Institute of Food Science + Technology ifst

IFST SPRING CONFERENCE 2023

TAMING THE PERFECT STORM

THE POWER OF FOOD SCIENCE AND TECHNOLOGY

27 APRIL 2023
CARDIFF METROPOLITAN UNIVERSITY

Welcome & Introduction

Sterling Crew Hon. FIFST

President
IFST

Welcome & Introduction

Barbara Bray MBE, FIFST

Spring Conference Chair
2023

Important Announcements

1. There are no fire alarm drills planned during the SC23 event. Should a certain case arise, please listen to the PA announcement and follow instructions.
2. The hospitality lounge next to the atrium is available as a quiet space or to meet fellow delegates.

SC23 Themes

Food Security

Health & Nutrition

The Environment

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POLL #1

https://app.sli.do

#4271 758

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IFST SC23
Keynote Speaker

Julie Hesketh-Laird

Deputy Chief Executive
Food Standards Scotland

Food Standards Scotland
For safe food and healthy eating

Food Security, Dietary Health and the Environment:

How Scotland is tackling the challenges

Julie Hesketh-Laird
Deputy Chief Executive, Food Standards Scotland

IFST SPRING CONFERENCE
27 April 2023

FSS in a nutshell

Established 1 April 2015 under the Food (Scotland) Act 2015 as the new public sector food body for Scotland

Independent of Ministers & industry. Accountable to the Scottish Parliament

We provide advice that is impartial and evidence based

Three objectives under The Food (Scotland) Act:

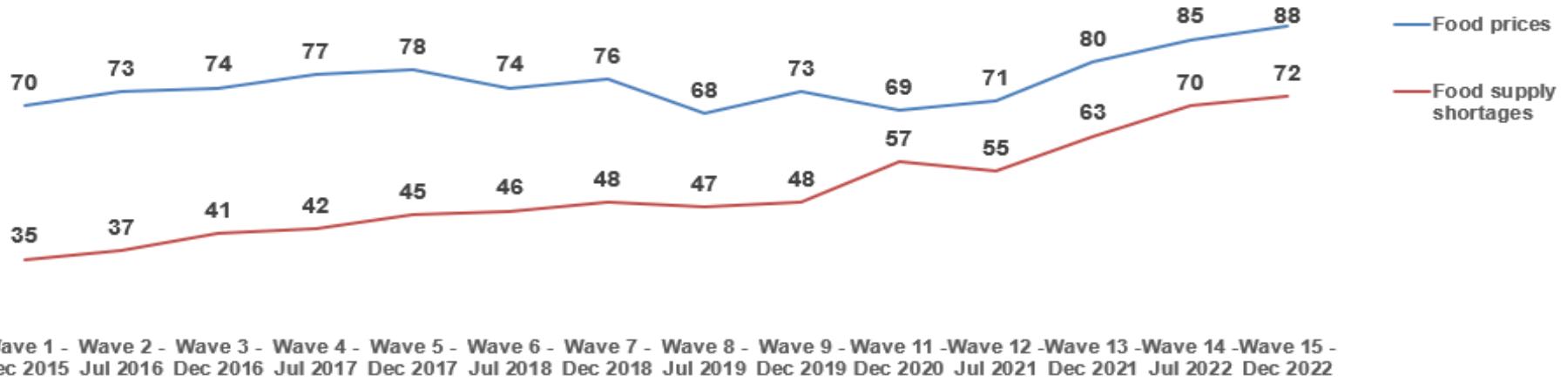
To protect the public from risks to health arising in connection with the consumption of food

Improve the extent to the public have diets conducive to good health

Protect other interests of consumers in relation to food

FSS Tracker – Concern to Consumers

Levels of concern about food prices and food supply shortages have significantly grown since tracking began in 2015.



Inflation - what is the data telling us?

Annual inflation rate for food and non-alcoholic beverages highest for over 45 years

Office of National Statistics

Food inflation rate is at its highest since 1977

Office of National Statistics

Between 1 in 4 and 1 in 5 have cut back on essentials such as food in early 2023

Scottish Government

9.3 million adults experienced food insecurity in Jan ‘23 with poorest being most impacted

Food Foundation

In the last 6 months 56% of those surveyed were eating out less often to save money

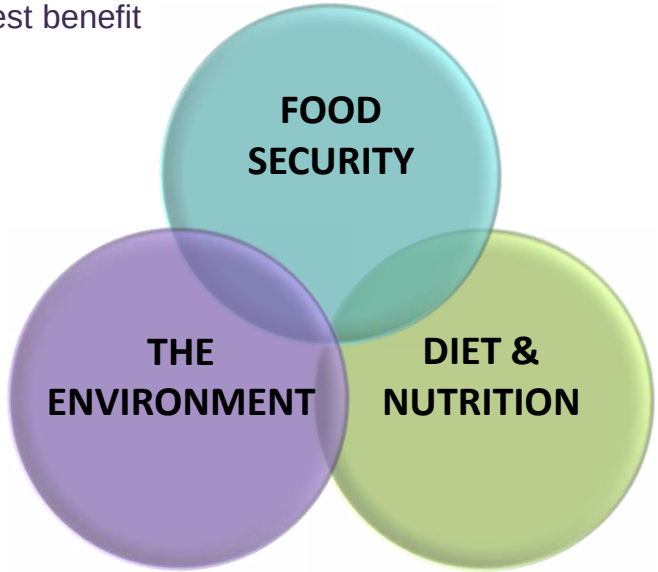
Food Standards Scotland

50% of consumers in Scotland have admitted to eating food passed its use by date to save money

Food Standards Scotland

The Global Challenge

- Interplay between food production and consumption, environment and health
- Systems level approach needed to understand the trade offs and identify solutions that will have the greatest benefit



Food Standards Scotland

For safe food and healthy eating

1. Food Security

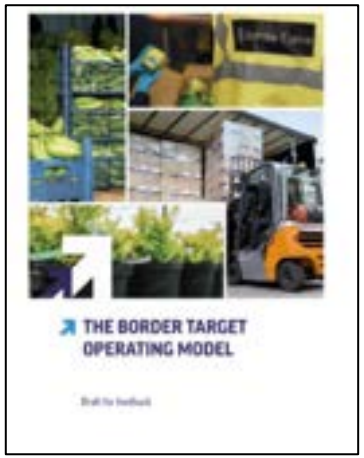
Food Standards Scotland

Food Security:

Food Imports

Nearly half of what we eat comes into the UK from abroad, and two-thirds of that has in recent years come from the EU.

The lack of full import controls on EU goods reduces our ability to prevent foods that do not meet the UK's high standards being placed on our market.



Food Security:

Scottish Government Food Security and Supply Taskforce

- Set up in March 2022, jointly with industry, to monitor, identify and respond to any potential disruption to food security and supply resulting from the impact of Russia's invasion of Ukraine.
- Chaired by Cabinet Secretary of Rural Affairs and CEO of Scotland Food and Drink.
- Recommended short, medium and longer-term actions to mitigate impacts, resolve supply issues and strengthen food security and supply in Scotland.

Food Standards Scotland

For safe food and healthy eating

2. Dietary Health

Dietary Health:

A Scottish Perspective

In Scotland:

- More than two thirds of adults live with overweight or obesity
- Average consumption of fruit, vegetables & oily fish significantly below dietary goals
- Growing concerns around food prices & cost of living and the impact on health inequalities
- Very little shift over the last 20 years

Dietary Health:
UK Government Food Strategy

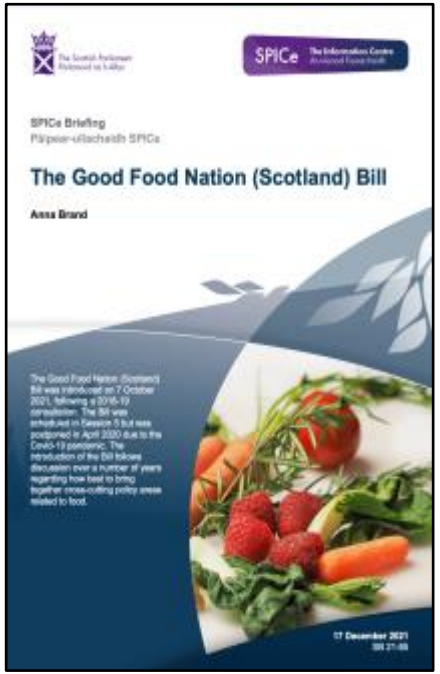
Objectives:

- To deliver a prosperous agri-food and seafood sector that ensures a secure food supply in an unpredictable world and contributes to the levelling up agenda through good quality jobs around the country.
- To deliver a sustainable, nature positive, affordable food system that provides choice and access to high quality products that support healthier and homegrown diets for all.
- To deliver export opportunities and consumer choice through imports, without compromising our regulatory standards for food, whether produced domestically or imported.

Dietary Health:
Scotland's Good Food Nation Act

"a Good Food Nation, where people from every walk of life take pride and pleasure in, and benefit from, the food they produce, buy, cook, serve, and eat each day."

- Places duties on Scottish Ministers and certain public authorities to produce plans for delivering outcomes which support Scotland's social and economic wellbeing, the environment, people's health and economic development.
- A Human Rights Bill giving effect to international human rights law in Scots law, including a right to adequate food, as part of the overall right to an adequate standard of living.
- The establishment of a Food Commission to review progress and support ministers and public authorities in achieving the desired outcomes.



Dietary Health:

FSS Public Health Nutrition Strategy

VISION: A healthier and more sustainable food environment

Drive change through legislative and voluntary measures

Science and evidence	Expertise	Collaboration	Influence
FSS nutrition monitoring and evidence	Leading authority on public health nutrition	Partnership working	Rebalance the food environment

UNDERPINNED BY: Public health nutrition monitoring and evidence

Reducing health inequalities

Food Standards Scotland

For safe food and healthy eating

3. The environment

The environment:

FSS Consumer Tracker data

The impact of food production and packaging on the environment continues to be in the 'Top 10 areas of concern' for people in Scotland.

Sustainable production and packaging of food is an important issue for consumers, but less than half (44%) feel they have clear information about this.

Consumer preferences do not reflect what Scotland produces (much of which is exported), healthy eating guidelines or net zero aims

Three-quarters of consumers say they always actively try to reduce food waste, but recognise more needs to be done

The Environment:
FSS contributions

FSS Sustainability strategy

Active promotion of the Eatwell Guide

Eat Well, Your Way online tool

Supporting partner campaigns

Keeping Pace as a Regulator

Emerging food systems and products

Novel breeding technologies

New farming systems

Alternative proteins

Methane reducing feed

Non plastic packaging

- **Risk Assessment**
- **Market Authorisation**
- **Food Safety Management**
- **Method Development**
- **Consumer interests**

Food Standards Scotland

For safe food and healthy eating

In summary

Food Standards Scotland

A combined effort

The Scottish Government

QMS Quality Meat Scotland

Scotland Food & Drink

Public Health Scotland

Food Standards Agency

SEPA Scottish Environment Protection Agency

NHS Scotland

defra

Zero Waste Scotland

Police Scotland

The Royal Environmental Health Institute of Scotland

Seafood Scotland

Scottish Federation Meat Traders Association

University of Aberdeen The Rowett Institute

COSLA

Scottish Association of Meat Wholesalers

Animal & Plant Health Agency

GOV.UK

KEY CHALLENGES

Public Sector Resourcing

- Lack of a sustainable supply of qualified Environmental Health and Food Safety Officers: ageing workforce, reduction in new entrants to the profession.
- Increased pressure on Local Authorities following EU Exit and COVID.
- Need for modernisation to align with changing priorities.

Science, Technology and Data

- Developing and maintaining an appropriate breadth of scientific expertise and laboratory capacity.
- Exploiting digital solutions – Apps, AI, blockchain.
- Improving data sharing and systems for managing and analysing big data.

Changing Population

- Risk factors and vulnerability to dietary and foodborne related diseases.
- Understanding attitudes and behaviours.
- Reaching consumers and influencing improvements to diet.

Food Standards Scotland

For safe food and healthy eating

Thank you

Q&A

Theme 1:
Food Security and The Environment

Transforming Food System Outcomes: Who Needs To Do What?

Dr John Ingram

Food System Transformation Programme Leader ECI
University of Oxford

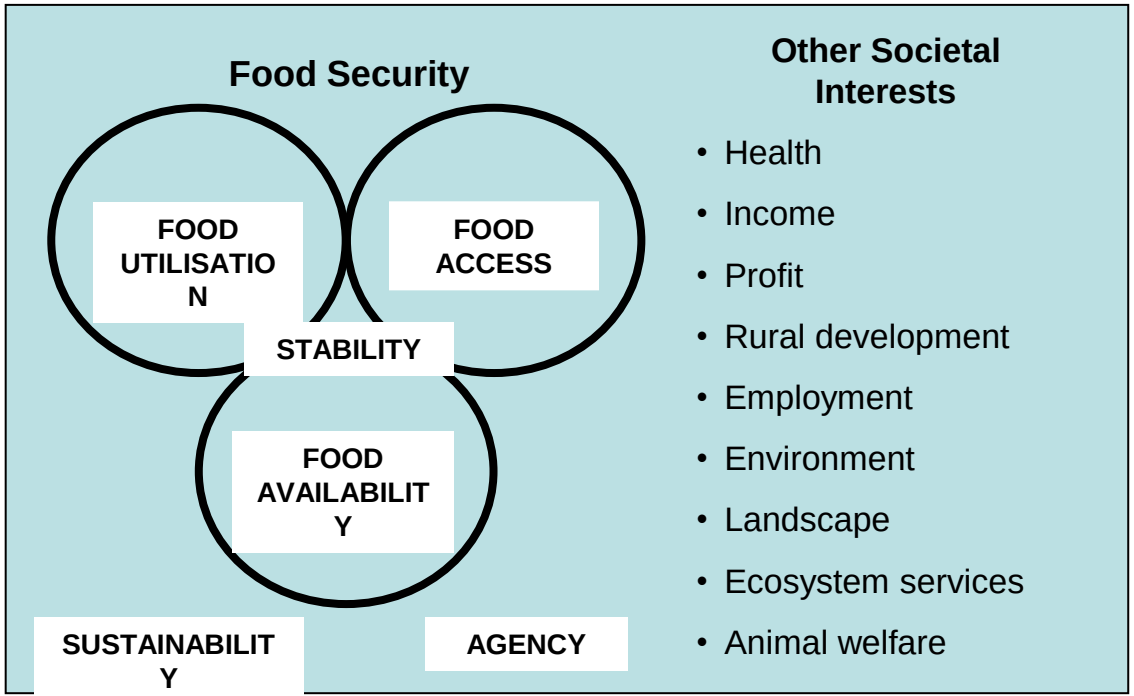
Transforming Food System Outcomes

Who needs to do what?

John Ingram

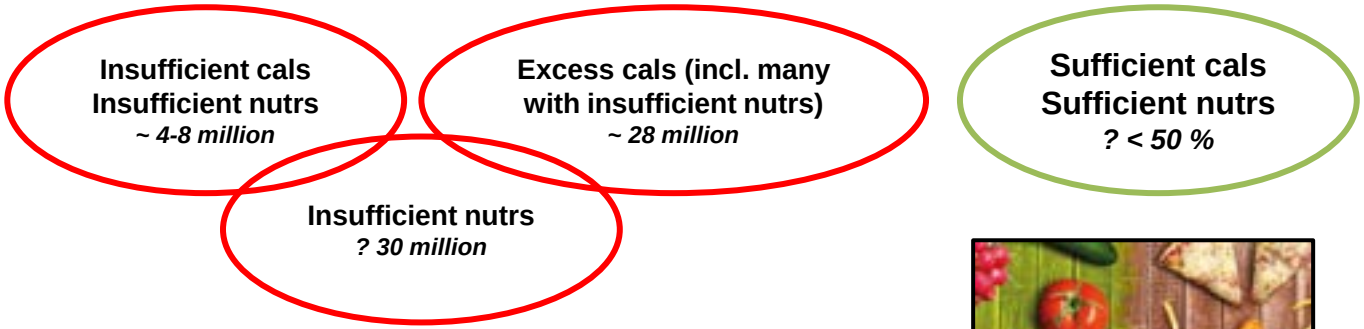
Food Systems Transformation Programme Leader
Environmental Change Institute, University of Oxford

Our starting point:
What do we want from Food Systems?

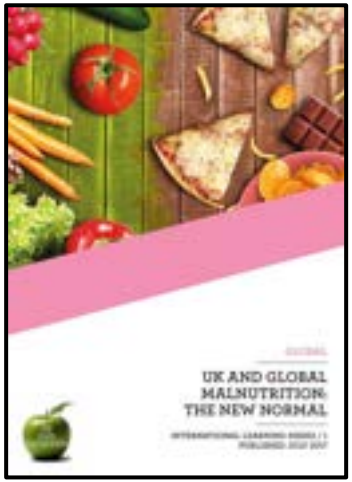


We know the overall UK food (in)security 'situation'

67 million



- Malnutrition: Triple aspects of food insecurity the "new normal".
- UK-wide NHS costs attributable to overweight and obesity are projected to reach £9.7 billion by 2050.
- Wider costs to society estimated to reach £50 billion per year by 2050



Health matters_ obesity and the food environment - GOV.UK

Aim for 'sufficient'

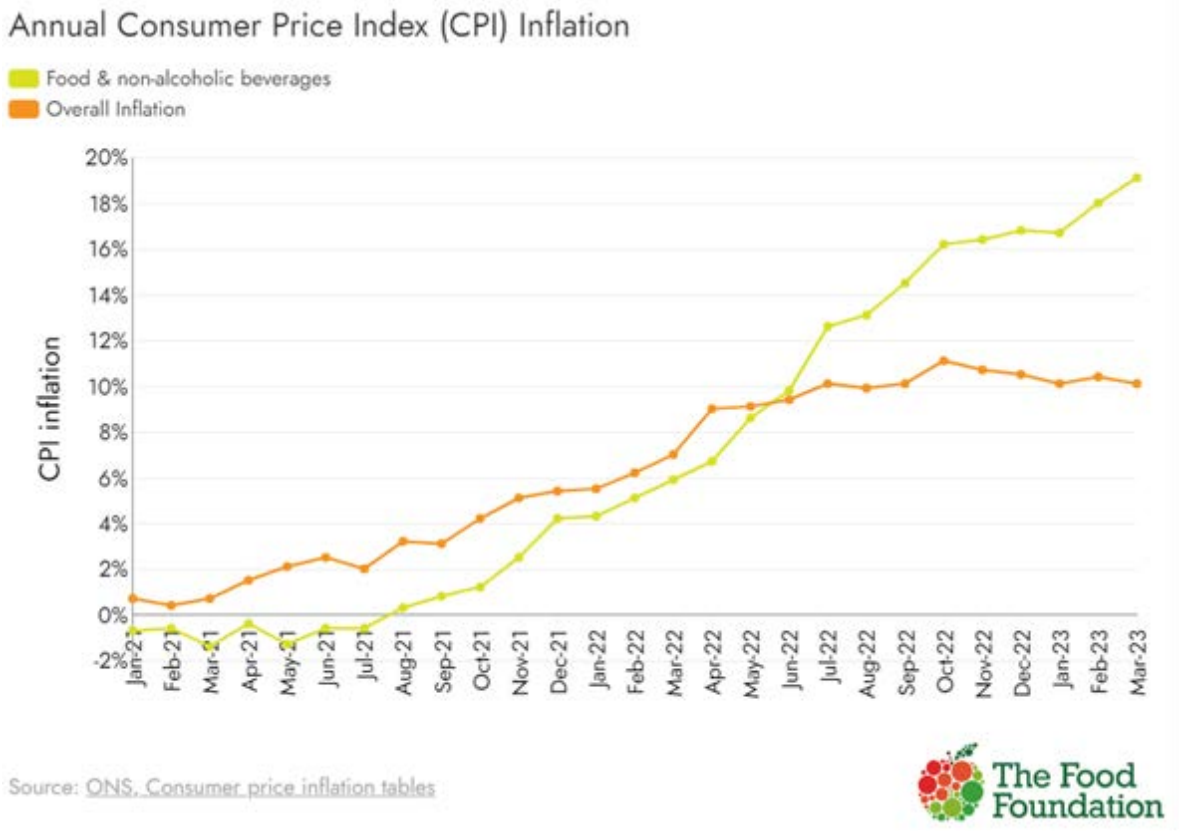
Food security

… exists when all people, at all times, have physical, economic and social access to **sufficient**, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

"enough for a particular purpose; as much as you need"

… OED

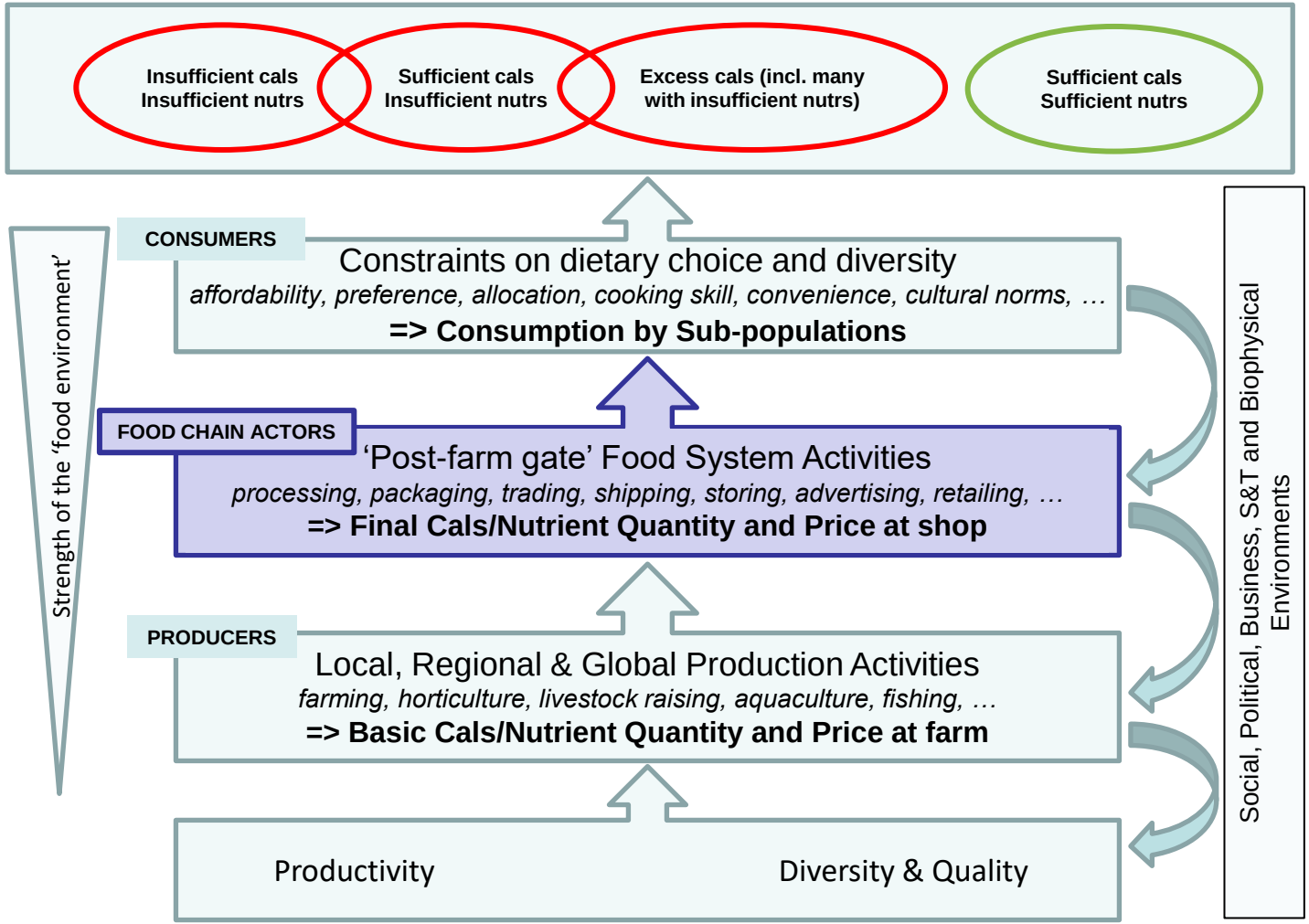
But we know that many are challenged by the 'cost of living' crisis



