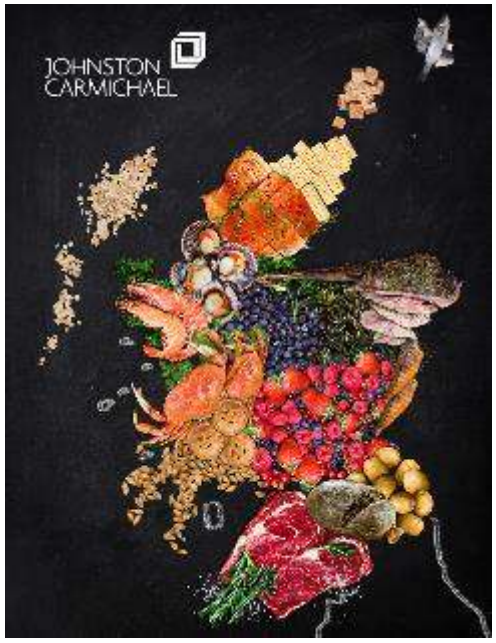
Scotland's Dinner Plate 2050



Prof. Derek Stewart

The James Hutton Institute

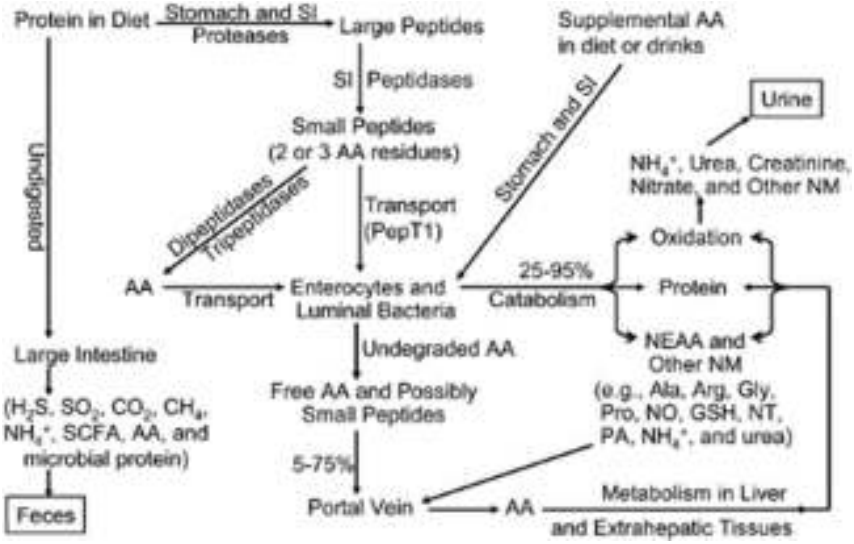
SEFARI

Protein

Table 1 Dietary protein requirements by humans of all age groups

Group	Age (years)	Dietary requirements of protein (g per kg body weight per day)		
		IOM[a]	FAO/WHO/UNU[b]	
		2005	1985	2007
Infants	0.3–0.5	1.52	1.75	1.31
	0.75–1.0	1.50	1.57	1.14
Children	1–3	1.10	1.18	1.02
	4–8	0.95	1.05	0.92
Adolescents	9–13	0.95	0.99	0.90
	14–18 (boys)	0.85	0.97	0.87
	14–18 (girls)	0.85	0.94	0.85
Adults	≥19	0.80	0.75	0.83

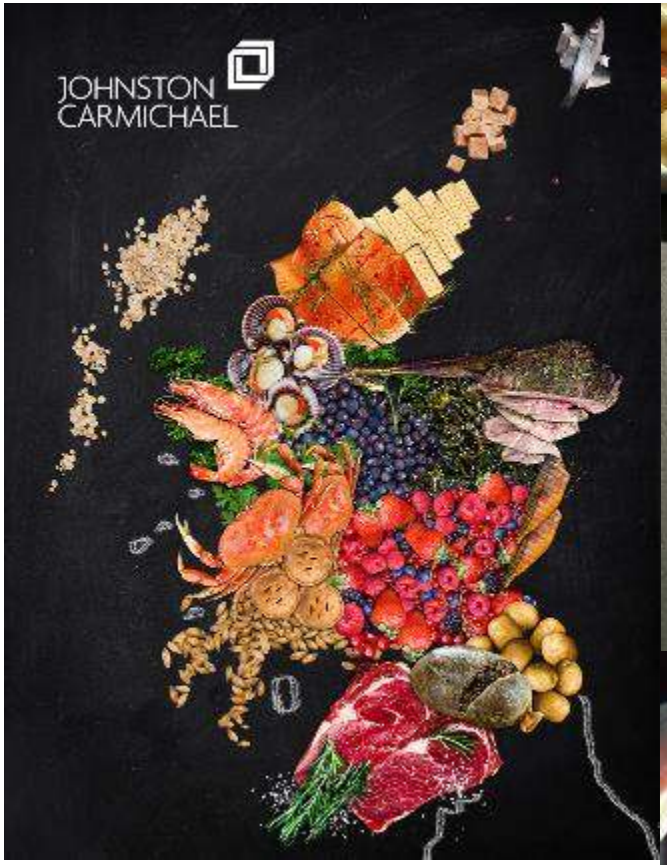
[a] Recommended dietary allowance (RDA) published by the Institute of Medicine.[26] [b] FAO/WHO/UNU (World Health Organization/Food and Agriculture Organization/United Nations University).[22]



- Is a nutrient - a substance that provides nourishment essential for the maintenance of life and for growth.
- Needed to build and maintain bones, muscles and skin.
- Normal sources - from meat, dairy products, nuts, and certain grains and beans.
- Proteins from meat and other animal products are complete proteins. This means they supply all of the amino acids the body can't make on its own.
- Most plant proteins are incomplete.

Protein Perceptions

The James Hutton Institute



Protein Perceptions

29/04/19

Did you know?

It takes **15,415** litres of water to produce 1kg of beef, but only **322** litres of water per 1kg of vegatables!

Go meat free for just one day and save water #watersavingweek

WATER SAVING WEEK

waterwise

Meat Free Monday

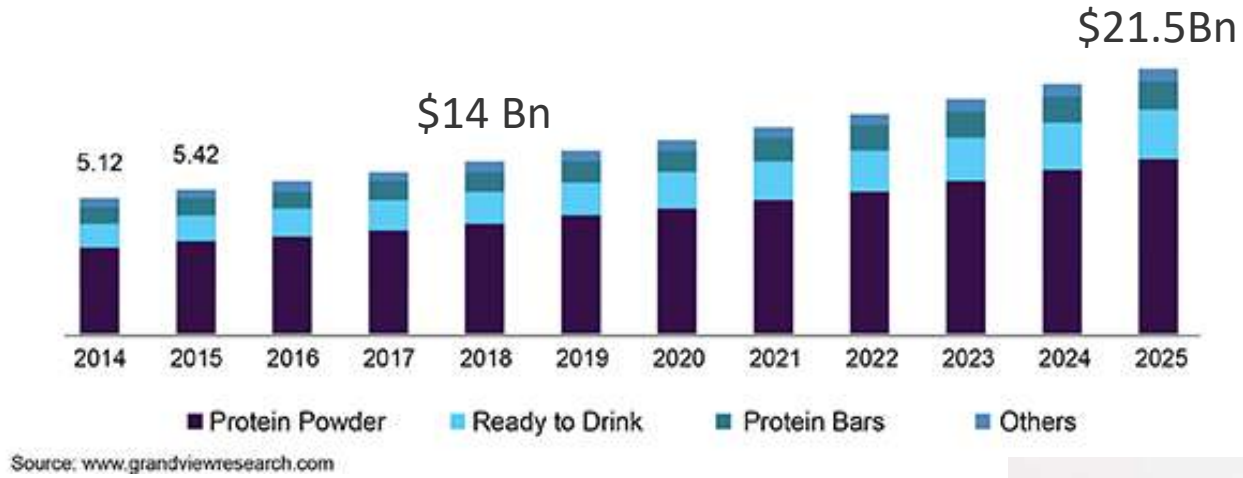
Ofwat

Protein Perceptions

Protein Perceptions – Supplements

The James Hutton Institute

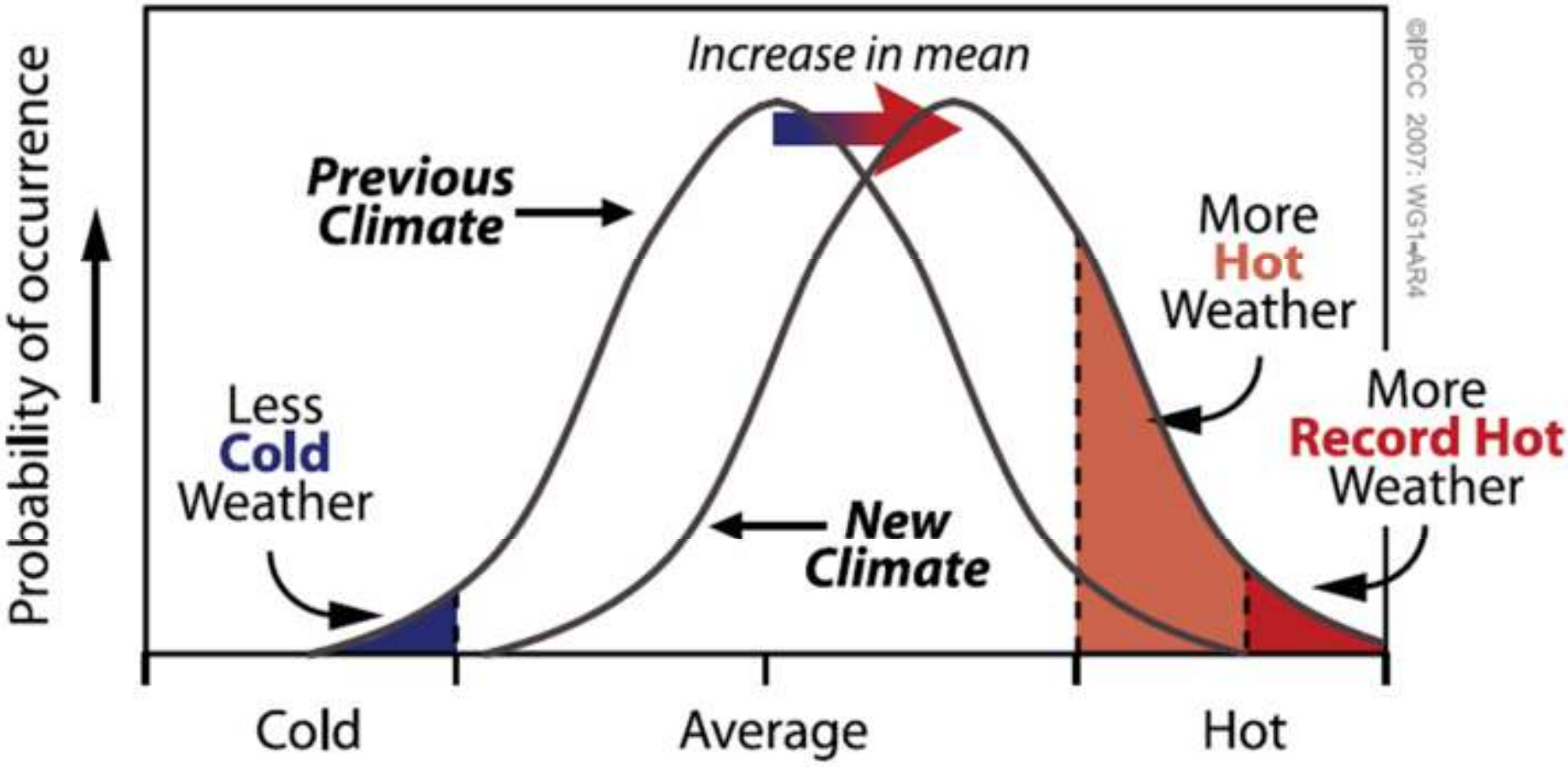
U.S. protein supplements market size, by product, 2014 - 2025 (USD Billion)



Source: www.grandviewresearch.com

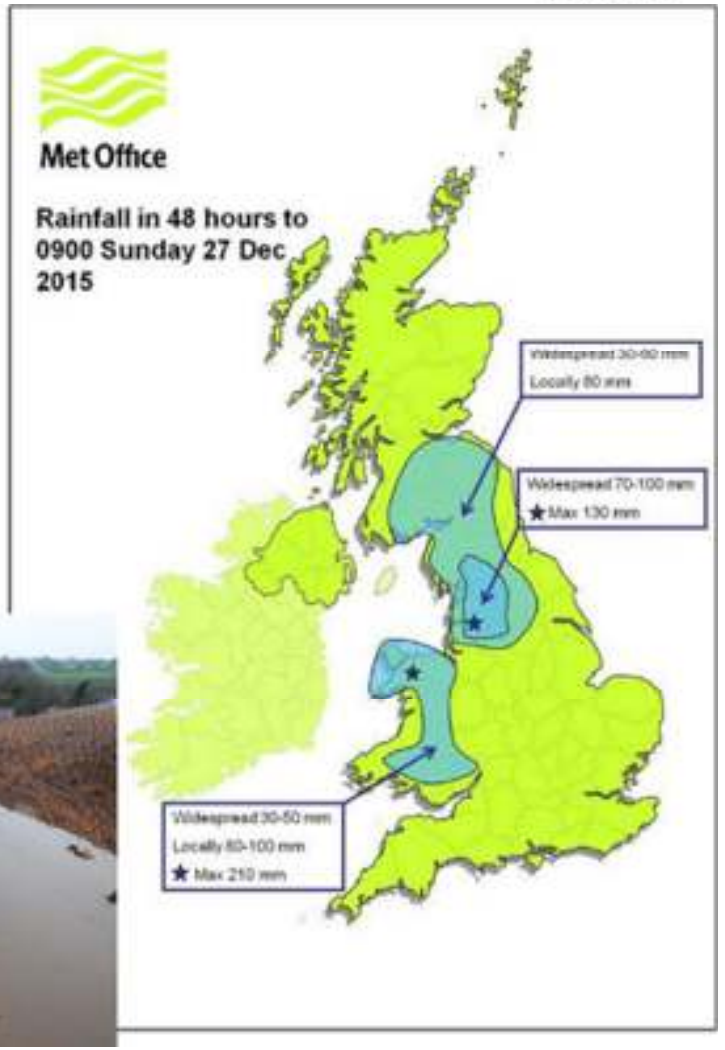
Protein Production

The James Hutton Institute

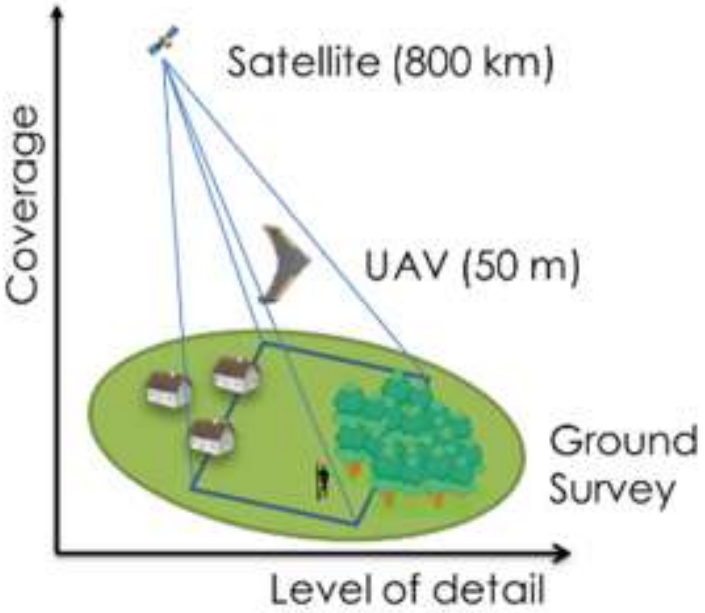


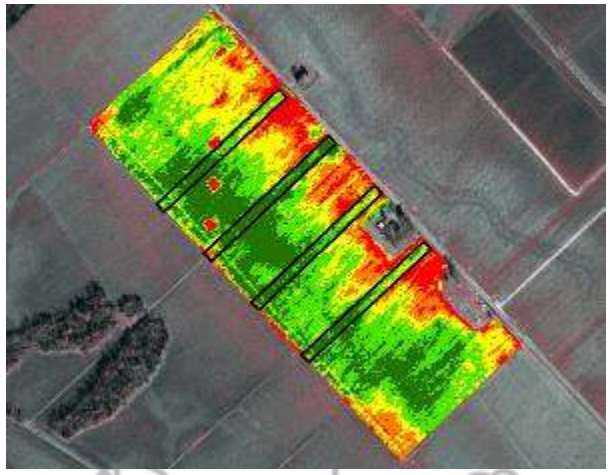
Protein Production

The James Hutton



Protein Production






Scottish
Aquaculture
Innovation
Centre


THE
DATA LAB
value from data


The James
Hutton
Institute


IBioIC


CENSIS


AGRIEPICENTRE
Engineering • Precision • Innovation


agri metrics


CIEL


CHAP
CROP HEALTH & PROTECTION


INTERNATIONAL
BARLEY HUB


ADVANCED PLANT
GROWTH CENTRE


BioSS


SRUC


Moredun


The Rowett
Institute


Royal
Botanic Garden
Edinburgh

Scotland's Dinner Plate 2050

The James Hutton Institute

10:00 -10:10. Introduction/Scene setting. Derek Stewart, The James Hutton Institute
10:10 -10:35. Scottish Agriculture 2050: Different climate, different products. Scot Walker, CEO, National Farmers Union Scotland
10:35 - 11:00. The Scottish Food and Drink industrial landscape 2050. Andrew Niven, Scotland Food and Drink

11:00 - 11:30. Coffee

11:30 - 12:00. Scotland's protein: Meat as part of a sustainable diet. Jennifer Robinson, Quality Meat Scotland
12:00 - 12:30. Scotland's protein: Sustainable protein sources. Derek Stewart, The James Hutton Institute
12:30 - 13:00. A healthy gut. Wendy Russell, Rowett Research Institute

13:00 - 13:45. Lunch.

13:45 - 14:15. Food innovation: home and abroad. Allene Bruce, New Nutrition Business
14:15 - 14:45. Will we still be wasting food in 2050? Luiza Toma. Scotland's Rural College
14:45 - 15:15. Emergent safety threats (and solutions). Nicola Holden, The James Hutton Institute

15:15 - 15:45. Coffee

15:45 - 16:30. Round up and panel discussion. Led by Derek Stewart

NFUScotland

Scott Walker
Chief Executive Officer

Where are we going….

70% more food by 2050

10bn people to feed

Global diet changing – high value animal protein

Urbanisation – how we eat

Who will farm in the future….

Rural Population ageing

Workers difficult to find

Work life balance

Operations will be done remotely, processes will be automated, risks will be identified, and issues solved. In the future, a farmer's skills will increasingly be a mix of technology and biology.

Some of the big issues

Food Waste

between

33% - 50% =

of all food produced
Globally is never eaten

25%

of all fresh water consumption

3rd largest emitter of green house gases after China and USA, if food waste were a country

Agricultural Revolution driven by science and technology

- Sensors – around the farm and on livestock
- Food genetics – animal breeding, crop genetics, animal feed
- Automation
- Digital Marketplaces
- Skills building tools

Change….

From hoes to horse drawn ploughs to high tech tractors to fully autonomous tractors

Algae as animal feed

- Algae in feeding troughs
- An alternative to soya rations
- Doesn’t compete with food for people!
- Uses less land and water than crops

Drones….

Specialist drones survey fields and flocks, mapping crops, grassland, weeds and soil.

Specialist drones spray crops

Give precise data on which decisions are made

Autonomous Agribots….

Autonomous agribots will drill, sow, water, weed, fertilise, spray and harvest crops

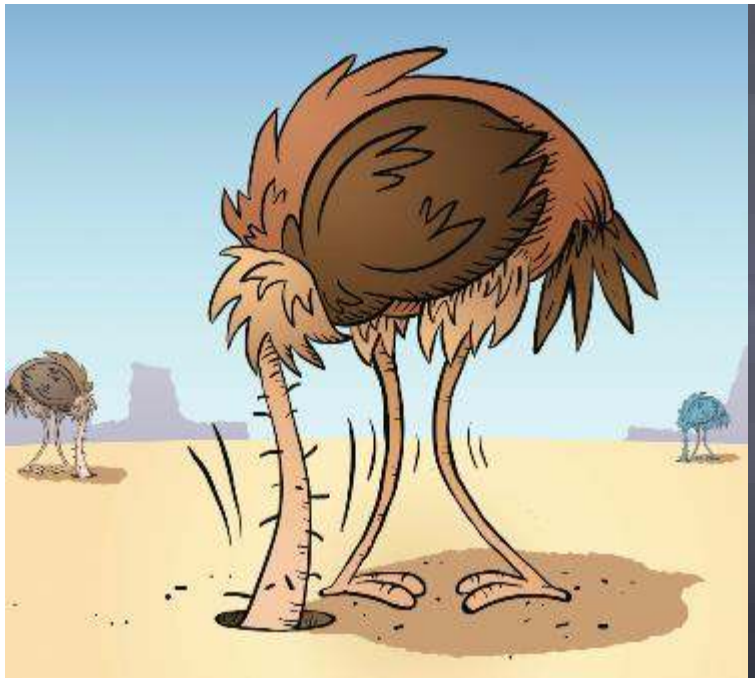
Wearables….

Wearable tech on livestock monitor their location and health

Farming….

A cow grazes in a field. A drone hovers above the herd collecting data which is analysed together with data collected from the cows wearable monitors and the array of sensors around the farm. A few miles away, the farmer acts on the information gathered and decides to move the herd. Virtual gates open in an invisible fence and the drone emits a signal that stirs the animals into movement.

Where are we going….

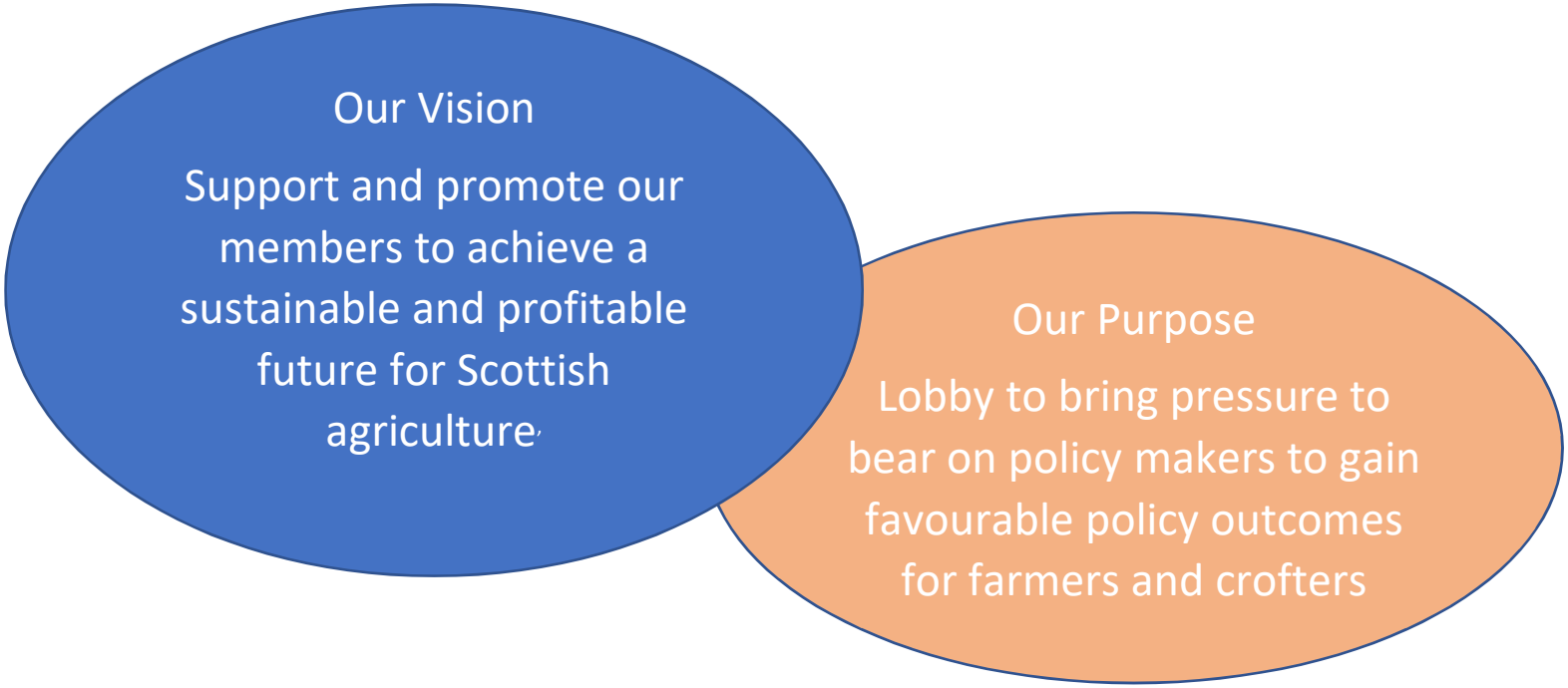


NFUScotland

If opportunity

doesn't knock then build a door….

NFU Scotland



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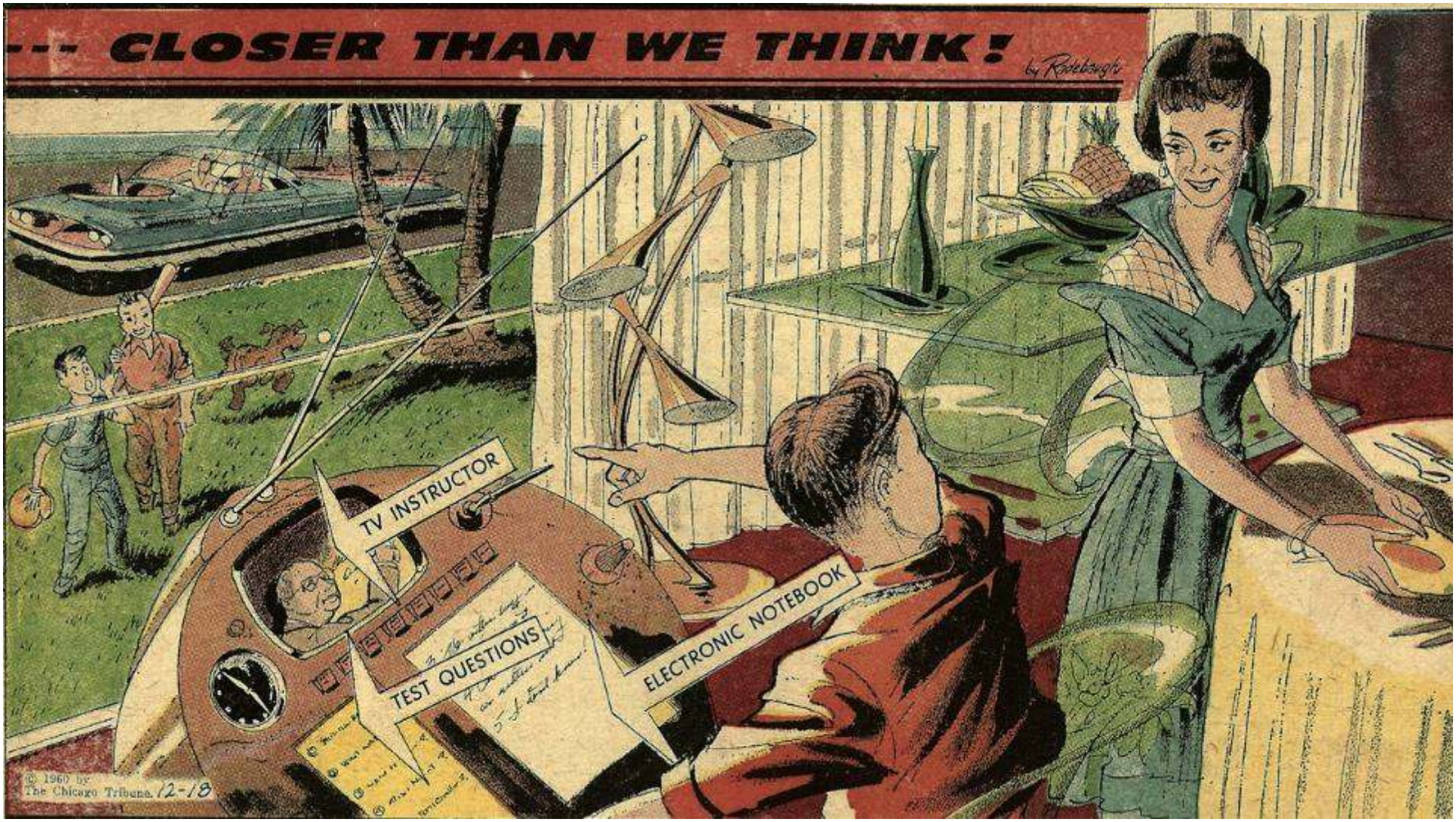
2050…Closer Than We Think!

