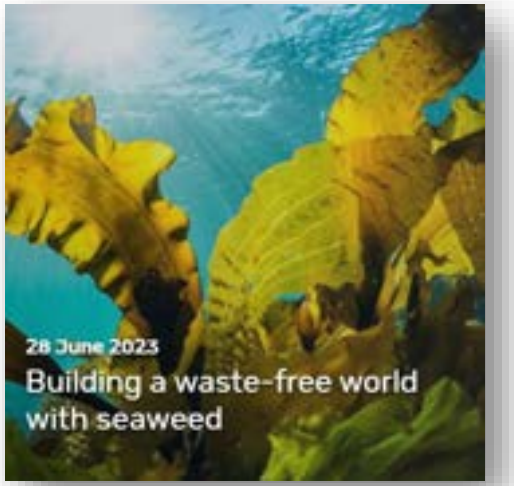
Greenhouse Gases: Science and Technology



Chemistry & Industry magazine

Events


5 December 2023
Healthy and sustainable diets: The role of animal-derived foods


28 June 2023
Building a waste-free world with seaweed


21 November - 22 November 2023
Bright SCIdea Challenge 2024 Training Workshops

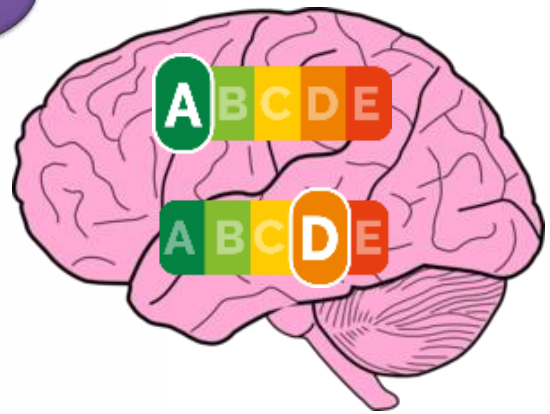

21 February 2024
AI4You: What can AI do for you and what do you need to be able to use it?


23 January - 24 January 2024
SCI Formulation Forum 5th Annual Event: design through characterisation and analysis

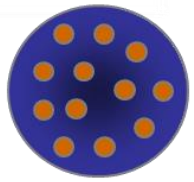

14 February 2024
Regenerative Agriculture


16 April 2024
What a chemist needs to know about patents 2024

Meeting the Challenges

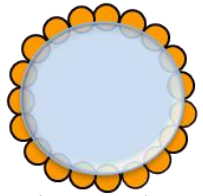


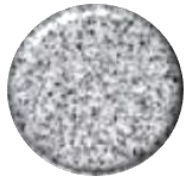
Microencapsulation – From Printing to Probiotics