Source: ONS, Consumer price inflation tables

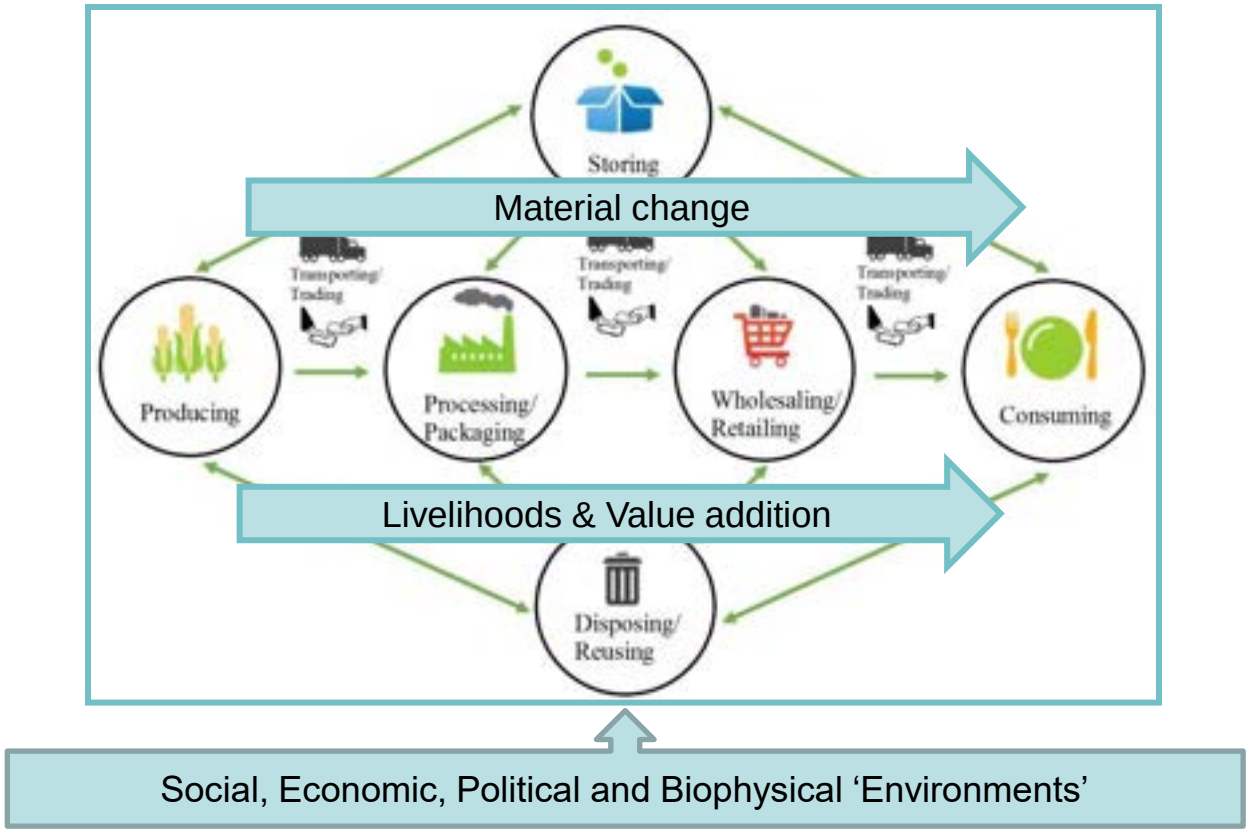
The Food Foundation

What determines which circle we fall into?



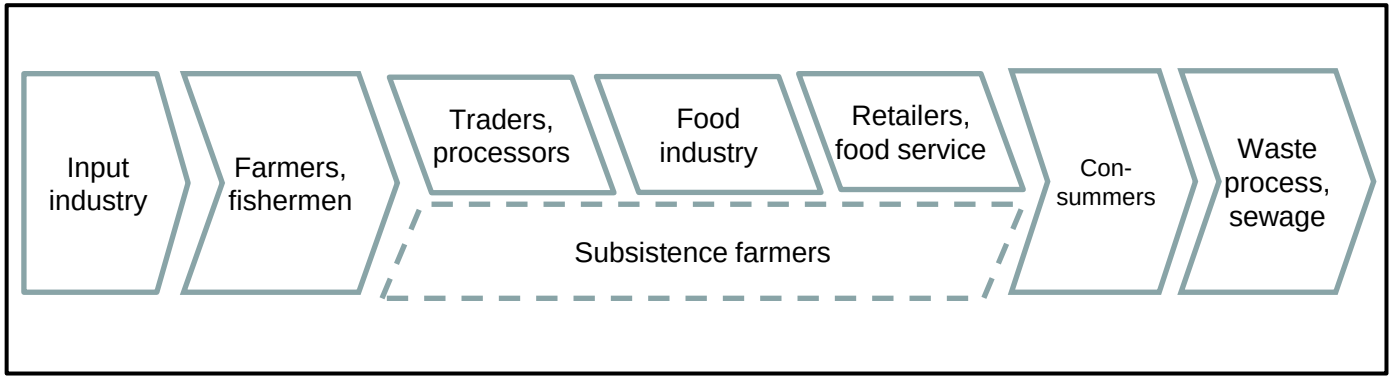
“Unpacking the Food System”

1: Recognising material change and value addition



“Unpacking the Food System concept”

2: Identifying the range of Food System ‘Actors’

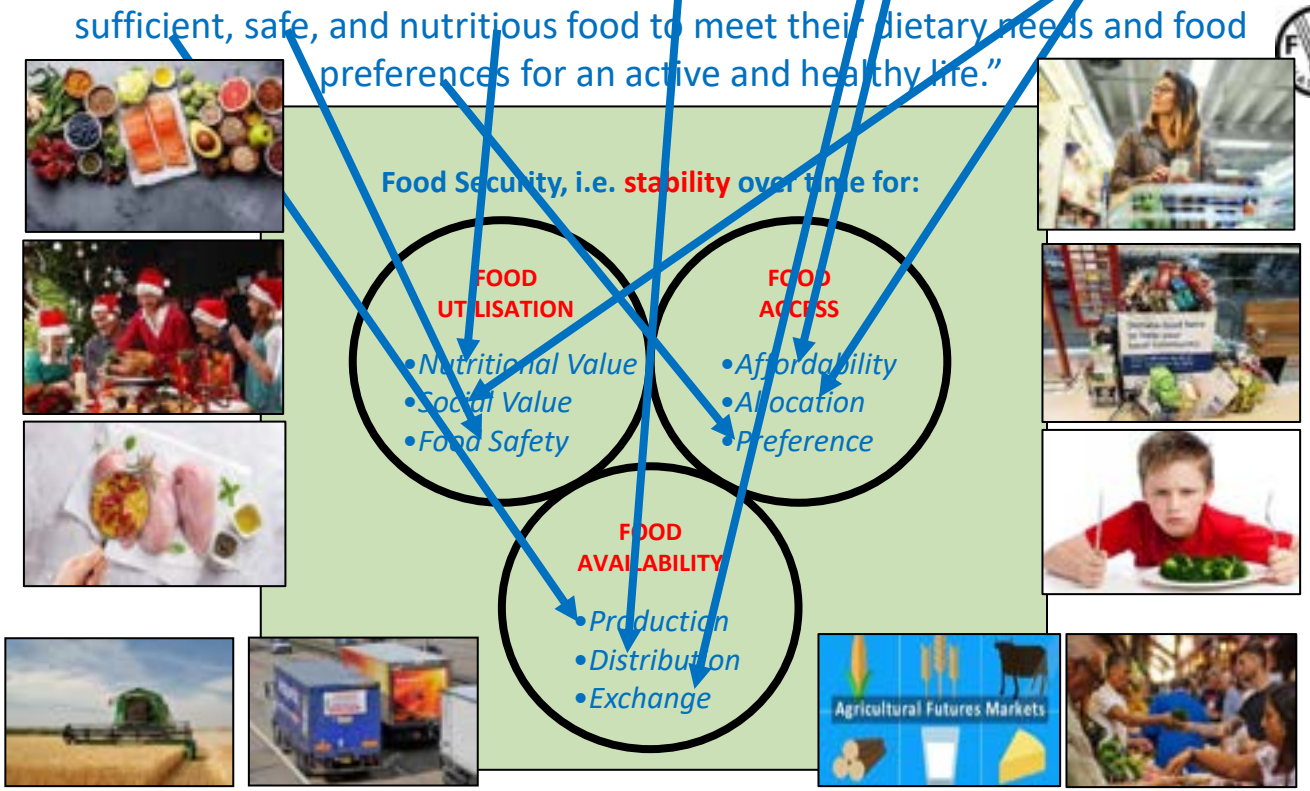


Noting they are all influenced by a range of ‘drivers’ (policy, economic, social, env, S&T, …)

…. and all have a range of motives

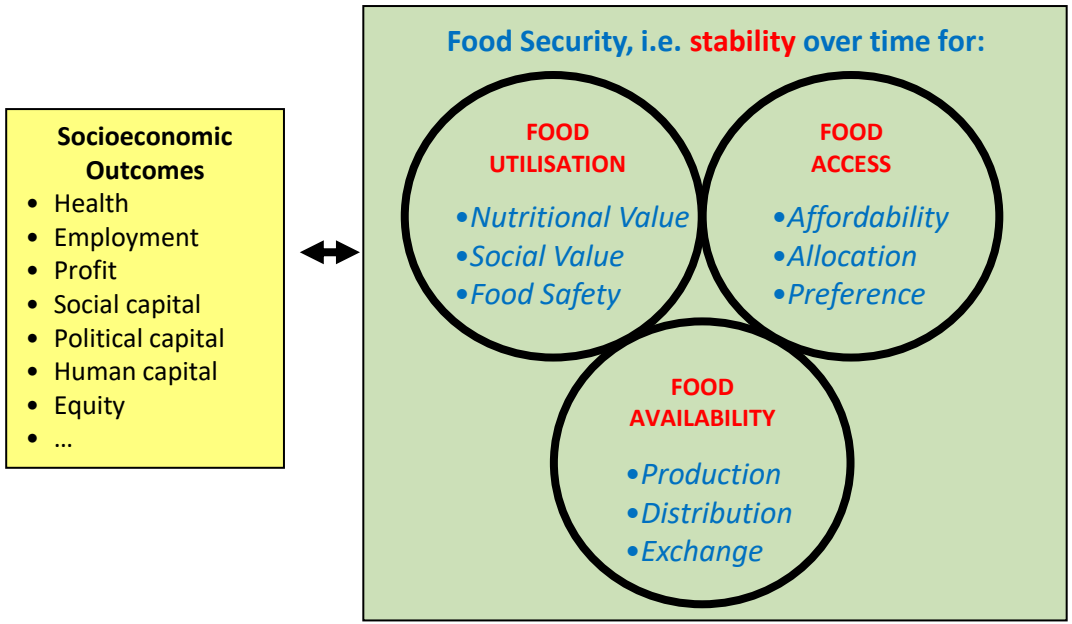
“Unpacking the Food System”
3: Clarifying food security ‘Outcomes’

“… when all people, at all times, have physical, economic and social access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life.”



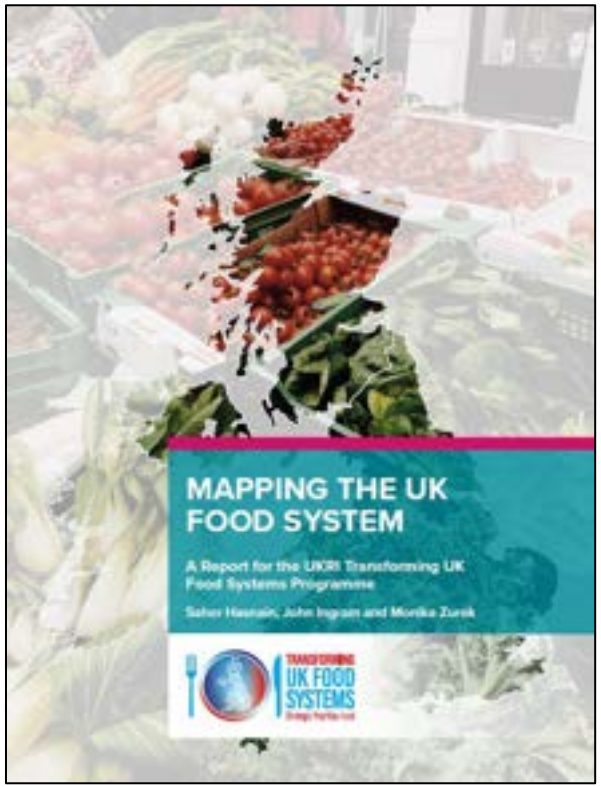
“Unpacking the Food System”

4: Recognising a range of other ‘Outcomes’



Mapping the UK Food System report

www.foodsecurity.ac.uk/uk-food-mapping

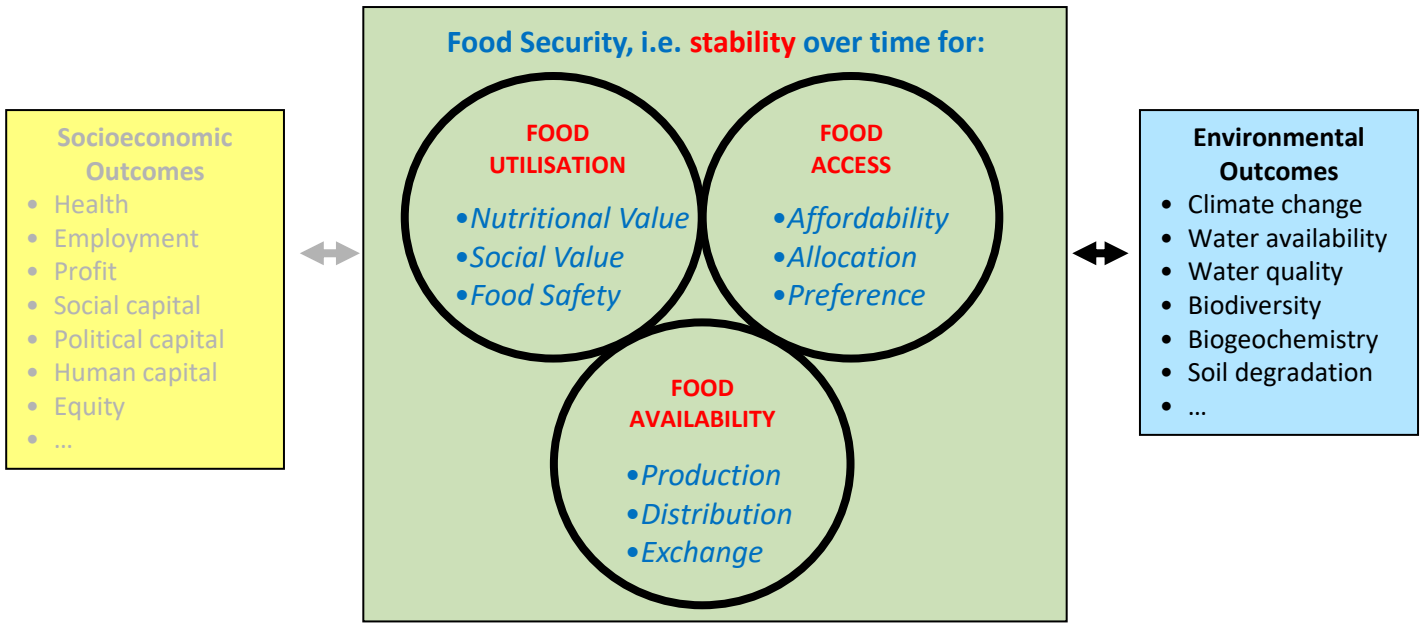


- ✓ Number of people employed in the UK food system
- ✓ Number of enterprises in the UK food system
- ✓ Economic summary of the UK food system

Hasnain, S., Ingram, J. and Zurek, M. 2020. Mapping the UK Food System – a report for the UKRI Transforming UK Food Systems Programme.

“Unpacking the Food System”

4: Recognising a range of other ‘Outcomes’



We know the current state of the food-related UK environment …

- Soil risks Compaction (4 MHa); Erosion (2 MHa)
- Fresh water >50% England water companies “Areas of serious water stress”
- Biodiversity 41% spp declined since 1970
- Marine resources 70% key populations over-fished

And pollution: chemicals, plastics, litter, …

ARTICLES
https://doi.org/10.1038/s43016-021-00225-9
nature food
Check for updates

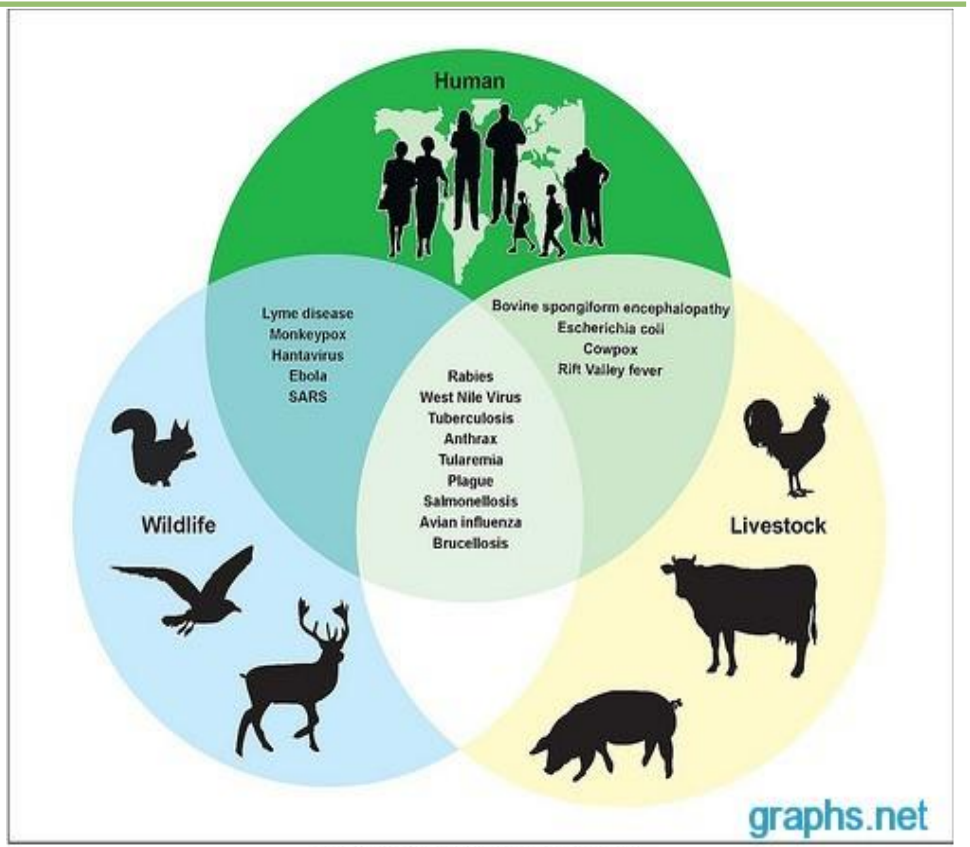
Food systems are responsible for a third of global anthropogenic GHG emissions

M. Crippa[1], E. Solazzo[1], D. Guizzardi[1], F. Monforti-Ferrario[1], F. N. Tubiello[2] and A. Leip[1]

NATURE FOOD | VOL 2 | MARCH 2021 | 198–209

… and the increasing issue of animal-human interactions …

- Increasing risk of disease emergence with the rapid changes at the A-H interface.
- Links between human and animal prophylaxis, e.g. AMR



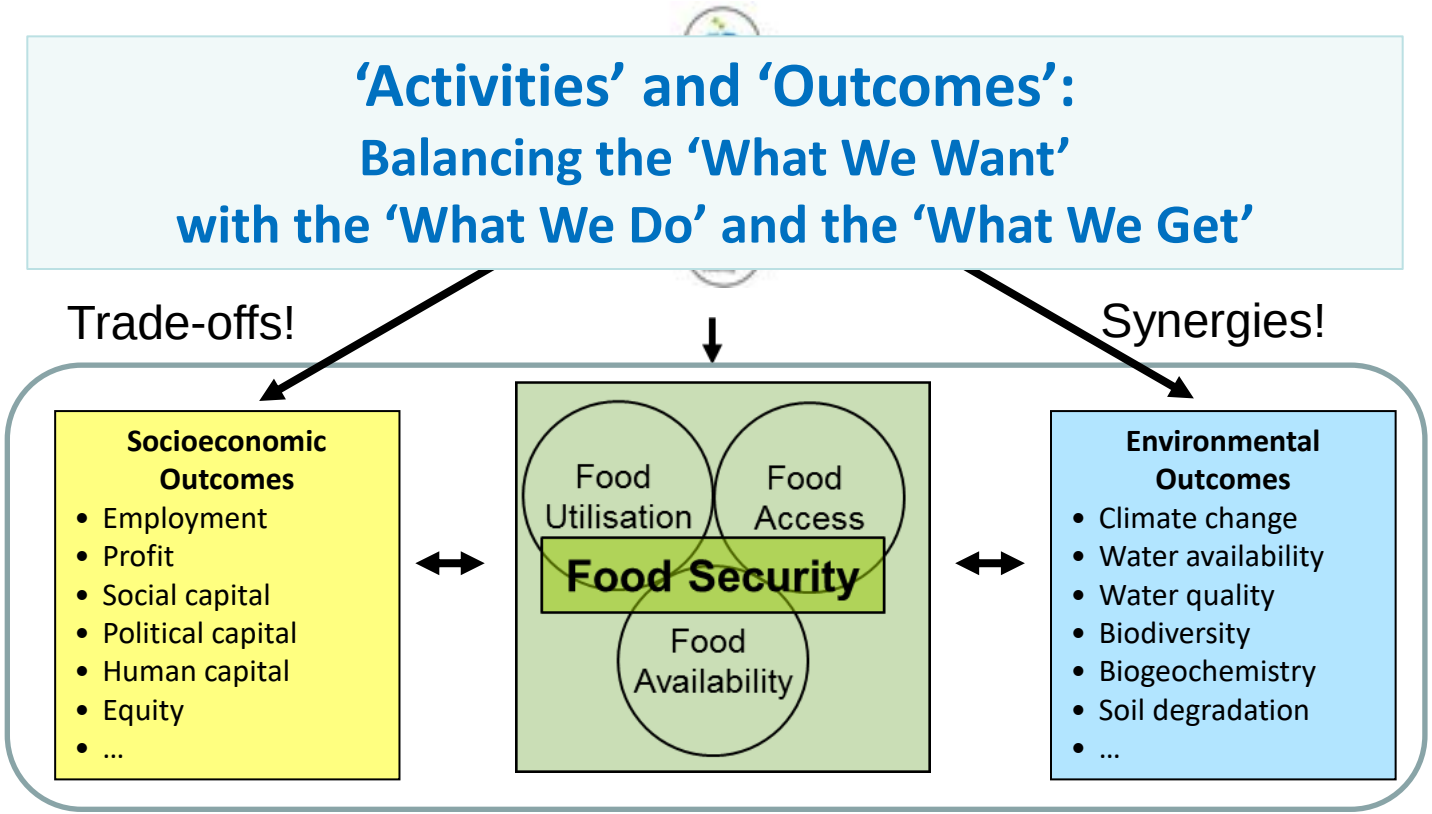
Source: GAO analysis of USGS data (data); Art Explosion (images).