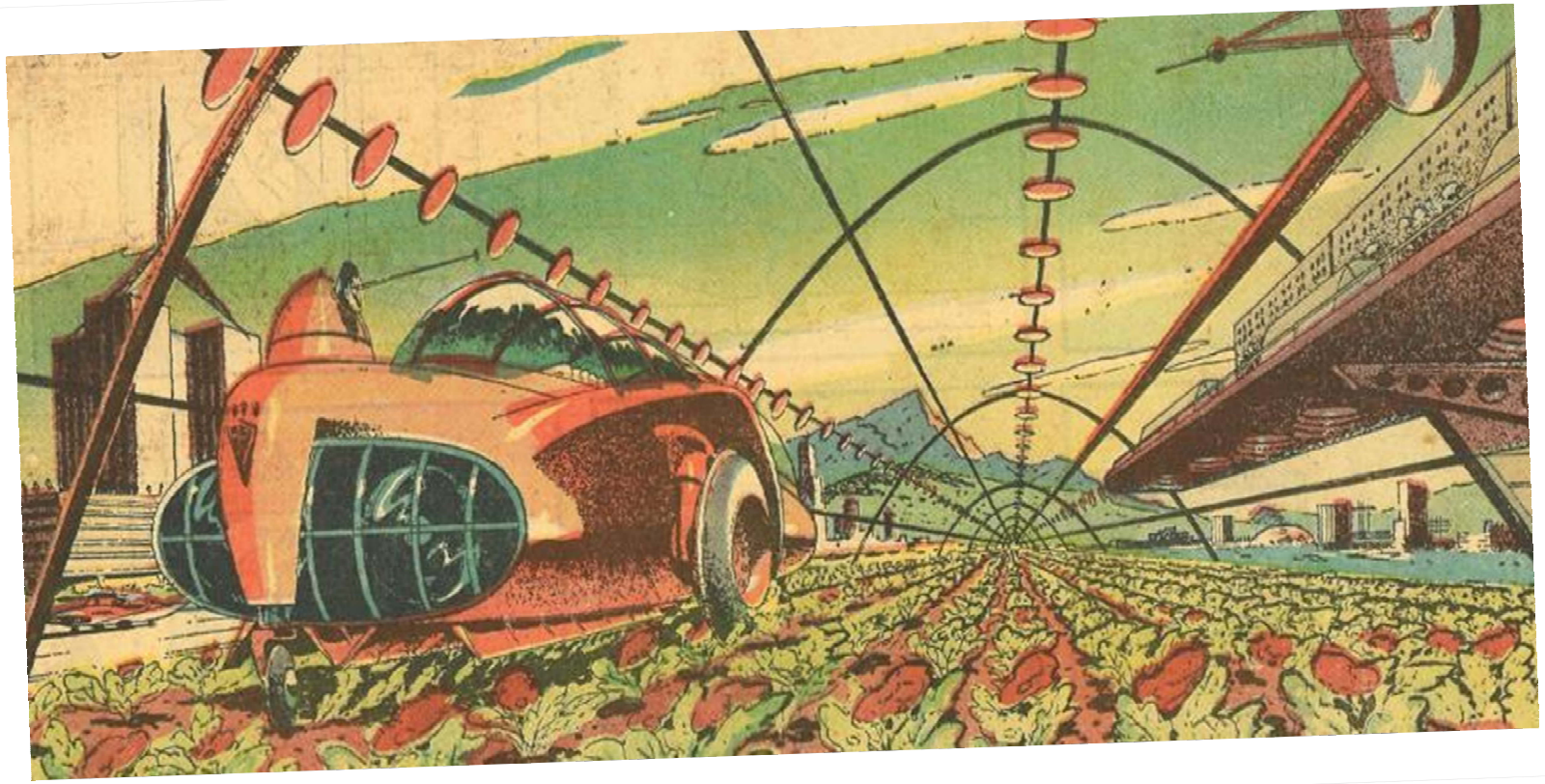
Scotland's Food and Drink
Industrial Landscape

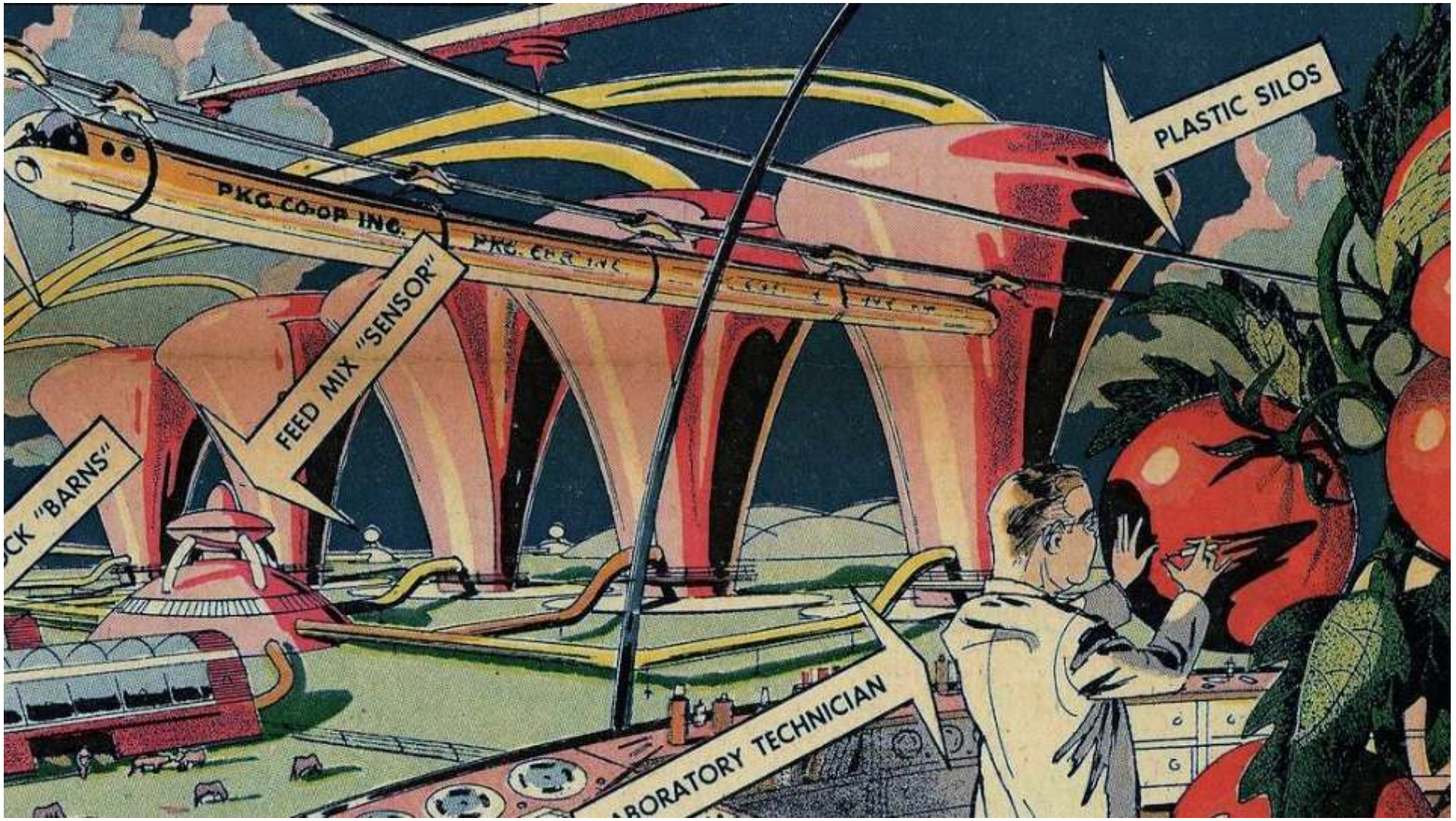
Andrew Niven

14.05.19

SCOTLAND FOOD & DRINK


--- CLOSER THAN WE THINK!
by Rodebaugh
TV INSTRUCTOR
TEST QUESTIONS
ELECTRONIC NOTEBOOK
© 1960 by
The Chicago Tribune. 12-18




PKG. CO-OP INC.
PLASTIC SILOS
FEED MIX "SENSOR"
CK "BARNS"
BORATORY TECHNICIAN

Robotics and Automation, Machine Vision, Ohmic Heating, Supersonic Steam Shockwave, Supercritical Carbon Dioxide, Cold Plasma, Remote Machinery Condition Monitoring, Aseptic Filling, Impingement Air Flow Freezing.

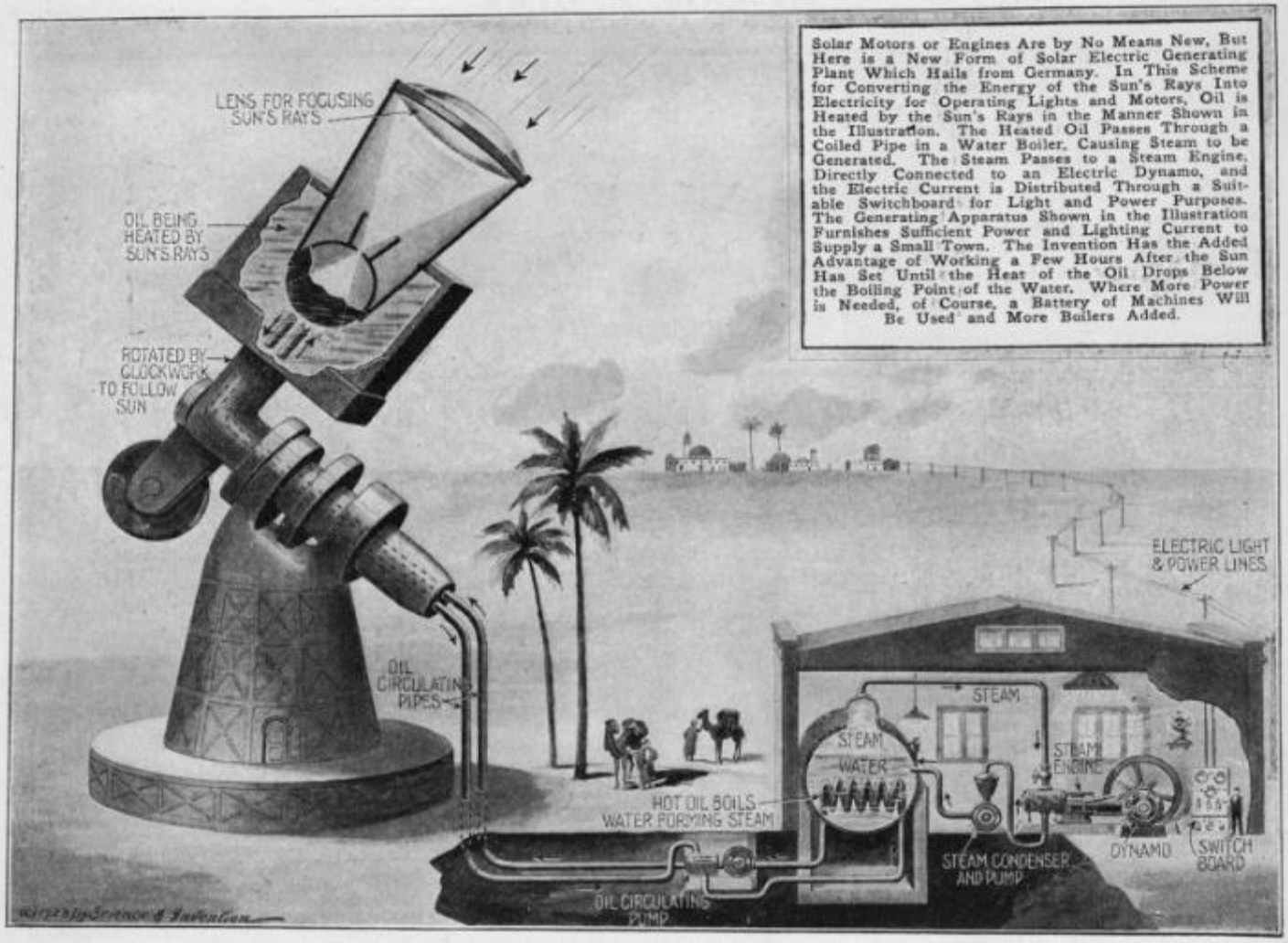
In-line Detection of Fouling, Radio Frequency Heating, Infra Red Heating, Continuous Dense Phase Carbon Dioxide, Pulsed light/UV, Ozonated water

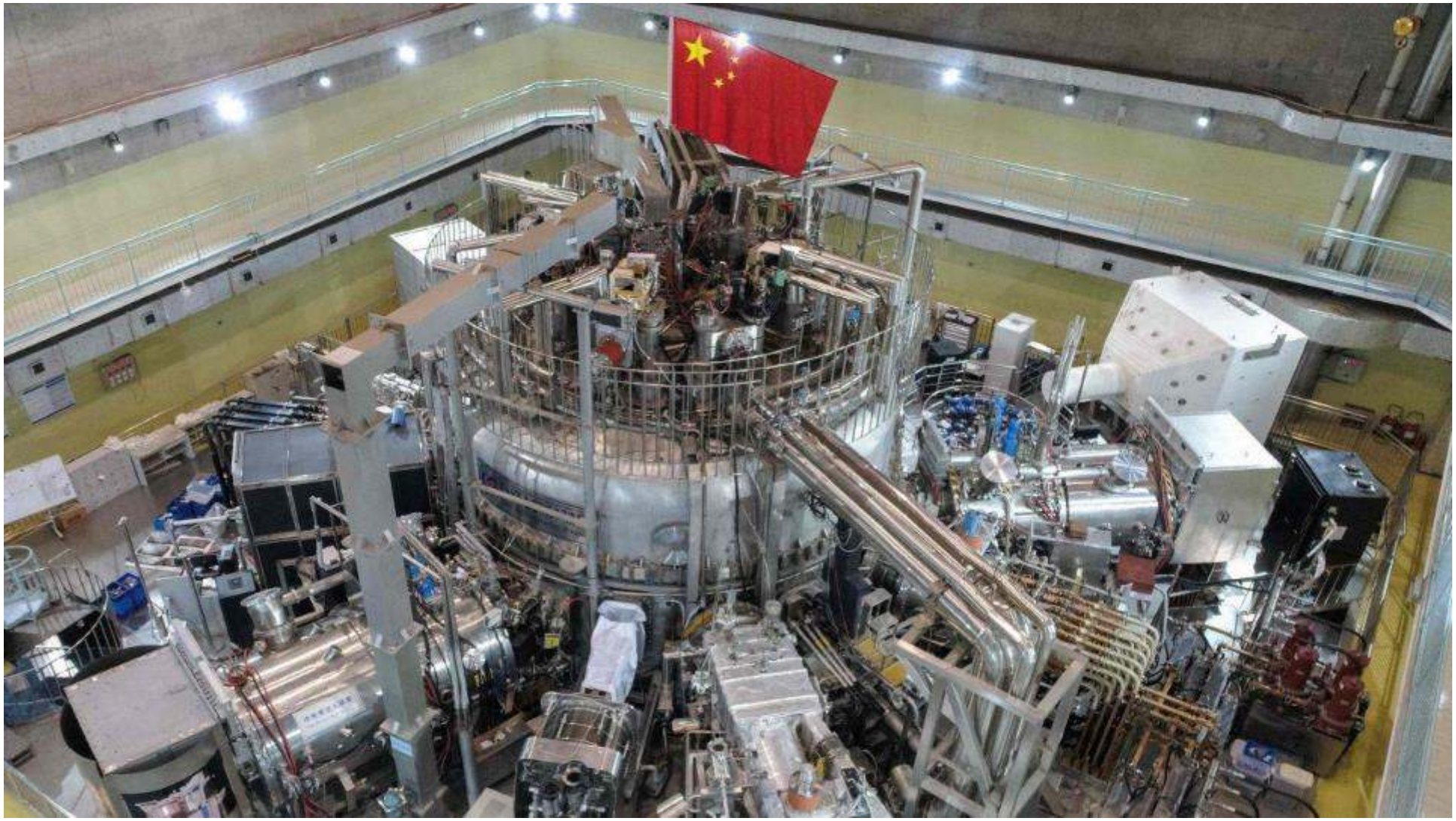
Hyperspectral Imaging, Laser Sealing, Bernoulli Gripper, Conditioned Gas Cooling, Soluble Gas Stabilisation, Coflux, Foreign Body Detection by Spectrometry, Pulsed Electric Field in Pasteurisation, Pulsed Electric Field in Cooking, Microsieves, Magnetic cooling

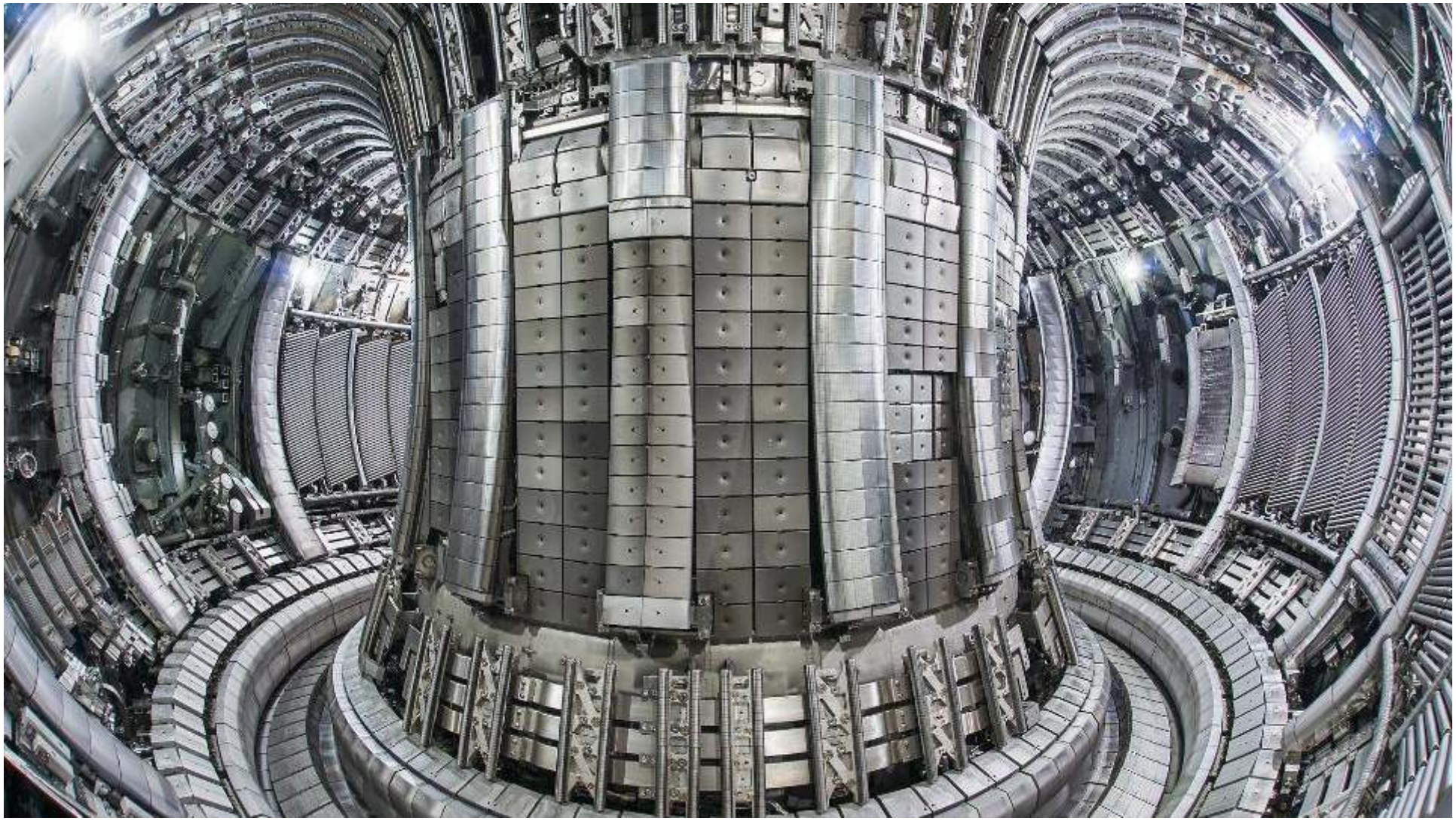
Heat Free Shrink Wrapping, On-line Safety and Quality Indication, Sonication Technologies, Electrocaloric Refrigeration

Spinning Disc Reactors, Continuous Oscillatory Baffle Reactor, Hydraulic Refrigeration, Optical Refrigeration, Thermal Fluid Heating, Thermoacoustic Refrigeration, Machine and Plant Simulations, Digital Twins, Data Analytics

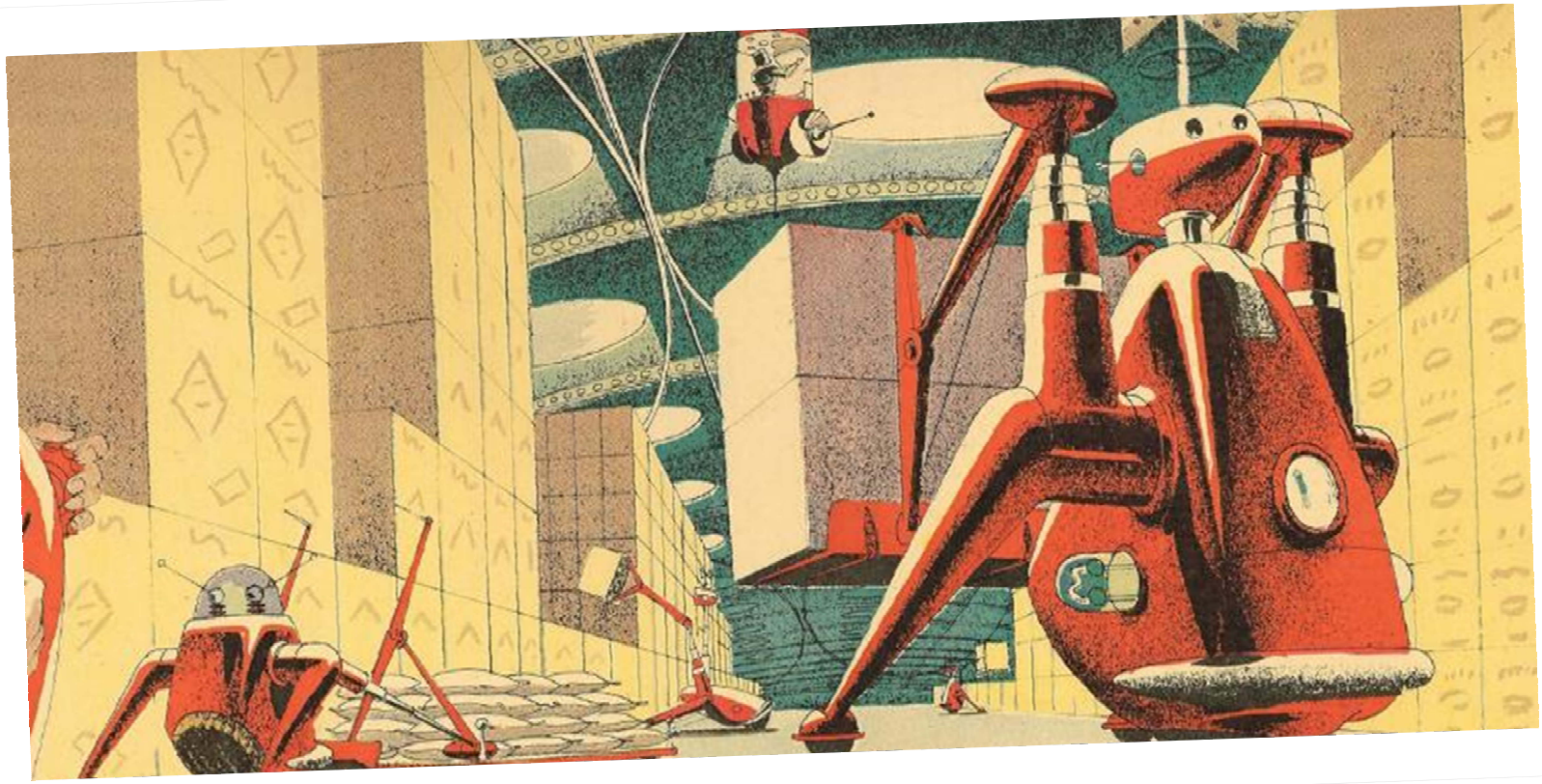
Source: Improve, Review of Technological Innovation F&D Manufacturing

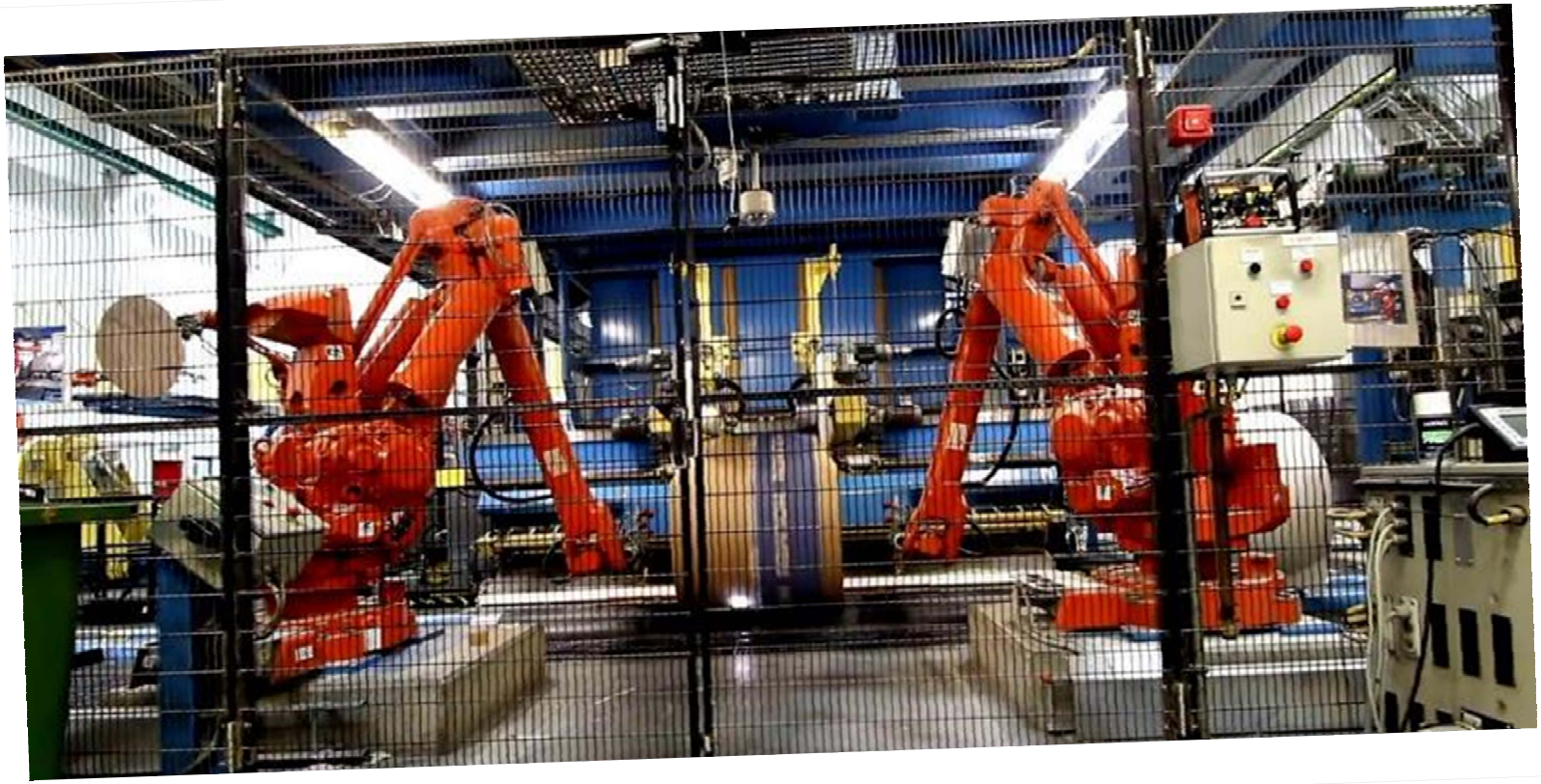

LENS FOR FOCUSING SUN'S RAYS
OIL BEING HEATED BY SUN'S RAYS
ROTATED BY CLOCKWORK TO FOLLOW SUN
OIL CIRCULATING PIPES
ELECTRIC LIGHT & POWER LINES
STEAM
STEAM
WATER
STEAM ENGINE
HOT OIL BOILS WATER FORMING STEAM
STEAM CONDENSER AND PUMP
DYNAMO
SWITCH BOARD
OIL CIRCULATING PUMP
Solar Motors or Engines Are by No Means New, But Here is a New Form of Solar Electric Generating Plant Which Hails from Germany. In This Scheme for Converting the Energy of the Sun's Rays Into Electricity for Operating Lights and Motors, Oil is Heated by the Sun's Rays in the Manner Shown in the Illustration. The Heated Oil Passes Through a Coiled Pipe in a Water Boiler, Causing Steam to be Generated. The Steam Passes to a Steam Engine, Directly Connected to an Electric Dynamo, and the Electric Current is Distributed Through a Suitable Switchboard for Light and Power Purposes. The Generating Apparatus Shown in the Illustration Furnishes Sufficient Power and Lighting Current to Supply a Small Town. The Invention Has the Added Advantage of Working a Few Hours After the Sun Has Set Until the Heat of the Oil Drops Below the Boiling Point of the Water. Where More Power is Needed, of Course, a Battery of Machines Will Be Used and More Boilers Added.