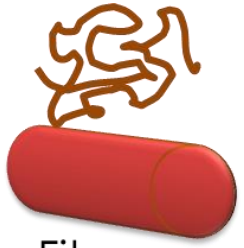

Matrix Particle


Hollow Particle

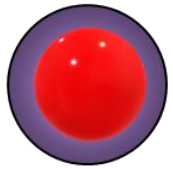

Carrier System


Pickering Emulsion


Surface Modified

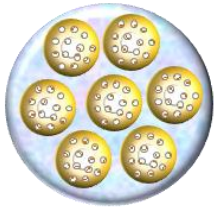

Fibre or Pellet

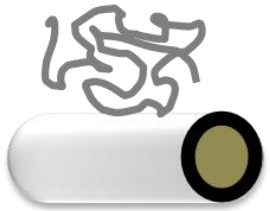

Liquid-filled Capsule

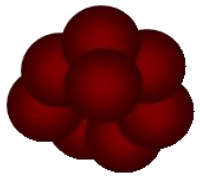

Core-Shell Capsule

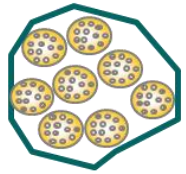

Multi-shell Capsule

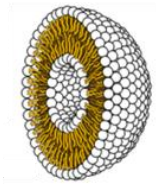

O/W & W/O Emulsions

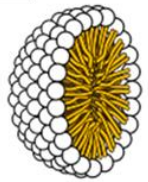

Complex Emulsion

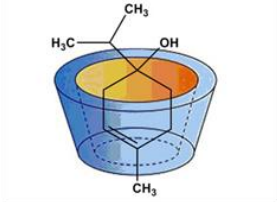

Tube


Granules


Granules


Liposome


Micelle

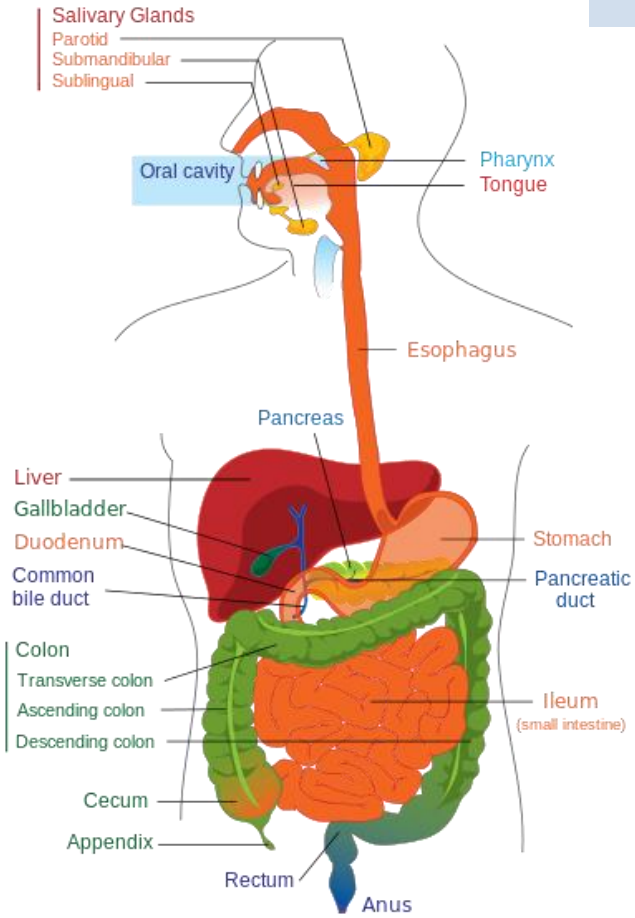


Inclusion Complex


Powders

Why Microencapsulation?

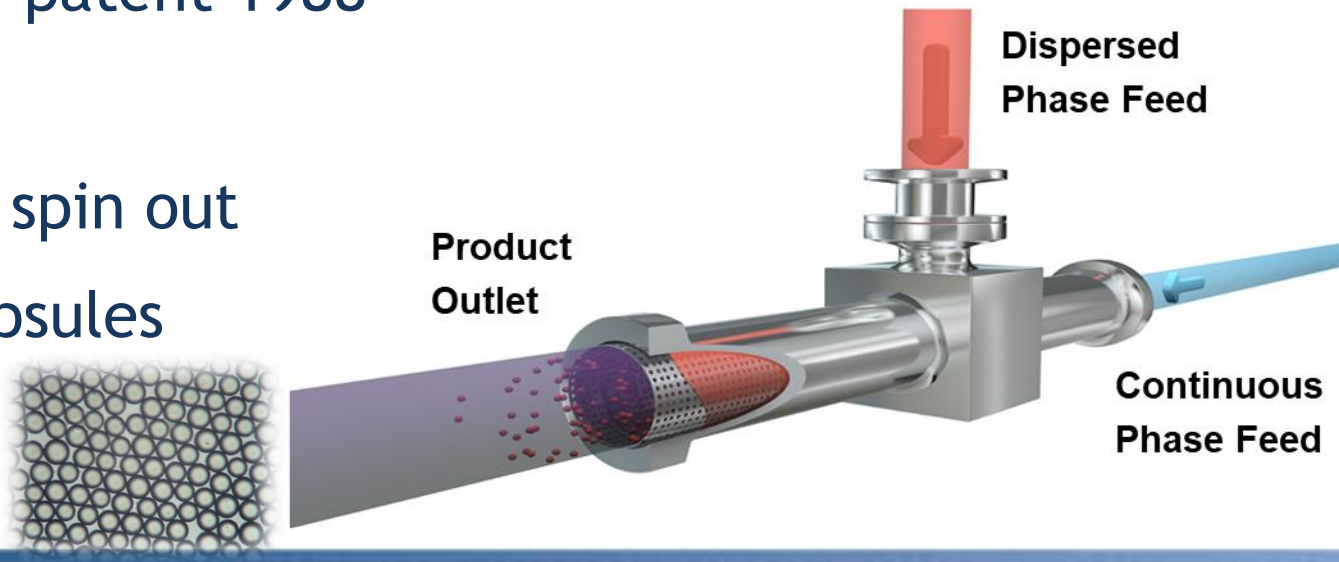
- Protect sensitive ingredients
- Improve handling
- Improve bioavailability
- Control retention/release
- Taste masking