… and a host of ethical and moral issues.

- Inter-generational environmental legacy
- Animal welfare
- Workers rights
- Food waste
- Farmer welfare and safety
- Equity
- Civil harmony
- …

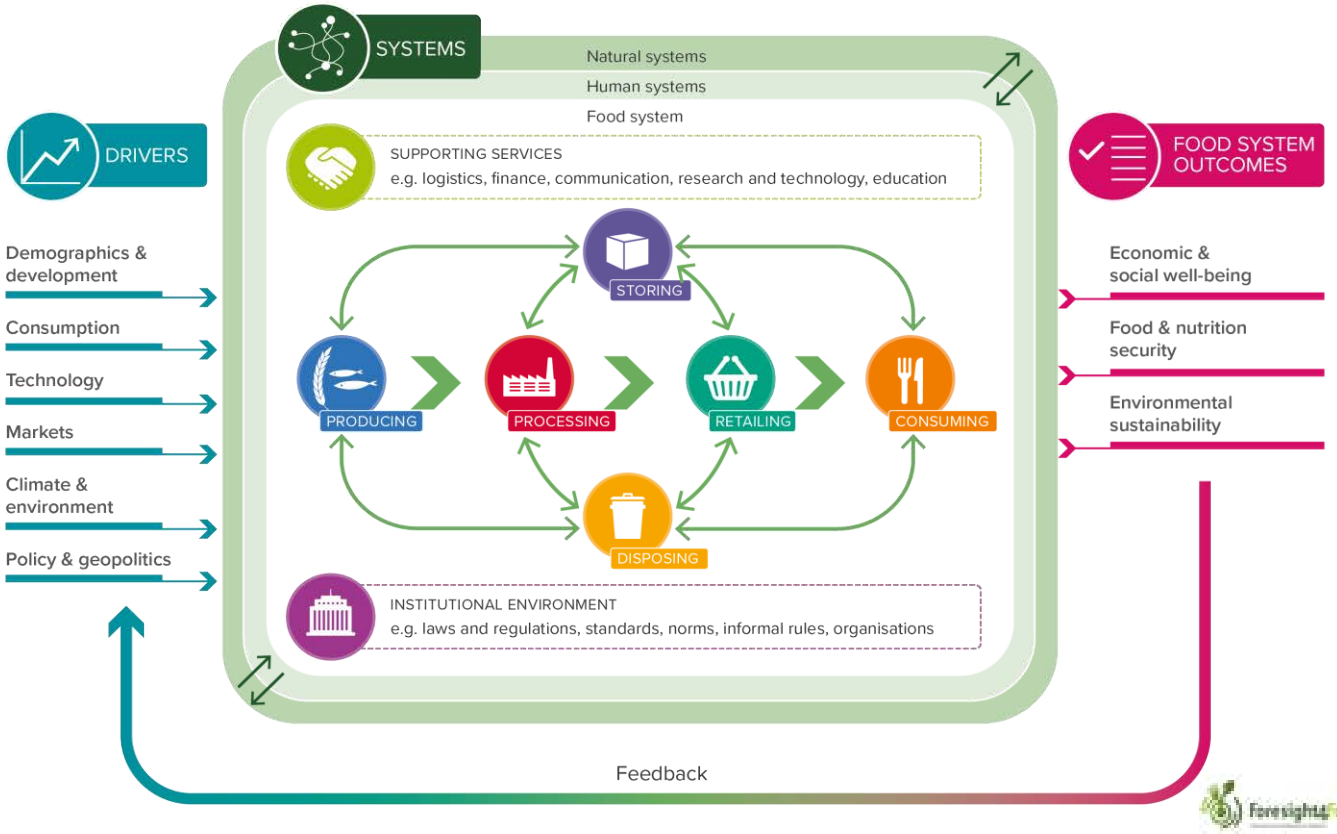
“Unpacking the Food System concept”

5: Including a range of ‘Outcomes’

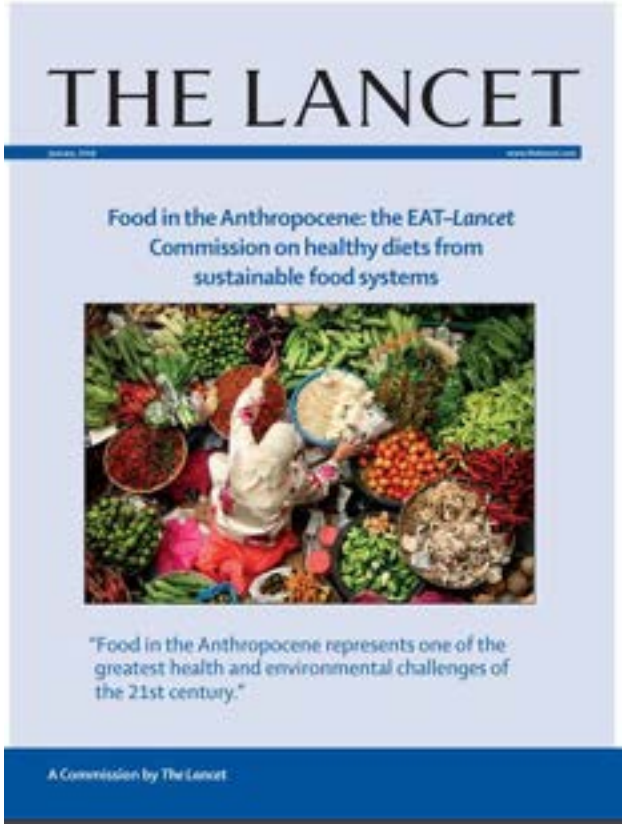


“Unpacking the Food System concept”

6: Recognising feedbacks (+ve and –ve!)



~~Sustainable Diets~~
Aim for healthy diets from sustainable food systems



Needs a Great Food Transformation
An unprecedented range of actions taken by all food system sectors across all levels that aim to normalise healthy diets from sustainable food systems.

Healthy Diet *Outcomes*

- ✓ Calorie and nutrient density
- ✓ Quality
- ✓ Diversity
- ✓ Safe
- ✓ Affordable
- ✓ Acceptable
- ✓ Sufficient

Sustainable Food System *Activities*

- ✓ Environmentally sound
- ✓ Socially acceptable
- ✓ Economically/Enterprise viable

Food System Activities *(Functioning)*

or

Food System *Outcomes* *(Function)*

Food System OUTCOMES

Social Welfare
- Health
- Employment
- Health
- Social capital
- Political capital
- Ethics
- …

Food Security
- Food Utilisation
- Food Access
- Food Availability

Environment
- Climate change
- Water availability
- Water quality
- Biodiversity
- Biogeochemistry
- Soil degradation
- …

The call for
‘Food System Transformation’

“Providing a healthy, affordable, and environmentally-friendly diet for all people will ***require a radical transformation of the system***. *InterAcademy Partnership: Nov 2018*

But what does ‘transformation of the system’ actually mean?

What are we actually trying to transform?

Ans: Food System ‘outcomes’ from state A to state B:

⇒ Poor diets to more balanced diets
⇒ Good food safety to even better food safety
⇒ Poor working conditions to fairer conditions
⇒ Poor environmental outcomes to better outcomes
⇒ Current incidence of food crime to reduced level
⇒ Poor animal welfare to better welfare
⇒ …

Reorienting our ‘views’ on Food System Outcomes
The need to ‘shift mindsets’


correspondence

The urgency of food system transformation is now irrefutable

To the Editor — Poor diets are the main contributor to the global burden of disease, accounting for 20% of premature disease-mediated mortality worldwide[1]. Approximately 3 billion people cannot afford a healthy diet, and more than 3 billion people suffer one or more manifestations of poor nutrition[2]. Poor nutrition can lead to reduced earning potential and increased costs for healthcare, it locks individuals and families into inter-generational cycles of poverty and deprivation, and perpetuates inequality and disadvantage.

Even without projected global population growth — predicting a global population of 9.7 billion by 2050[3] — it is likely that food systems are already operating beyond some planetary boundaries[4–6]. Agriculture and its associated land-use changes are the biggest contributors to climate change, accounting for roughly 21% of

“Achieving transformation will **require a major shift in mindsets** — especially regarding possible futures versus the status quo…” *Webb et al, Nature Food, 2020*

= Shifting our expectations from what we are currently getting (less good) to what we want to get (more good)

=> Better health, reduced environmental impact, fairer and more just enterprises, …

1. Agree what Outcomes are acceptable/sought [shift in mind set]
   (for who, from who's perspective, by when…)

2. Adapt the Activities to transform the Outcome(s) from State A (current) to State B (future)
   (who, how, …)

Degree of transformation sought in food system Outcomes determines the degree of adaptation required in food system Activities

But needs negotiation (winners and losers)

So who has to do what to Transform Food System Outcomes?

Reassess

Adapt

Transform

Food System Policies

Signals Opportunities or Threats

Social, Economic, Political, Science & Technology and Biophysical Contexts

Food System **Activities**

Food System **Outcomes**

Socioeconomic Outcomes

Food Security Outcomes

Environmental Outcomes

Ingram and Thornton, *Nature Food* 2022

Q&A

Break

A Vision of the Food System 2045 CE: Smart People, Smart Processes, Smart Factories

Dr Wayne Martindale

Associate Professor
NCFM - University of Lincoln

A Vision of the Food System, 2045 CE-

Smart People, Smart Processes, Smart Factories

Dr Wayne Martindale, Ph.D FIFST
Food Insights and Sustainability

27th April 2023

SC23

National Centre for Food Manufacturing

Our Research Goal- we seek a more sustainable global food system that provides security, safety and assurance for 9 Billion consumers.

Our approach- enable interdisciplinary transformation with food system data to develop manufacturing tools. These are utilised by manufacturers to deliver productive, efficient, sustainable and healthy future foods. They identify innovative product development and process technology strategies for food and beverage manufacturers - meeting UN Sustainable Development Goals and Science Based Targets in commercial practice.

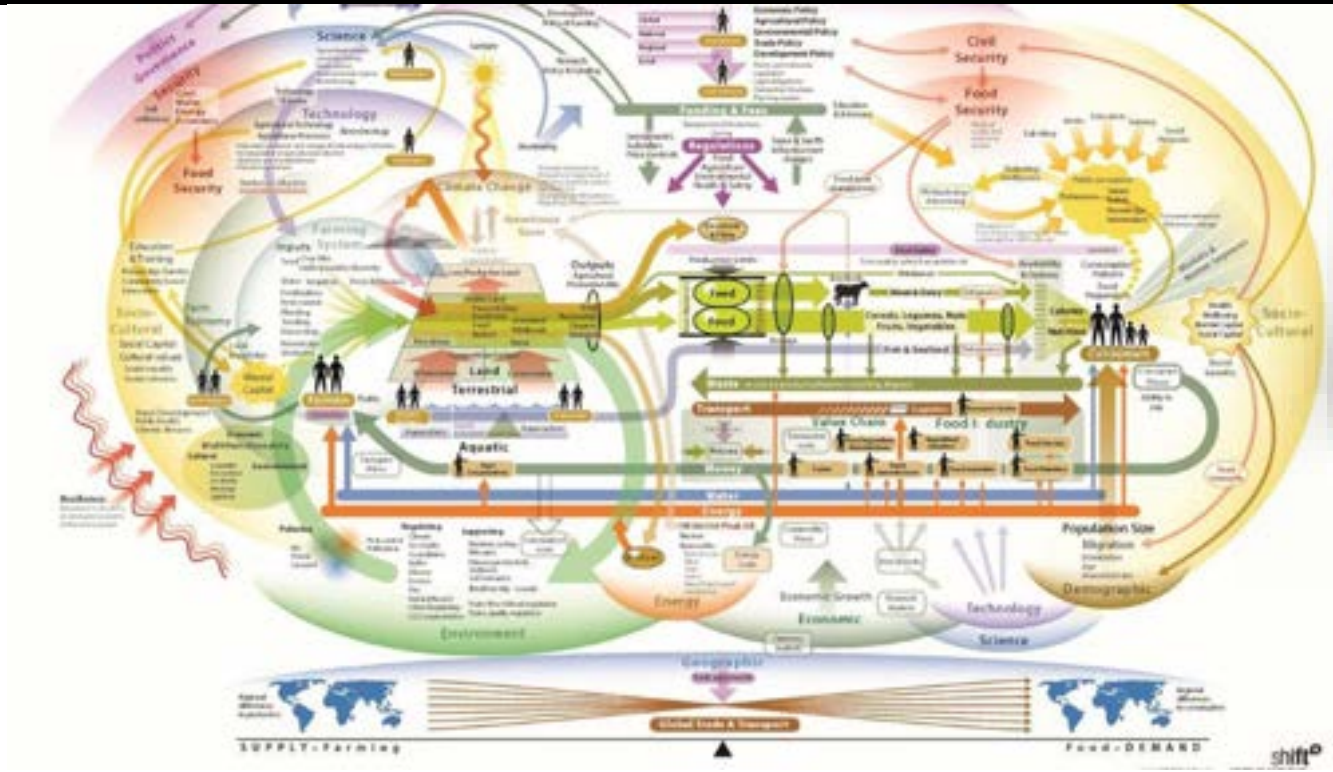
S3 – Lincoln NCFM Team:

Dr Wayne Martindale – Principal Investigator
Associate Professor Janet Bellamy – Co-Investigator.
Professor Mark Swainson – Co-Investigator.
Emma Vincent – Research Projects Manager.

Websites and further information,

S3 Project, https://www.s3project.net/
Food Insights & Sustainability,
https://fis19.blogs.lincoln.ac.uk/
NCFM Research https://www.lincoln.ac.uk/holbeach/research/

Q1. What do we know about our food system?



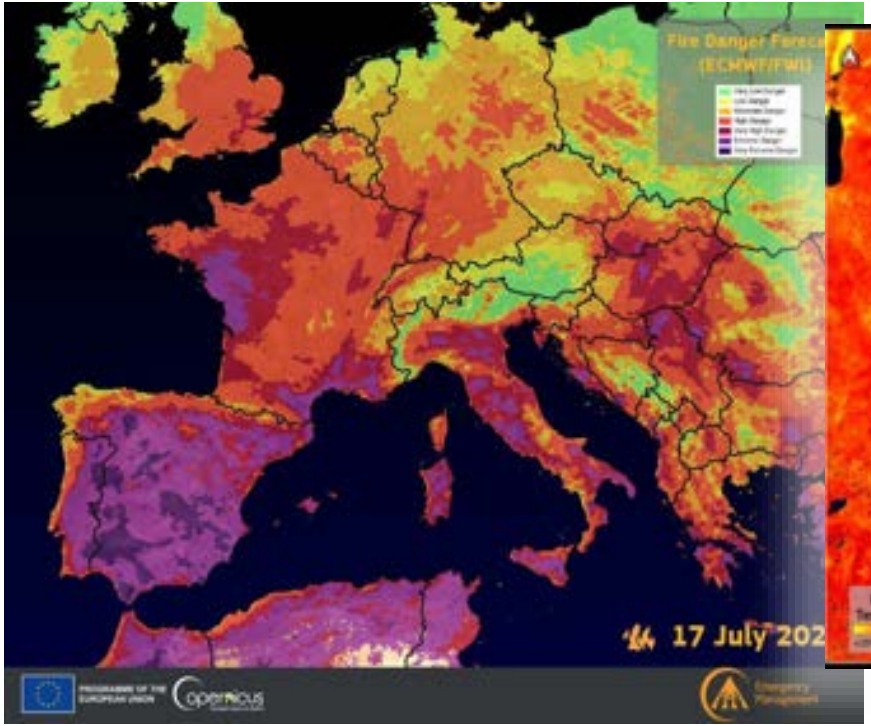
Global sourcing

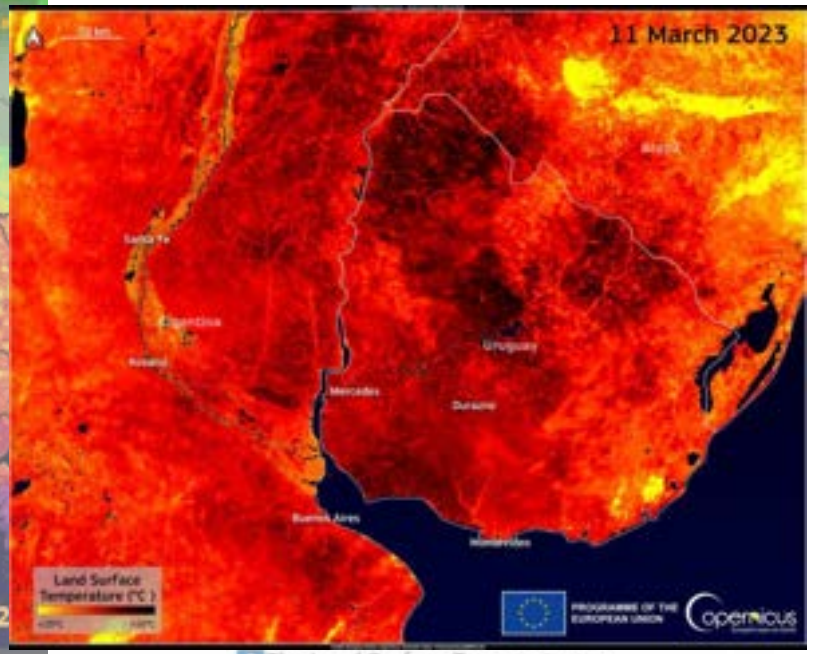
The Russia-Ukraine Conflict: Its Implications for the Global Food Supply Chains. Jagtap et al (2022) Foods https://doi.org/10.3390/foods11142098

The Impact of Resource and Nutritional Resilience on the Global Food Supply System. Martindale et al. (2019) https://doi.org/10.3390/su12020751

Q2. Why is the UK food system not secure for 70 million?

Climate change- risks move around, scale is crucial

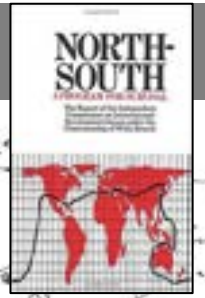


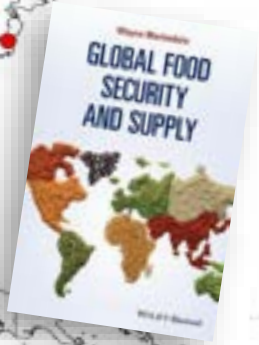


The Land Surface Temperature as measured on that day by #Copernicus #Sentinel3 shows peaks at 48°C

11:16 AM · Mar 13, 2023 · 79.3K Views

Waste and loss- without balance, failure is certian



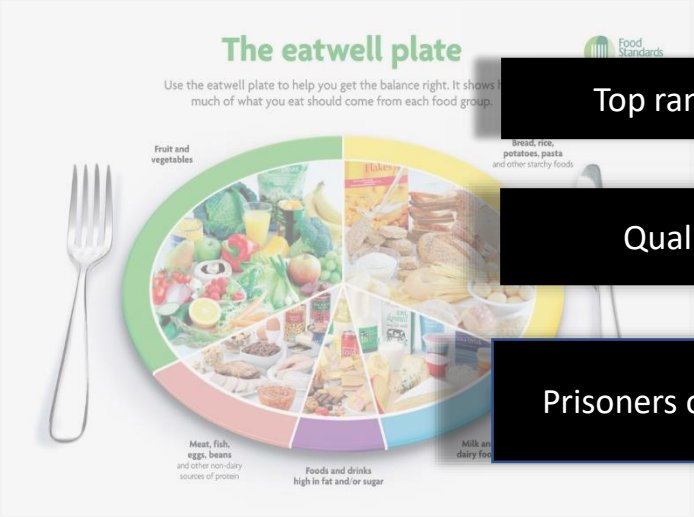


Dr Wayne Martindale 10/2022

<750 Calories/capita/day- 40%, <u>33 wasted diets/capita/day</u> in HI nations; 4 wasted diets/capita/day in LMI nations

Martindale W (2021) Our connected future with the turn-key technologies that are reducing food waste and improving nutrition. New Zealand Science Review Vol 77

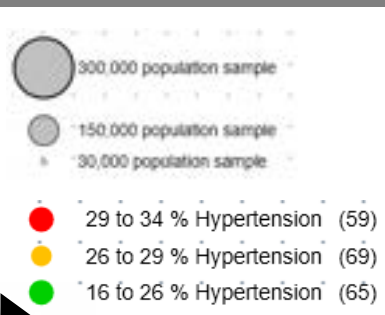
Health and future lifestyles- the most chaotic issue

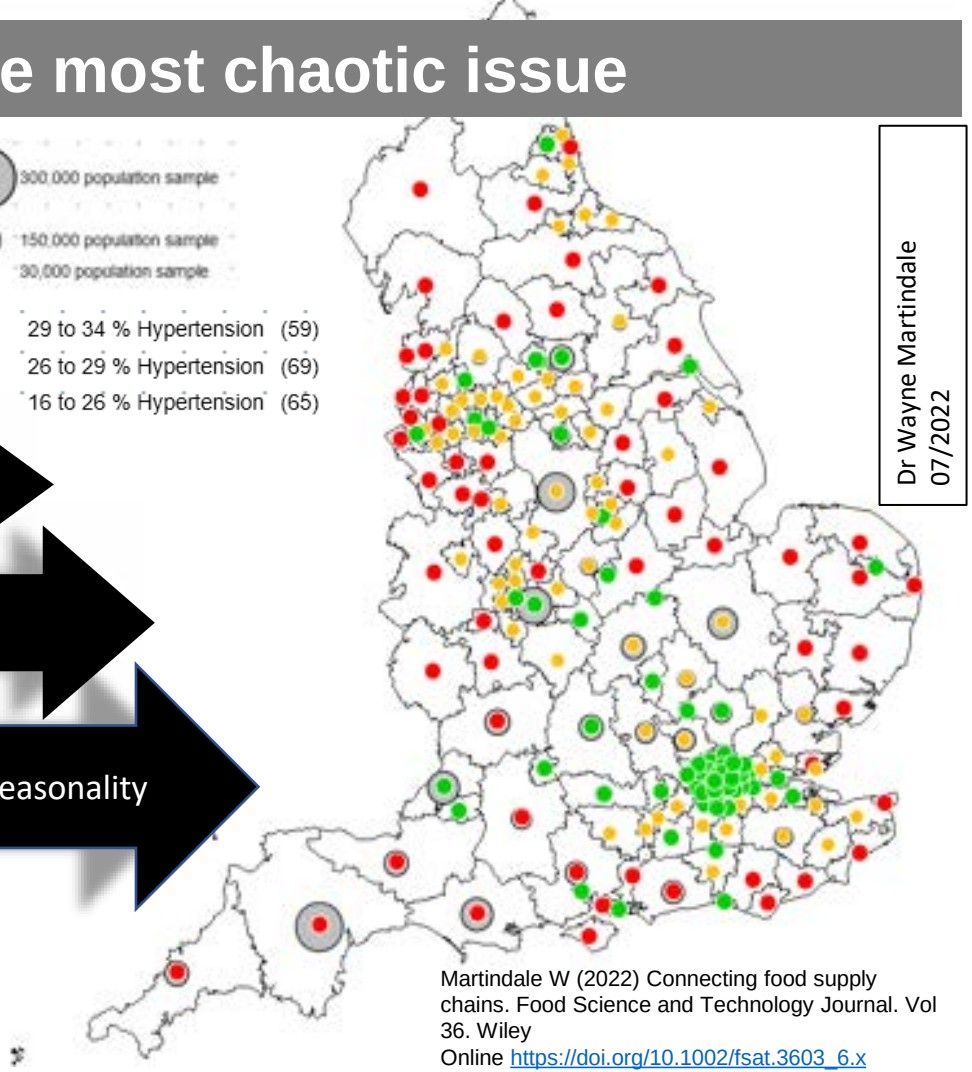


Top rank proteins

Quality and markets

Prisoners of geography or seasonality





Dr Wayne Martindale 07/2022

Martindale, W., Mark, S., Hollands, T. (2020) Protein Diversification. Food Science and Technology Journal. Vol 33. Wiley Online