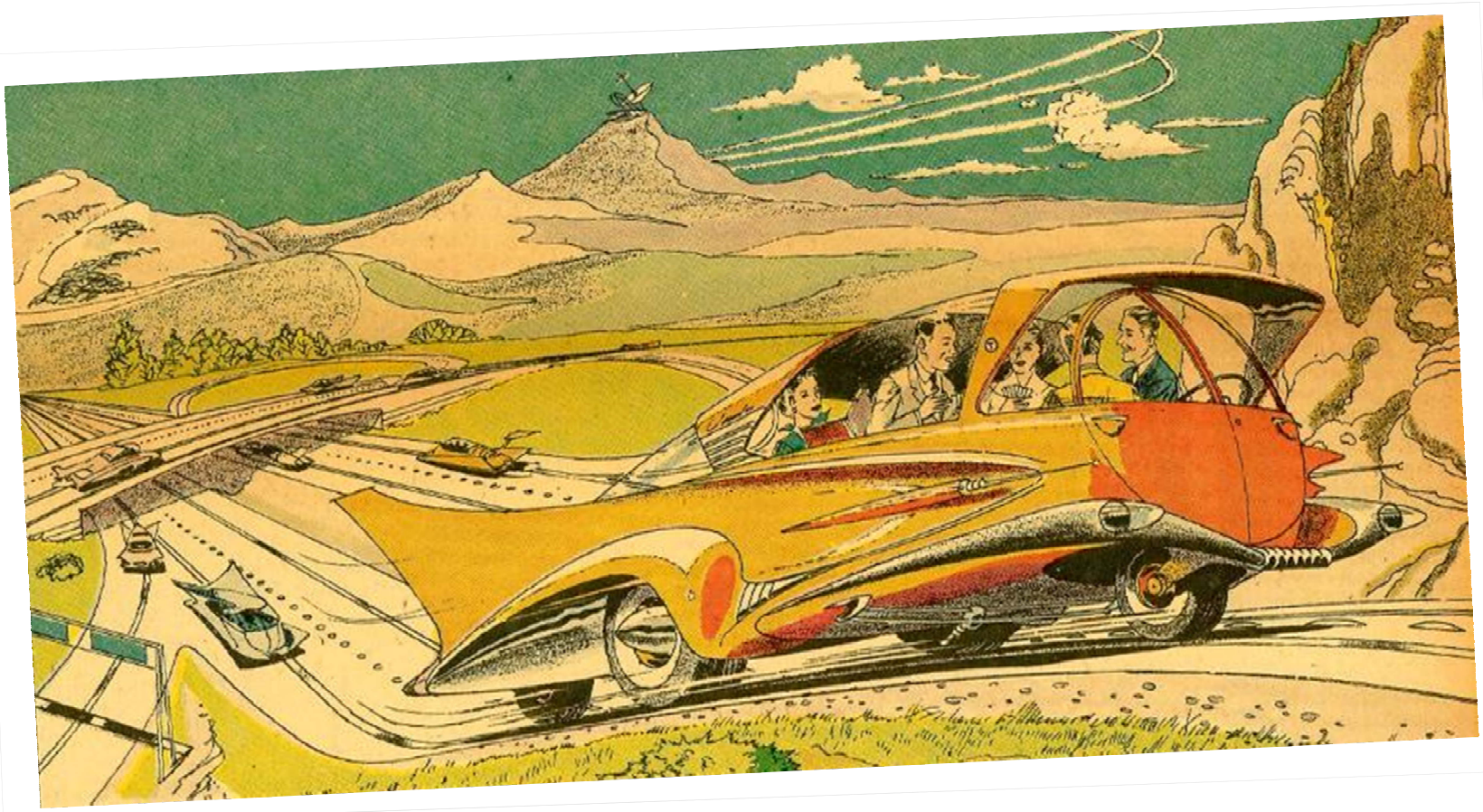





THE GOOD SHIP
BREWDOG








--- CLOSER THAN WE THINK!
by Rabinowich
ROBOT RAILROADING
Future trains will be fully automatic—robots that can regulate their own speed and control their own movements to meet the most precise schedules.
The Union Switch and Signal Division is currently working on two kinds of electronic "brains" to make this possible. One type would be a trackside "decision maker," to regulate train speed, routing, starting and stopping. The other would be a "control servo," to signal that the robot train is obeying orders—or isn't, and why. A central monitoring panel would oversee train movements for hundreds of square miles. The first such installation may be on the New York subway shuttle trains.
Next week: Lunar Power Pack
NO ENGINEER!
RADAR SERVO
SPEED MONITOR
ROUTE MONITOR
4-24
© 1949 by The Chicago Tribune


SAVING FUEL AND IMPROVING SAFETY
A FUTURE TRANSPORT CONCEPT BY VOLVO GROUP
SOLUTIONS FOR CONNECTED DRIVING
SOLUTIONS FOR CONNECTED DRIVING
approx. 15 m
SOLUTIONS FOR CONNECTED DRIVING
SOLUTIONS FOR CONNECTED DRIVING
Vehicle following lead vehicle
Vehicle leading platoon


SUMMATION
GENERATOR 3

… Closer Than We Think!

Food and Drink Industrial Landscape 2050

Andrew Niven

14.05.19

SCOTLAND FOOD & DRINK

Scotland's Protein: Meat as part of a sustainable diet

Jennifer Robertson
Health & Education Manager, Quality Meat Scotland


traceable
HEALTH
BUY LOCAL
SCOTCH LAMB
DELICIOUS
ENERGY
NATURAL
fresh
tradition
iconic
local
SCOTCH
INNOVATION
LAMB
environment
IRON
WELFARE
grass-based
VITAMIN
LAMB
sustainable
BIODIVERSITY
landscape
MEAT
high standards
Quality
family
IRON
SPECIALLY SELECTED
market
SHORT SUPPLY CHAIN
PORK
Assurance
farms
world-famous
Growth
health
local
50,000 jobs
PROTEIN
Innovation
PGI
Scotch Beef
world leading
LAMB
contributes
over £2 billion
ENERGY
SPECIALLY SELECTED
MEAT
Scotch
animal health
welfare
GRASS
SCOTCH
BEEF
SCOTCH BEEF
SCOTCH LAMB
SPECIALLY SELECTED
PORK


traceable
BUY LOCAL
HEALTH
SCOTCH LAMB
VITAMIN
MEAT
IRON
SPECIALLY SELECTED
PORK
Quality Assurance
ENERGY
IRON
WELFARE
LAMB
NATURALfresh
INNOVATION
tradition
iconic
local
SCOTCH
LAMB
grass-based
sustainable
family farms
world-famous
BIODIVERSITY
landscape
Growth
Innovation
PGI
Scotch
MEAT
SPECIALLY SELECTED PORK
GRASS
health
local
50,000 jobs
PROTEIN
Scotch Beef
world leading
LAMB
welfare
SCOTCH BEEF
SCOTCH BEEF
SCOTCH LAMB
SPECIALLY SELECTED
PORK

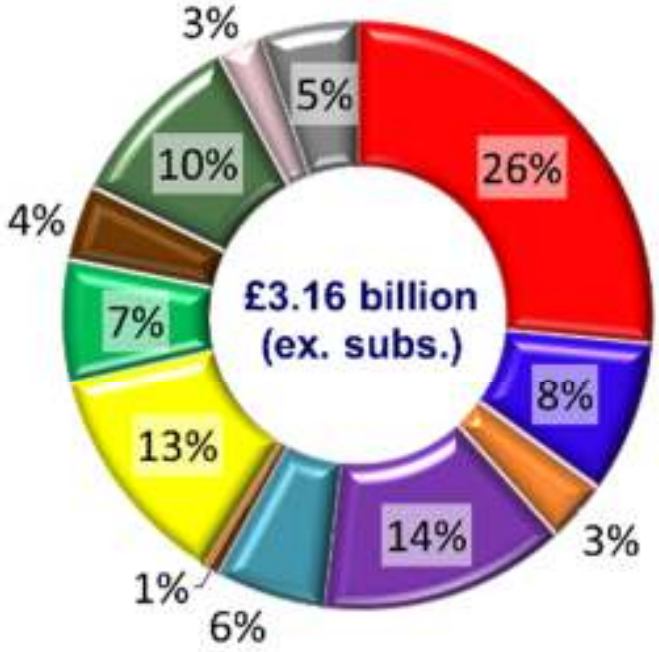
Livestock Farming – A key part of the Scottish Economy

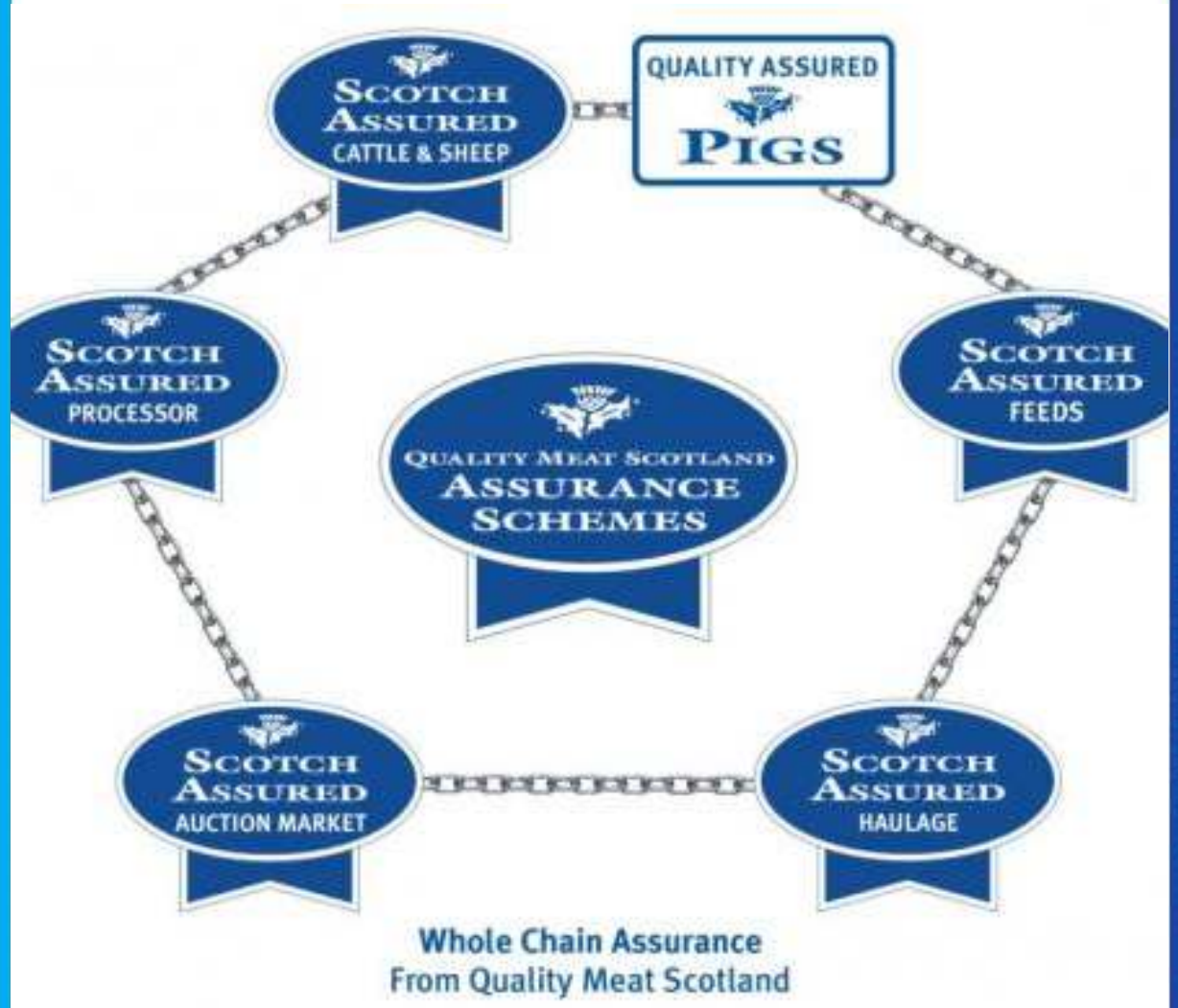
Red meat production

37% of agricultural output

> £2billion to the economy

> 50,000 jobs





Whole Chain Assurance
From Quality Meat Scotland

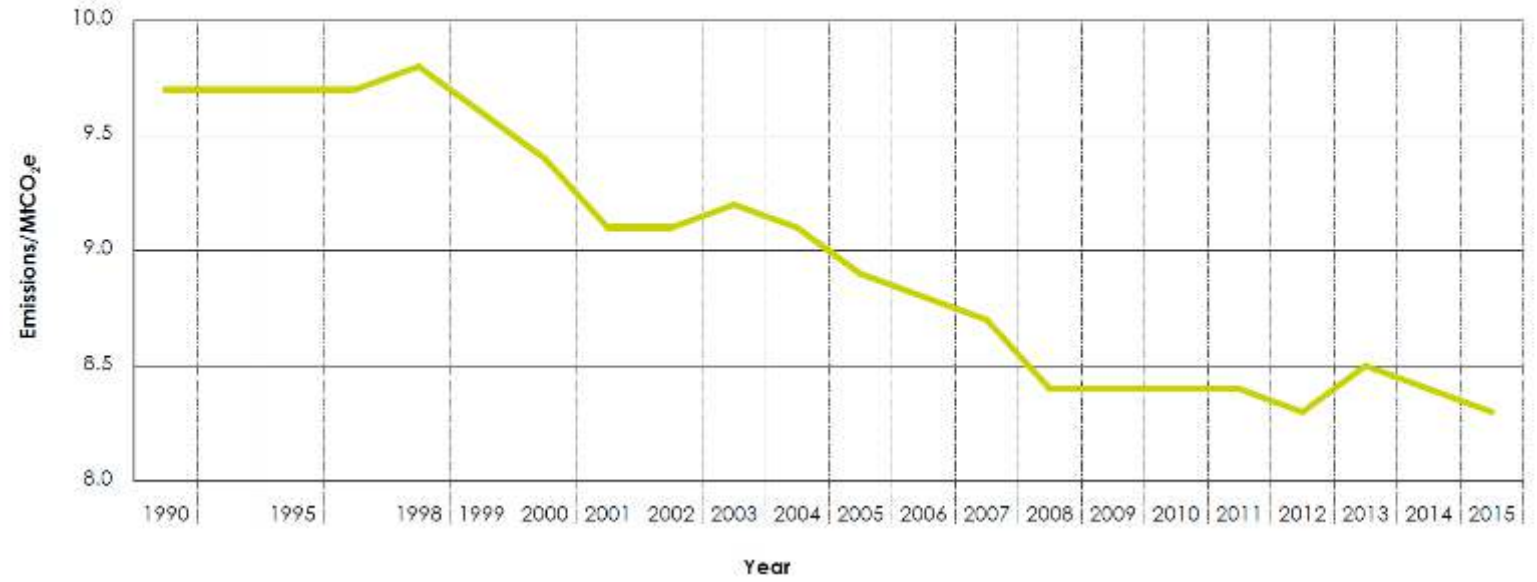
QMS
QUALITY MEAT SCOTLAND

- Longest running quality assurance schemes in the world
- Animal Welfare a priority
- Unique partnership with Scottish SPCA

SCOTCH BEEF · SCOTCH LAMB · PORK

Reduction in Scottish Agricultural Emissions

Figure 19: Agriculture historical emissions[144]



Climate Change Committee, 2018

Importance of Scottish Soils

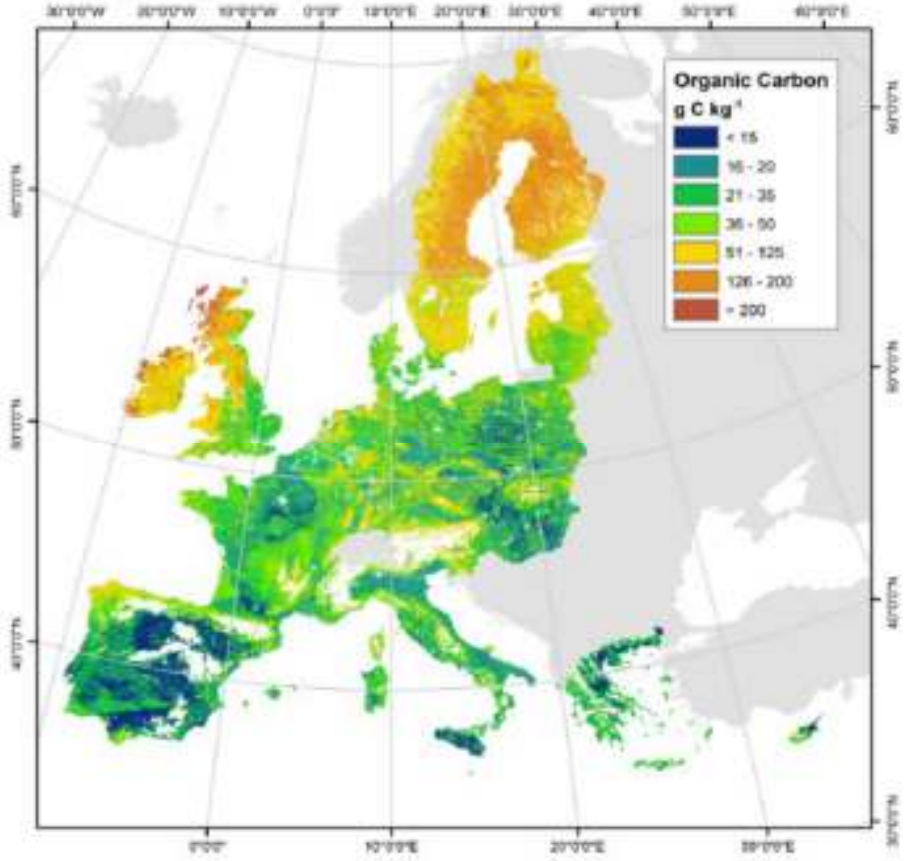
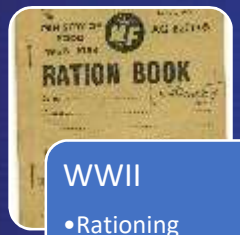


Figure 2. Map of predicted topsoil organic carbon content (g C kg^{-1}) (Brogniez *et al.*, 2015)

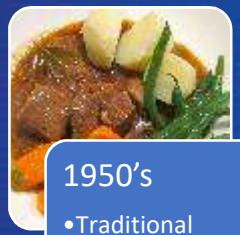
The carbon locked up in Scottish peatland soils is equivalent to 140 years' worth of Scotland's total annual greenhouse gas emissions[6].

A brief history of food……..



WWII

- Rationing
- Meat rationing ended 1954

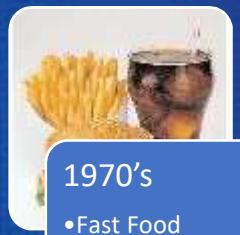


1950's

- Traditional
- Meat with 2 vegetables

1960's

- Fridges
- Freezers



1970's

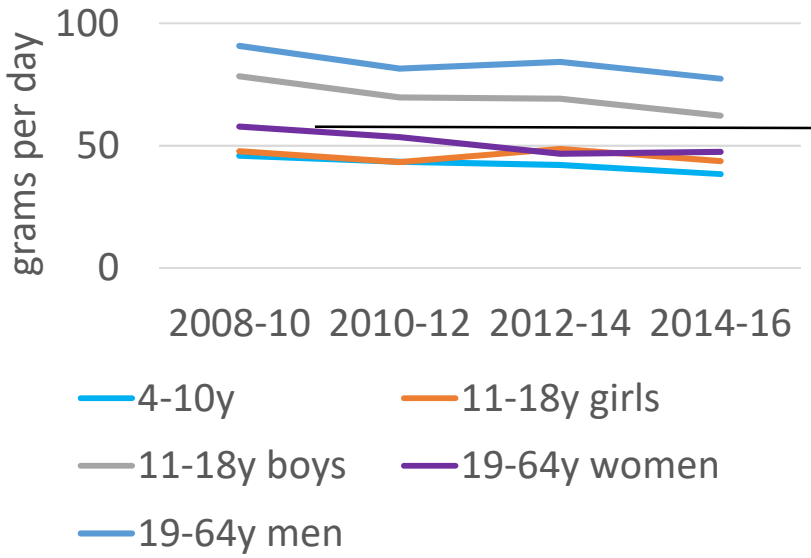
- Fast Food
- "Foreign" food
- Flavours

1980-90's

- Convenience
- Ready Meals

Portion Control - Out of Control!

Red meat consumption has been falling



UK upper target of 70g/day

Compared with 8 years ago, women are eating 19% less red meat while men are eating 15% less.

Scottish average intake **56g per day** (FSS, 2018)

How much should we be eating?

- Up to 500g cooked red and processed meat per week or 70g pppd
- Approx. 700g raw meat
- Reduce if greater than 90g pppd

Portion sizes

- Limited reference guidelines
- Approx. size of a deck of cards
- or the palm of your hand

Potential for Nutritional Deficiencies

Eating a diet rich in fruit and vegetables and containing lean red meat as a protein source provides a perfect balance of nutrients

Limiting the amount of red meat especially in our children's diets could lead to nutrient deficiencies or shortfalls

27% women and 42% teenage girls fail to achieve the minimum iron intake

1 in 10 teenage girls have low haemoglobin levels and 22% have low ferritin levels

22% teenage girls don't get enough zinc

Traditional diet containing meats and vegetables – great combination

Haem + Non-Haem = improved absorption

Combine with Vitamin C containing fruits or vegetables

Flexitarianism / Plant Based

- Rise of vegetarianism/veganism – 5% population (swings between 4-5% over last decade)
- Therefore, 95% of population are still meat eaters
- Meat is bought by 99.2% of all households (Kantar Worldpanel)
- Flexitarian approach more potential. Plant based doesn't always mean not including meat.
- Eat less, Eat Better?

Education is Key

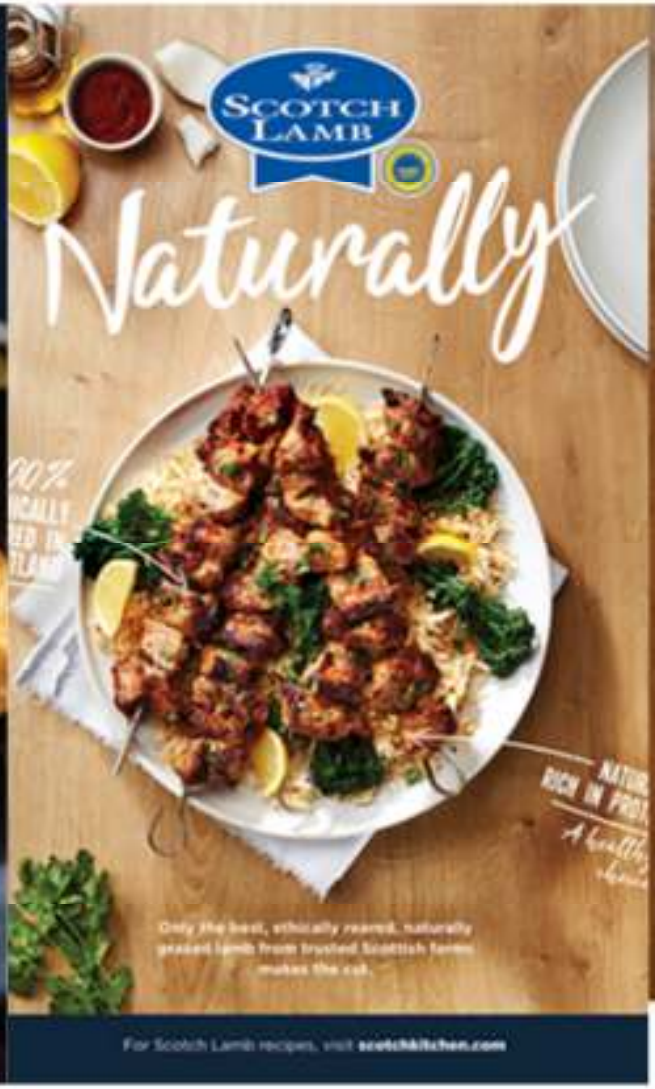
- Develop knowledge and necessary life skills; cooking for health and future!
- Allow choice and opinion
- Food Science – Product development career opportunities

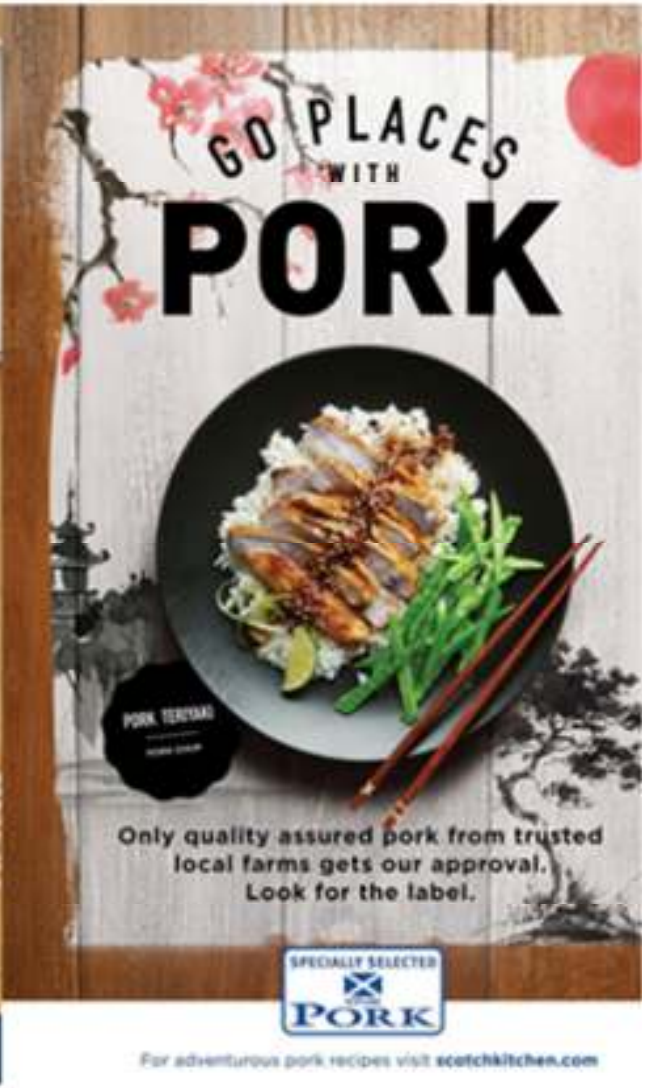
If you choose to Eat Less, then Eat the Best!

High quality, traceable, fully assured

- Scotch Beef
- Scotch Lamb
- Specially Selected Pork


SCOTCH BEEF IS ALWAYS TRACEABLE, LOCAL & QUALITY ASSURED.
Know your Beef
Scotch Beef
Look for the label
scotchkitchen.com


Scotch Lamb
Naturally
For Scotch Lamb recipes, visit scotchkitchen.com


GO PLACES WITH
PORK
Only quality assured pork from trusted local farms gets our approval. Look for the label.
Specially Selected
Pork
For adventurous pork recipes visit scotchkitchen.com

Scotland's Dinner Plate 2050

Scotland’s protein: Sustainable protein sources

Prof Derek Stewart

The James Hutton Institute

Protein – Flexitarianism

Protein: Rural Affairs, Food and Environment Research Strategy for 2016 - 2021

Sustainable nutrition – the role of plant protein

Key messages on challenges and opportunities for the food sector

'Plant protein has an important role to play as part of a healthy and sustainable diet, but in the UK only baked beans appear in the top ten diet sources – we need to reformulate, educate and innovate'.

Significant work in the research themes;

- A Productive and Sustainable Land Management and Rural Economies (T-2).
- A Food, Health and Wellbeing Theme (T-3)
- Natural Assets (T-1)

Reformulation: reduction of meat protein and substitution of plant protein

Innovation : New product development to meet specific consumer demands

Waste/Circular Economy: Can we recover and/or better utilise protein.

Education : for consumers about provenance / health effects

SEFARI

Sustainable Protein in Scotland

- **Protein quantity** – how much you need depends on differs between individuals and at different life stages; individual requirements of each nutrient are related to a person's age, gender, level of physical activity and health status – ageing adults do not consume enough protein to support health.