From the Brain to the Bank

- Membrane Emulsification
  - Traditionally – high-pressure homogenizers and rotor–stator systems are high energy systems generating heat
  - First membrane emulsification patent 1988
  - This innovation patented 2006
  - Commercialised via University spin out
  - Controlled emulsions/microcapsules
    - Pharma, Ag-Chem, Food

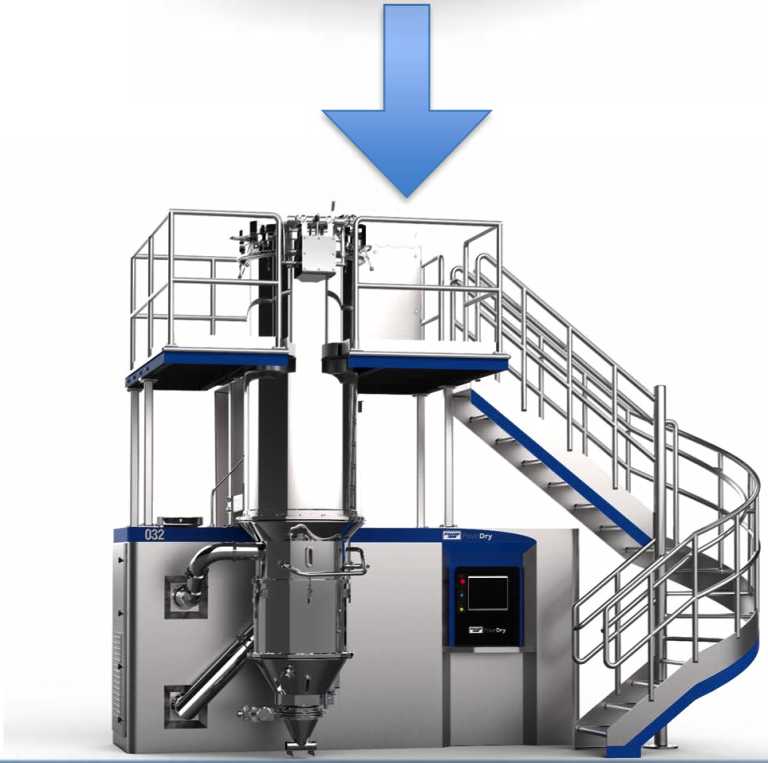
Micropore Technologies



Images courtesy of Micropore Technologies Ltd.

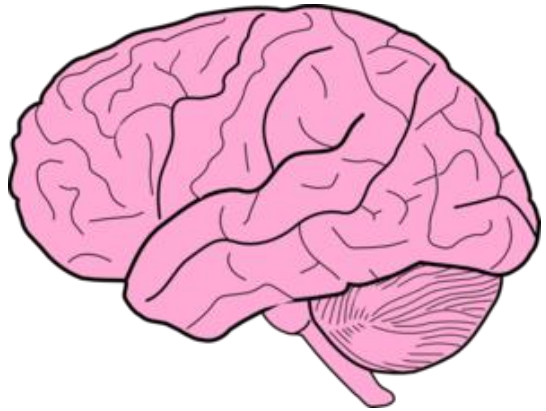
Something Borrowed

- Electrostatic Spray Drying
  - Electrostatic Printing Invented 1778
  - Spray Drying 1860-1872
  - Electrostatic Crop Spraying in the 1970s
  - Electrospray Mass Spectrometry in 1980s
  - Electrostatic atomisation/spray dryer patents 2015/16
  - Taken from bench to production scale



Images courtesy of Fluid Air
Division of Spraying Systems Co. USA.