Martindale W (2022) Connecting food supply chains. Food Science and Technology Journal. Vol 36. Wiley
Online https://doi.org/10.1002/fsat.3603_6.x

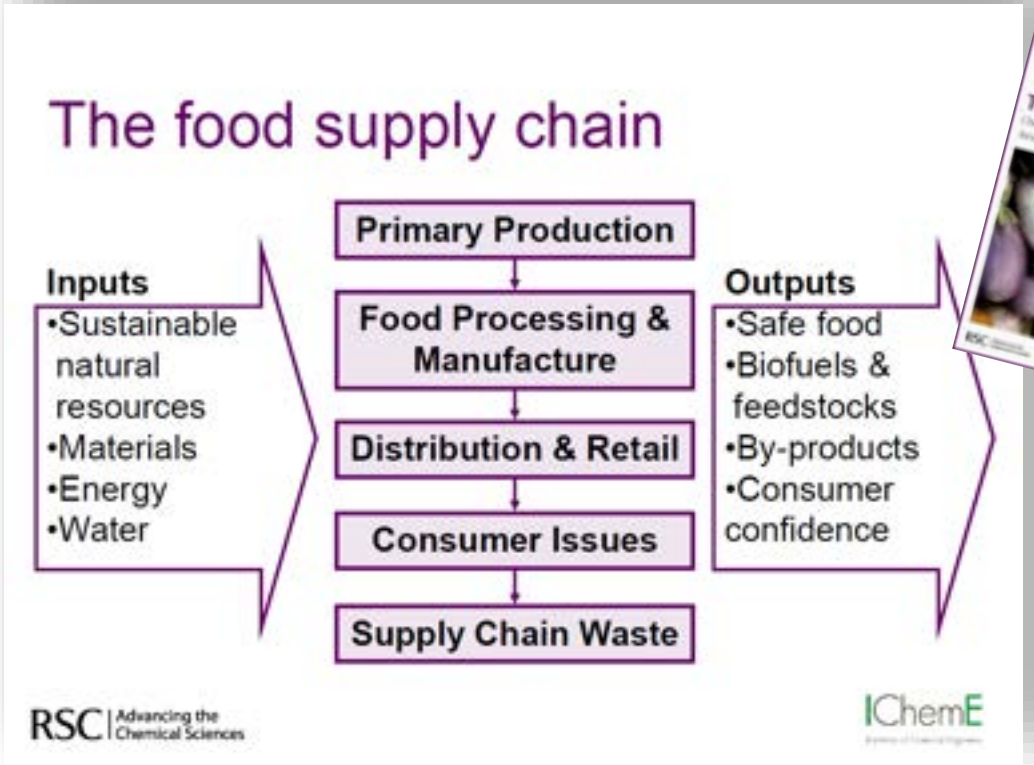
Q3. What we are doing to improve our food system?

Structure and ecosystem

11 600 manufacturers

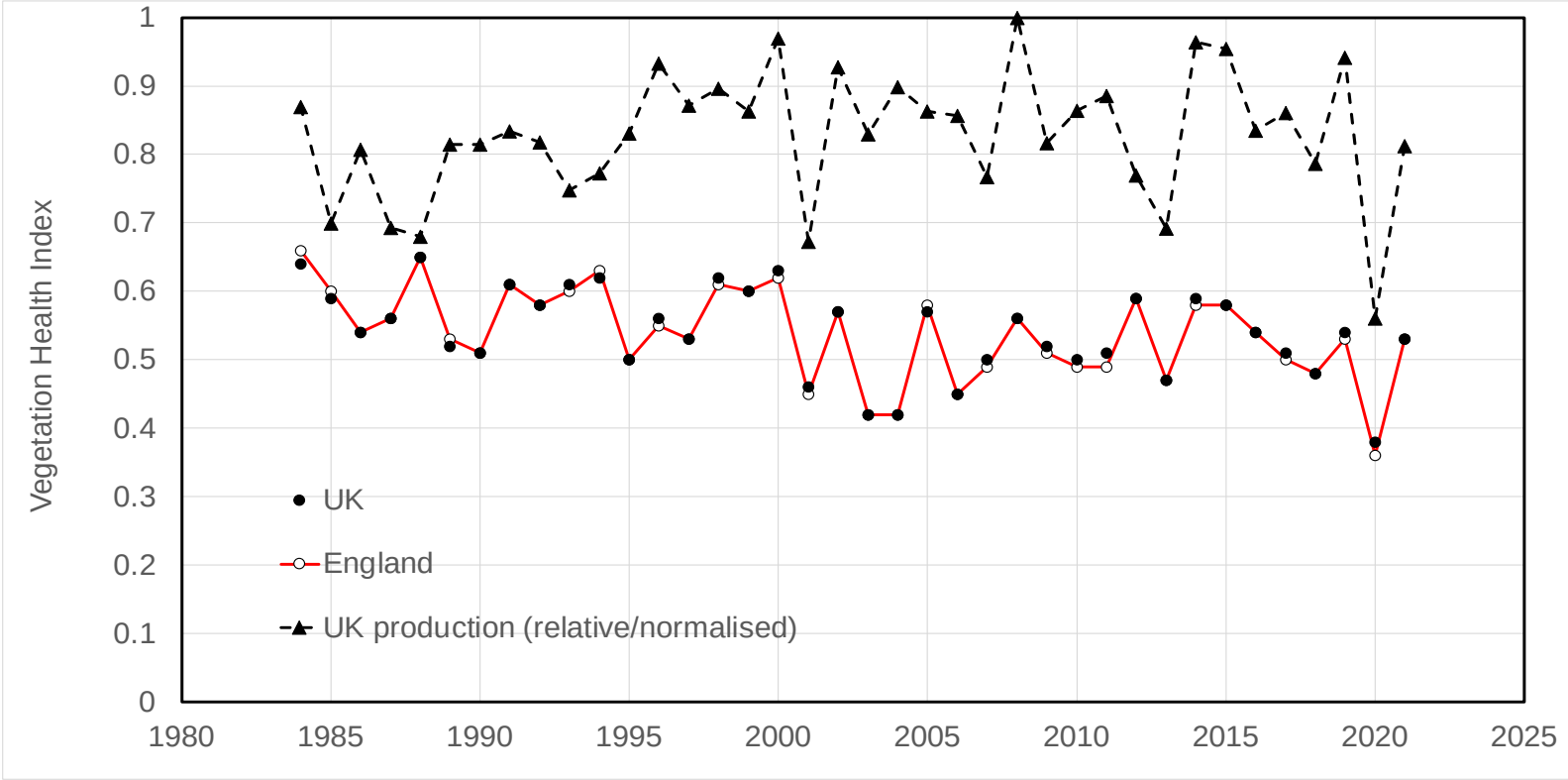
Accessibility, affordability, assurance

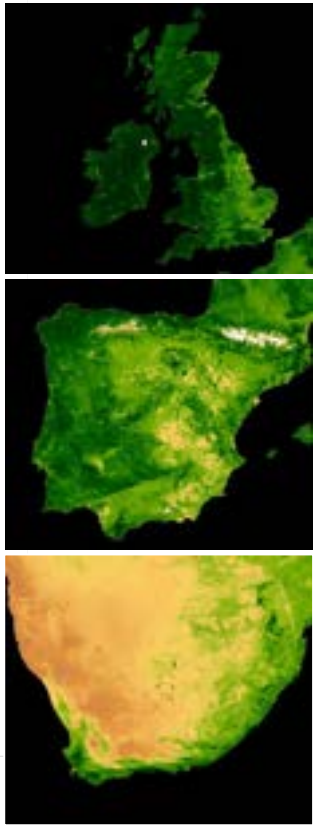
Manufacturing is turn-key

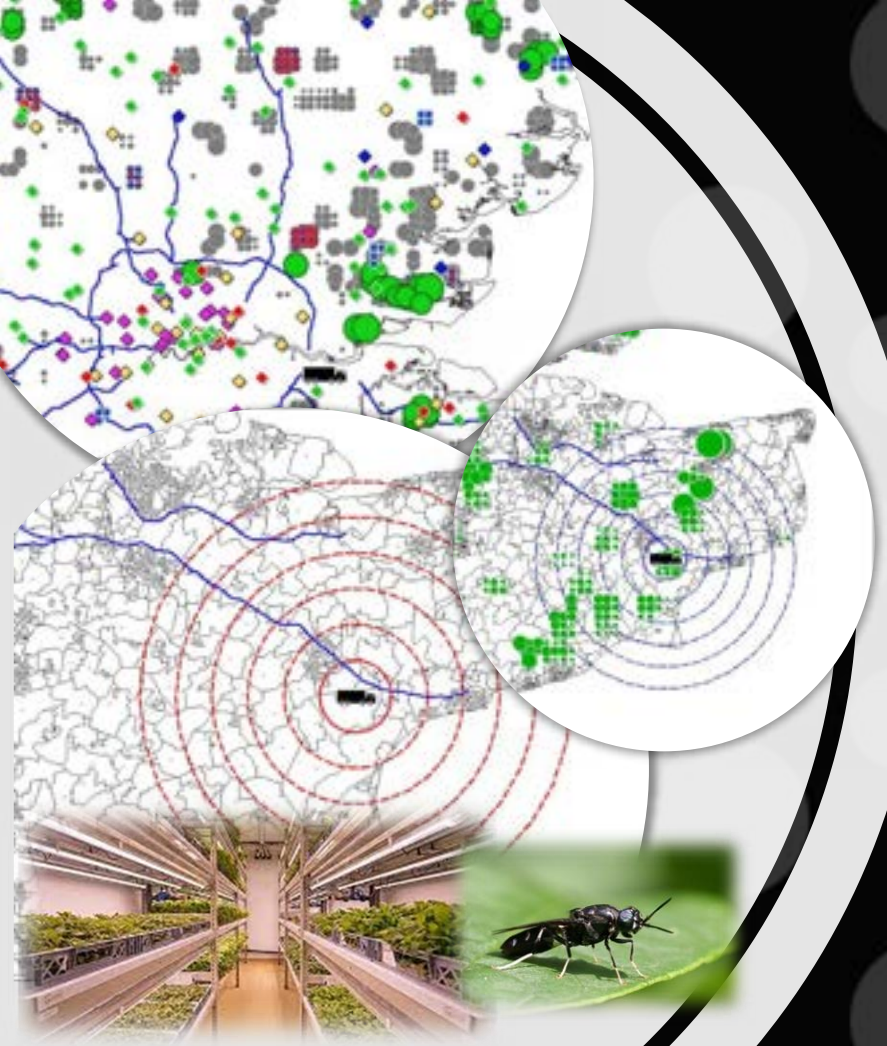


New direction for NPD. Martindale, Hollands, Swainson (2019) https://doi.org/10.1002/fsat.3301_9.x

Smarter supply chains- can we really not do this?







There is a need to re-think the system

Food-resource futures

Dynamic, real -time simulation of futures, beyond crisis thinking into strategic thinking

- ‘System change’, ‘resilience’, ‘regionalization’
- Net carbon zero targets, SDG 12
- Production
- Consumption

Codesign of Food System and Circular Economy Approaches for the Development of Livestock Feeds from Insect Larvae Jagtap et al., Foods 2022 https://doi.org/10.3390/foods10081701

Dr Wayne Martindale 01/2023

The demonstration of the now and the future- what we are doing

P1

P2

P3

smart people
smart process
smart factory

UK Research and Innovation

Supported by UK Research and Innovation

Other projects supported by UKRI in this round:
£14 million funding for sustainable smart factory projects – UKRI

Gamification of carbon savings will allow workforce to contribute to and benefit from real-time CO2e reductions

Smart people + smart process = smart factory will provide a step-change in carbon savings.

Food production and supply, arguably the backbone of our society, is being operated unsustainably. Any major step-change that we can achieve in the way we grow, process and consume our food will create huge and far-reaching changes. It also follows that the effort required to effect any such change will be commensurately significant.

This is the situation which has given rise to the S3 project and the scale of change it aims to achieve.

This project revolves around the 320 members of staff from the factory, transport and office functions in Raynor Foods, who are leading the project consortium with a investment of c £1.5m of the c.£2.5m project budget. Raynors will constitute the testbed that will change practice and behaviour so that measurable sustainable outcomes will be reported, employing innovative gamification strategies to build 'Carbon Hero' games.

Testing the data platforms required for the 21st century food system using an industry ecosystem approach. Martindale, Hollands et al., (2020) https://doi.org/10.1016/j.scitotenv.2020.137871

Dr Wayne Martindale
01/2023

Summary

- A need to re-think the system, including materials
- Develop solutions for meals
- Be ready for crisis
- Smarten up, connecting data
- Break repetition

"I think in England you eat too much sugar and meat and not enough vegetables."

Arsene Wenger

A Vision of the Food System, 2045 CE-

Smart People, Smart Processes, Smart Factories

Dr Wayne Martindale, Ph.D FIFST
https://waynemartindale.com/

27th April 2023

Turn-key research in food processing and manufacturing for reducing the impact of climate change

Martindale, Hollands, Hebishy, Jagtap and Duong (2023)

Institute of Food Science + Technology ifst SC23

Q&A

Labels and Impact On Consumer Behaviour

Andrea Martinez-Inchausti

Deputy Director of Food Policy
BRC

INSERT SLIDES

Q&A

Lunch

Theme 2:
Environment and Nutrition

An Industry With Treasure In Their Trash Bin

Naomi MacKenzie

Co-CEO
Kitro

Q&A

Microbial Protein: The Future of Green Pharming

Matt Longshaw

Senior Scientist
Calysta


THE WORLD NEWS
Since 1883
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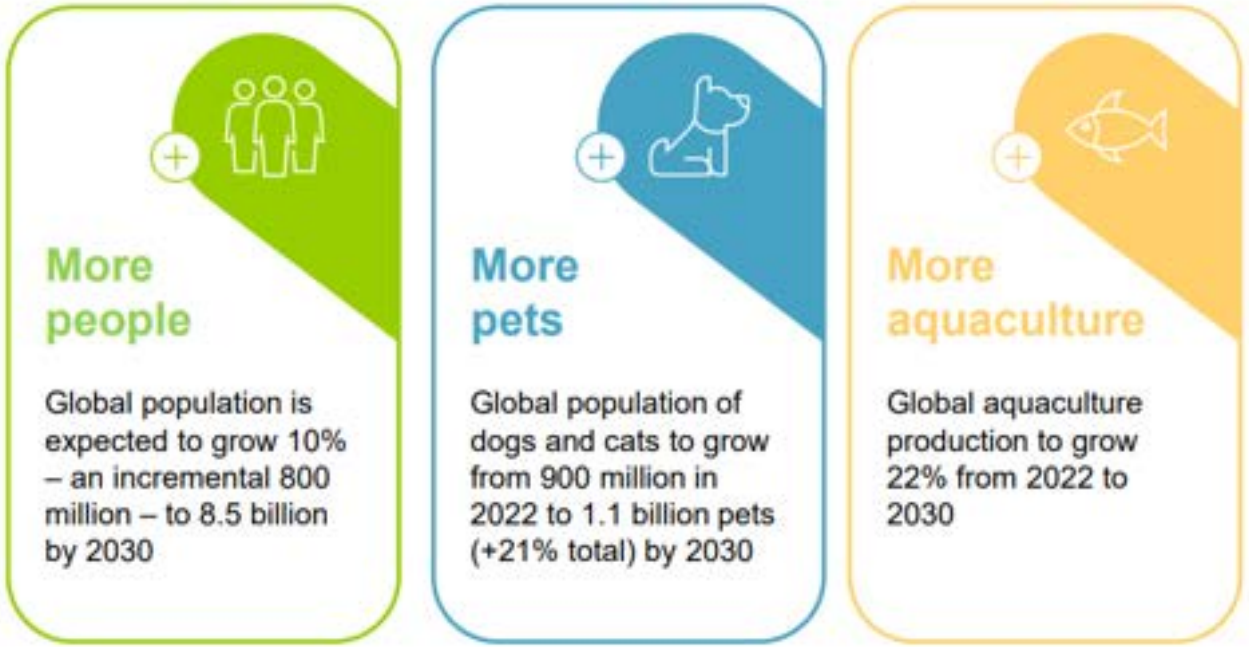
THE SKY IS FALLING!
RELIGIOUS LEADERS
CHICKEN LITTLE
NOWHERE TO BE FOUND

CALYSTA
MORE FROM LESS

Microbial Protein: the Future of Green Pharming

Matt Longshaw, Senior Scientist

Demand for protein is growing rapidly, and shows no sign of slowing…



…. while food supply systems are vulnerable, with resources strained and production unsustainable

Limited natural resources: arable land & water

Fresh water used for global food production

Currently **70%** of the planet's freshwater

By 2050 **+15%**

Arable land used for global food production

Currently **40%** of land use

Current protein production systems are unsustainable

Intensified animal and crop production systems accelerate:

- Climate change
- Pollution – air, soil, water
- Deforestation
- Loss of biodiversity
- Soil erosion
- Animal welfare issues
- Antibiotic resistance
- Unfair working conditions

Calysta is addressing the dual challenge of food security and climate change

Limited Need for Arable Land

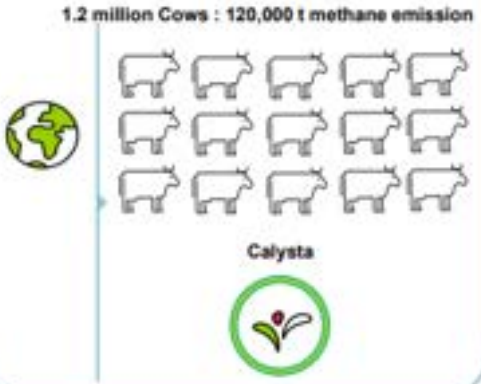
Land required to produce microbial protein in a Calysta 100,000-ton plant is a fraction of the land use for other protein products (km^2); 750 km2 – the size of NYC

Significantly Lowers Water Usage

Calysta's microbial protein uses 90% less blue water than equivalent soy protein or wheat production

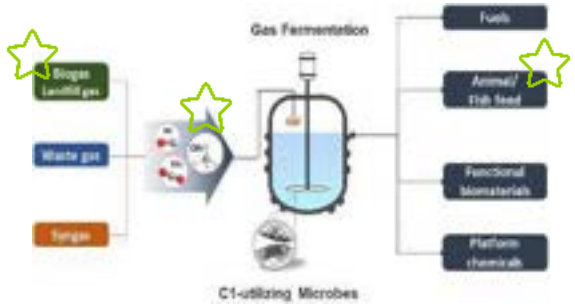
Reduce Animal Driven Emissions

Calysta's protein can reduce animal meat production and animal methane emission; our 100,000 ton plant is equivalent protein to 1.2 million cattle



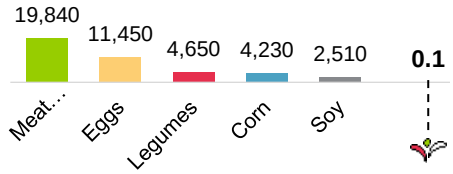
C1 gas feedstocks are infinitely abundant; Net Zero food production without driving deforestation

C1 compounds (i.e., CO_2, CO/syngas, methane, methanol) are the next generation feedstocks for microbial cell factories to support the sustainable development of a net zero economy



- C1 compounds are inexpensive, abundant, and widely accessible
- Using nature-based sequestration of carbon feedstocks from the atmosphere can greatly contribute to the reduction of global warming
- Methane CH4 can be produced from CO2 (air) using Green H2/renewable energy which Calysta can convert to carbon negative protein (FeedKind 2030)

Land Required to Produce Protein Equivalent to a 100,000 mtpa FeedKind Plant (km^2)



- Unlike animal or plant protein products, FeedKind does not need carbohydrates (C6) for growth or compete with land for photosynthesis
- Increasing land availability for Soy demand is a driver of deforestation
- 0.1 sq Km factory (10 soccer pitches) can displace 2,500 km^2 of soy (annual Amazon forest loss is 10,000 km^2 in 2021)

Calysta's protein is inspired by ancient health in nature, with our microbe isolated from hot springs in Bath

Hot springs have been revered since antiquity for their natural life-giving qualities and were worshiped by the Romans through Sulis / Minerva, the goddess of medicine

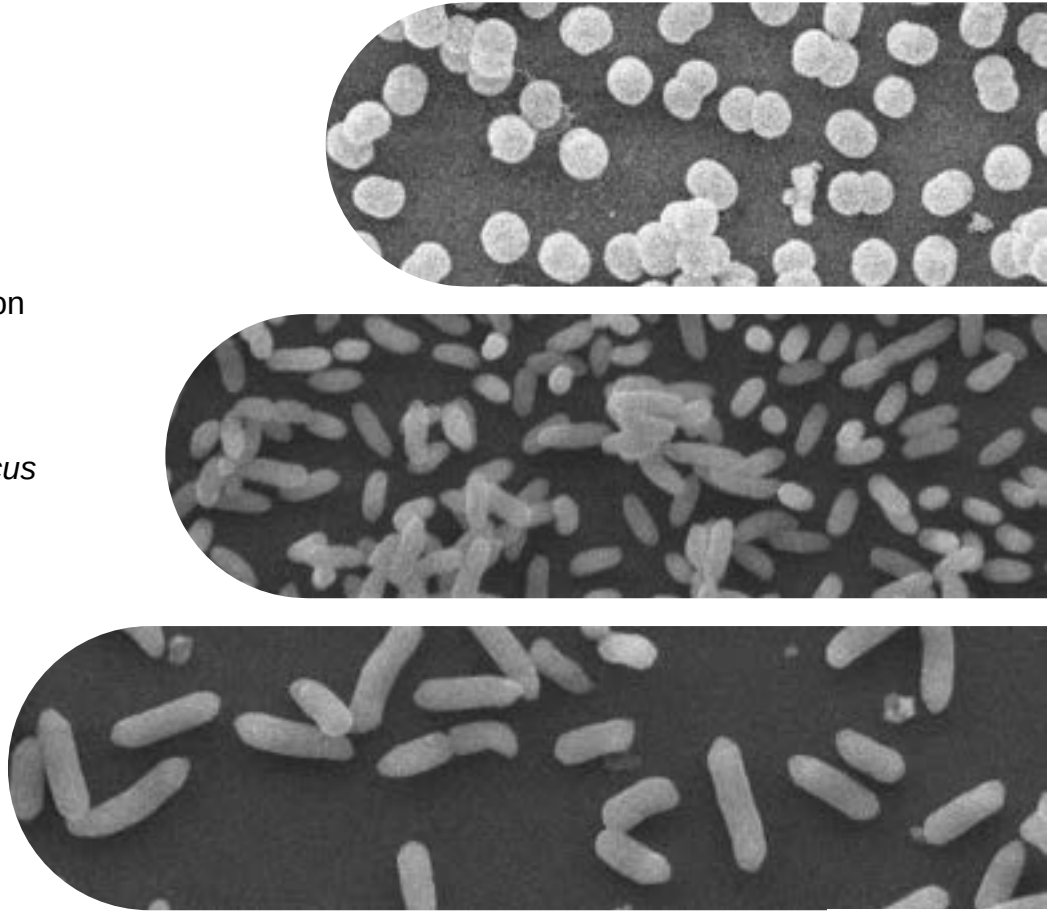
In the 17th-century, doctors began to prescribe the drinking of the thermal waters for internal conditions and illnesses