- **Protein distribution** – not just what we eat, but when we eat that is important

- **Protein quality** – types of protein - we eat food not nutrients

- **Protein and health** – we need food and beverage solutions to support protein as a functional food for appetite control and maintenance of muscle mass for our ageing population

- **Protein and red meat** – 'eat less but eat better' for healthy and sustainable diet

SEFARI

Protein - Sources

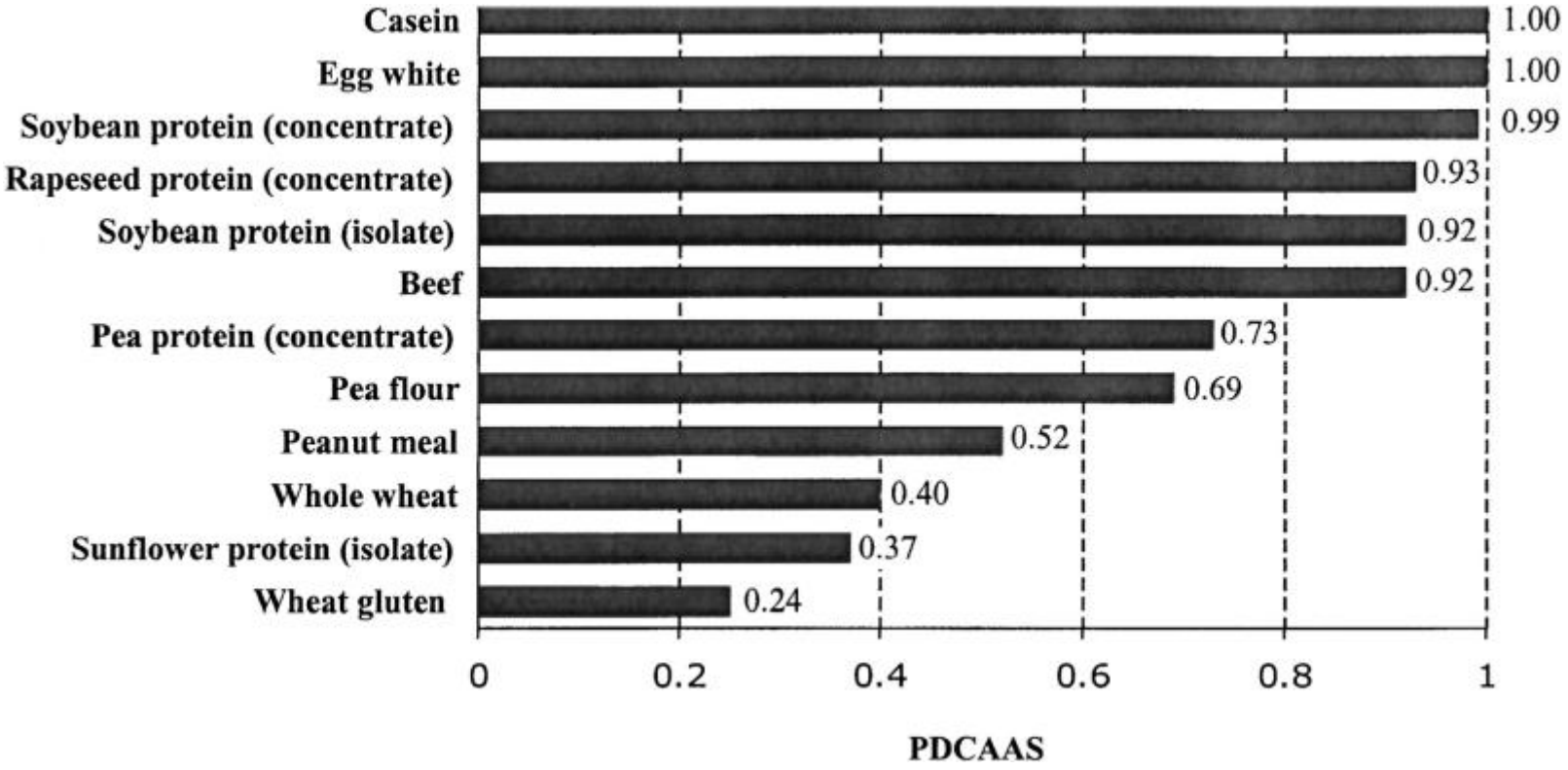
What are the non-meat sources?

- Dairy
- Eggs

- Fish
- Fungi
- Algae
- Insects
- Plants inc fruit, vegetables nuts and pulses/legume

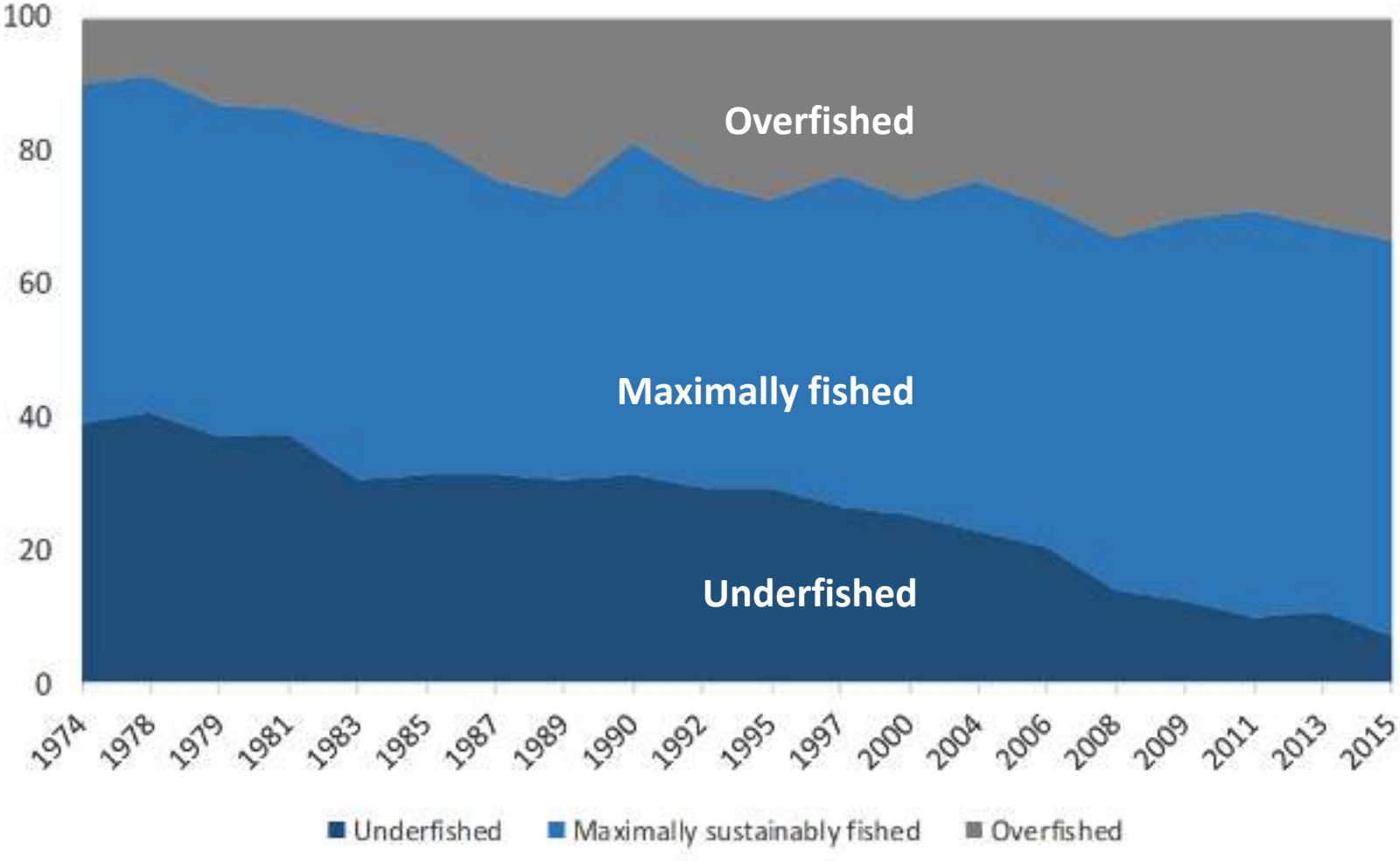
- Co-products/Waste

Protein Digestibility



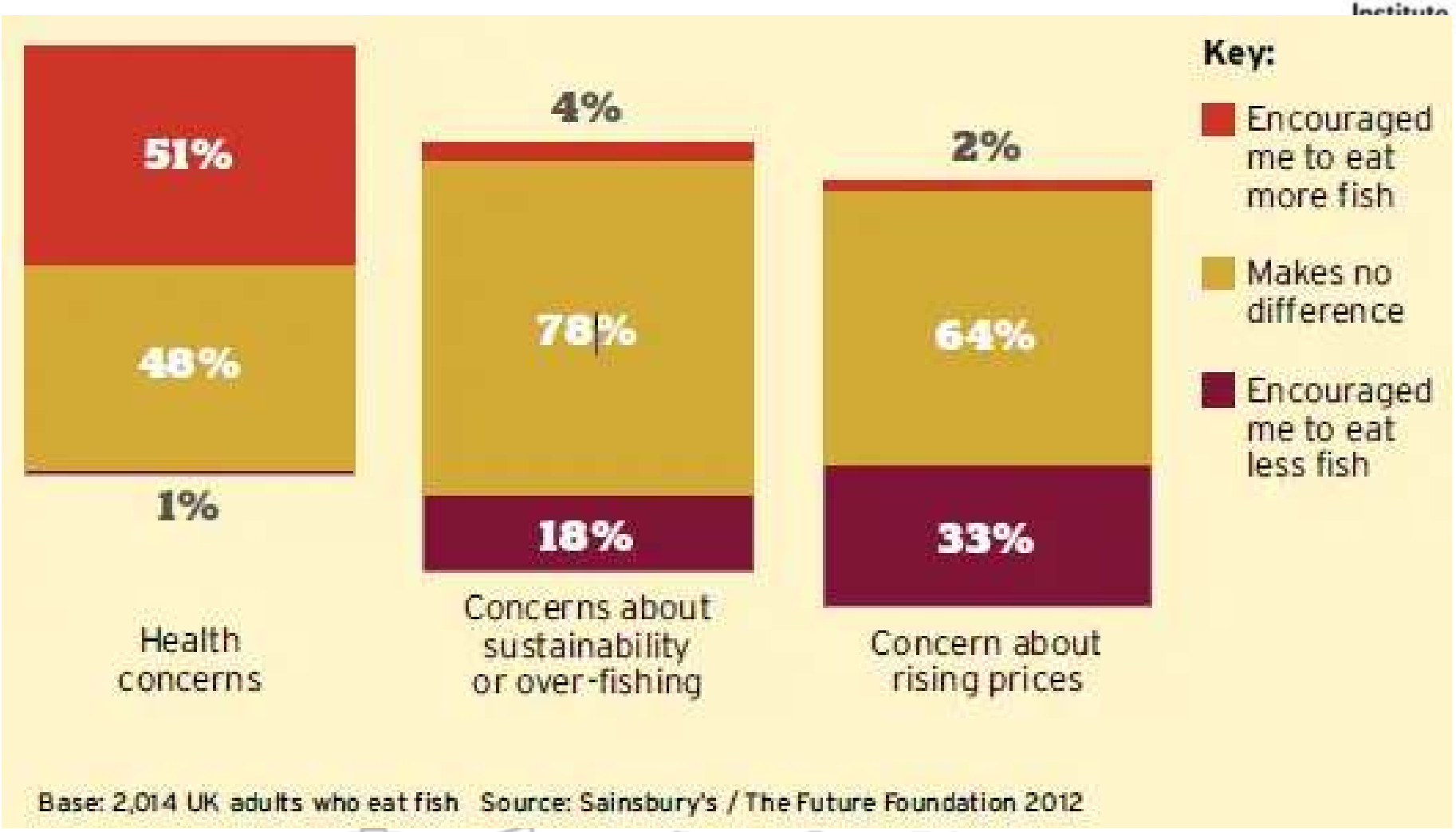
Krishnan doi:10.2135/cropsci2005.0454

Protein - Fish

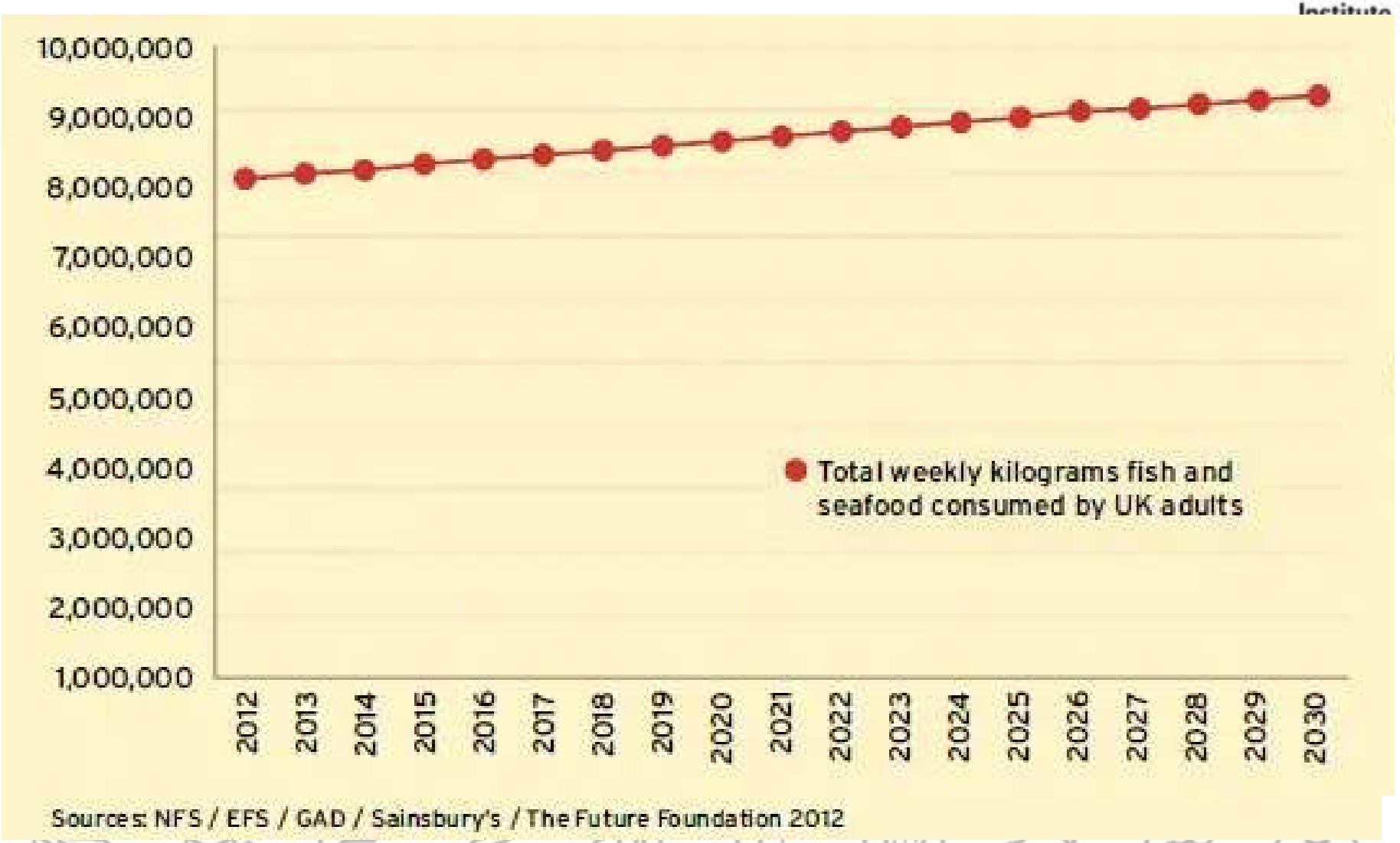


Biodiversity: Finance and the Economic and Business Case for Action, OECD May 2019

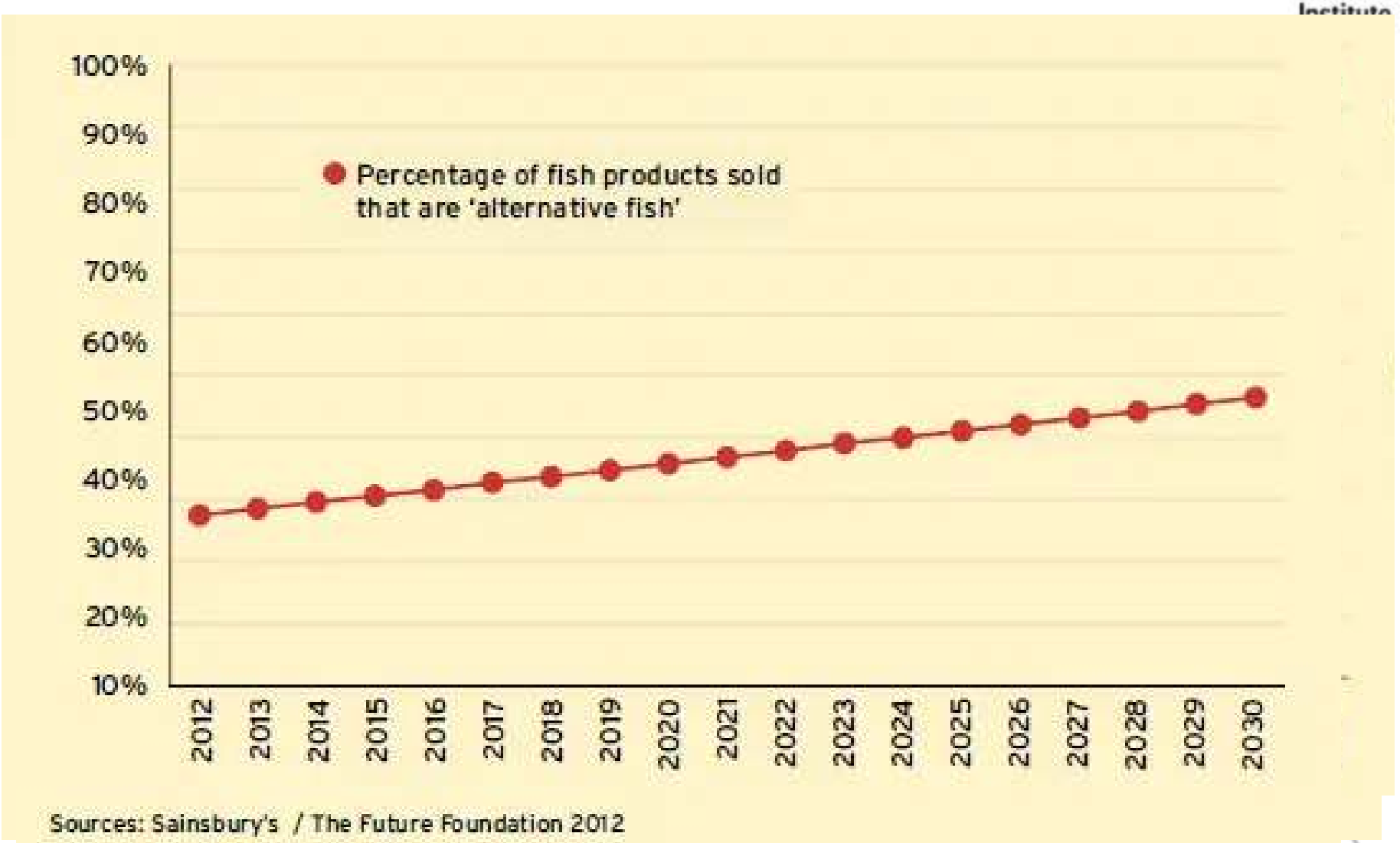
Protein - Fish



Protein - Fish



Protein - Fish



Sources: Sainsbury's / The Future Foundation 2012

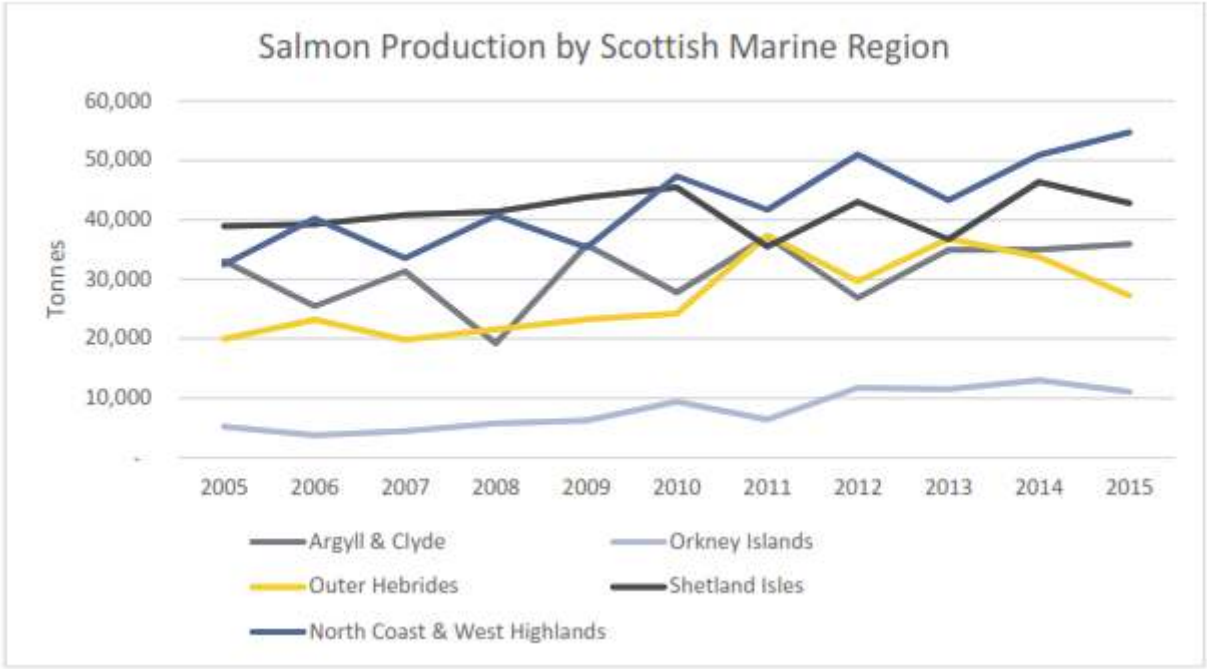
Protein - Aquaculture

Protein – Salmon

TABLE 4: SALMON PRODUCTION BY COUNTRY

	Tonnes GWE	%
Norway	1,054,000	54.1
Chile	454,000	23.3
North America (mainly Canada)	148,100	7.6
Scotland	144,100	7.4
Faroe Islands	69,600	3.6
Other Countries	78,900	4.0
Total	**1,948,700**	

FIGURE 4: TRENDS IN SALMON PRODUCTION BY REGION, 2005-2015



Protein - Rainbow trout

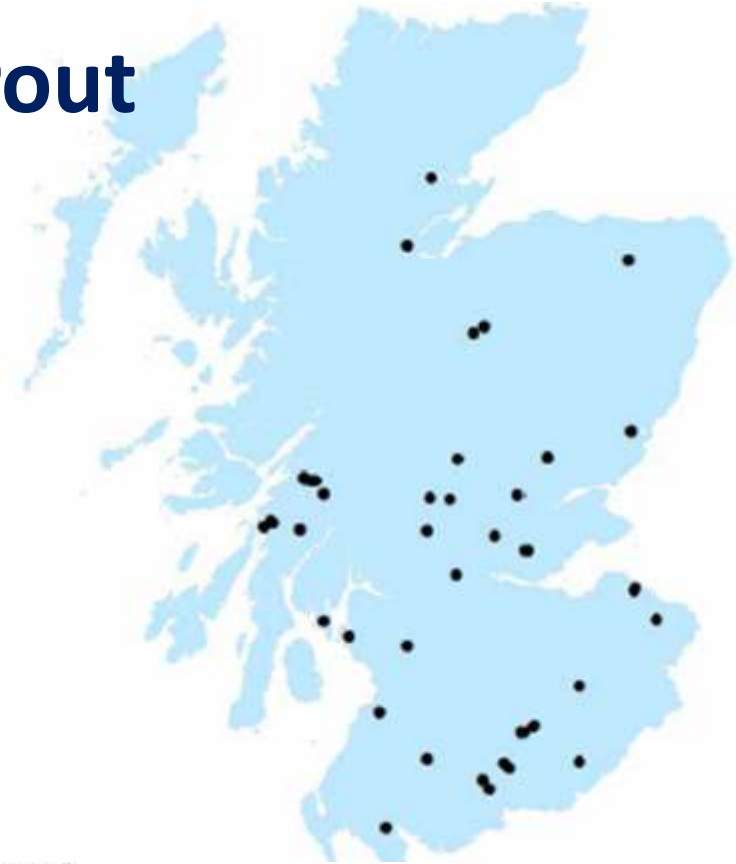


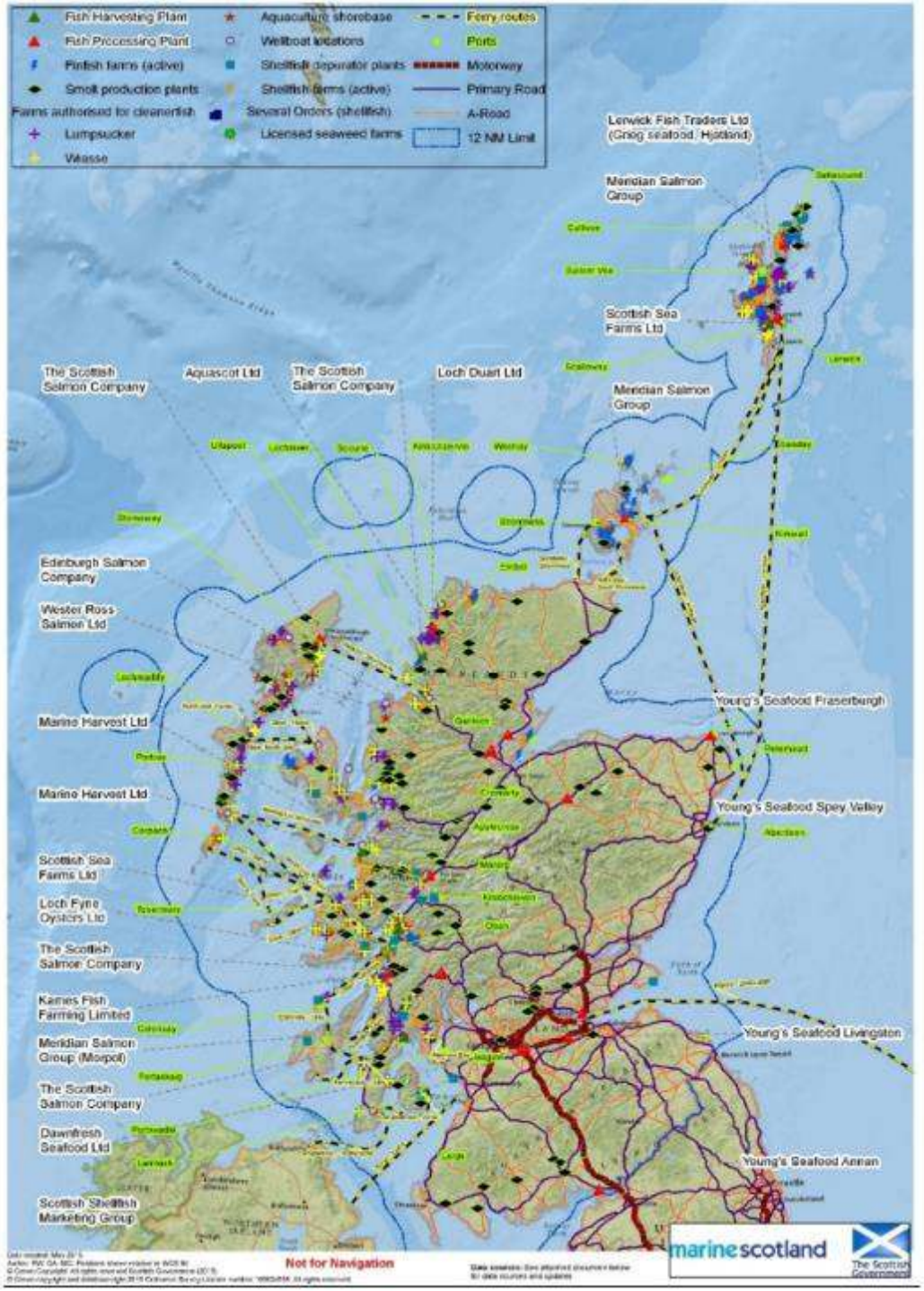
TABLE 16: RAINBOW TROUT PRODUCION AND EMPOYMENT BY REGION 2015 [40]

	Production		Employment		Production per FTE
	Tonnes	**%**	**FTEs**	**%**	
North	2	0.02%	8	7%	n/a
East	962	12%	41	34%	23
West	6,115	76%	48	40%	127
South	954	12%	22	18%	43
Total	**8,033**	**100%**	**119**	**100%**	**68**

Map of aquaculture related infrastructure in Scotland. (as produced by Marine Scotland in 2015)

2030 projections:

- 300-400kT/annum for finfish production, with a medium production figure of 350kT/annum of salmon
- 21KT shellfish/annum

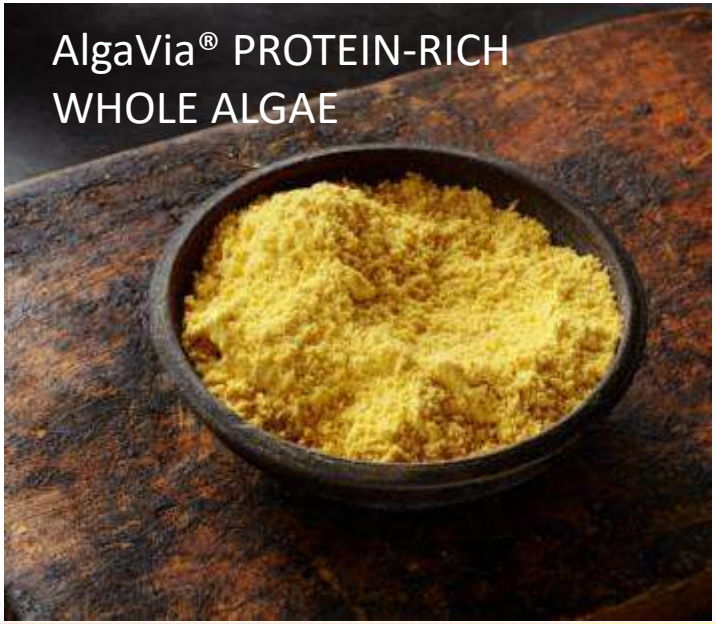


The James Hutton Institute

Protein - Algae

Seaweed and microalgae are rich sources of protein and contain all of the essential amino acids at various concentrations

Some species of red seaweeds (Rhodophyta), such as P. palmata and P. tenera, have been reported to contain as much as 33% and 47% dry weight.
Spirulina ca be up to 63% dw in Spirulina sp. [115].