Key Learnings



- Long-term collaborative networks
- Generalists and specialists in the same room
- Bringing academia and industry together
- Include SMEs and multinationals
- Diversity is key – be aware of unintentional bias

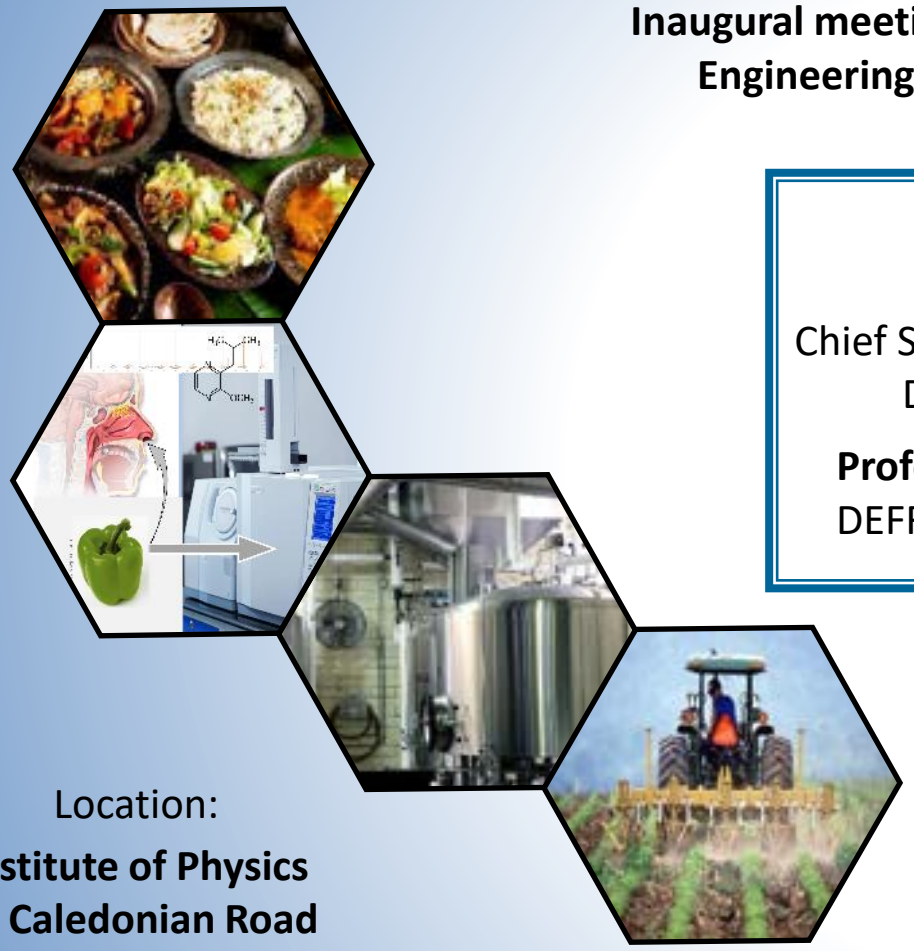
Panel Discussion
How can ProFSET support the vision of healthy, desirable, and affordable food for all?

Facilitated by Prof Ian Noble

VP R&D Mondelez, Chair of Innovate UK Food Sector Group

Transdisciplinary Solutions to Meet the UK Food System Challenges

Inaugural meeting of the Professional Food Science, Engineering and Technology group (ProFSET)



Keynote talks from:

Kate Halliwell
Chief Scientific Officer at Food and Drink Federation (FDF)

Professor Gideon Henderson,
DEFRA Chief Scientific Adviser

Location:

Institute of Physics
37 Caledonian Road
London N1 9BU, UK

10.30 am to 3.30 pm
23rd November 2023

Supported by:

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