The history of Bath is intrinsically linked with the natural hot springs that the city is founded upon. The first shrine at the site of the hot springs was built by an Iron Age tribe called the Dobunni, who dedicated it to the goddess Sulis, who they believed possessed healing powers

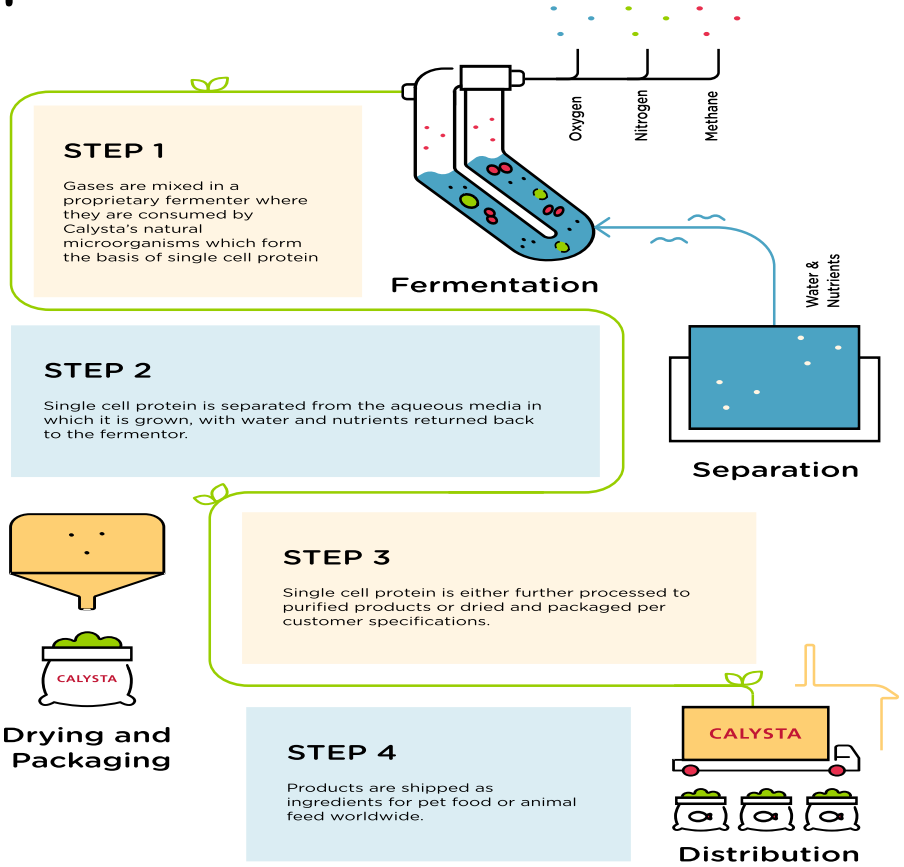
Our bacteria

Consortia working together

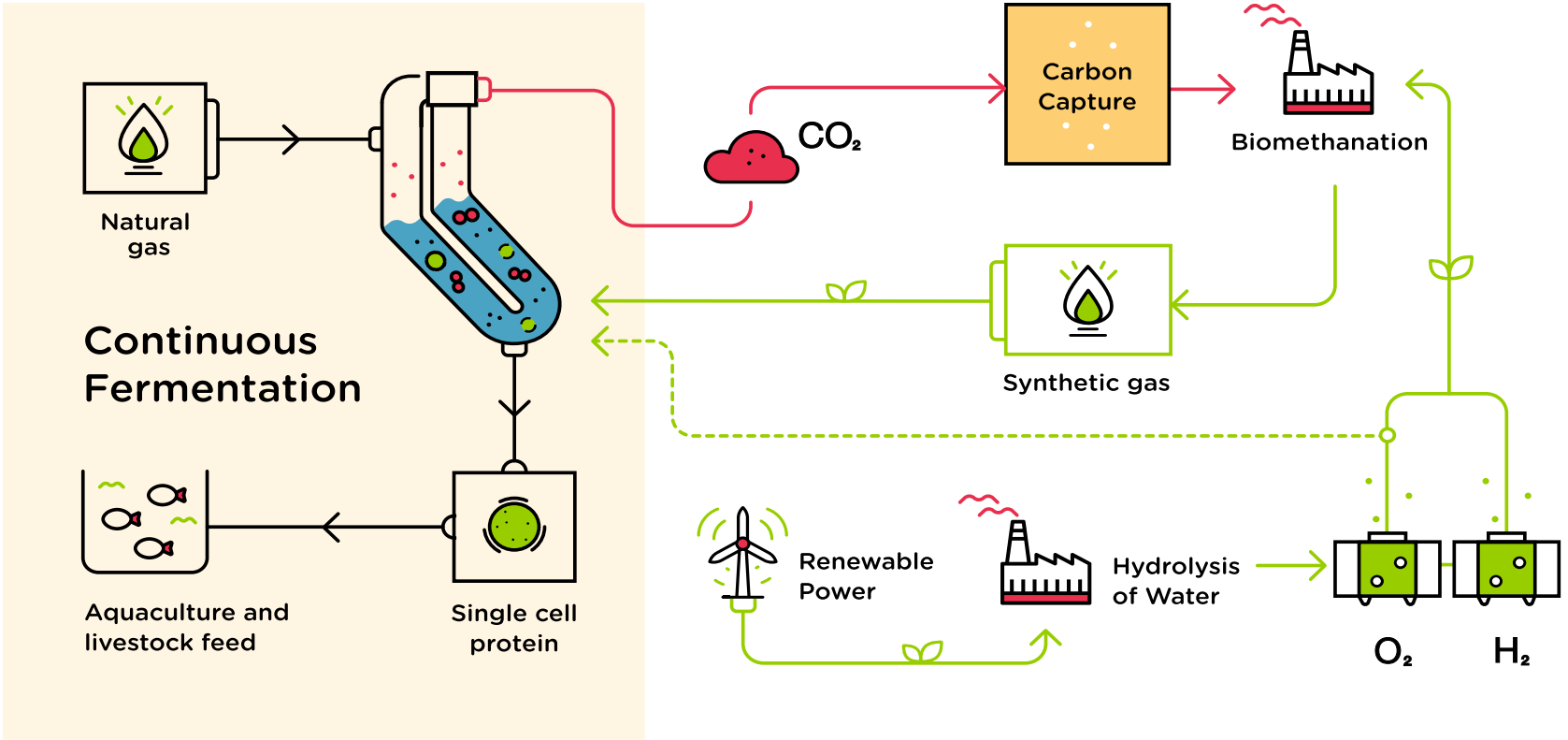
- *Methylococcus capsulatus* (>91%)
- *Cupriavidus* sp. (DB3) (6-8%) – consumes oxidation products of alkanes
- *Brevibacillus agri* (DB4) and *Aneurinibacillus danicus* (DB5) (<1%) – suppress spore forming bacteria



Our current process

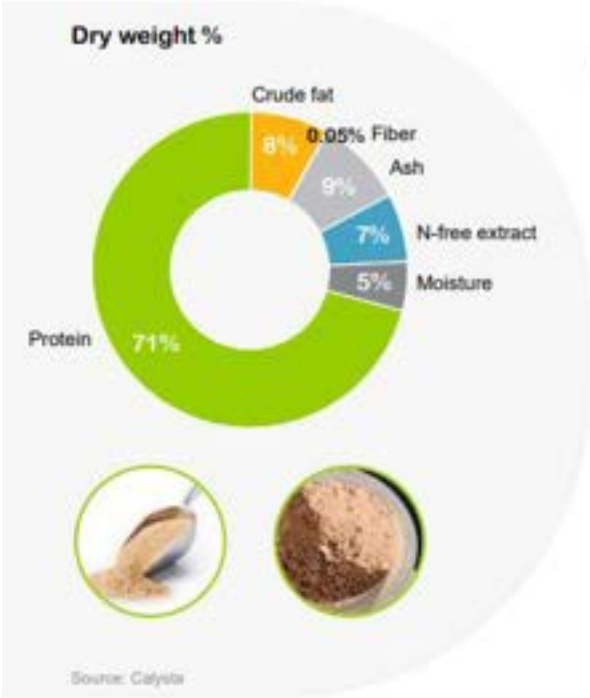


Carbon Negative by 2030



Our products are high-protein, with a complete amino acid profile and additional benefits

Protein content of 71% to 82%; increasing in isolate form



Description

Nutritionally dense single cell protein source

Complete and balanced amino acid profile complimentary to other major sources of protein

Rich in B12 and iron

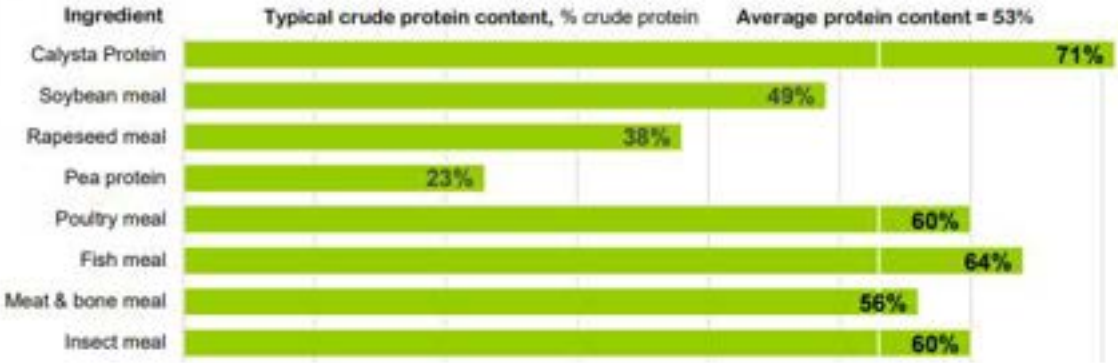
Features / Application

Flexibility in formulations through:

- 71% crude protein and 8% fat mean high protein and high calorie value
- Low fiber adds flexibility to formulation and increases digestibility
- Balanced amino acid profile provides excellent nutritional properties
- Controlled production process provides consistent year-round product with reduced risk of contaminants (e.g., mycotoxins, pesticides)

Protein Isolates unique ingredient properties:

- High solubility, good emulsion and water binding properties
- Foaming
- Dark red color



Calysta's protein characteristics outperform many other proteins in the marketplace

Protein Source	Calysta Protein	Meat Products	Egg Albumin	Whey protein isolate	Soy proteins	Wheat proteins	Pea proteins	Insect proteins	Algal proteins
PDCAAS	1	0.9	1	1	0.9-1	0.2-0.4	0.6-0.9	0.35 - 1	0.6-0.8
Vegan	Yes	No	No	No	Yes	Yes	Yes	No	Yes
Gluten free	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
GMO free	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Organoleptic Properties	Neutral	Meaty taste	Neutral	Neutral	Poor to ok	Poor to ok	Poor to ok	Poor to ok	Poor
Allergies	Low	Low	High	High	High	High	Medium	High	Low
Pathogens	Low risks	Some risks	Some risks	Low risks	Low risks	Low risks	Low risks	Low risk	Some risks
Pesticides / heavy metals	N/A	Low risks	Low risks	Low risks	Risks	Risks	Risks	Low risk	Risks
Sustainability	Good	Very poor	Poor	Average	Poor	Average	Average	Good	Av. - Good

SCP (Calysta) Safety Credentials

	Plant Protein	Animal Protein	SCP* Calysta
Inherent Bacterial Contamination	✓	✓	✗
Mycotoxins	✓	✓	✗
Animal Diseases	✗	✓	✗
Pesticide & Herbicides	✓	✓	✗
Environmental Chemical Contamination	✓	✓	✗
Heavy Metals	✓	✓	✗
Alkaloids	✓	✗	✗
Veterinary Drugs	✗	✓	✗
Hormones	✗	✓	✗

Calysta has validated FeedKind with leading academics, CROs, and aquafeed companies – it outperforms existing proteins

FeedKind's value and efficacy has been validated in dozens of species with the world's leading aquaculture universities

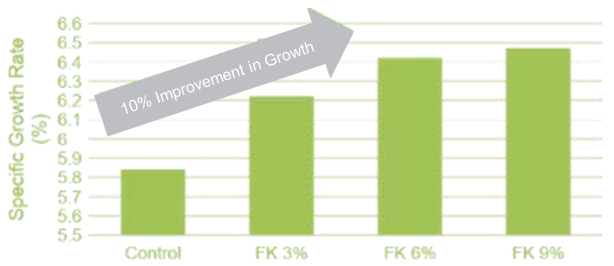
Nofima

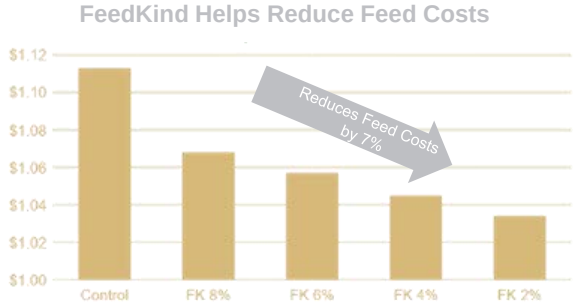
TEXAS A&M UNIVERSITY

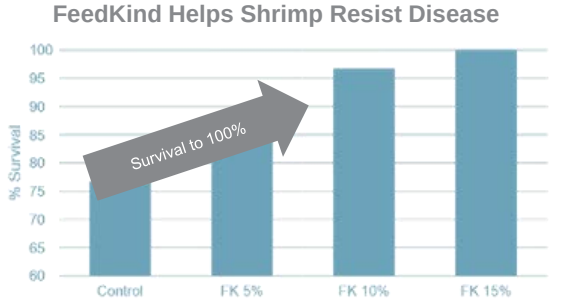
KINDAI UNIVERSITY

中国海洋大学 OCEAN UNIVERSITY OF CHINA

Protein is more than 90% digestible







Commercially validated design using methane for fermentation

- 2000s - $400+ million invested; Operated over 3 years on a “campaign” / run basis by DuPont
- 2014 - Calysta acquired designs and IP from Statoil-Dupont JV (10,000 MT per annum)
- 2017 - Calysta’s demonstration operating pilot plant in Teesside, UK with 50 MT annual capacity
- 2020 – JV between Calysta and Adisseo
- 2022 – completion of 20,000 MT plant in Chongqing, China
- 2023 – Plant commissioned; commercial sales Q2 2023
- 2025 and beyond – 100,000 MT plants in USA and KSA

CALYSTA ADISSEO

CALYSSEO


CALYSEO
CALYSEO

Challenges

Keeping them Happy and Alive!

Talent & Skills

Single cell proteins

No longer “alternative” the future is now!

Yeasts and fungi

- **Protein content**: Yeast 38-52%; Fungi 0.23-15%
- **Characteristics**: Uses different substrates, produce vitamins and micronutrients
- **Limitations**: Possible presence of toxins, limited protein content and poor amino acid profile
- **Examples**: *Saccharomyces cervisiae, Kluyveromyces marxianus, Aspergillus oryzae, Yarrowia lipolytica*

Microalgae

- **Protein content**: 60-70%
- **Characteristics**: Phototrophic, produce omega-3 fatty acids
- **Limitations**: Scale up, digestibility
- **Examples**: *Tetraselmis suecica, Isochrysis galbana, Dunaliela tertiolecta, Chlorella stigmatophora, Spirulina* spp.

Bacteria

- **Protein content**: 50-80%
- **Characteristics**: High protein content, grown on C1 substrates
- **Limitations**: Palatability issues, high nucleic acid content, production of toxins
- **Examples**: *Methylobacterium extorquens, Methylococcus capsulatus, Rhodobacter sphaeroides, Clostridium autoethanogenum, Afifella marina*

Fermentation to create sustainable protein

In the last 10 years, fermentation has emerged as a commercially viable method of replacing animal proteins to feed people, pets and livestock

Source: Good Food Institute – Scope: Alternative protein technologies for food applications

The solution – a revolution in protein supply

Our microbial protein, grounded in proven technology, can sustainably address the global protein needs in feed, pet and human food

CALYSTA

Aquaculture and Feed	FeedKind		Protein ingredient in feed for diverse fish including salmon and shrimp, as well as other livestock
Pets	PetProtein		High-quality protein ingredient for dogs and cats
Human food	Whole-cell	 	Protein-rich ingredient for fortified foods, bars and nutritional applications
	Protein isolate		Protein-rich additive for alternative protein food manufacturing

Calysta's protein can make scalable contributions to improving sustainably based global food security

Calysta's strategy will produce 300,000+mt per annum by 2027, and nearly 1M mt globally by 2030

- Our 100,000 mt production site and process can meet the annual nutritional protein needs of **3M+** people*
- By 2030, Calysta could provide sustainable nutrition equivalent to the protein needs of nearly 30M people per year
- The Ukraine disruptions have made food security a global imperative; diversification of food sources is a key step
- In June 2022, the G7 described the disruption as a multidimensional crisis that has left as many as 323 million people around the globe at high risk of food shortages, a record

Impact across many of the 17 UN sustainability goals, with emphasis on:

* *Assumes 60g protein/day/person, Calysta ~ 70% protein content*

Thank You!

Matt Longshaw, Senior Scientist

jblair@calysta.com

07725203239

CALYSTA

MORE FROM LESS

Q&A

Shifting the Environment: Making Healthy and Sustainable Diets the Norm in Retail Settings

Dr Vicki Jenneson

Public Health Nutritionist
University of Leeds Institute for Data Analytics

Shifting the environment

making healthy & sustainable diets the norm in retail settings

Dr Vicki Jenneson
ANutr, BSc, MPH, MSc, PhD
Research Fellow, University of Leeds

Consumer Data Research Centre
An ESRC Data Investment
LIDA

Food for thought

1. Does healthy *always* mean sustainable?

3. Why is shifting retail environments important?

4. What have we learnt so far?

1. Does healthy *always* mean sustainable?

Exploring definitions, metrics and trade-offs

What is a sustainable diet?

Sustainable diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources.

FAO, 2010, Sustainable Diets and Biodiversity.

What is a healthy diet?

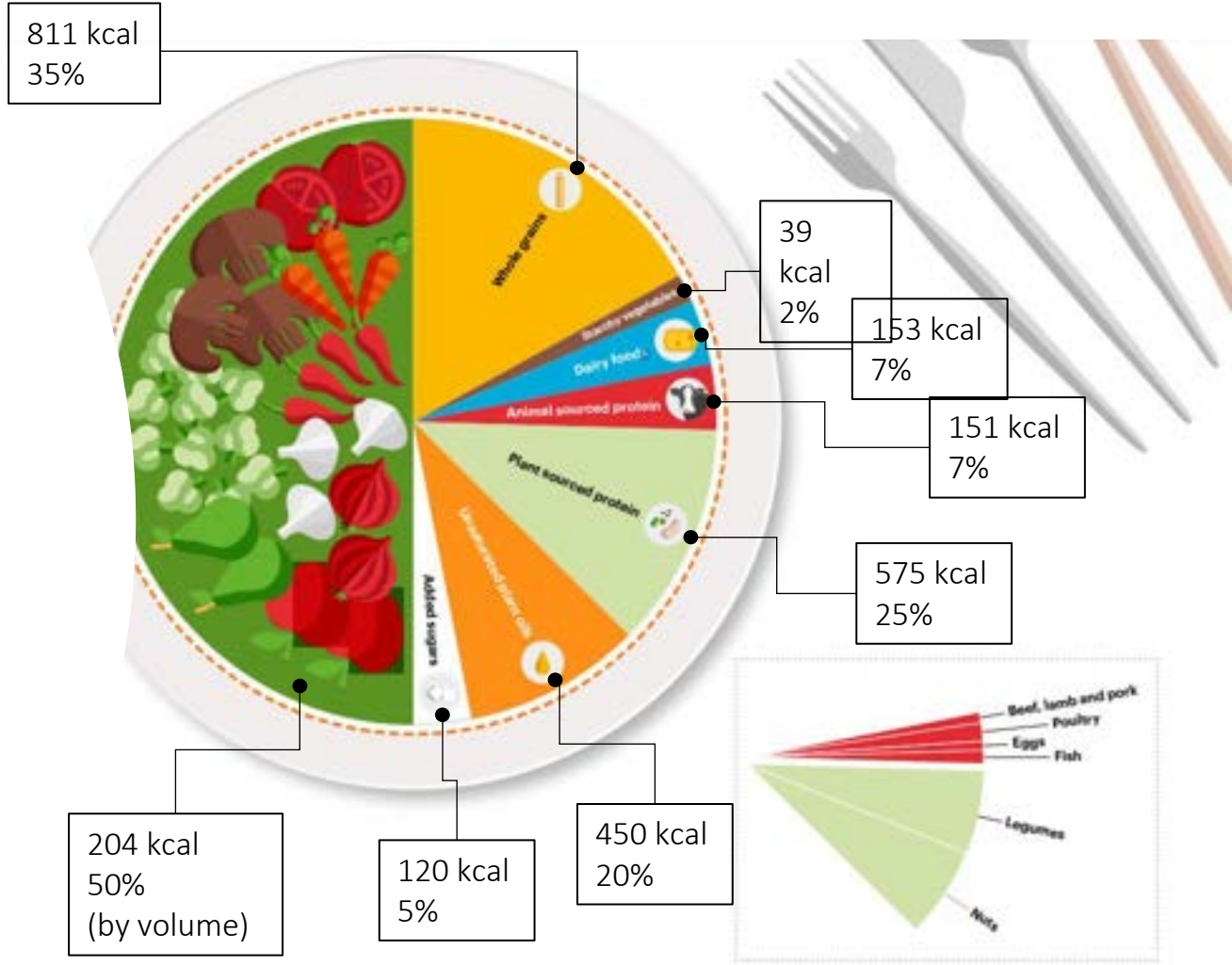
A healthy diet is one in which macronutrients are consumed in appropriate proportions to support energetic and physiologic needs without excess intake while also providing sufficient micronutrients and hydration to meet the physiologic needs of the body.