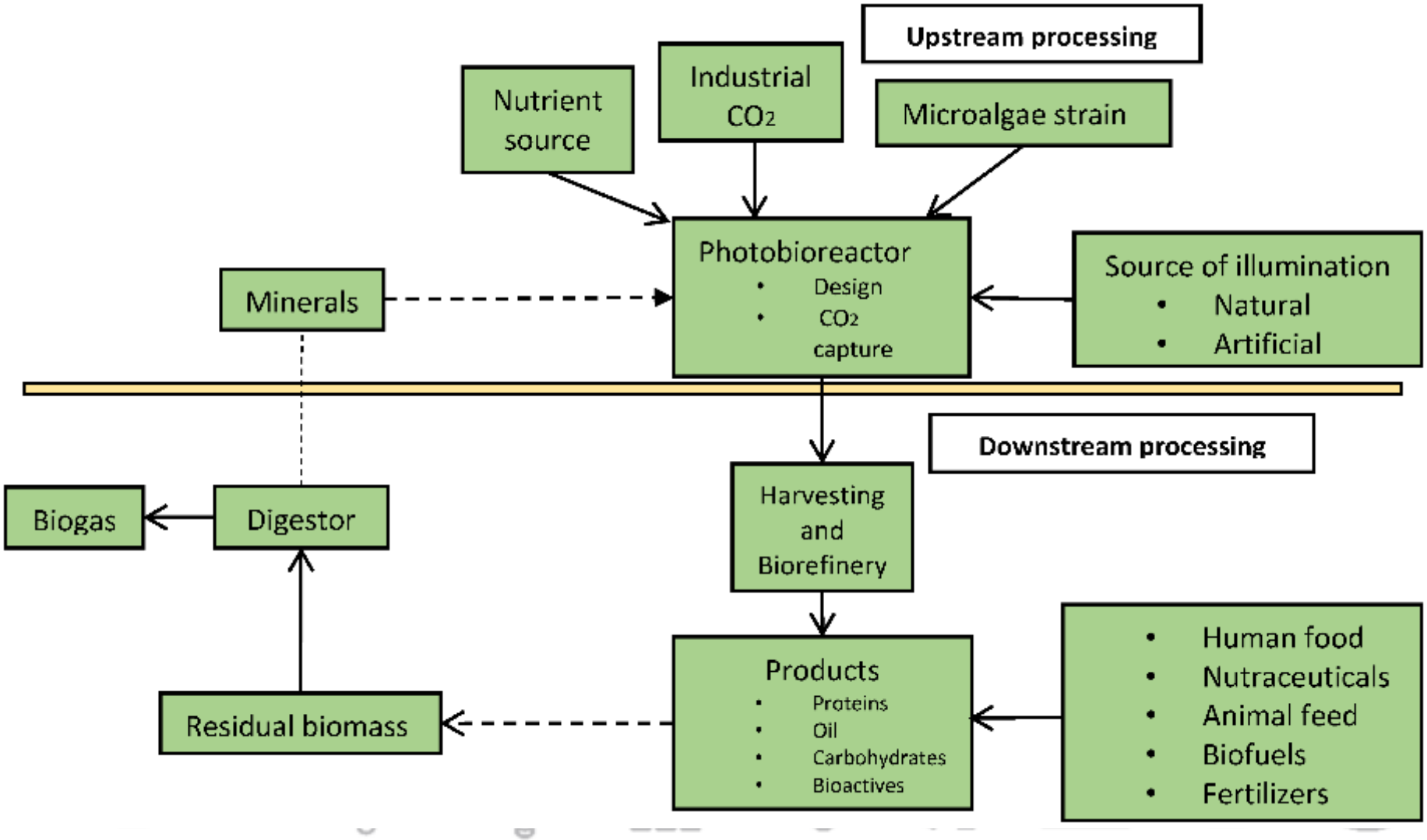


Protein - Algae

The James Hutton Institute

	Scenedesmus			*Chlorella*			*Nannochloropsis*		
Metric[a] (%DW)	Early	Mid	Late	Early	Mid	Late	Early	Mid	Late
Ash	5.6	2.3	2.1	4.7	2.1	2.6	14.2	13.6	5.1
Ferm carbs[b]	20.9	46.3	37.9	5.8	36.7	23.6	4.6	8.0	7.6
Mannitol	ND	ND	ND	ND	ND	ND	4.0	2.1	2.2
Other carbohydrates	3.4	1.6	1.3	5.9	5.0	3.5	2.9	1.5	2.1
Glycerol[c]	0.7	2.9	4.5	1.4	2.5	4.5	1.4	2.8	6.4
Protein	34.5	12.8	8.9	40.2	13.2	12.7	32.7	23.1	9.4
Lipids total (as FAME)	6.6	26.5	40.9	13.0	22.1	40.5	12.3	25.6	57.3
Lipids (<2 unsat FAME)	3.1	17.1	33.4	7.0	15.5	35.0	6.2	16.1	43.0
PUFA (>2 unsat FAME)	3.5	9.4	7.5	6.0	6.6	5.5	6.2	9.5	14.3
Sterols	0.9	0.7	0.4	0.2	0.4	0.3	0.4	0.6	0.2
Chlorophyll (33% of MW as phytol)	3.0	1.2	1.2	5.8	2.4	2.1	3.0	1.8	0.3
Non-FAME lipids[d]	4.1	2.8	1.3	3.8	1.7	1.5	3.8	3.3	1.2
Nucleic acids	4.1	1.5	1.0	4.6	1.1	0.9	4.6	1.1	0.9
Mass closure[e]	83.8	98.6	99.5	85.4	87.2	92.2	83.9	83.5	92.7
Biomass energy content, HHV,[f] in $\times 10^3$ BTU per lb (and MJ kg^{-1})	9.2 (21.3)	10.1 (23.4)	11.1 (25.9)	9.2 (21.5)	9.4 (21.8)	10.8 (25.2)	9.2 (21.4)	10.1 (23.5)	13.2 (30.6)

Protein - Algae



Protein - Fungi

- The global Mushroom market accounted for US$ 38.13 Bn in 2017, expanding at a CAGR of 7.9% from 2018 to 2026.
- UK 125kT in 2013 to 148kT in 2017: 18% increase

Table 1. Basic Composition of Cultivated Mushrooms (on Fresh Weight Basis)

mushroom	protein g/100 g	total carbohydrates g/100 g[a]	dietary fiber g/100 g	energy kcal/100 g[a]	crude fat g/100 g	ash g/100 g	dry matter %
Agaricus bisporus/white	2.09	4.5	1.5	27	0.33	0.78	7.7
Agaricus bisporus/brown	2.07	4.6	1.6	27	0.31	0.78	7.8
Pleurotus ostreatus	1.97	5.0	2.4	28	0.35	0.64	8.0
Lentinula edodes	1.8	5.8	3.3	30	0.31	0.49	8.4

[a] Calculated values.

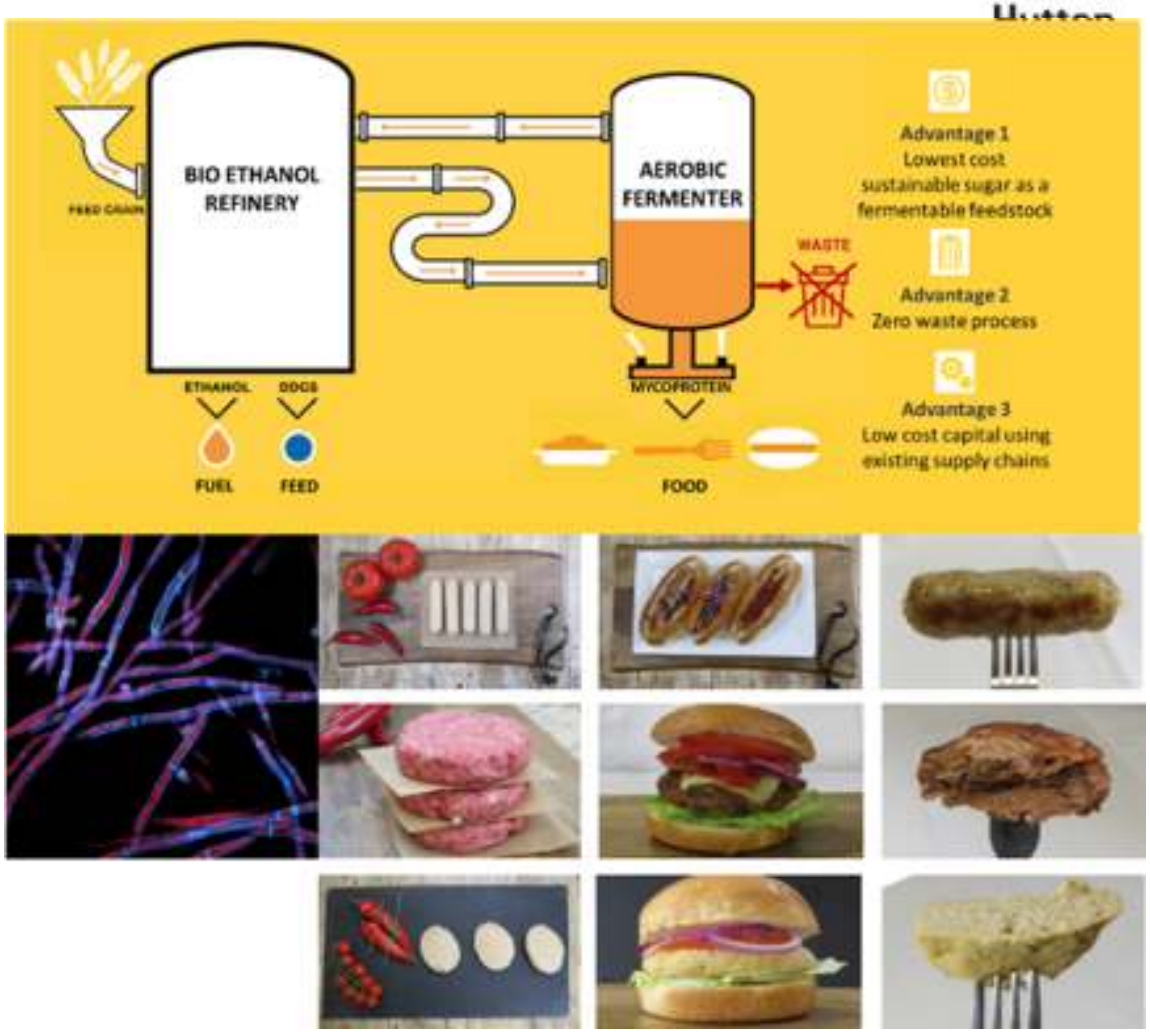
Protein - Fungi

The James Hutton Institute

Protein – Fungi. 3 F Bio

3F BIO are a bio tech company based in Scotland

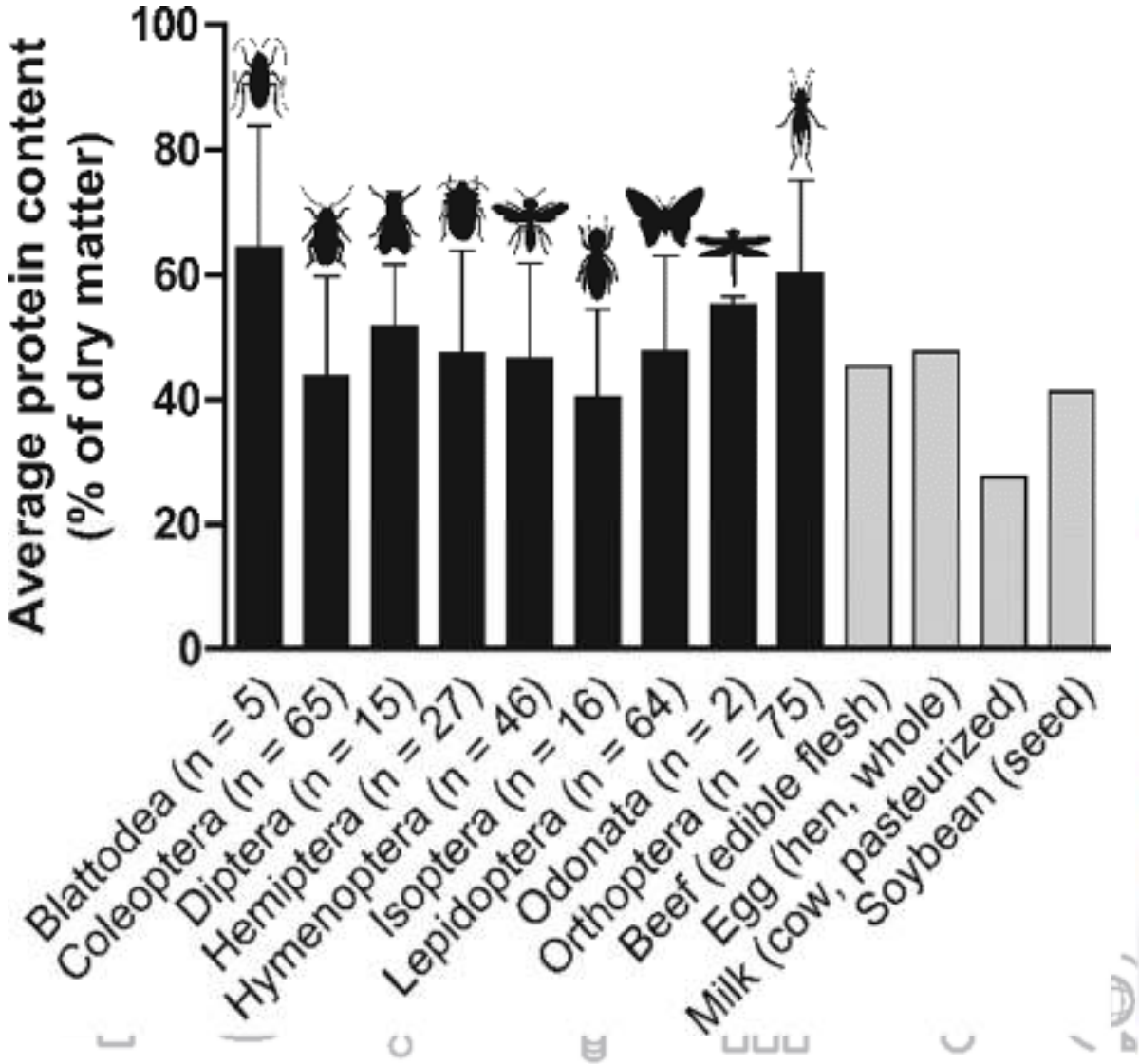
A vison to tackle the combined issues of feeding a growing global population and the unsustainable impact of traditional protein farming



ABUNDA® mycoprotein is:

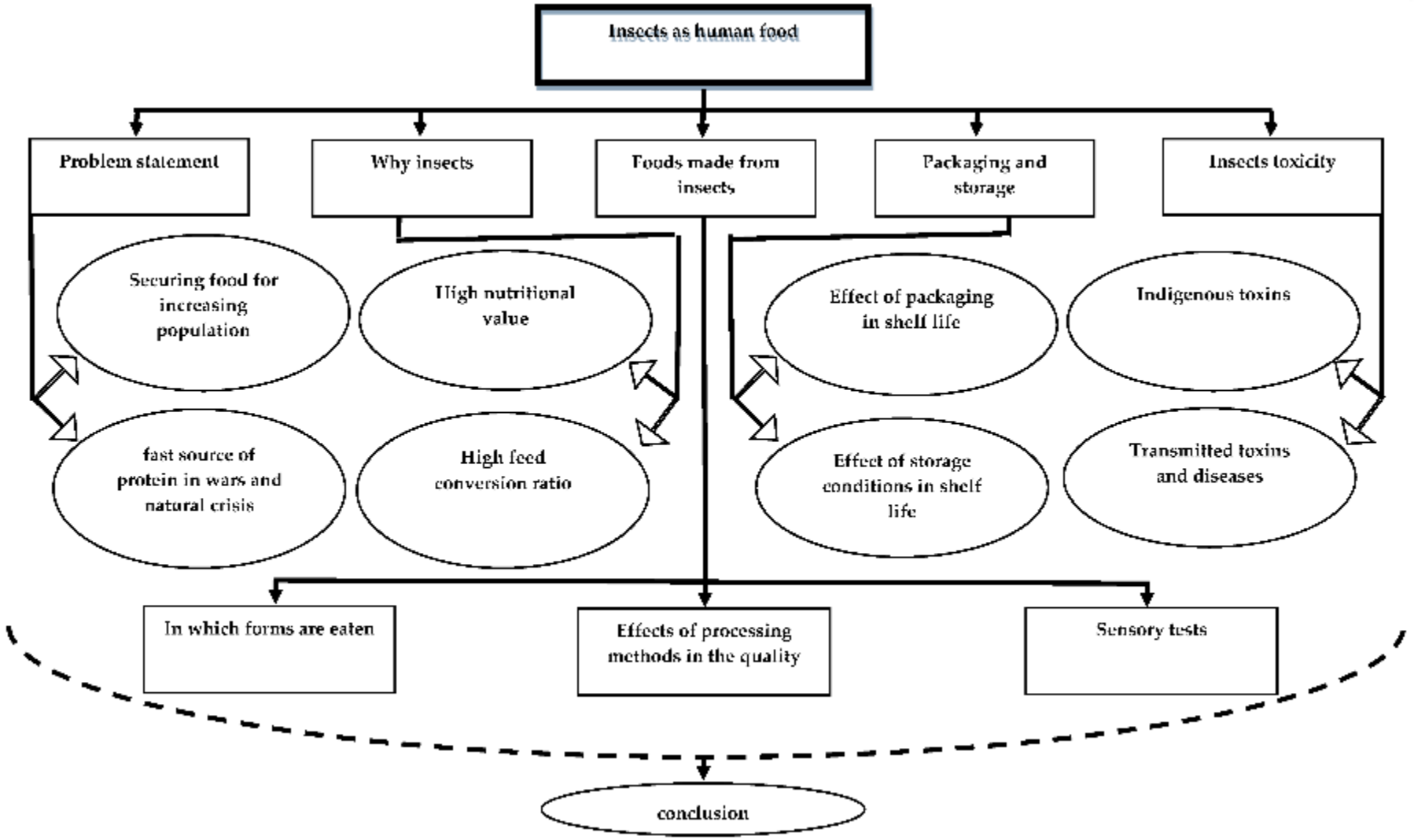
- *Delicious & Versatile*
  - clean in taste with a meat-like texture
- *Sustainable & Scalable*
  - the "most sustainable" source of protein, scalable to meet increasing demand
- *Highly Nutritious & Functional*
  - 12% protein, 6.2% fibre, 0% saturated fat, all essential amino acid

Protein - Insect

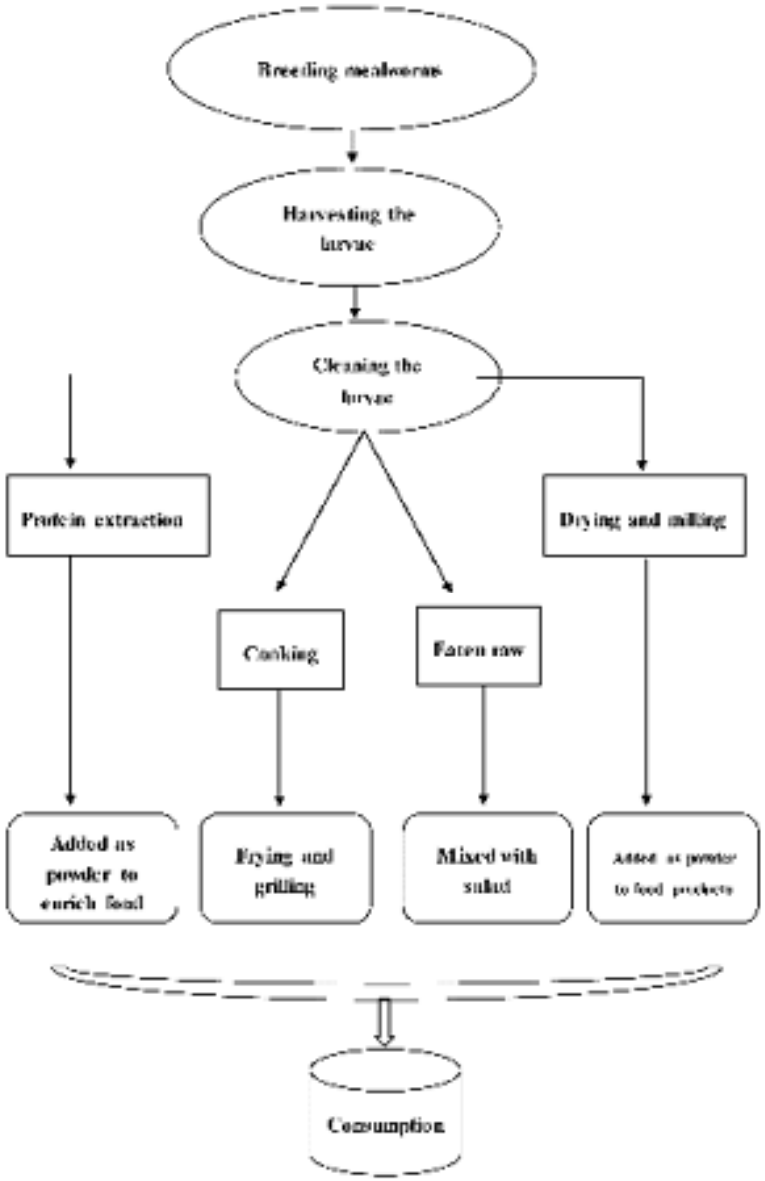


Protein content (mean ± SD) expressed as a percentage of dry matter of various edible insects.

Protein - Insect

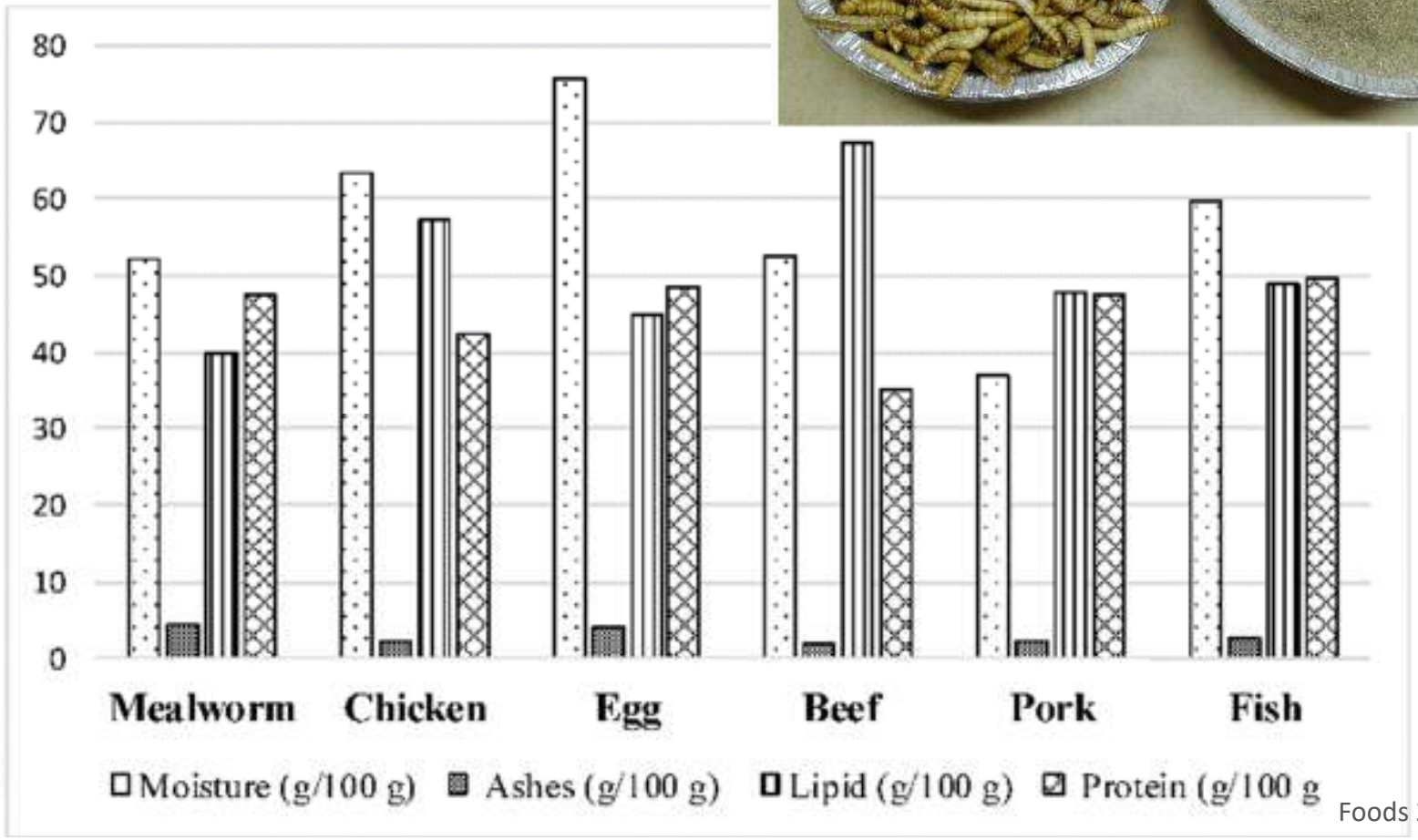


Protein - Insect



Insect order	Images	Protein content (%)
Coleoptera Beetles, weevils		23–66
Lepidoptera Butterflies, moth		14–68
Hemiptera True bugs		42–74
Hymenoptera Bees, wasps, ants		13–77
Odonata Dragonflies Damselflies		46–65
Orthoptera Grasshoppers Locust, crickets		23–65