Stark C. Guidelines for Food and Nutrient Intake. (2013)

EAT Lancet
Planetary Health Diet

To feed a world population of 10 billion people in 2050

Would lead to 11 million fewer premature adult deaths (20% reduction)

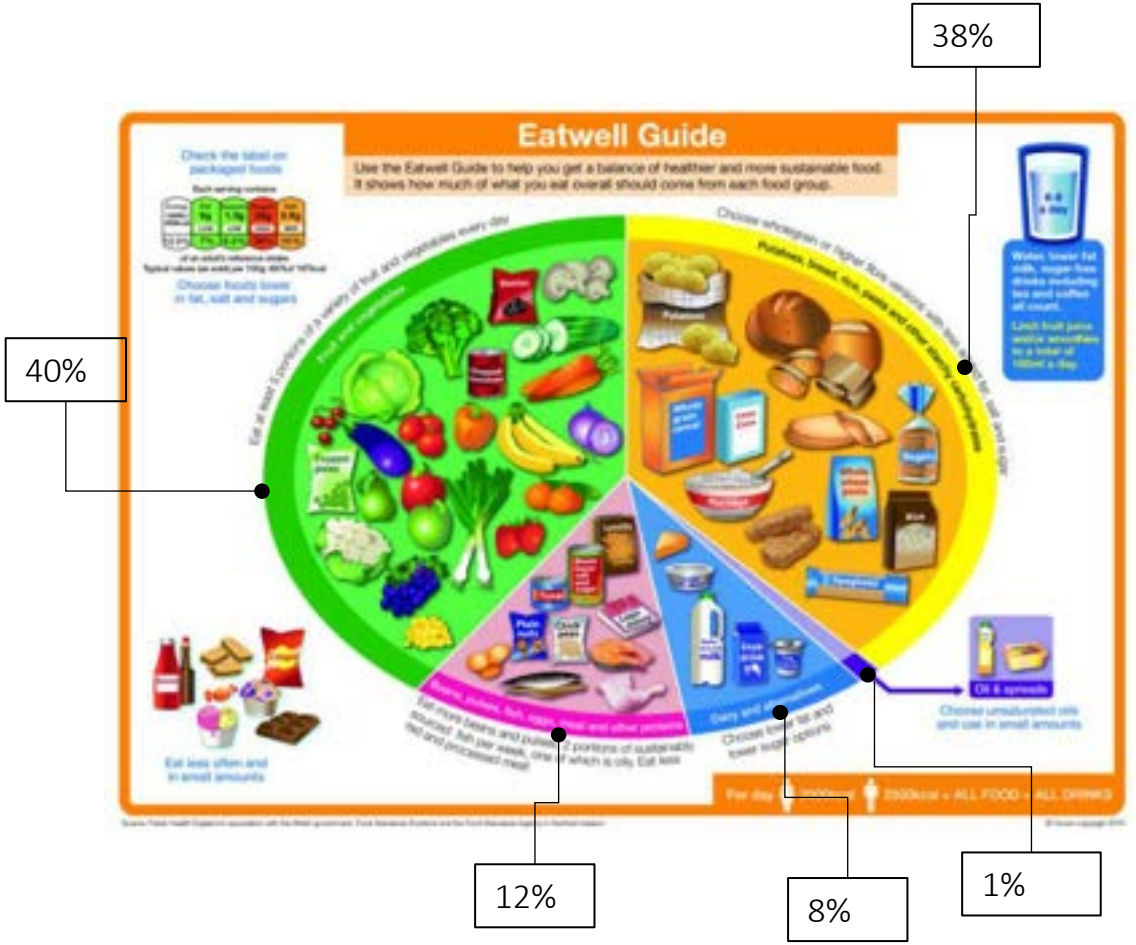


UK Government Eatwell Guide

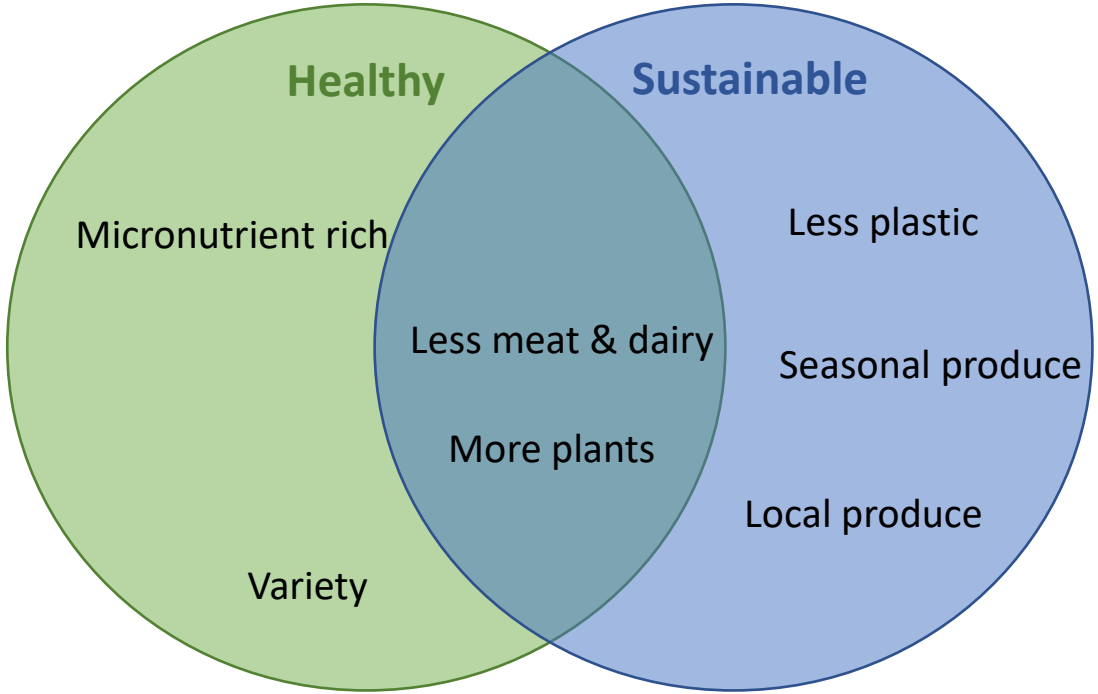
Just 1% of the UK population currently meet Eatwell Guide recommendations

Aligning to the Eatwell Guide would lead to

- 31% lower GHGEs
- 34% lower land use
- 17% lower water use
- 17.9m more healthy life years

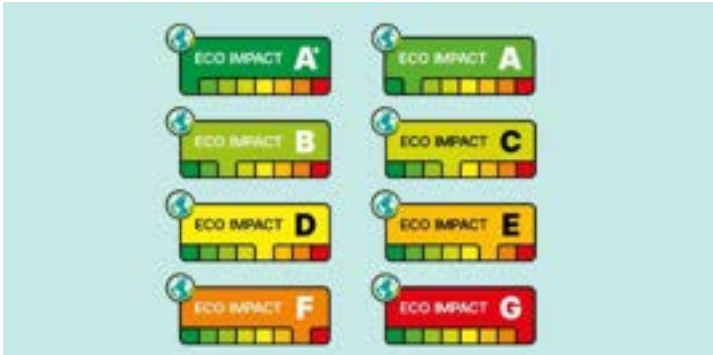


Principles of healthy & sustainable diets




The power to choose
35,000
choices daily
227
related to food
(Wansink and Sobal 2007)

What do *sustainable* products look like?



No single accepted definition of what a sustainable food is (holistic concept)

Sustainability **not communicated well** to the consumer

Retailer sustainability **metrics are lacking**

Life Cycle Assessment evidence required to substantiate green claims

Tesco plant-based burger ad pulled over “misleading” claims about the planet

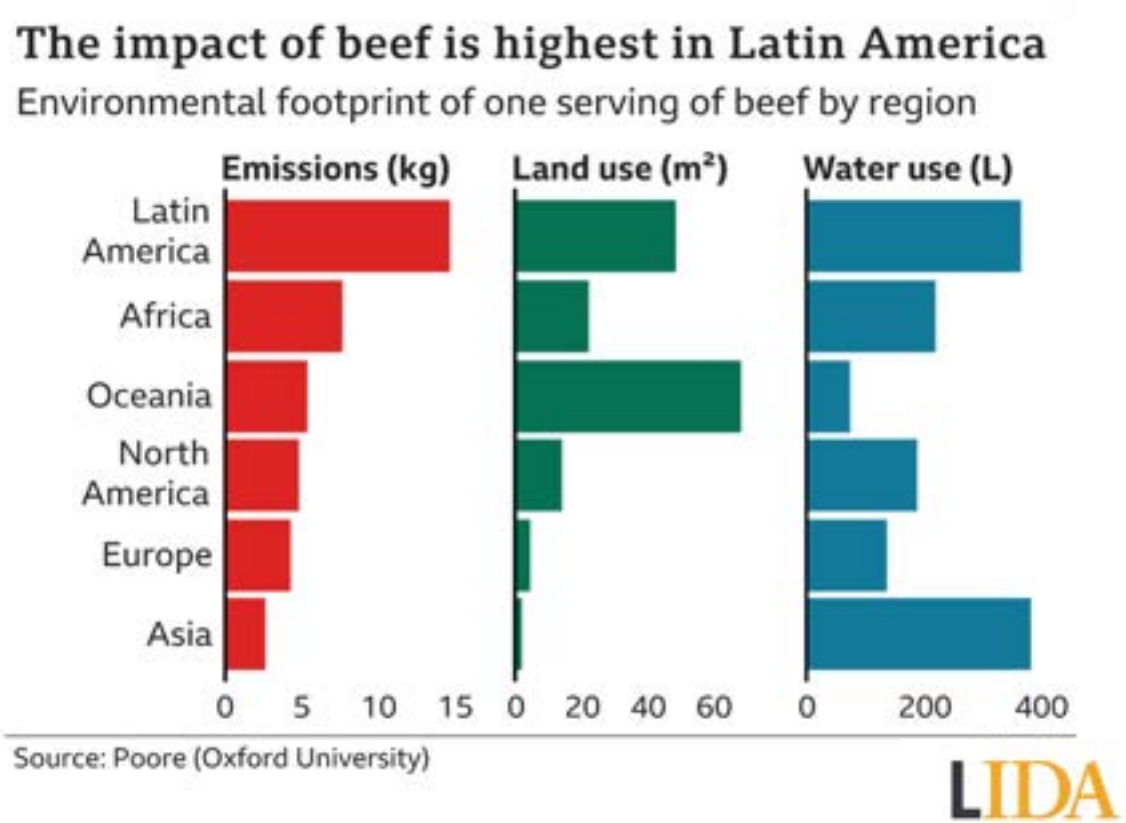
08 Jun 2022 --- The UK’s Advertising Standards Authority (ASA) has resolved that a 2021 Tesco ad regarding its own brand Plant Chef plant-based burger was “likely to mislead” the public. The claims under scrutiny were that the burger had “positive environmental differences to the planet compared to their meat equivalents.”

ASA ruled that these ads must not appear again in their current form and for Tesco not to make unsubstantiated claims about their products in the future.

“Because we had not seen evidence…that demonstrated that Plant Chef products could make a positive environmental difference to the planet compared to their meat equivalents, nor had we seen evidence for the full life cycle of the Plant Chef burger, we concluded the claims regarding their positive benefits to the planet had not been substantiated,” concludes ASA.

Product-level choices can make a big difference

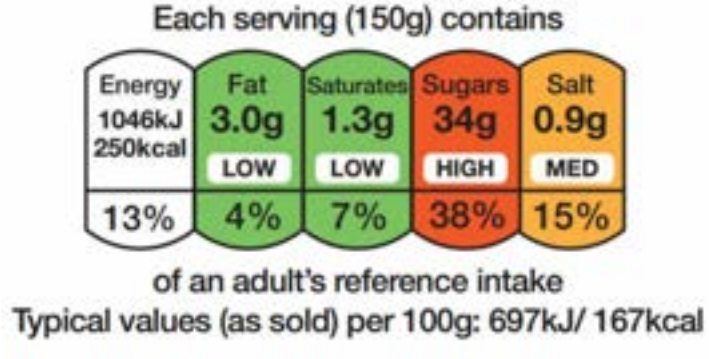
- **Focus on carbon** emissions
- **Population-level average** – (total food imports & percentage from each country)
- **Farm to retail -** (discount home cooking)



Produce of

Produce of United Kingdom, Morocco, Netherlands, Spain

What do *healthy* products look like?



Nutrient Profile Models help us quantify the 'healthiness' of foods

Front of pack labelling allows key nutrition indicators to be highlighted to consumers

Back of pack nutrient panel puts products in context of individual daily allowances

Nutrition and health claims are regulated and must be backed up with evidence

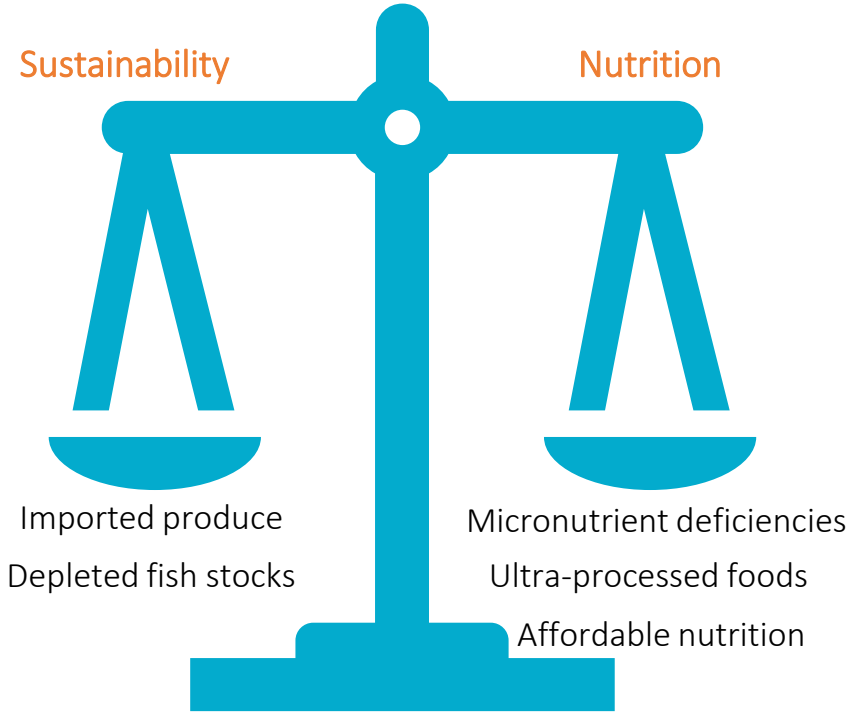
Nutrition

Typical values	100g contains	Each slice (typically 44g) contains	% RI*	RI* for an average adult
Energy	985kJ 235kcal	435kJ 105kcal	5%	8400kJ 2000kcal
Fat	1.5g	0.7g	1%	70g
of which saturates	0.3g	0.1g	1%	20g
Carbohydrate	45.5g	20.0g		
of which sugars	3.8g	1.7g	2%	90g
Fibre	2.8g	1.2g		
Protein	7.7g	3.4g		
Salt	1.0g	0.4g	7%	6g

This pack contains 16 servings

*Reference intake of an average adult (8400kJ / 2000kcal)

Trade offs


Sustainability
Nutrition
Imported produce
Depleted fish stocks
Micronutrient deficiencies
Ultra-processed foods
Affordable nutrition

2. Why is shifting retail environments important?

Exploring industry responsibility & the importance of data

Escape the Junk Food Cycle and protect the NHS

National Food Strategy

- **9/10** people regularly buy their groceries from supermarkets
- The junk food cycle – food environment is flooded with cheap poor quality food, setting us up to fail
- Nearly **300** UK obesity policies in the last **30** years

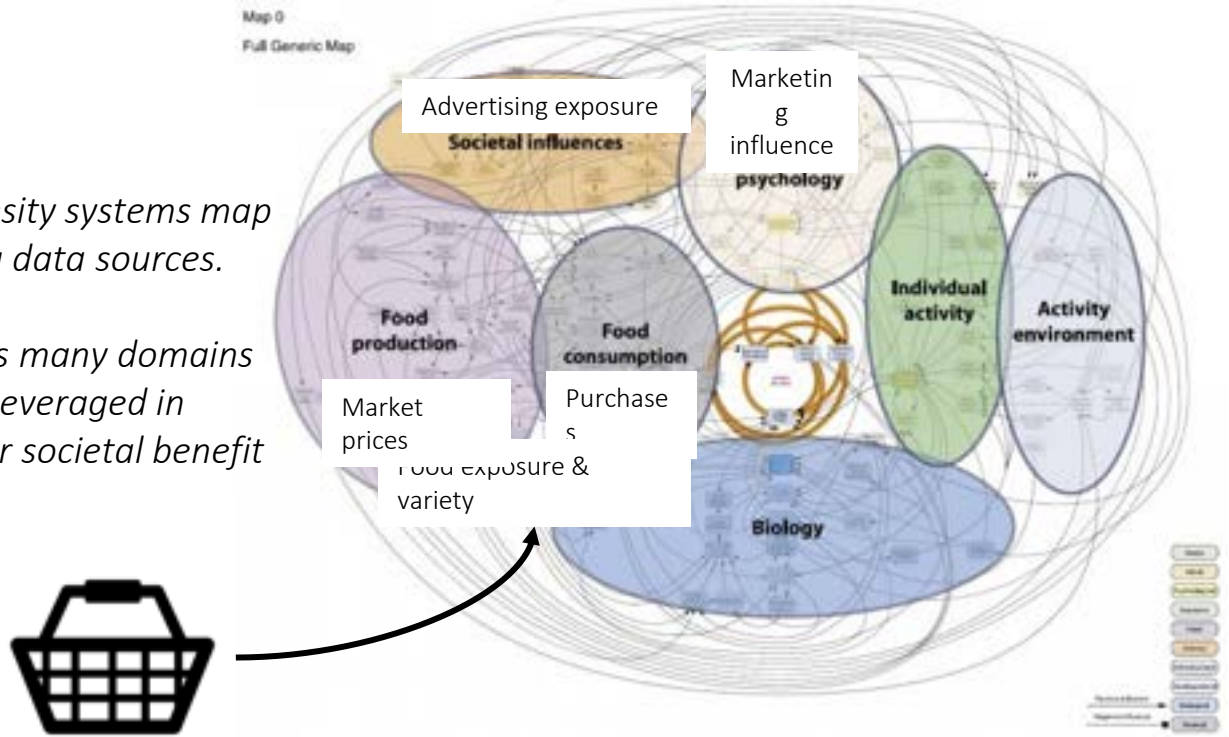
  (Theis D, 2021)

The power of retail data

Morris et al

“80% coverage of the Foresight obesity systems map is possible using a wide range of big data sources.

Big data offer great potential across many domains of obesity research and need to be leveraged in conjunction with traditional data for societal benefit and health promotion.”



The role of retail

- Sourcing
- Ranging
- Marketing
- Monitoring

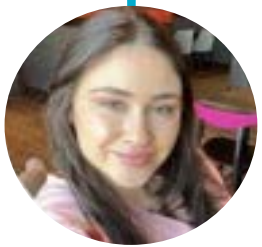
Nutrition And Lifestyle Analytics Team

Michelle Morris
Associate Professor

Vicki Jenneson
Research Fellow

Rayan Onyonka
Data Scientist

Elliot Karikari
Data Scientist



Mariana Dineva
Research Fellow

Fran Pontin
Research Data Scientist

Ann Onuselogu
Former Data Scientist

Alex Dalton
Former Data Scientist

Maddie Thomas
Former Nutrition undergraduate

3. What have we learnt so far?

Case studies from the IGD Healthy & Sustainable Diets programme trials

IGD Healthy & Sustainable Diets trials

Challenge

The food we consume is bad for our health and our planet. Only 1% of the UK population meet Eatwell Guide dietary recommendations.

But changing our behaviours is hard.

5 behavioural levers have been proposed as promising to nudge customers towards healthy & sustainable choices in store.

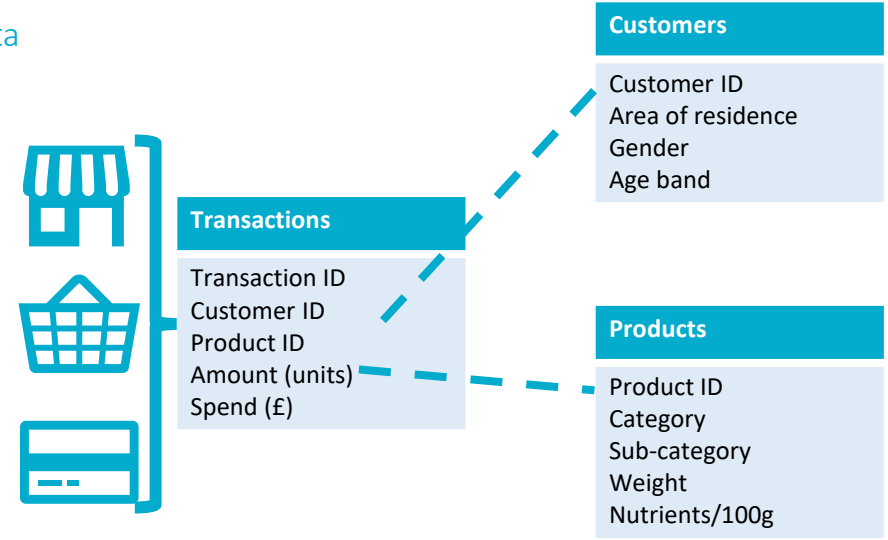
Health and Wellbeing

What we did

Worked with the IGD to engage their Healthy and Sustainable Diets working group members (20+ retailers & manufacturers) to

- Evaluate existing industry initiatives
- Co-design & implement new interventions
- Share industry-wide knowledge on what works to shift customer behaviour

Data



Trial metrics

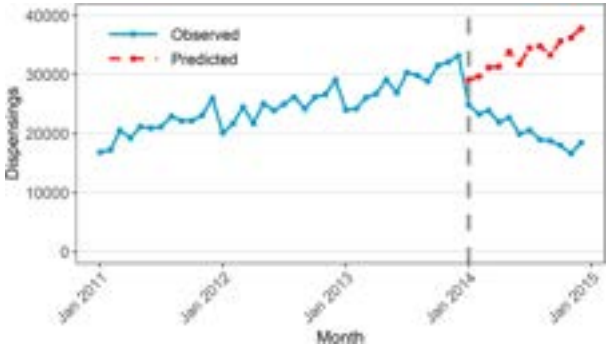
Challenge

Developing a set of common metrics which can be used across retailers to evaluate trials.

Incorporate aspects of health and sustainability (despite data limitations).

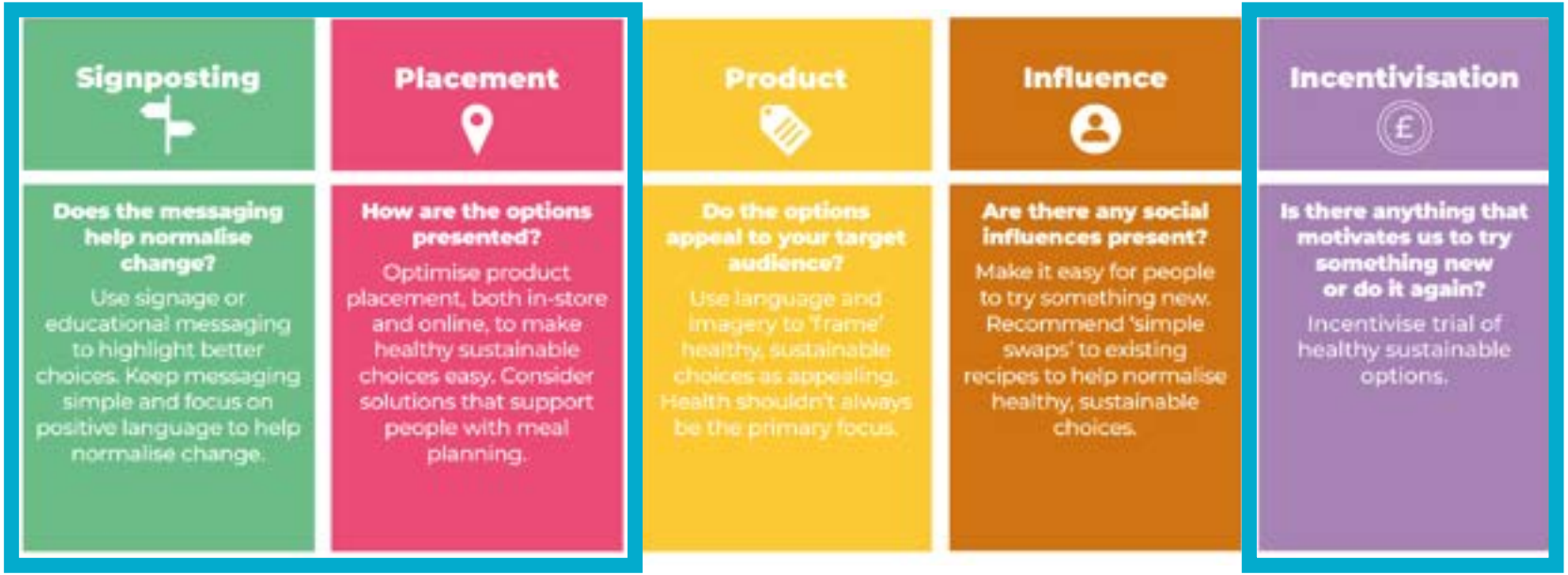
Health and Wellbeing

Sales – interrupted time-series



Basket composition – Eatwell Guide analysis

IGD behavioural levers



Sainsbury's 60p fruit & veg

Challenge

Price has been cited as a barrier to consuming healthier and more sustainable diets.