Protein - Insect

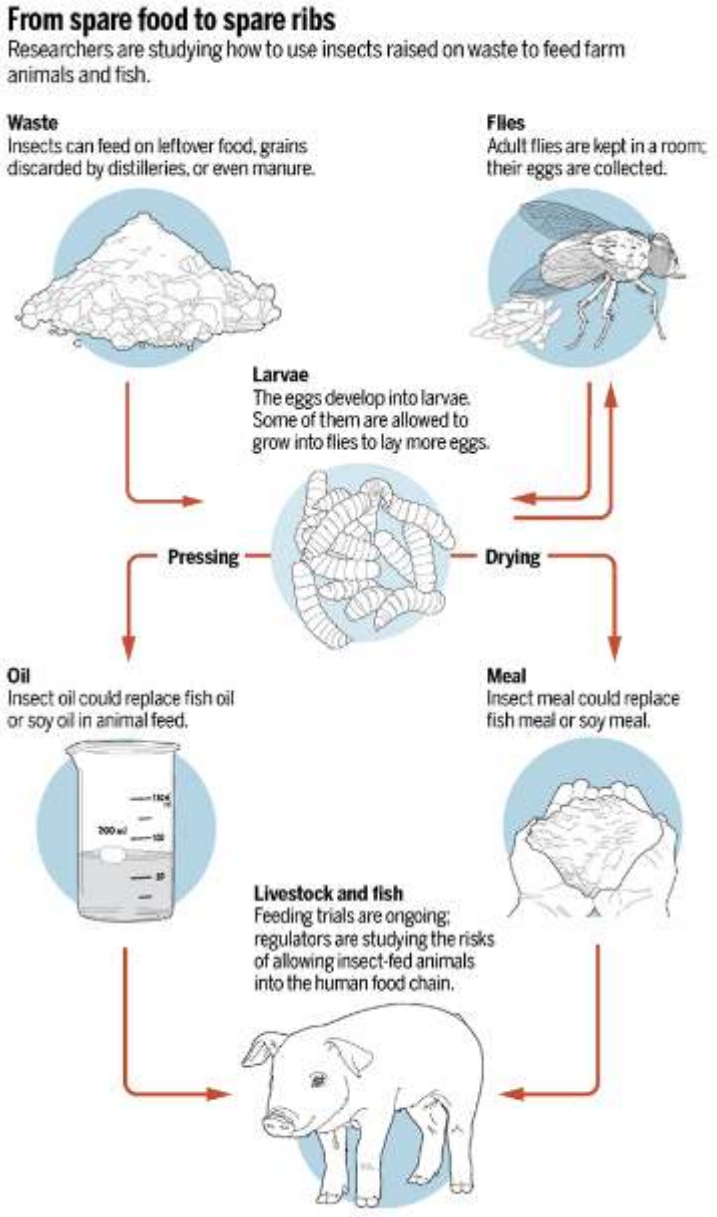


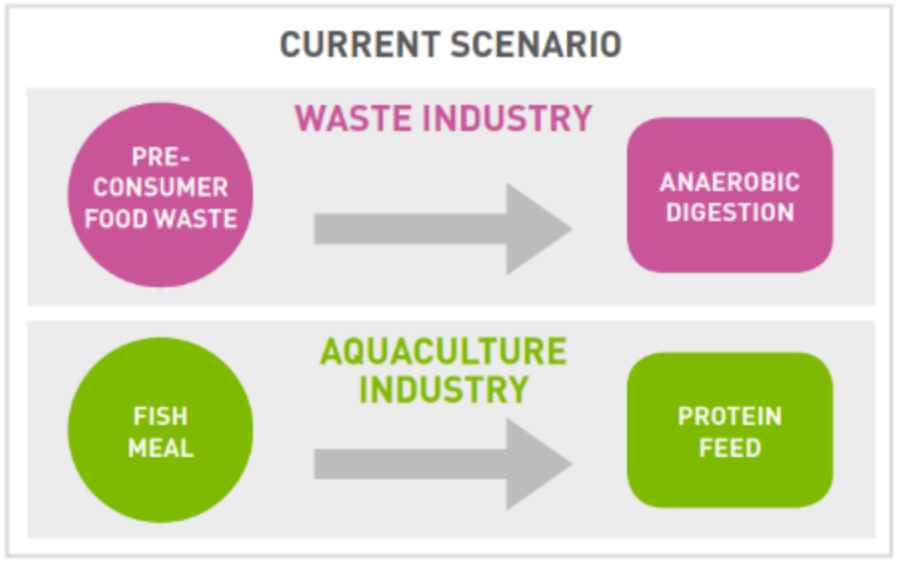
Foods 2019, 8(3), 95

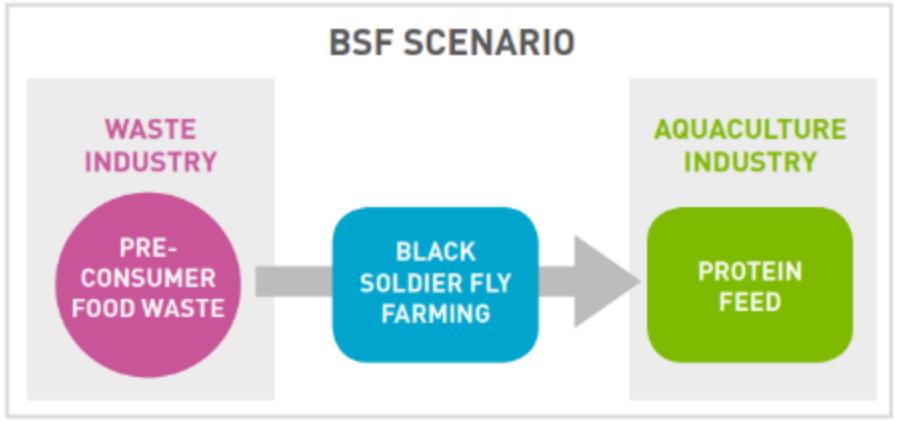
Feedstocks	Insect production	Target species
✓ Plant-based substrates ✓ Unprocessed former foodstuff: dairy and eggs ✗ Unprocessed former foodstuff: meat and fish ③ ✗ Catering waste and slaughterhouse products ③ ✗ Animal manure		Protein / Fat / Live ✓ ✓ ✓ ✓① ✓ ✓ ✗② ✓ ✓ ✗② ✓ ✓

Step	Target	Timeframe
1	Authorise insect proteins for aqua feed use	Target achieved Authorisation effective since 1 July 2017
2	Authorise insect proteins for use in pig and poultry feed	EU discussions may begin end-2018. Approval by Member States possible during the 1st quarter of 2019
3	Authorise 'former foodstuff' and/or catering waste as feed for insects	2020 onwards

Black Soldier Fly Protein



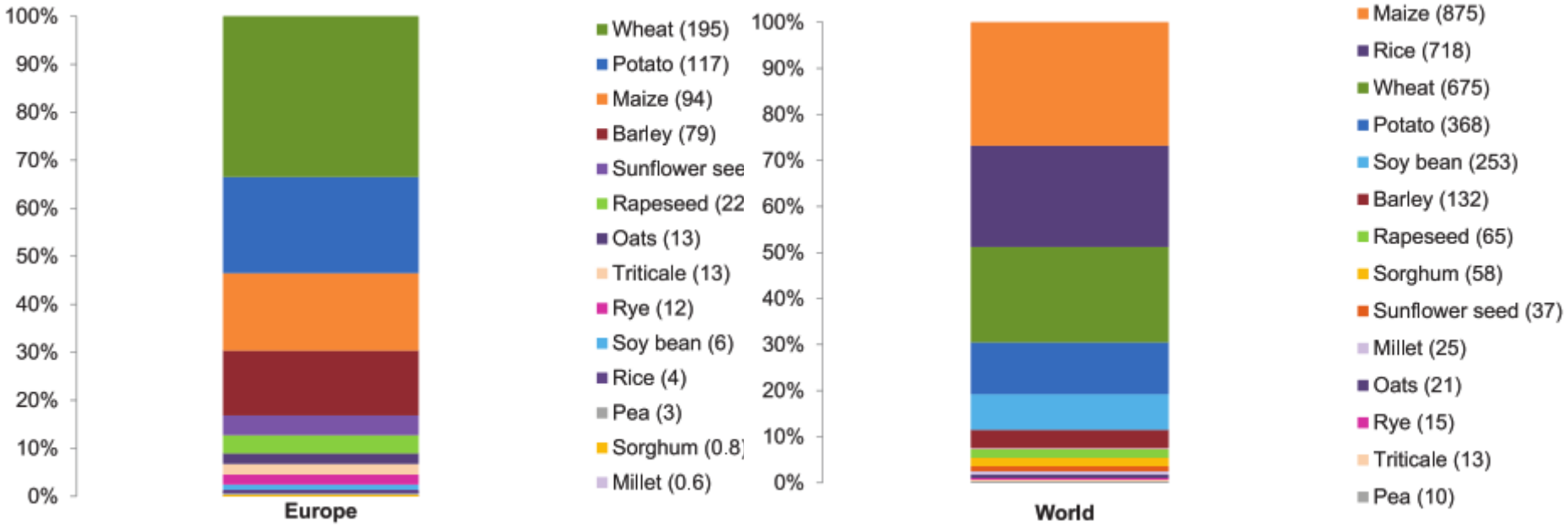




https://www.zerowastescotland.org.uk/content/report-black-soldier-fly-circular-economy-solution-scotland

Protein - Plants

Production (million tons) of protein containing crops



Protein - Plants

GRAIN – for feed and food

Peas (*Pisum*)

Beans (*Vicia's*)

FORAGE - feed, green- & living-manures, cover crops

Clovers

Vicia

Protein – Plants

Conventional cropped systems:barley in Scotland as a case study

- **~55% of the Scottish arable area is cultivated with mainly spring barley**
  - *This is a 'crop sequence' not a crop rotation in the intended holistic sense*
- ~½ is malted for use in the brewing & distilling
  - Beer and whisky production contribute **£10 billion** UK annual tax revenue
- ~½ is used for animal feed or meat production
  - Scottish meat export value ~£80 million
  - ~½ is used for animal feed or meat production

- ***Can INTERCROPPING with legumes 'green' barley production?***

Protein - Plants

SEFARI

Barley-pea intercropping

Average grain yield of barley and pea

Treatment (seeding rate % of conventional)	Grain Yield (kg ha^{-1})			LER
	Barley	Pea	Total	
Barley, monocrop (100%)	4595		4595	
Pea, monocrop, (100%)		1917	1917	
Barley-Pea Intercrop (50%)	4590	**299**	4890	**1.2**

- **LER = Land Equivalency Ratio (intercrop yield / monocrop yield)**
- **5-15% more N in barley and pea (what of other nutrients?)**
- Average data are of variety combinations (5 varieties of each species)
- N content of peas and barley increased (10-25%) depending on variety

Protein - Plants

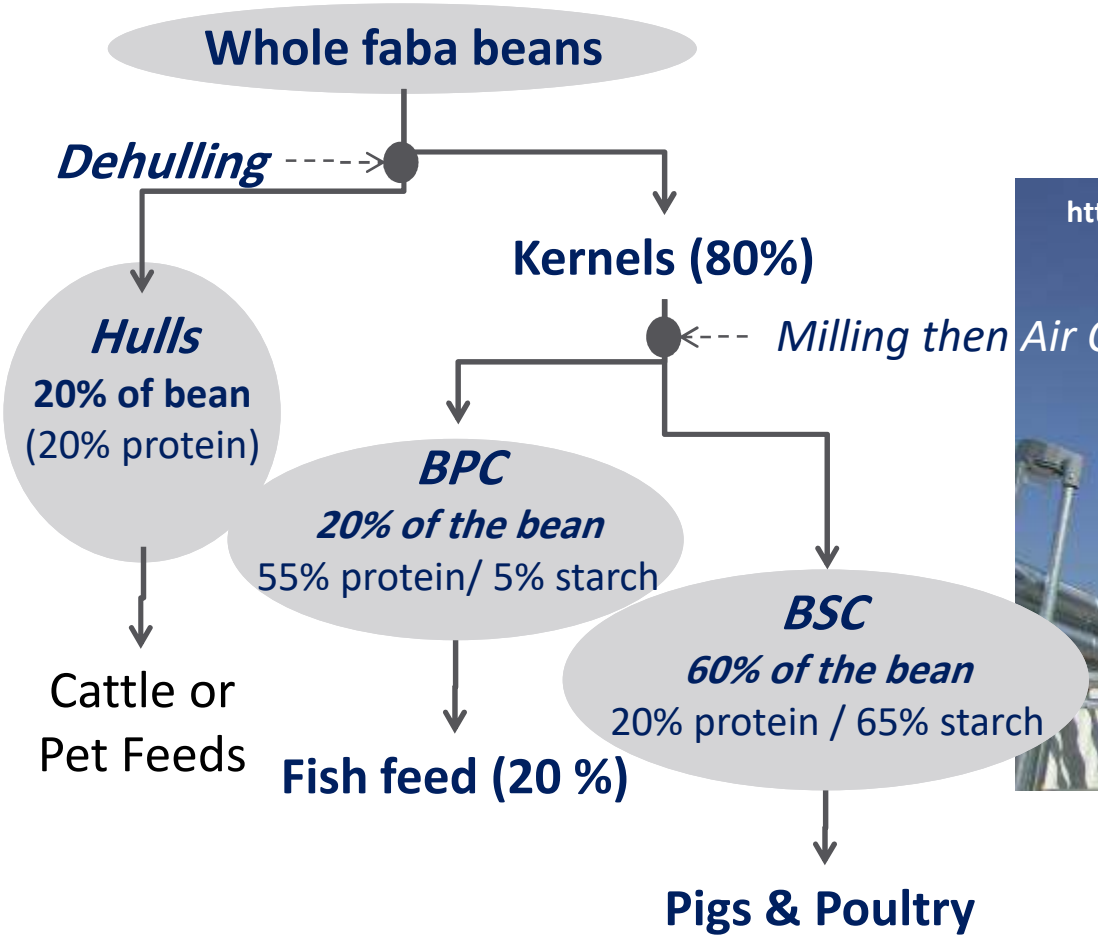
Scottish Salmon

- Scotland's second largest export
- £600m at farm gate
- Feed Conversion 1.25
- Salmon feed high in grain legume protein
- **To serve just Scottish aquaculture beans need grown 1/12 (~8% of rotation)**
- Faba bean concentrates (50%+) required

www.beans4feeds.net

Faba bean processing *(value of parts > whole)*

- *'Air classification' of milled faba beans kernel*
- *Provides enriched products – not complete separation*
- ***B**ean **P**rotein- and **S**tarch-**C**oncentrates (**BPC** and **BSC**, respectively)*



vertical cyclonic air stream
larger/heavier starch granules fall
lighter protein bodies rise

Faba bean processing *(value of parts > whole)*

- *'Air classification' of milled faba beans kernel*
- *Provides enriched products – not complete separation*
- ***B**ean **P**rotein- and **S**tarch-**C**oncentrates (**BPC** and **BSC**, respectively)*

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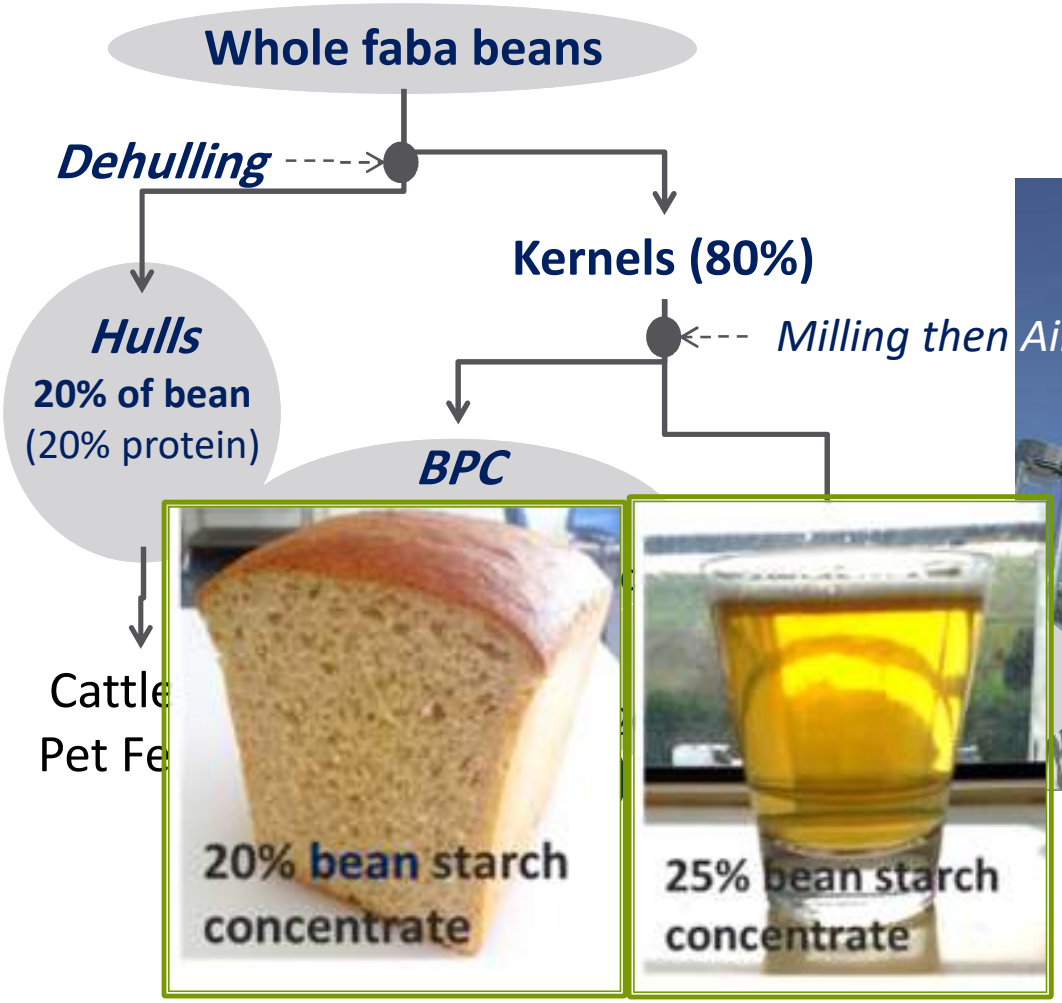


vertical cyclonic air stream
larger/heavier starch granules fall
lighter protein bodies rise

Breeding beans for key traits

- germplasm collection

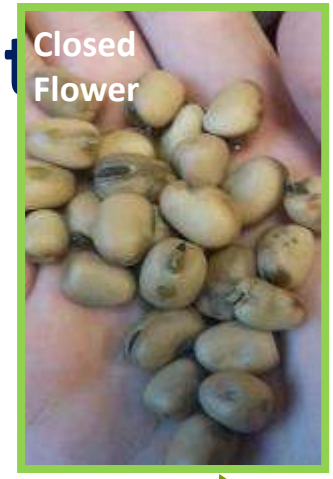
- Germplasm collection (400 types) screened
- 239 grown over 5 y
- Seven lines with consistently high N content were identified
- Early and short type (for intercropping?)

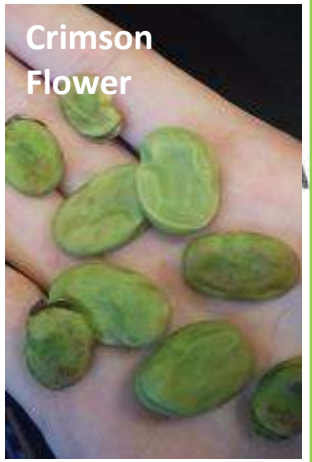
Protein-N (%)	2012	2013
Early_Longpod	30.39	32.68
ILB_287	30.41	35.10
ILB_369	30.57	32.86
Closed_Flower	31.84	35.80
Martock_Bean	31.94	35.30
Dacre	32.90	36.80
Crimson_Flower	33.01	35.74


ILB287


Martock
Bean


ILB369

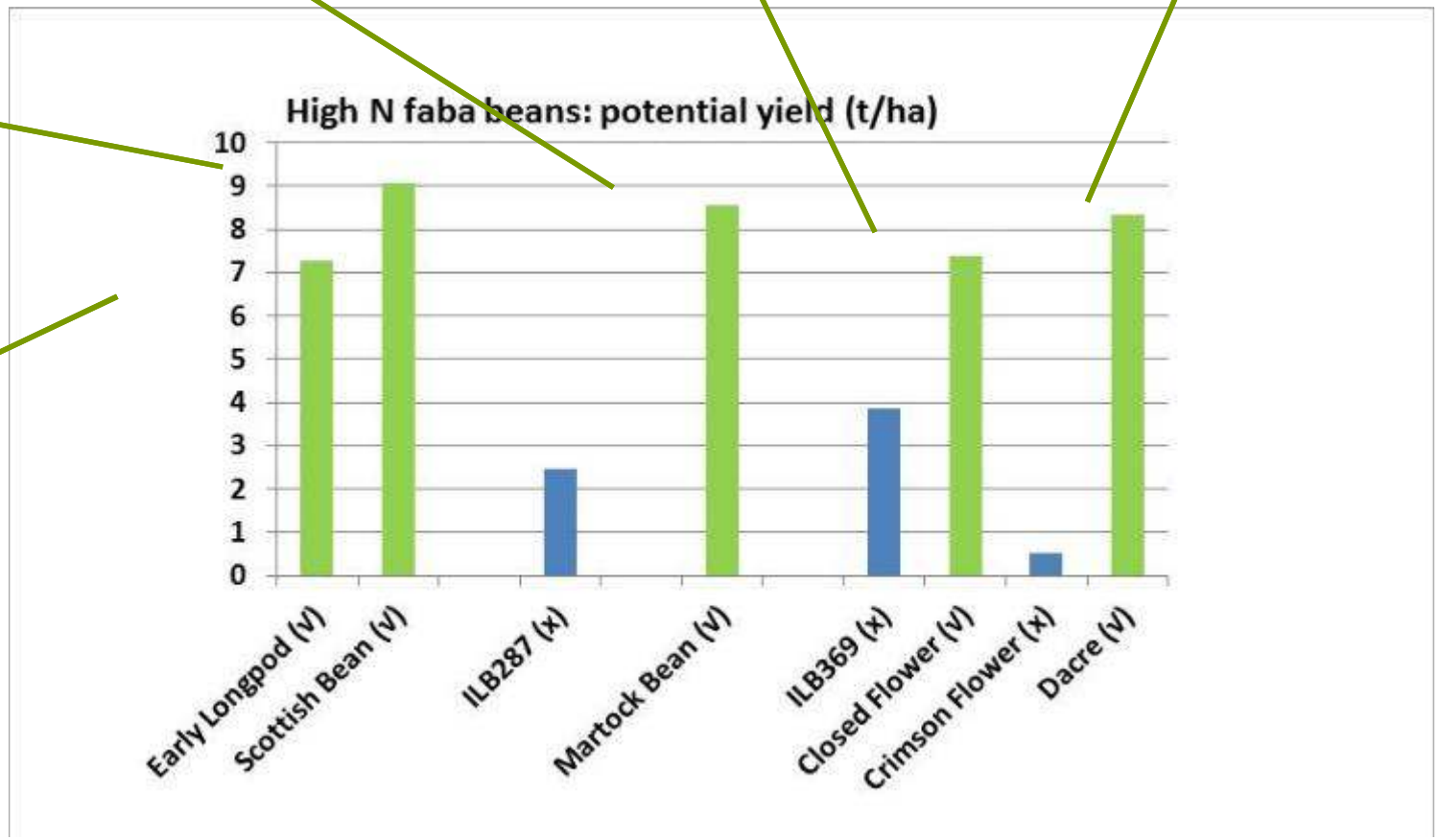

Closed
Flower


Crimson
Flower


Dacre

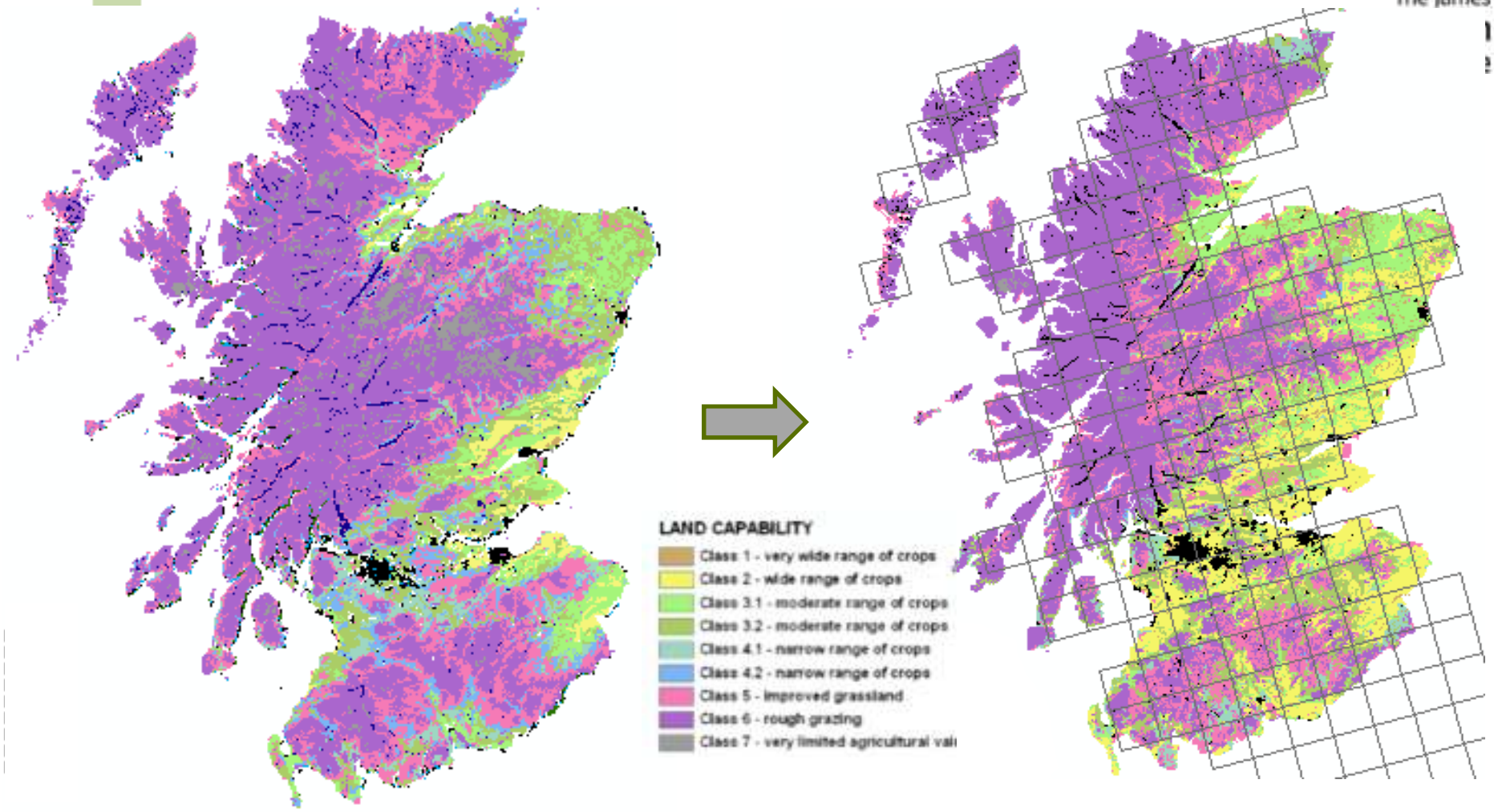

Scottish
Bean


Early longpod


High N faba beans: potential yield (t/ha)
10
9
8
7
6
5
4
3
2
1
0
Early Longpod (√)
Scottish Bean (√)
ILB287 (x)
Martock Bean (√)
ILB369 (x)
Closed Flower (√)
Crimson Flower (x)
Dacre (√)

Non-traditional crops:
soybean in Scotland?

Future Changes in Land Capability for Agriculture

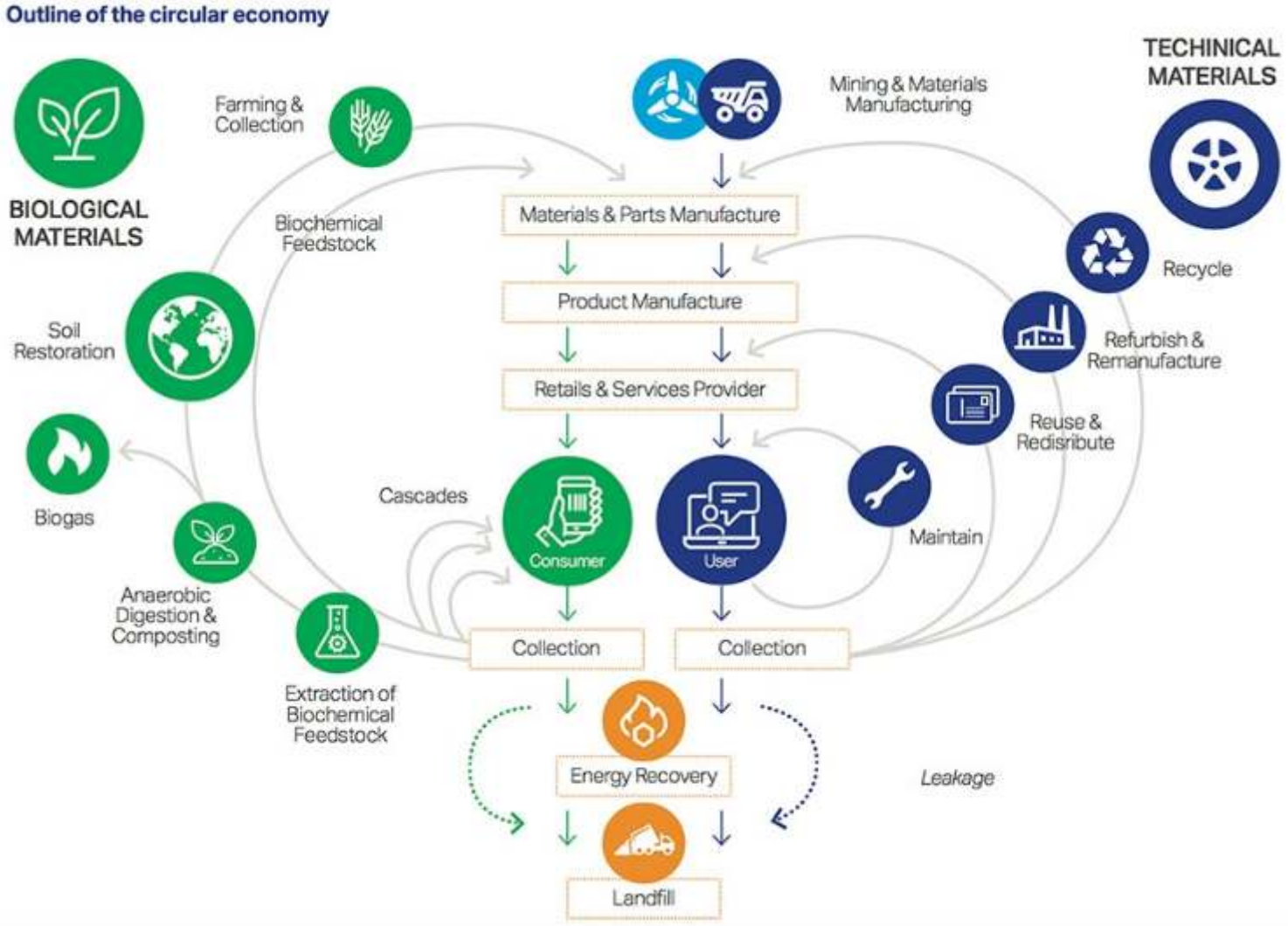


Current

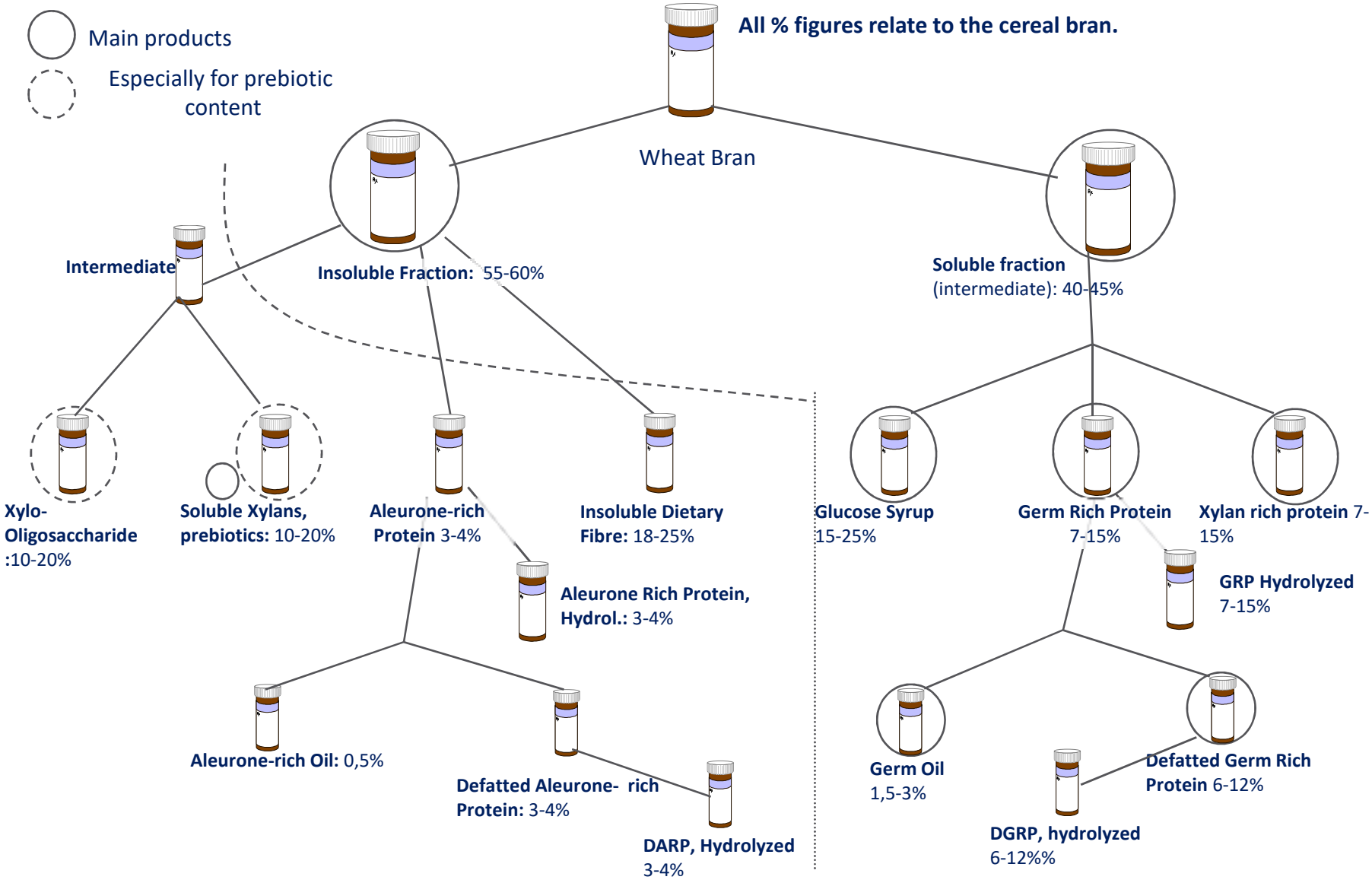
2050s projection [UKCP09 q3]

Source: Brown et al. (2008, 2011)

Evolving Scottish Science Circular Economy



What about Scottish Co-products? Wheat, barley etc

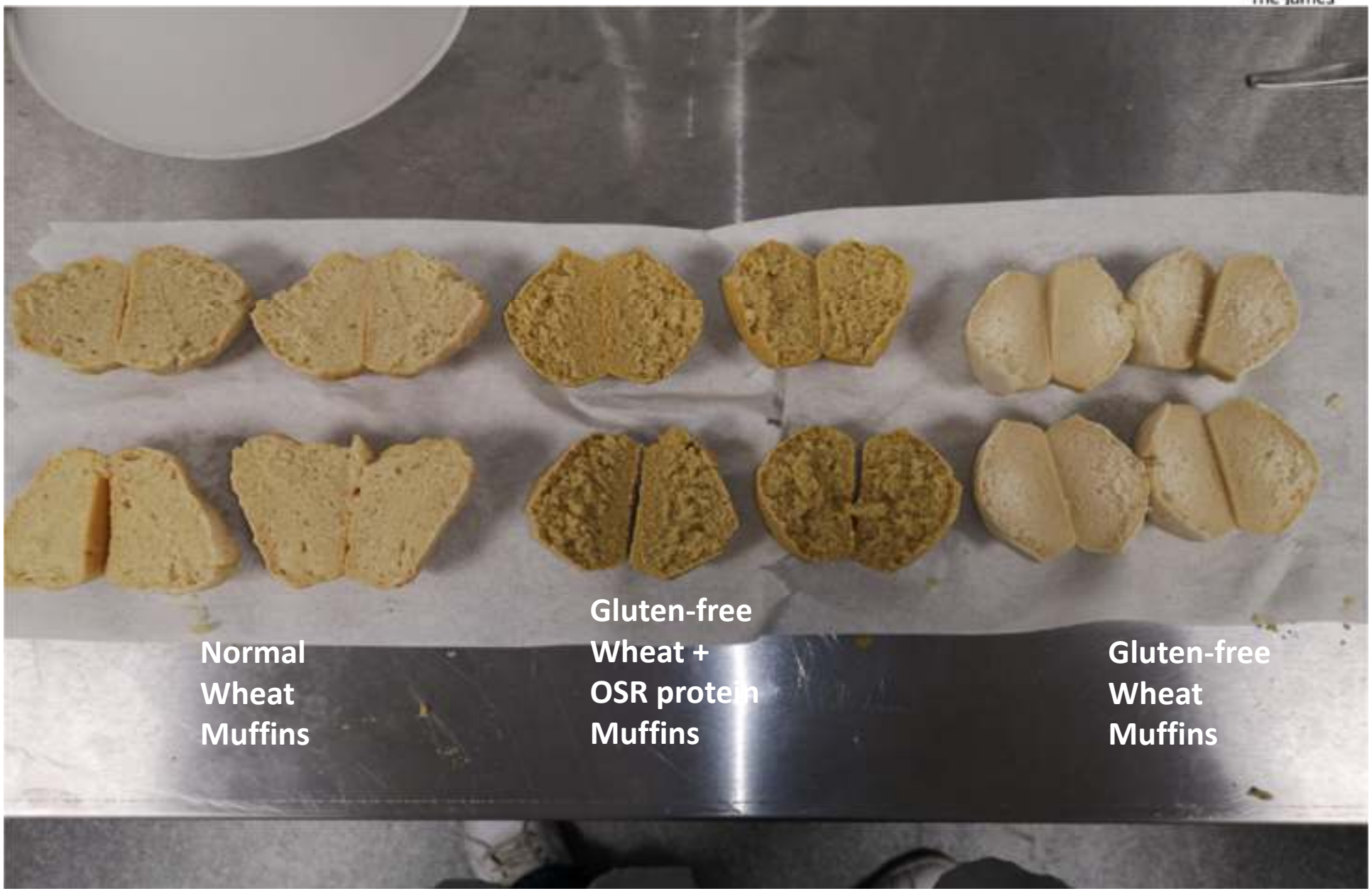


Wheat (Cereal) Milling

Wheat Bran Processing: Staring with 100kTonnes	
Flour	80000
Bran	20000
Extracted products from the bran	
Dietary fibre	5300
High protein powder	**2150**
Low protein powder	**1550**
Glucose syrup	4700
Aleurone powder	**500**
Soluble Dietary Fibre	2250
Probiotics	3250

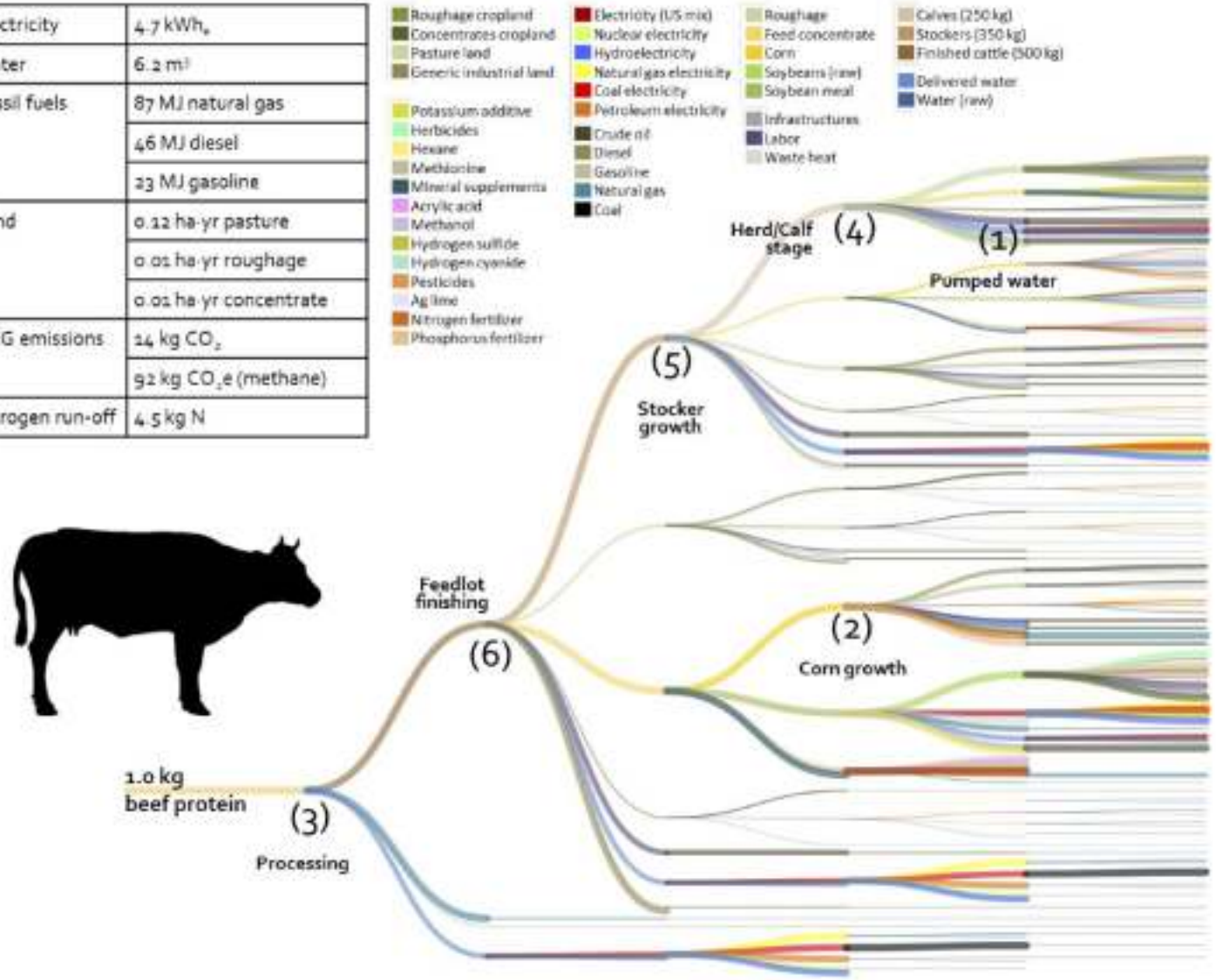
Protein – Co-products, OSR

Protein – Co-products, OSR



Protein - Not just an ingredient but a business

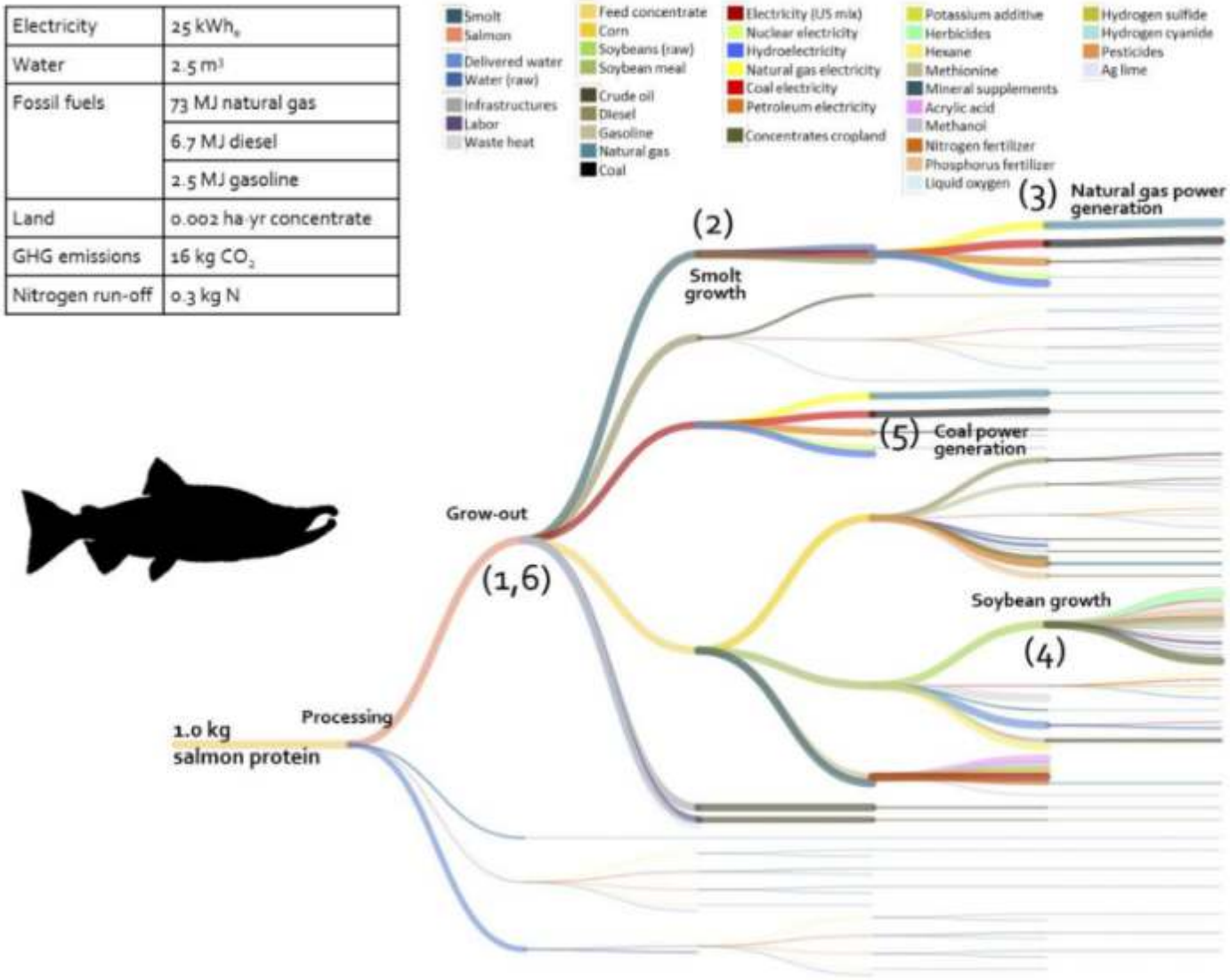
Electricity	4.7 kWh$_e$
Water	6.2 m^3
Fossil fuels	87 MJ natural gas
	46 MJ diesel
	23 MJ gasoline
Land	0.12 ha·yr pasture
	0.01 ha·yr roughage
	0.01 ha·yr concentrate
GHG emissions	14 kg CO_2
	92 kg CO_2e (methane)
Nitrogen run-off	4.5 kg N



De-risking Protein Strategies Using a Systems Approach: A Novel Analytical Framework. Lux Research.

Protein - Not just an ingredient but a business

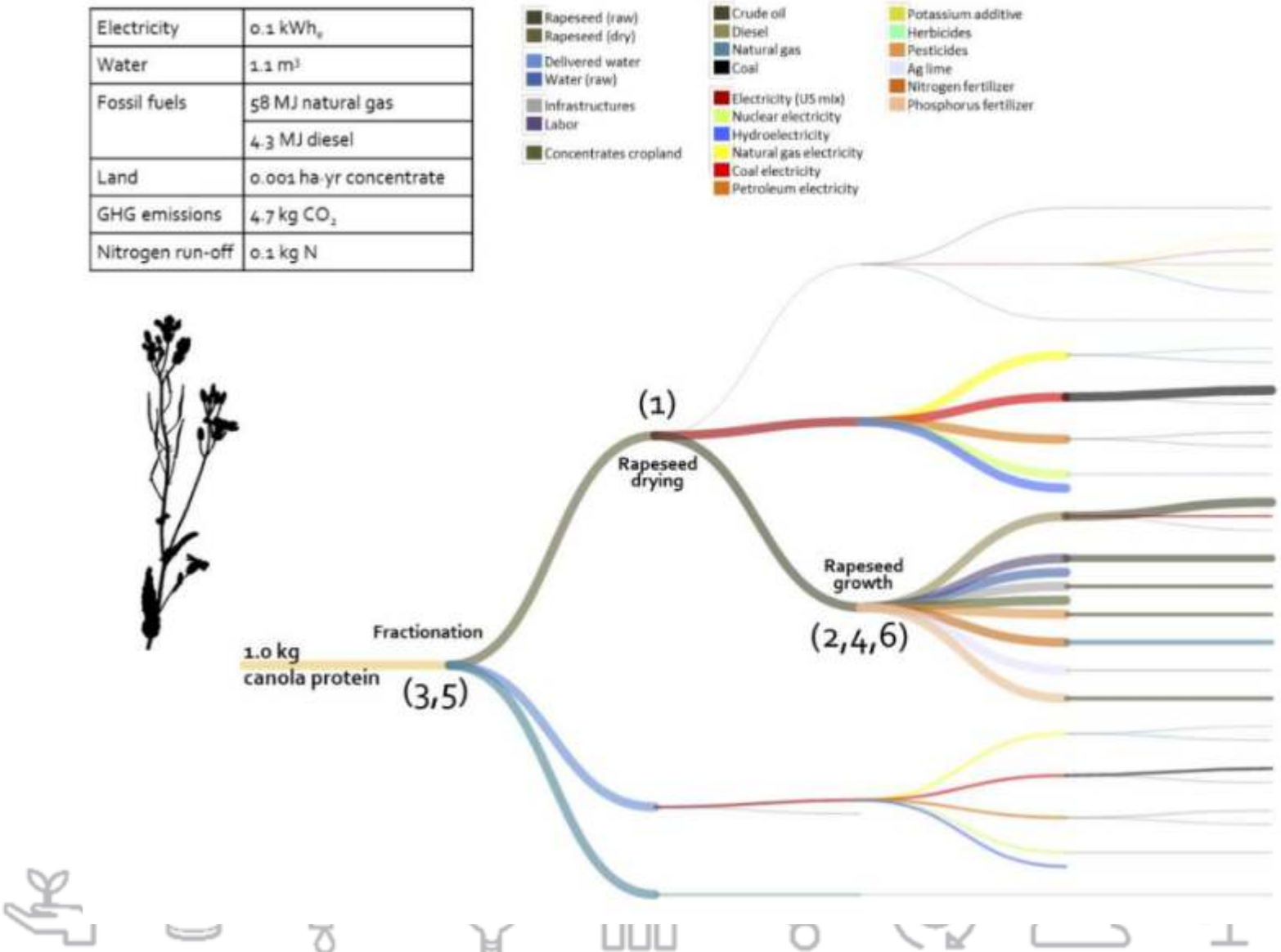
Electricity	25 kWh_e
Water	2.5 m^3
Fossil fuels	73 MJ natural gas
	6.7 MJ diesel
	2.5 MJ gasoline
Land	0.002 ha·yr concentrate
GHG emissions	16 kg CO_2
Nitrogen run-off	0.3 kg N



De-risking Protein Strategies Using a Systems Approach: A Novel Analytical Framework. Lux Research.

Protein - Not just an ingredient but a business

Electricity	0.1 kWh_e
Water	1.1 m^3
Fossil fuels	58 MJ natural gas
	4.3 MJ diesel
Land	0.001 ha·yr concentrate
GHG emissions	4.7 kg CO_2
Nitrogen run-off	0.1 kg N



Protein – Scotland's future opportunities

The James Hutton Institute

- The opportunities for non-meat protein are increasing
- Scotland's ability to generate this protein is there in various formats
- The step from primary to secondary production is the next wave for development:
- Crop/fish/fungi/algae/coproduct ➔ product
- Insects? Insect ➔ fish/chicken ➔ You!

Scotland's Dinner Plate 2050

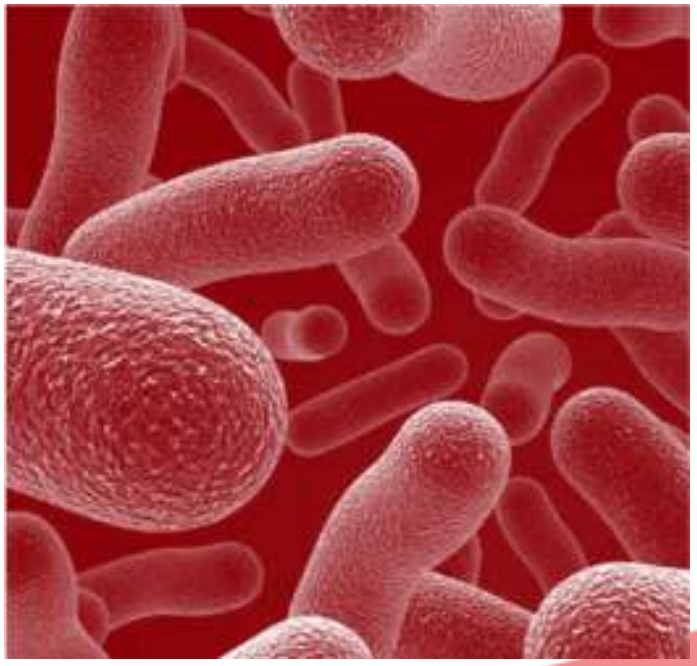
Scotland’s protein: Sustainable protein sources

Thanks for your attention

UNIVERSITY OF ABERDEEN
The Rowett Institute

SEFARI

The Healthy Gut

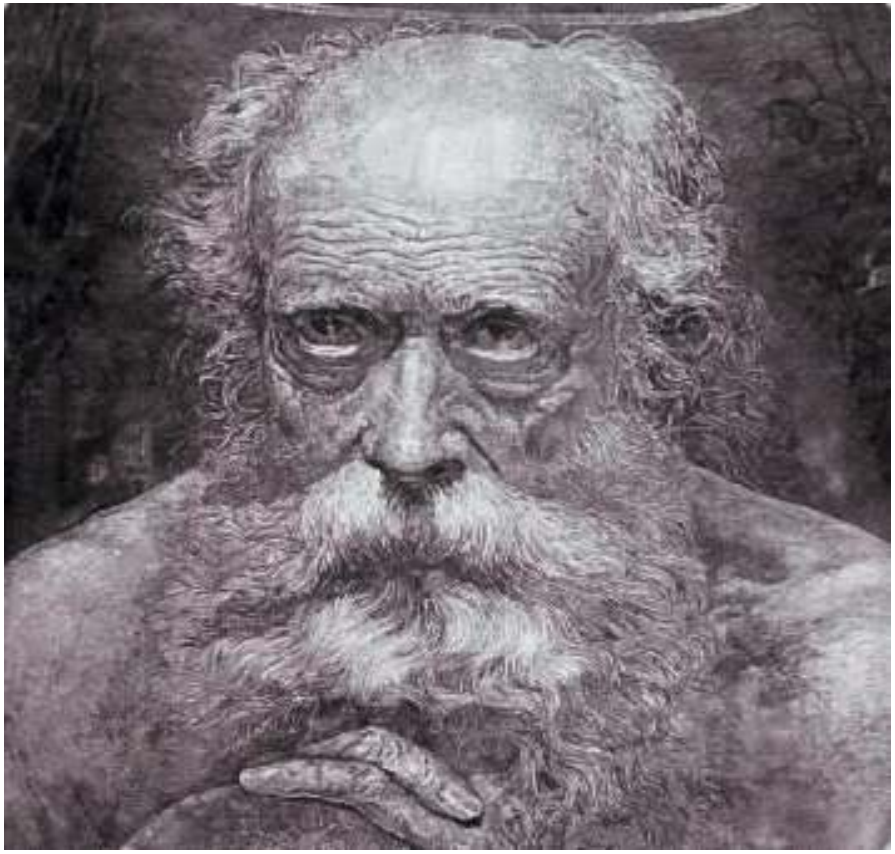


Professor Wendy Russell

@natprodchem

Scotland's Dinner Plate 2050
14 May 2019; Edinburgh

“death sits in the bowls” Hippocrates (400 B.C.)