Only a third of adults achieve their 5-a-day and most stick to a narrow range of products.

Sainsbury's

What we did

Sainsbury's reduced the price of some fruit and veg products to 60p, throughout January for 2 consecutive years (2020 and 2021). Examined impact on sales.

Findings

- Sales of fruit and vegetables increased by 78%
- Diets shifted towards the Eatwell guide
- The trial was most effective for higher value tropical fruits
- Fruit and vegetables not on promotion also saw an uplift
- Effects lasted for 3 weeks of the 4 week trial & were not sustained long term

Health and Wellbeing

Dr Michelle Morris, Dr Fran Pontin, Maddie Thomas,
Leeds Institute for Data Analytics

ASDA Merchandising plant-based

Challenge

Plant-based meat alternatives are growing in popularity as customers seek healthy and more sustainable choices.

But some customers lack awareness or are unwilling to try.

Moving plant-based options into the meat bay has been suggested to encourage flexitarian choices.

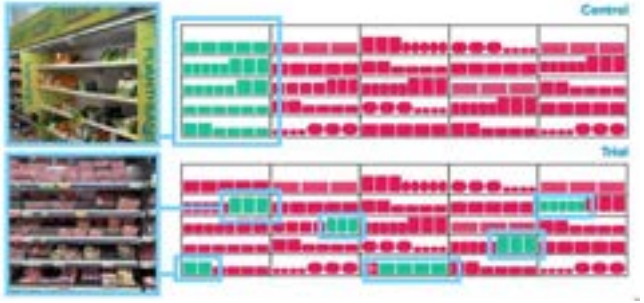
Health and Wellbeing

Dr Michelle Morris, Dr Fran Pontin,
Leeds Institute for Data Analytics

Placement

What we did

Asda moved plant-based items next to their meat-based counterparts within the fresh meat bay for 12 weeks.



Findings

- Sales of relocated products declined by 30%
- This decline was greater in urban and more deprived areas
- Customers did not switch to other categories such as meat or frozen, suggesting they shopped elsewhere for their plant-based products
- Plant-based shoppers were reluctant to explore the meat aisle so couldn't find the products they were looking for
- Meat eaters weren't persuaded to purchase plant-based options, potentially put off by their higher price tag
- ASDA has since committed to increasing their vegan range by 50% in 2023, and improving the price comparability with meat

Trials outputs to date

- 2 retailer master collaborations
- 3 year collaboration (ongoing)
- 4 IGD Driving Change reports
- 5 retailer trials

Data gaps

Product weight data

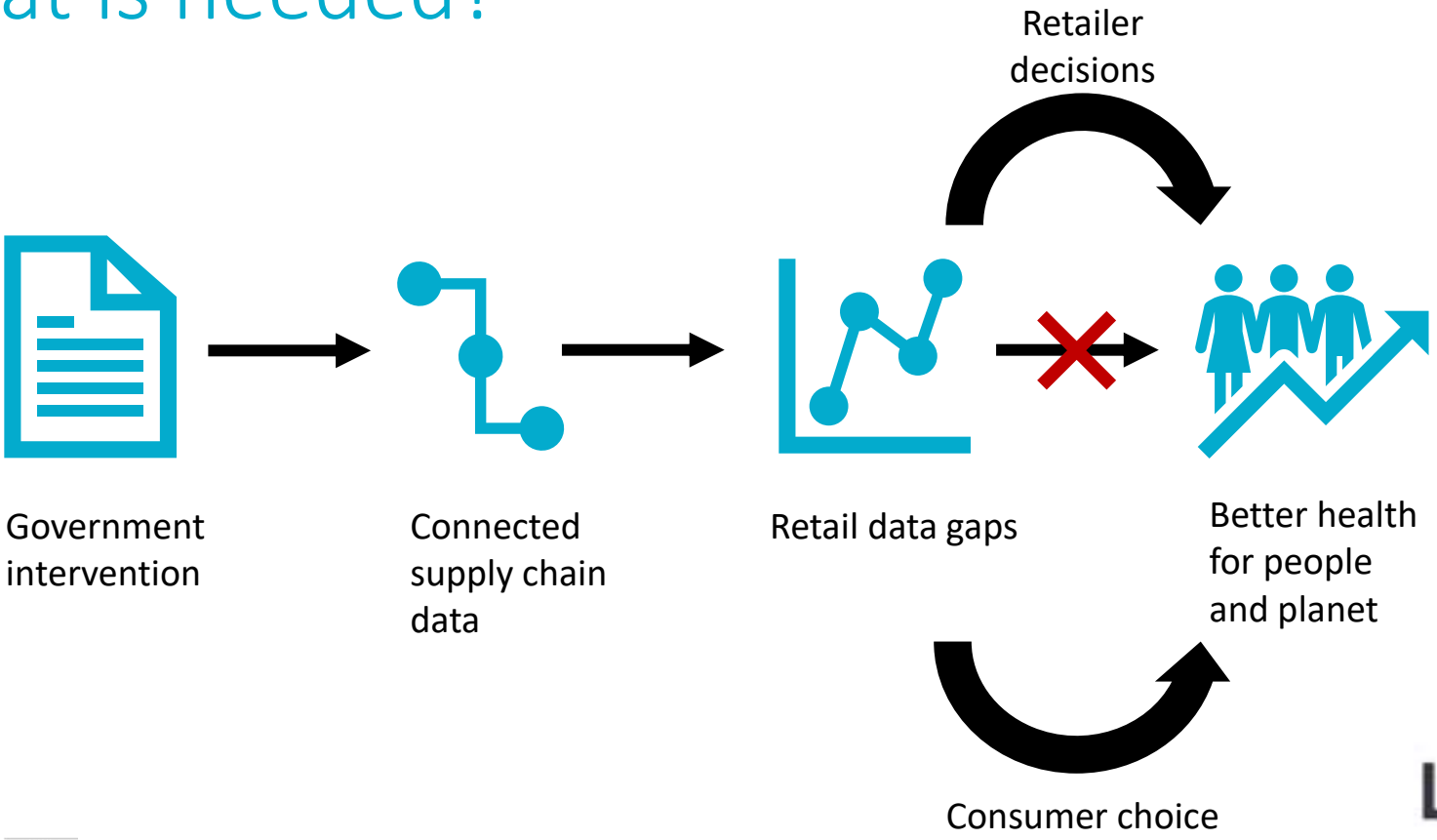
Product-level sustainability data

Crossover between sustainability & nutrition

Food system digital twin

Sustainability labelling

What is needed?



Thanks for listening!

A challenge to industry

What decisions would you make for the food system if you were designing for you?

Q&A

Break

Theme 3:
Nutrition and Food Security

Innovation Sweet Spot: Steering Food Technology Towards Improving Health and Food Environments

Parita Doshi

Deputy Director
A Healthy Life Mission - Nesta

Innovation Sweet Spot: Steering food technology towards improving health and food environments

Parita Doshi -
Deputy Director, A Healthy Life Mission, Nesta

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About Nesta

We are the UK's innovation agency for social good. We design, test and scale new solutions to society's biggest problems, changing millions of lives for the better.

For over 20 years, we have worked to support, encourage and inspire innovation that benefits society, a purpose that is more relevant now than ever.

→ Read more about our history

our missions

A fairer start

Narrow the outcome gap between children growing up in disadvantage and the national average.

A healthy life

Increase the average number of healthy years lived in the UK, while narrowing health inequalities.

A sustainable future

Accelerate the decarbonisation of household activities in the UK and improve levels of productivity.

We design, test and scale new solutions to society's biggest problems.

our roles

Innovation partner

Design, test and scale innovative solutions hand in hand with those who will use them.

Venture builder

Create, support and invest in early-stage ventures to develop new solutions and shift key markets.

System shaper

Influence wider systems of policy, practice and funding to support and promote innovation.

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Our practices

Behavioural Science

Experimentation & Evidence

Arts

Our approach to innovation harnesses the **collective power of different disciplines, methods and perspectives** to help us see problems in new ways, borrow solutions from different fields, and continually push boundaries of what we think is possible. Our expertise includes:

Design & Technology

Collective intelligence

Data Science

A healthy life

Our mission is to increase the average number of healthy years lived in the UK, while narrowing health inequalities.

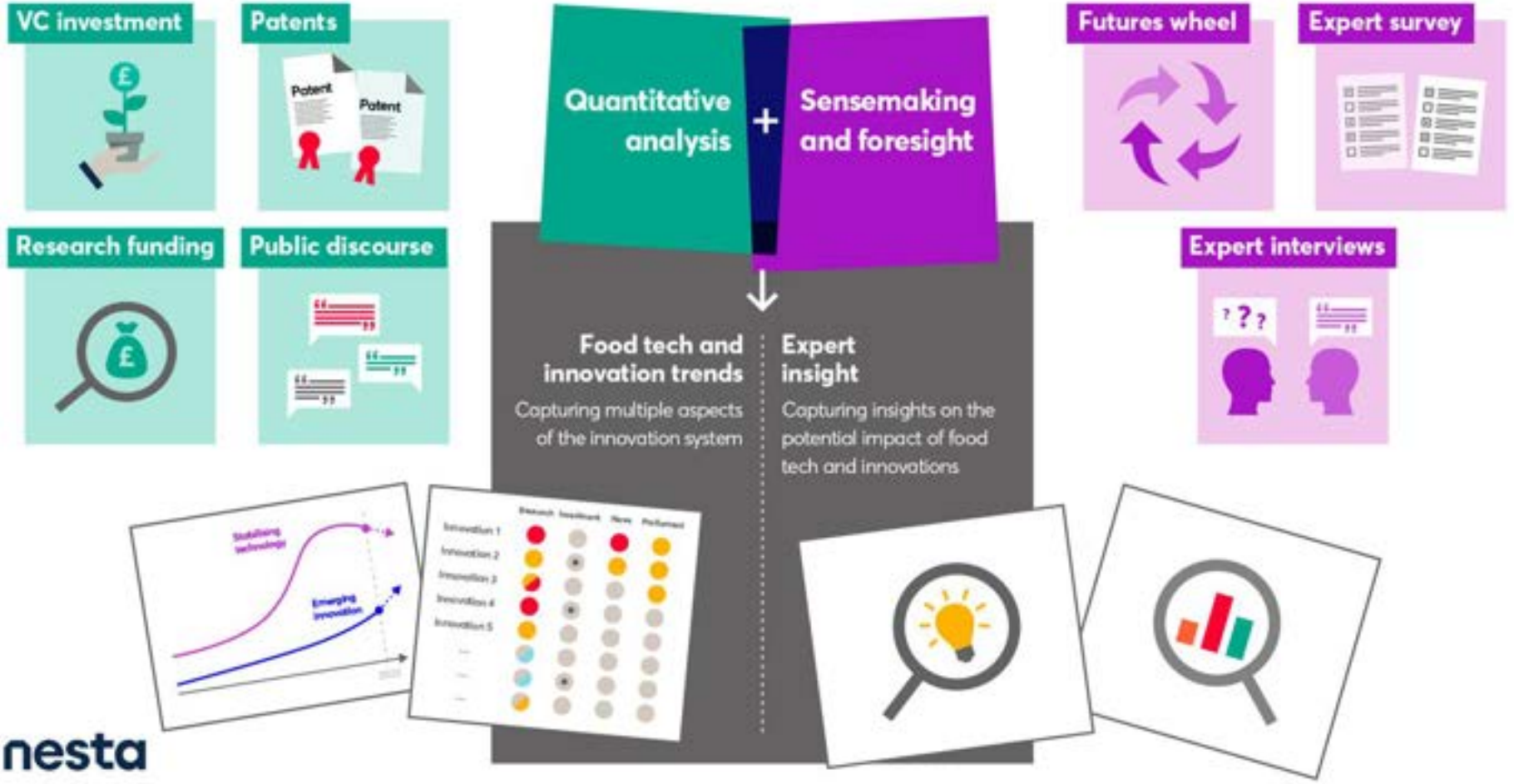
At Nesta, we are focusing on halving the prevalence of obesity by 2030.

We do this by designing, testing and scaling solutions that drive the change needed: changes in our food environment – the places we shop, the foods we buy, the streets we walk on – to make healthy eating easier and more appealing.


What surrounds us shapes us...
The price of healthy options
How convenient it is to find, prepare and eat healthier foods
Portion sizes of meals in resturants, takeaways and ready meals
The range of healthy products developed by food manufacturers
The availibility of healthy options stocked by retailers
Advertising and promotions that we are exposed to
The food environment is made up with everything we experience in a place that relates to food.
This could be your:
Workspace
Online Spaces
Neighbourhood

Innovation Sweet Spots: Food innovation, obesity and food environments

Innovation Sweet Spots at a glance…



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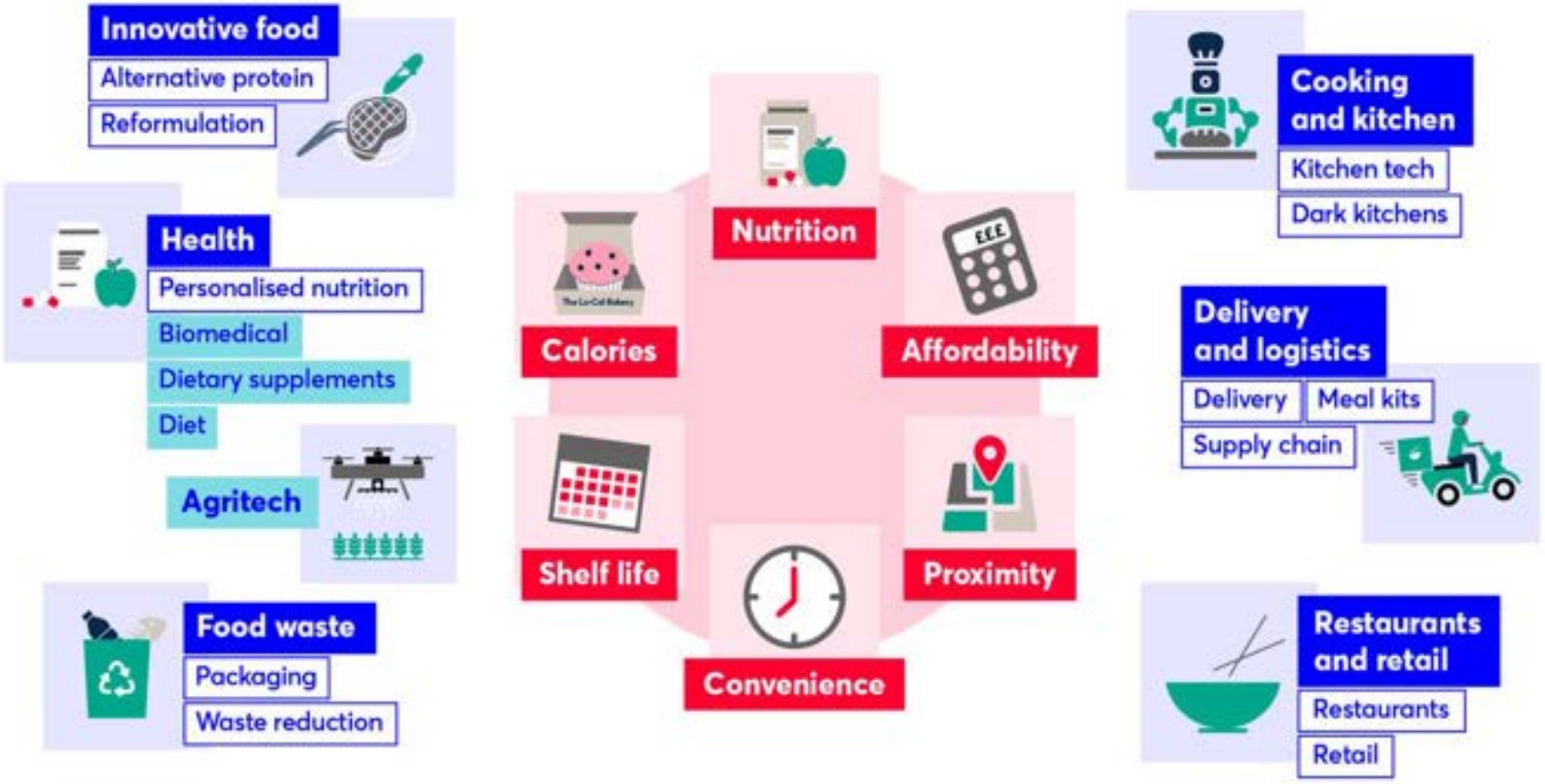
Food tech and innovation landscape



What we found

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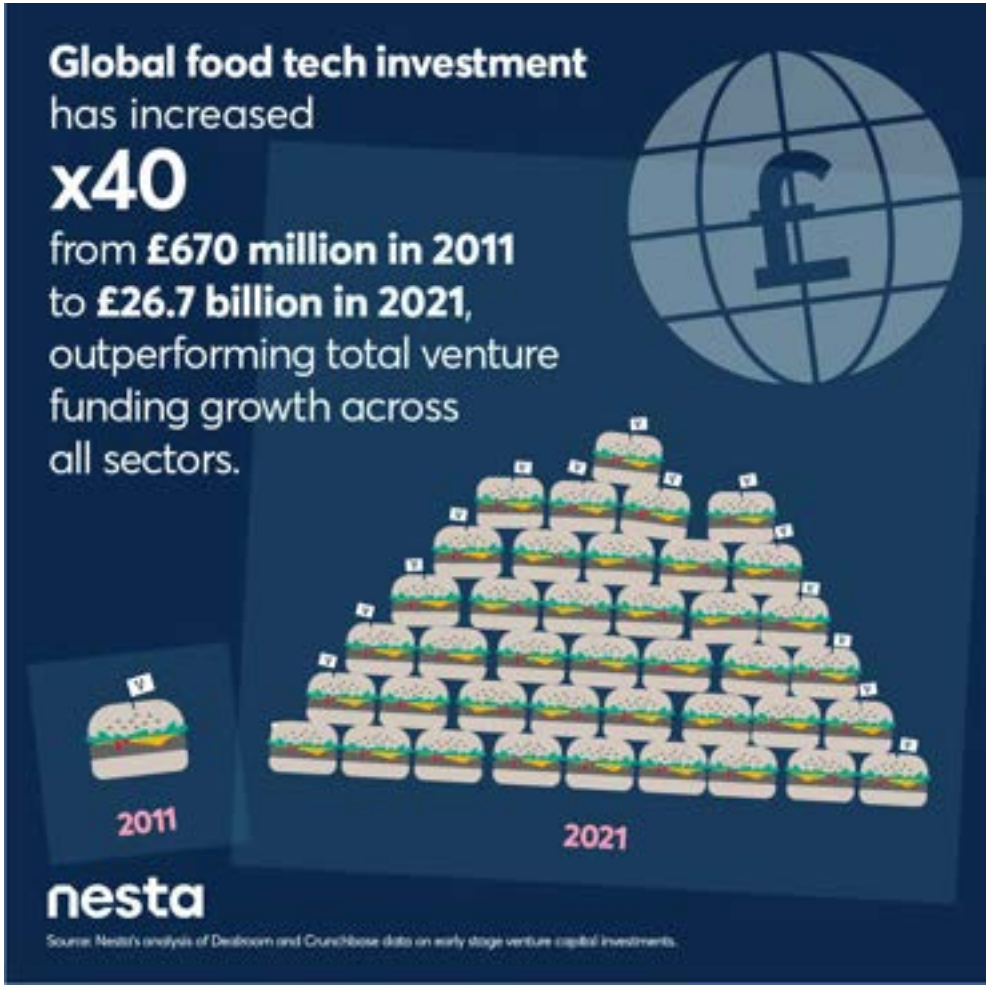
Messages

A wave of innovation: A surge of research and investment has given rise to a host of food innovations.



BUT…

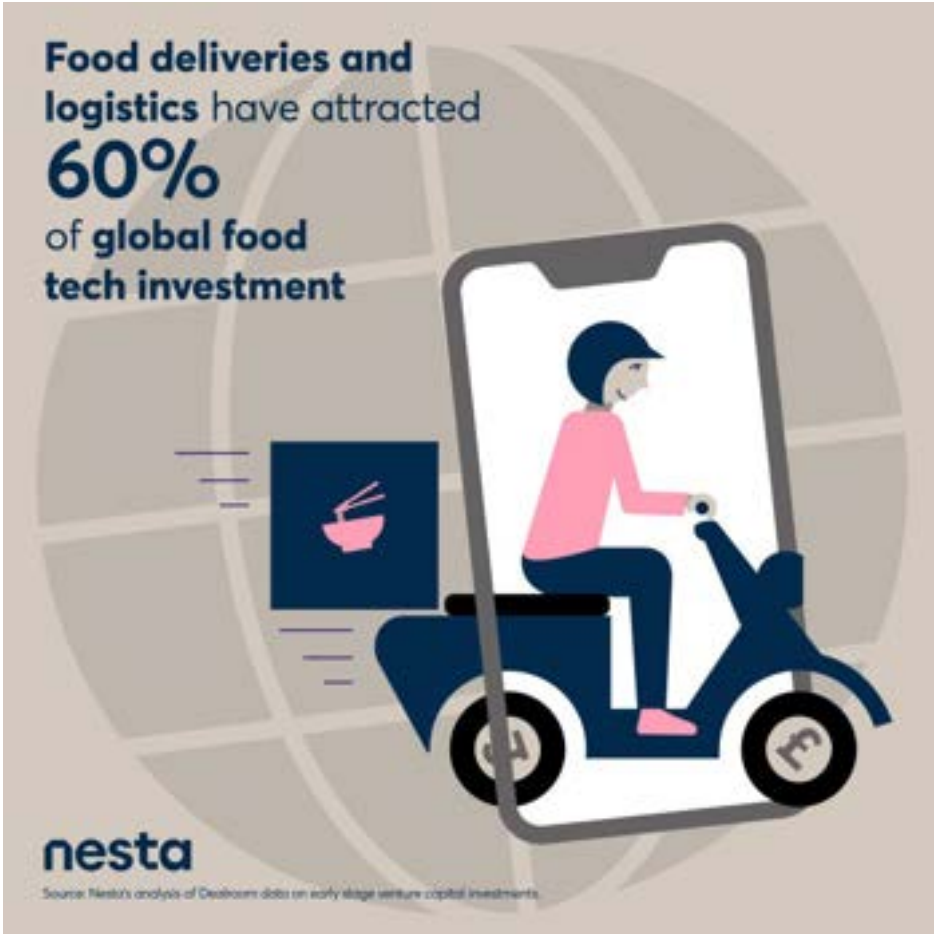
🤔 **We question is the wave heading in the right direction?**

AND…

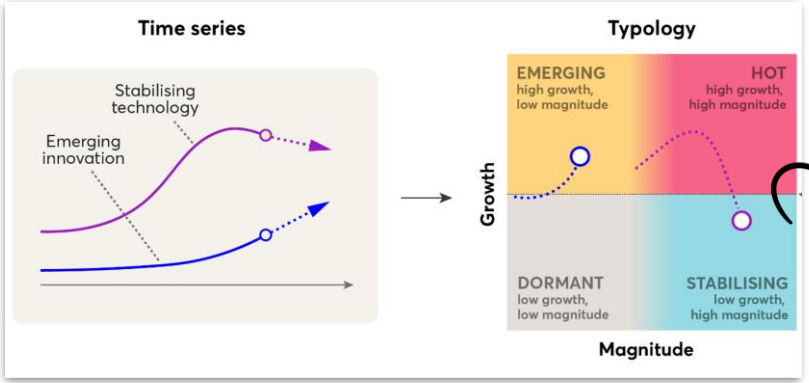
🤭 **Suggest what could be done to steer the wave**

Findings

Investment boom in food delivery and logistics: A challenge for the quality of food environments?



Findings


Time series
Stabilising technology
Emerging innovation
Typology
EMERGING
high growth, low magnitude
HOT
high growth, high magnitude
DORMANT
low growth, low magnitude
STABILISING
low growth, high magnitude
Growth
Magnitude

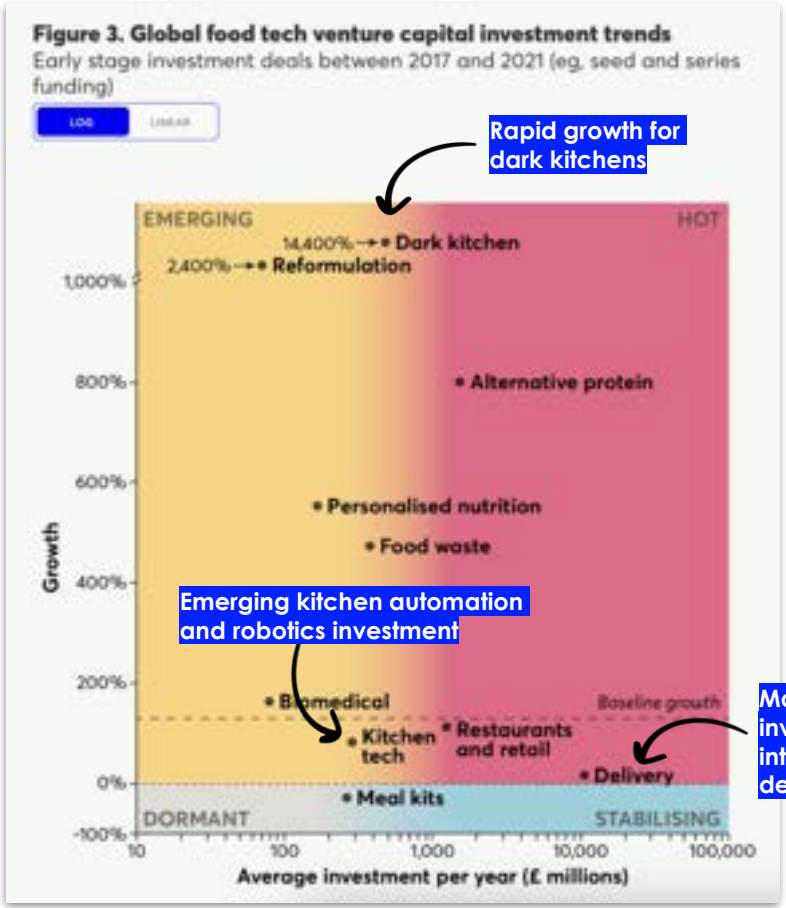
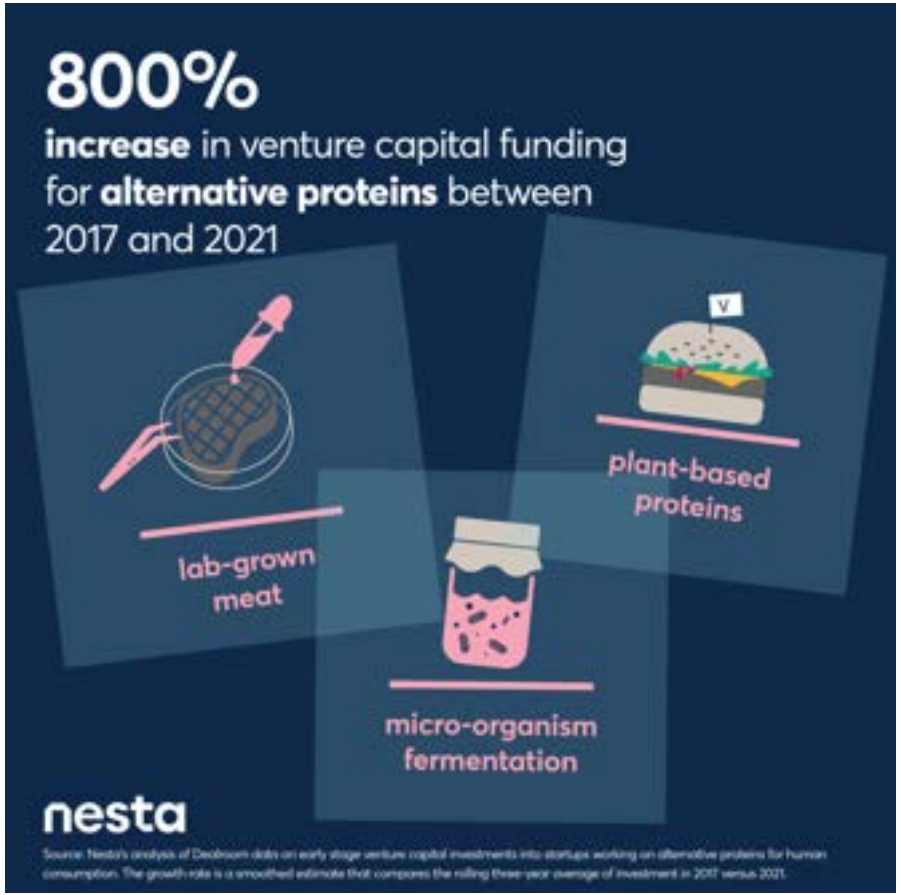


Figure 3. Global food tech venture capital investment trends
Early stage investment deals between 2017 and 2021 (eg, seed and series funding)
LOG
LINEAR
Rapid growth for dark kitchens
EMERGING
HOT
14,400% Dark kitchen
2,400% Reformulation
1,000%
800%
600%
400%
200%
0%
-100%
Alternative protein
Personalised nutrition
Food waste
Growth
Emerging kitchen automation and robotics investment
Biomedical
Baseline growth
Kitchen tech
Restaurants and retail
Delivery
Meal kits
Massive investment into deliveries
DORMANT
STABILISING
10
100
1,000
10,000
100,000
Average investment per year (£ millions)

Findings

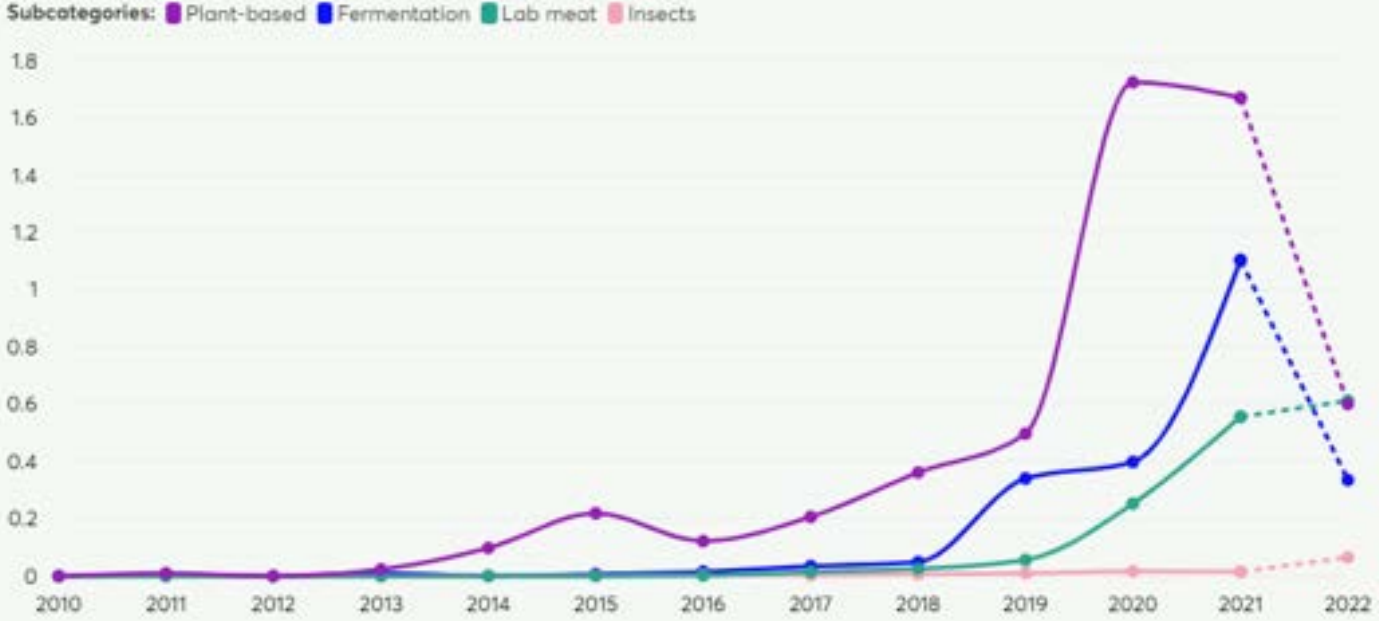


Alternative proteins: An area of rapid growth but with unclear implications for health

Findings

Figure 14. Global investment into alternative protein start-ups

Early stage deals, eg, seed and series funding (£ billions)



Source: Nesta's analysis of Dealroom data • Analysis aimed to include companies producing protein for human consumption only
Dashed lines indicate the most recent (incomplete) data for 2022.

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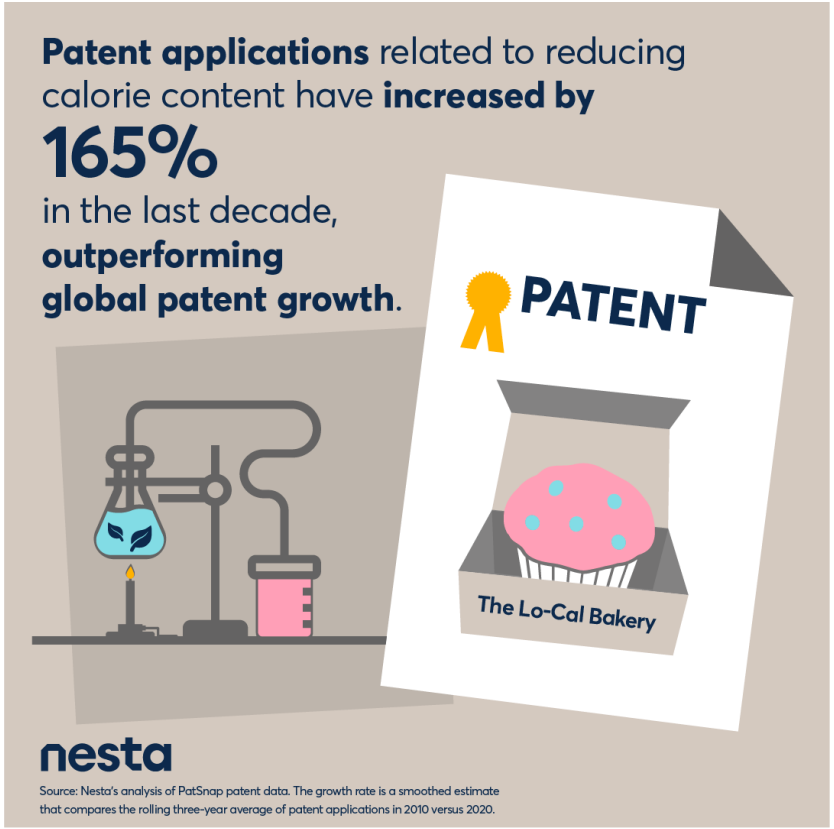
Findings

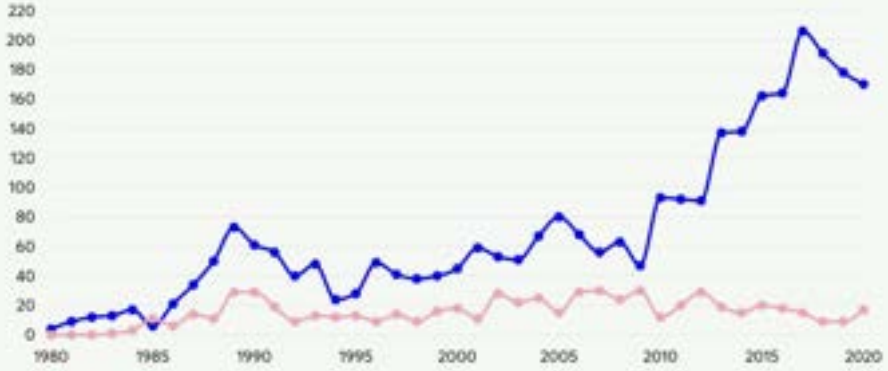
The rise of innovation in reformulation: Good news for the future of our health?



Findings

Figure 29. Global patent applications for reduced calorie food stuffs

Patents that add substantially **indigestible additives** such as dietary fibre (Group 1) or use other mechanisms to reduce calories (Group 2)



Source: Nesta's analysis of PatSnap data

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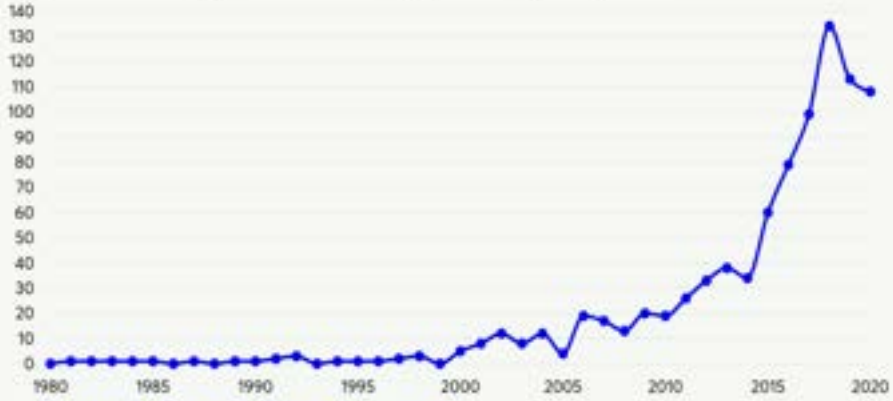
580% growth in 2010-2020

Figure 31. Global applications for satiety-increasing food patents



Source: Nesta's analysis of PatSnap data • Patents were identified using search terms and subsequent filtering by patent symbols related to food (as there are no patent symbols for satiety as such).

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Our work investigating targeted reformulation

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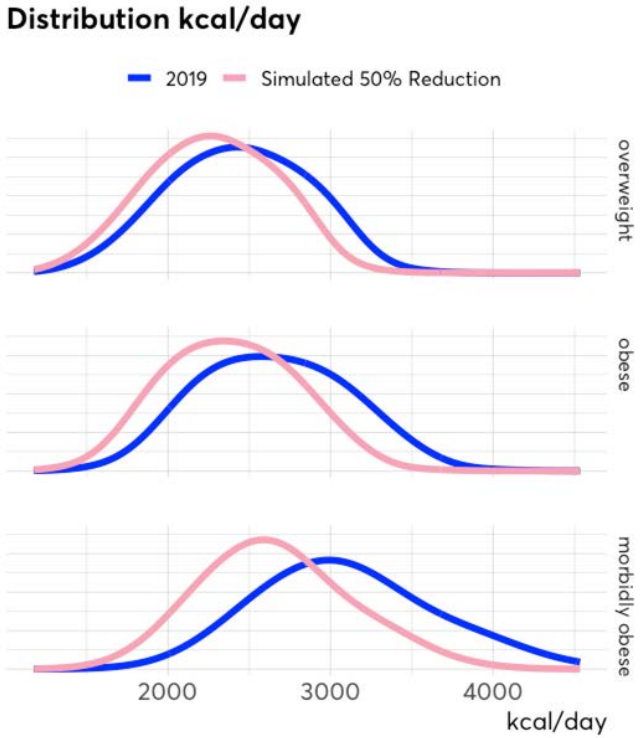
Modelling halving obesity by 2030

Achievable by a reduction of **216 kcal** daily on average



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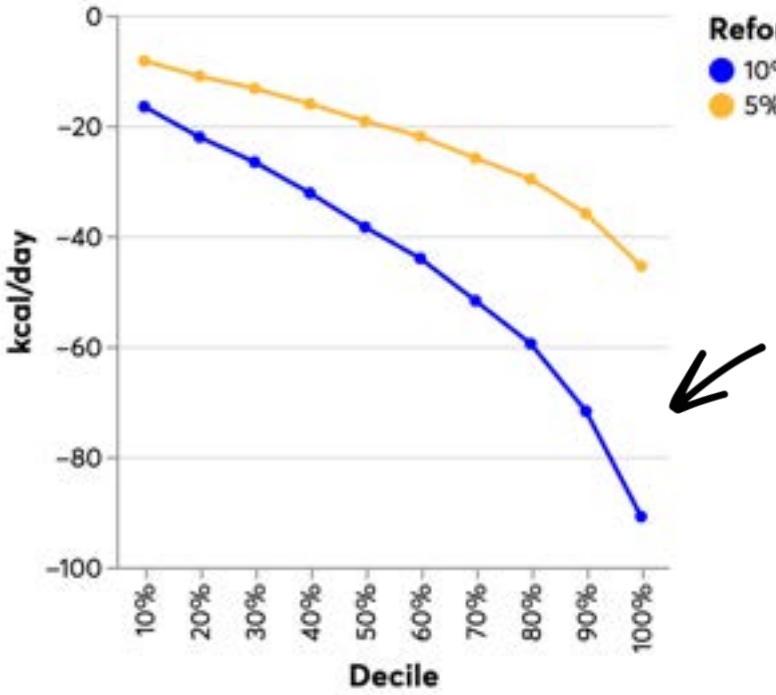
And what impact targeted reformulation could have..



A 10% reduction would remove…

38 kcal/day per person

⅕ of what we need to reach our goal

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Findings

Creating a multi-dimensional view of the food tech system

Explore the interactive version on the report's website (see Figure 5)

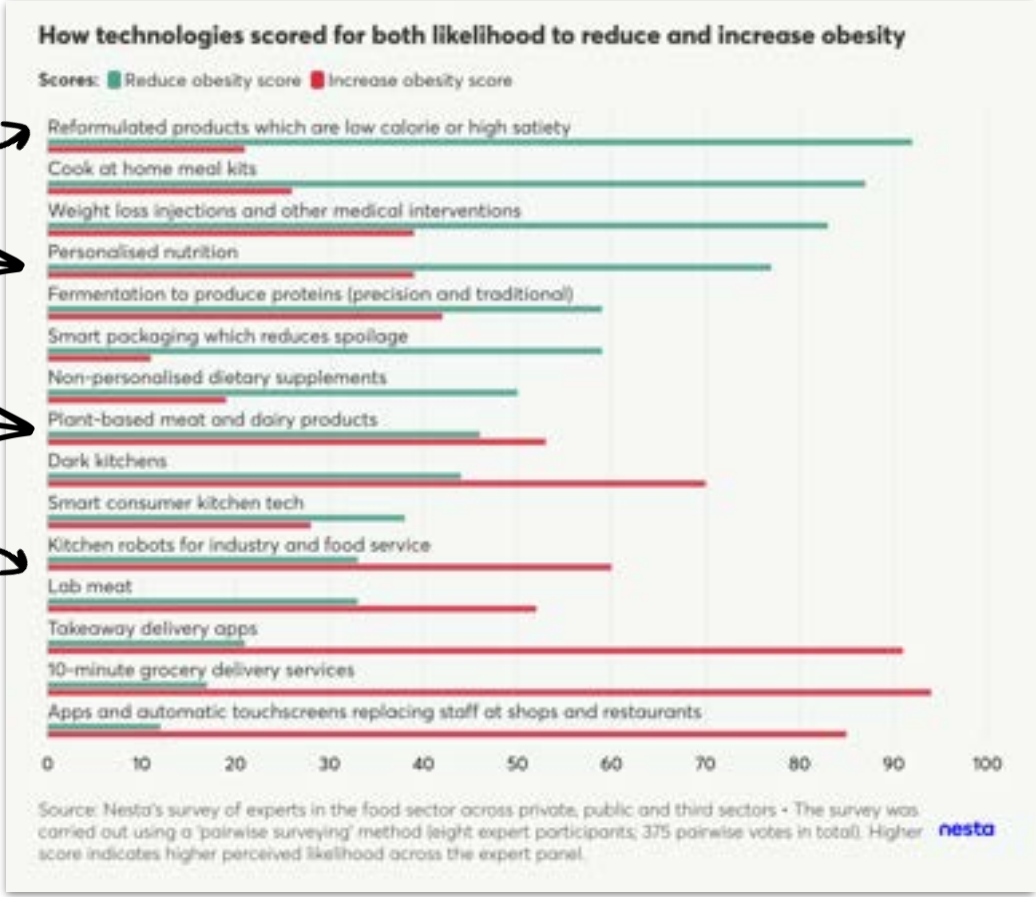
Findings

Reformulation scored the highest in terms of potential to reduce obesity

Meal kits, weight loss injections and personalised nutrition also ranked high

The long-term health impact of **alternative proteins** is unclear

Dark kitchens, kitchen automation and food deliveries ranked low



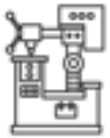
Ranking innovations by potential impact on obesity

🤔 It appears that innovations in this space aren't driven by or enabling health

So what can we do about it..?

Recommendations

Fiscal incentives



HMRC should introduce corporate tax relief for retrofitting food production plants to enable process innovation to reduce calories

UK Gov should put in place Mission-Oriented tax credits and business rates reduction

UK Gov should explore a Health Innovation Levy

British Business Bank should co-invest with private sector capital in food tech companies with positive impact on health

Consumers

UKRI should fund more research and experimentation addressing consumer concerns around food innovations

A taster of some of our other work…

Thank you very much!

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Questions?

Q&A

Regenerative Food Innovation: How We Can Tame Food Processing To Relive The Pressures On Food Security and Sustainability

Prof. Charles Brennan

Executive Dean of School of Sciences
RMIT University

INSERT SLIDES

Q&A

POLL #2

https://app.sli.do

#4271 758

PANEL SESSION: GETTING THE BALANCE RIGHT

Oliver Camp
Senior Associate
GAIN

Dr Joanna Trewern
Head of Consumption
WWF-UK

Chair

Kate Halliwell
Chief Scientific Officer
Food & Drink
Federation

James Lloyd-Jones
Founder
Jones Food Company

Nathan Barnhouse
Director for Wales
FSA

Closing Remarks

Barbara Bray MBE, FIFST

Spring Conference Chair
2023

We want to hear from you!

Scan the barcode to take our survey.

IFST Conference

IFST Wales Branch

Thank you

See you next year!