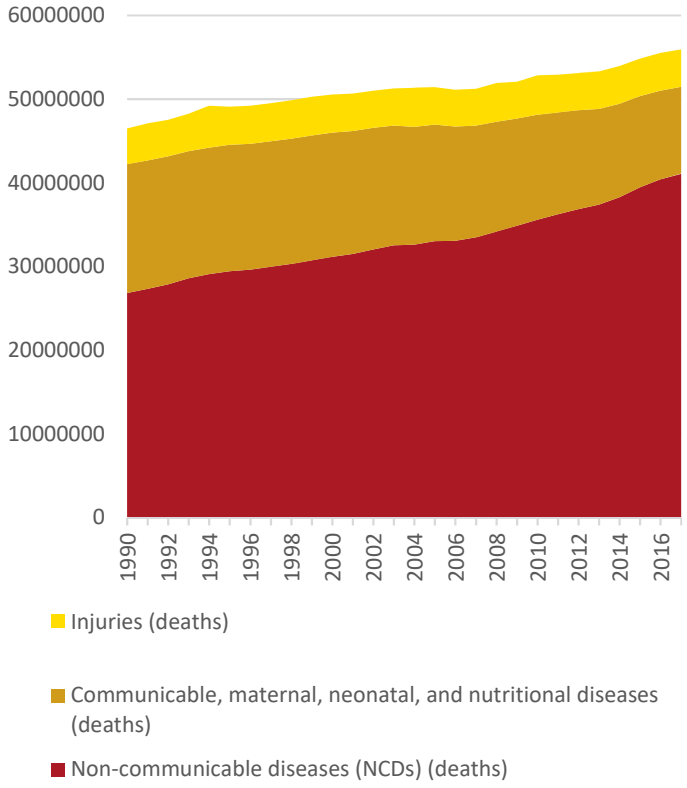


Number of Deaths by Region (x 1000)

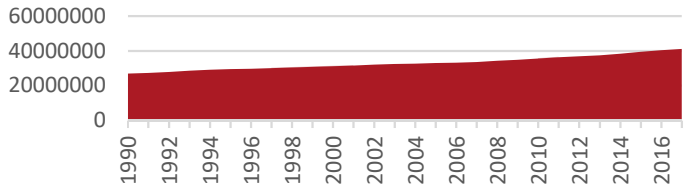
World Health Organization

	Africa	Western Pacific	Europe	Americas	Eastern Med.	South-East Asia	Total
Infection and Parasitic	5787	794	212	394	959	2968	11114
CVD	1136	3817	4857	1927	1080	3911	16728
Cancer	410	2315	1822	1115	272	1160	7094
Respiratory Infection	1071	511	273	228	365	1393	3841
Perinatal and Maternal	585	371	69	192	371	1183	2771
Injuries	747	1231	803	540	391	1267	4979

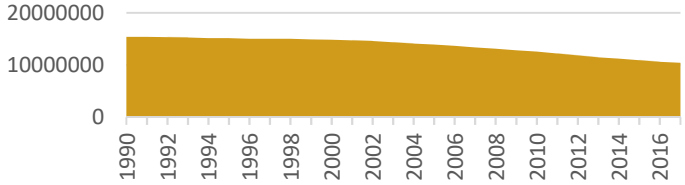
Deaths: All (World)



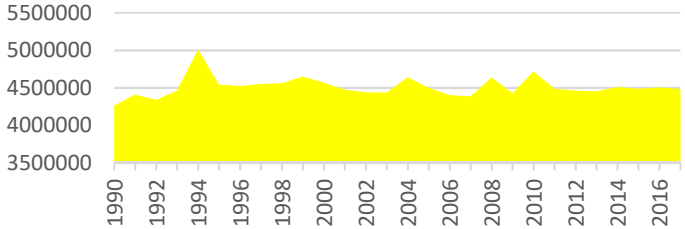
Non-communicable diseases (NCDs) (deaths)



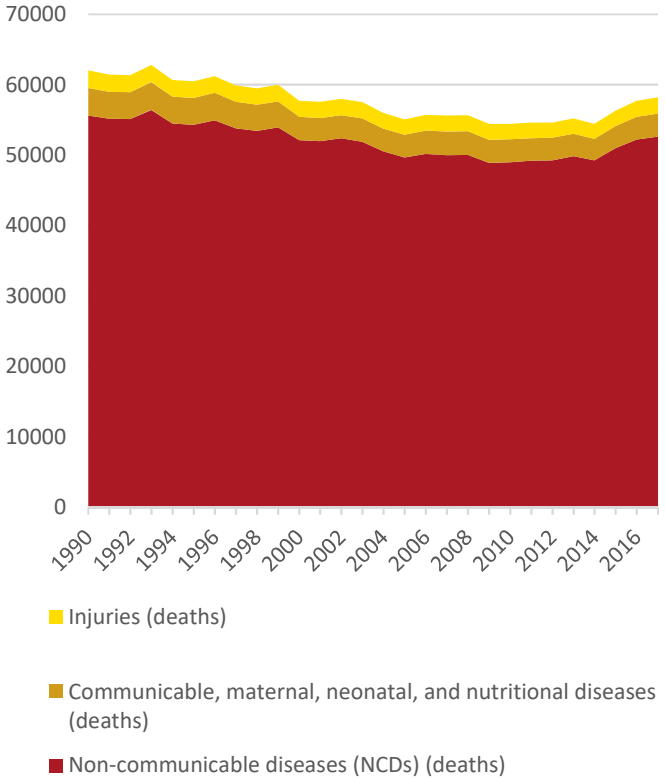
Communicable, maternal, neonatal, and nutritional diseases (deaths)

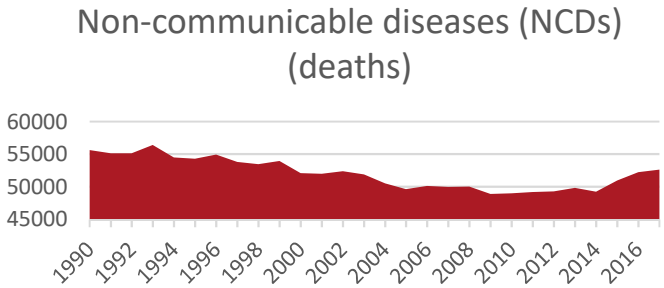


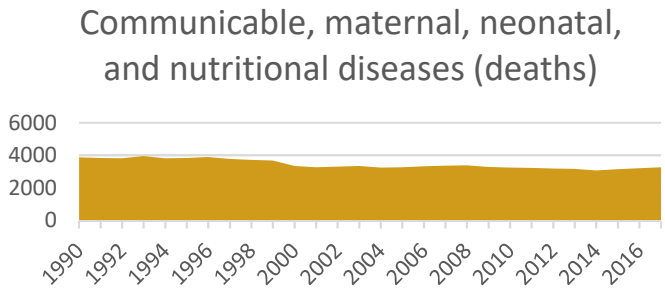
Injuries (deaths)

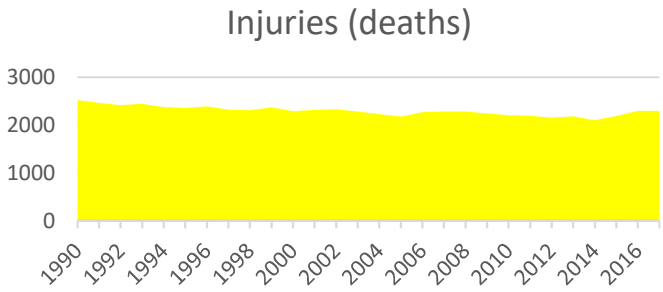


Deaths: All (Scotland)

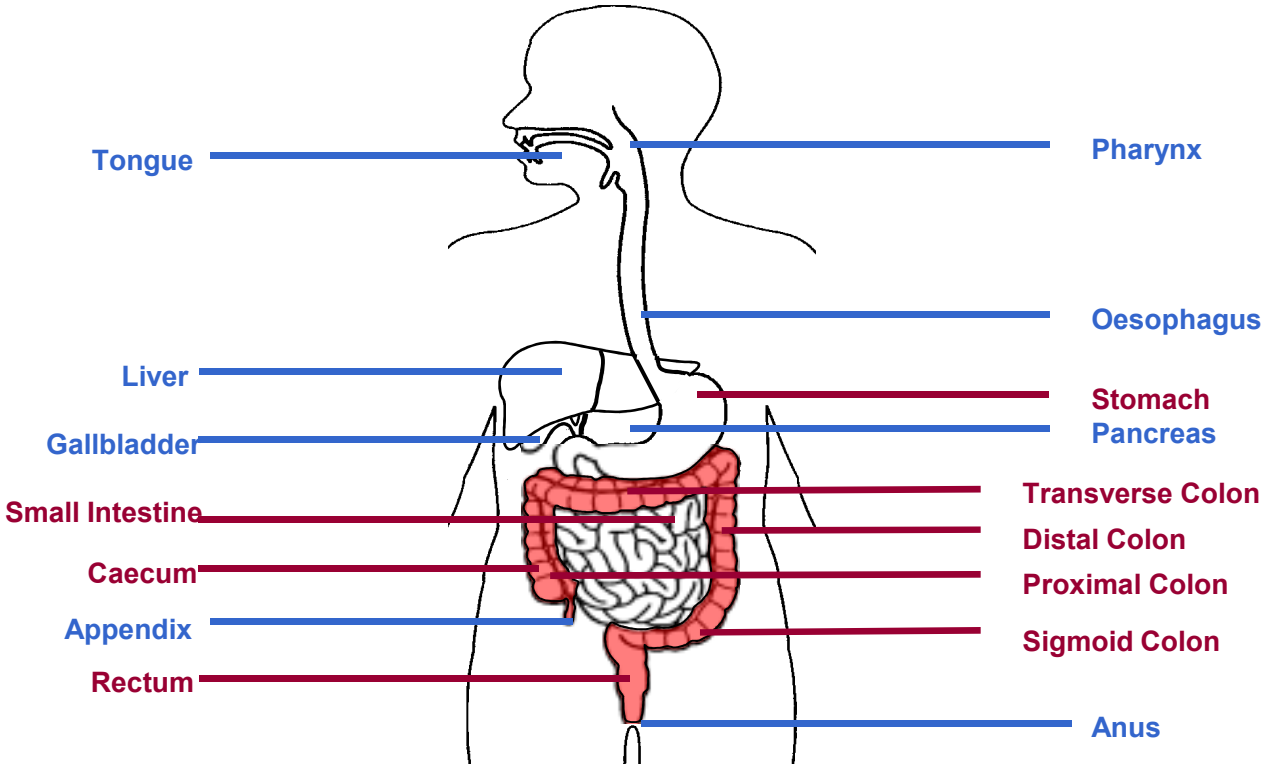








The Human Gut



Cancer Incidence & Mortality (Scotland 2016)

Oesophagus	864	820
Stomach	626	408
Liver	620	584
Pancreas	823	719
Colorectal	3761	1617

Cancer Prevention

Colorectal
Deaths 1,617
Prevented by Diet 75%

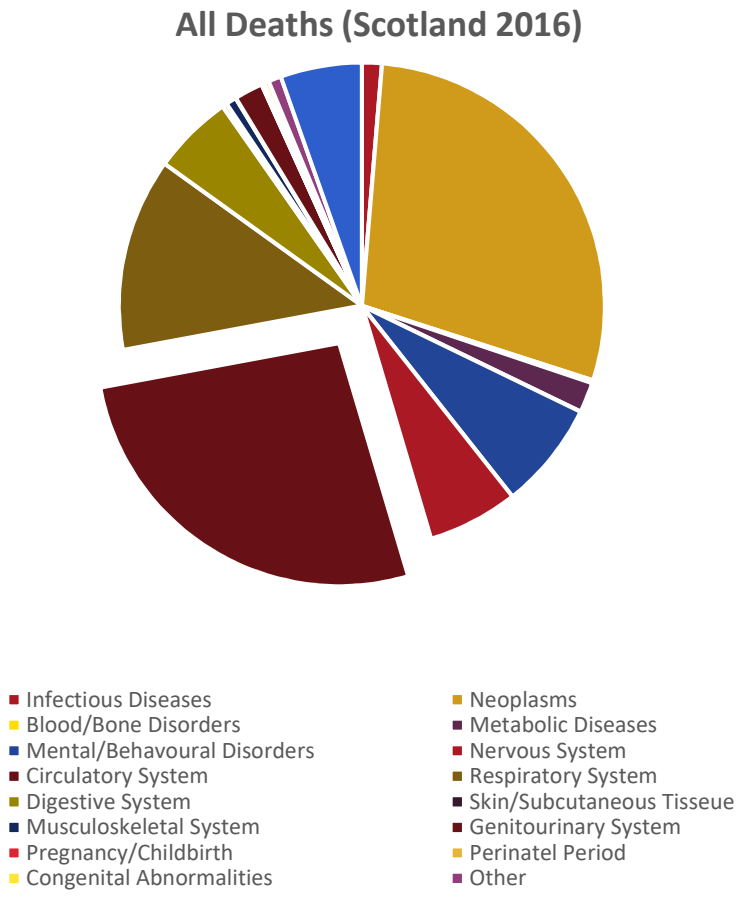
Liver
Deaths 584
Prevented by Diet 66%

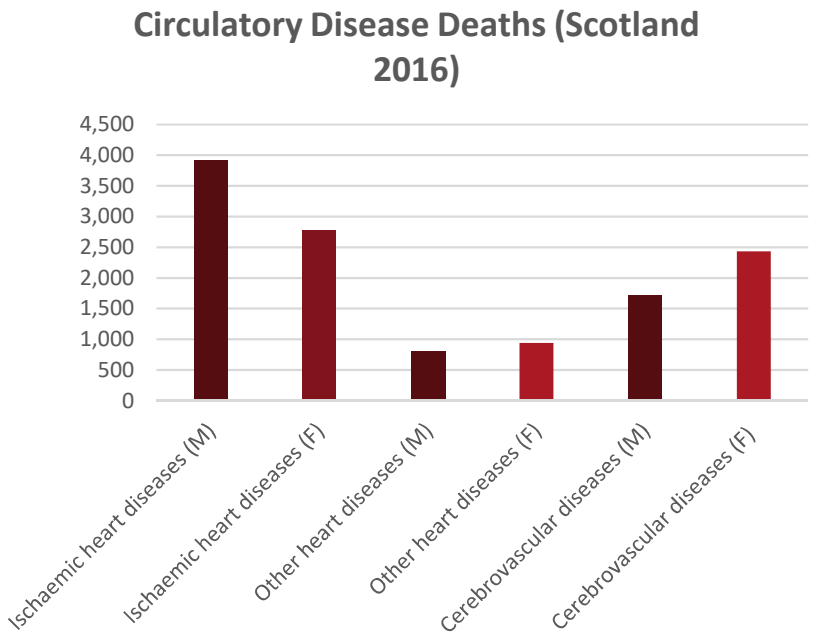
Pancreas
Deaths 719
Prevented by Diet 50%

	Preventable by Diet (up to %)
oral	50
larynx	50
oesophagus	75
lung	33
stomach	75
pancreas	50
liver	66
colorectal	75
breast	50
ovary	20
endometrium	50
cervix	20
prostate	20
thyroid	20
kidney	33
bladder	20

Cancer Research UK/AICR

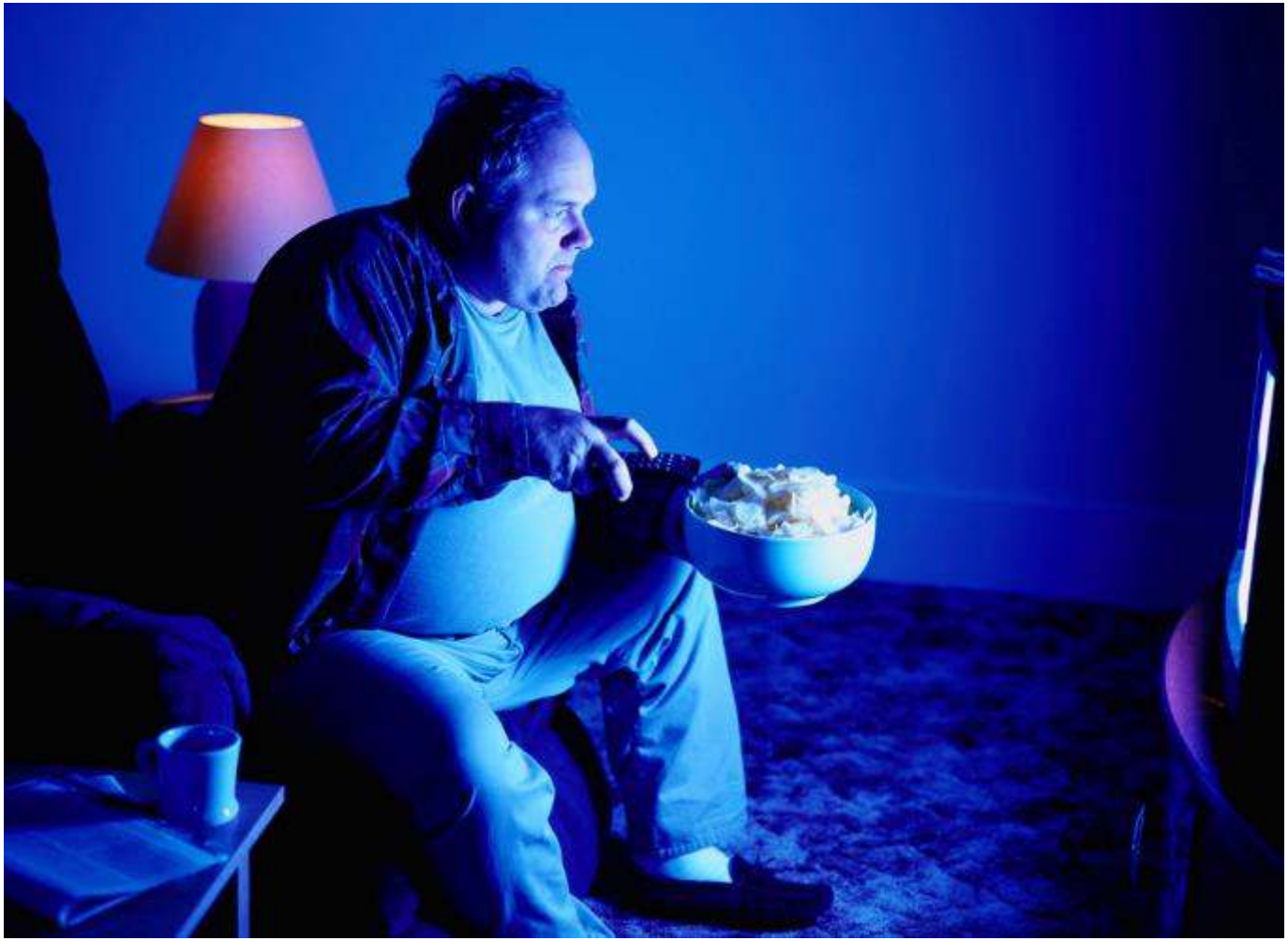
Circulatory Disease Mortality



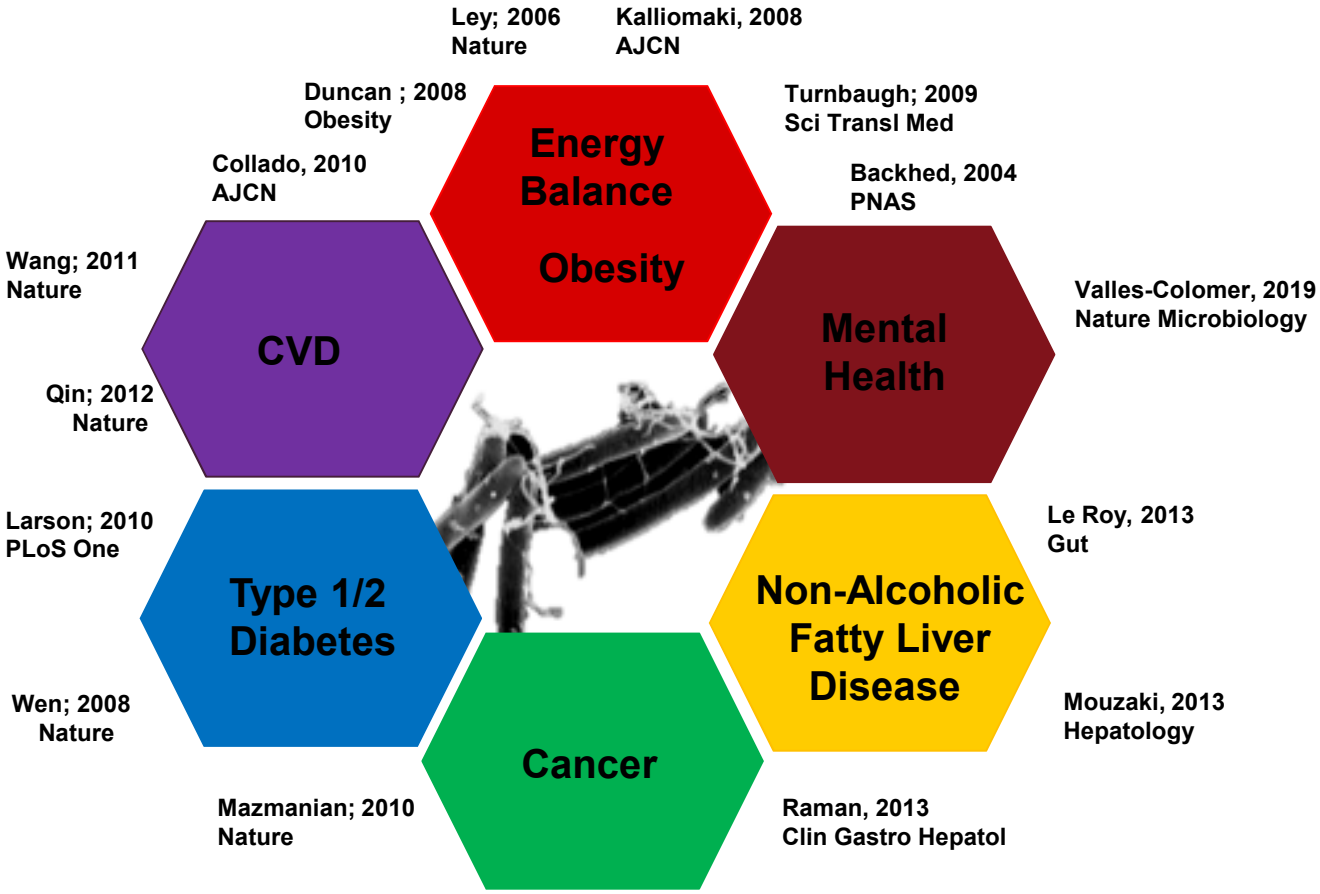


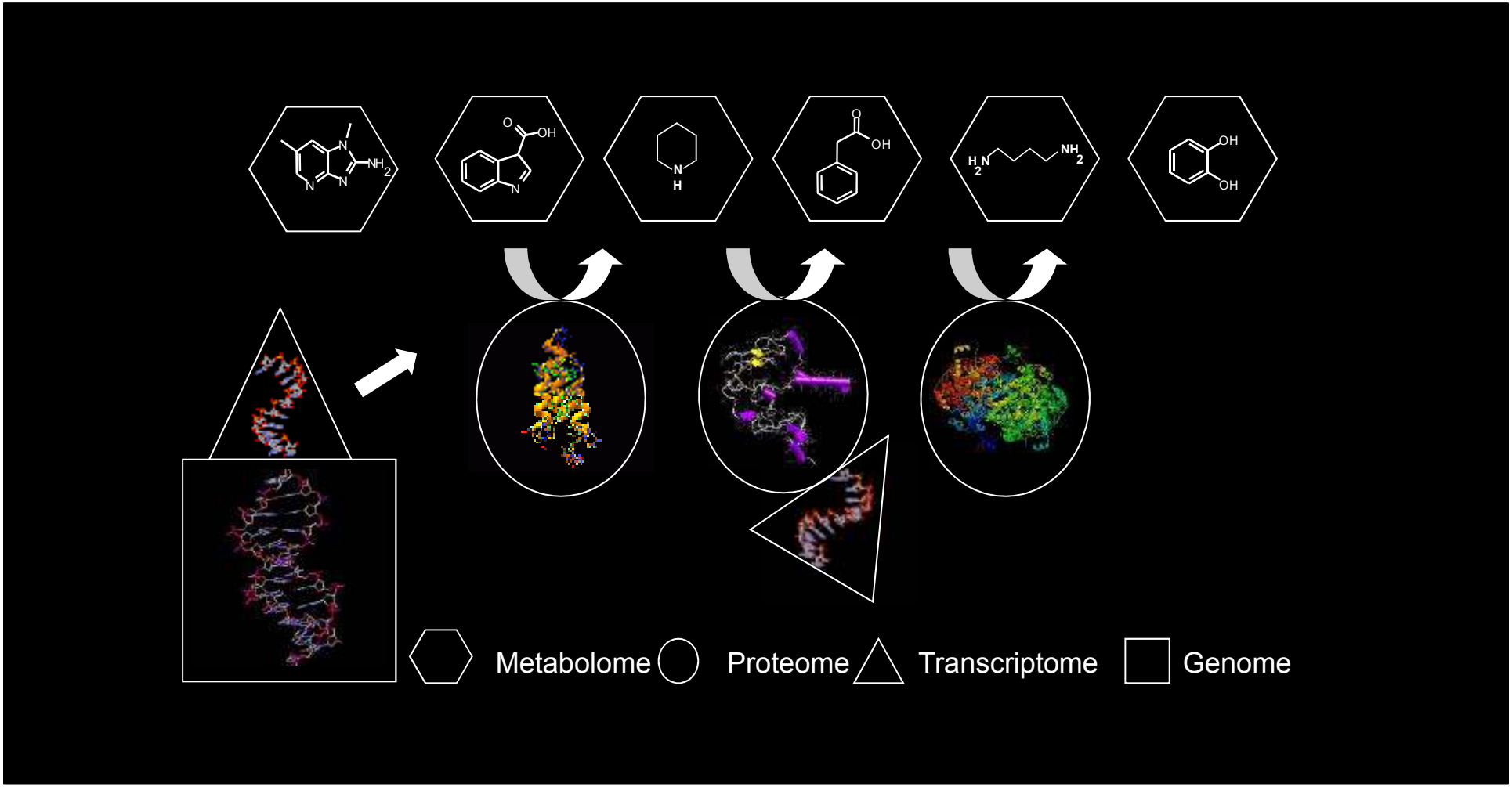
Healthy Diet **31% lower risk of heart disease**
33% lower risk of type 2 diabetes
20% lower risk of stroke

Chiuve et al *Journal of Nutrition* **2012**



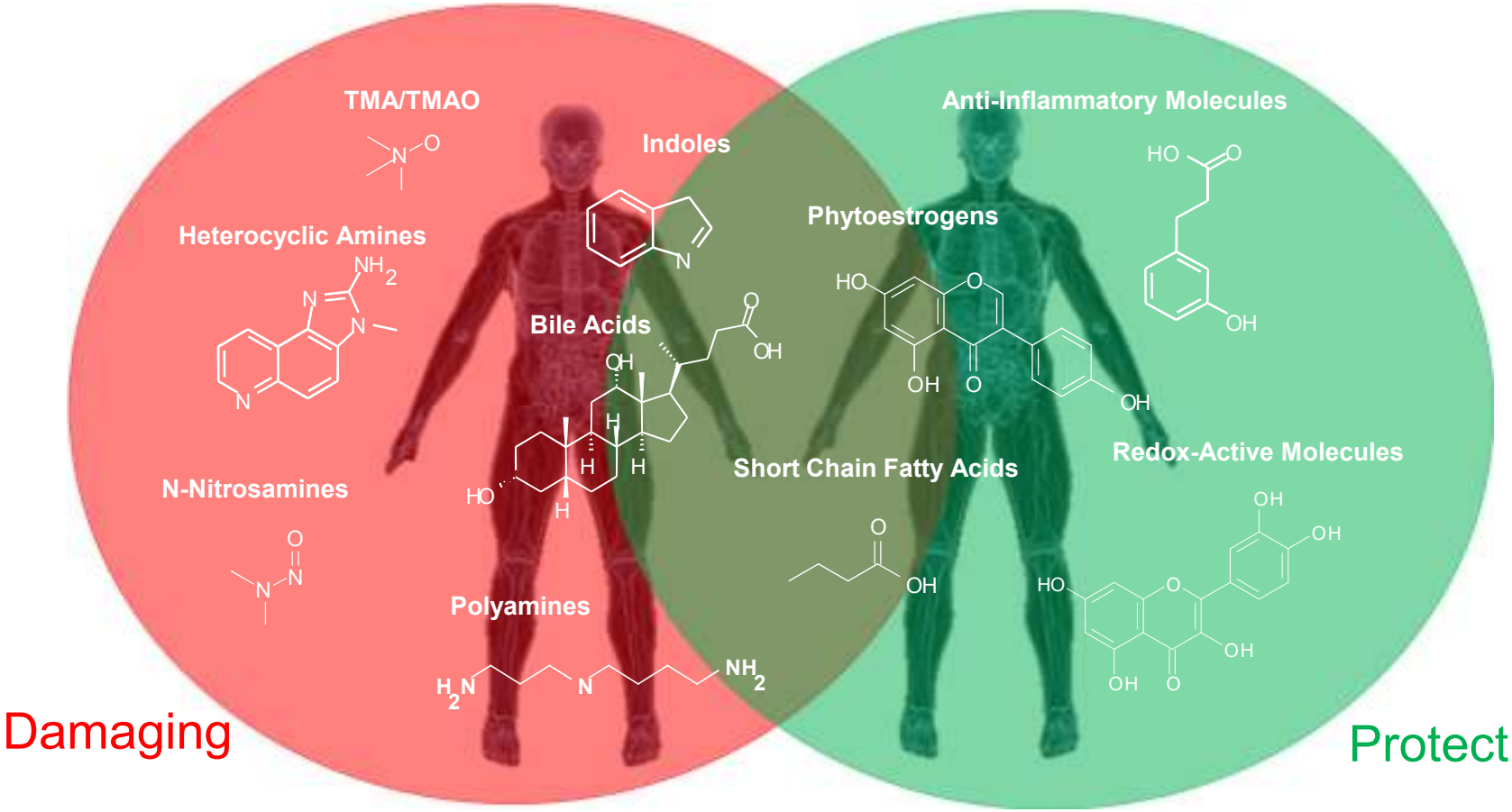
Spectrum of Disorders





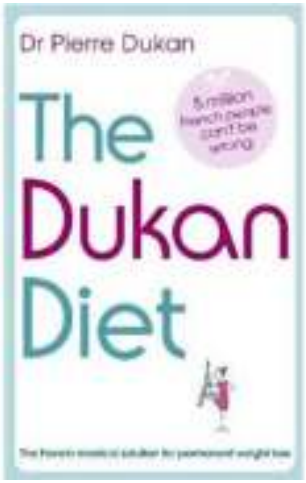
Russell and Duncan *Trends in Analytical Chemistry* **2013**

Dietary-Derived Gut Metabolites



What foods contribute to a healthy gut?

High Protein Diets!

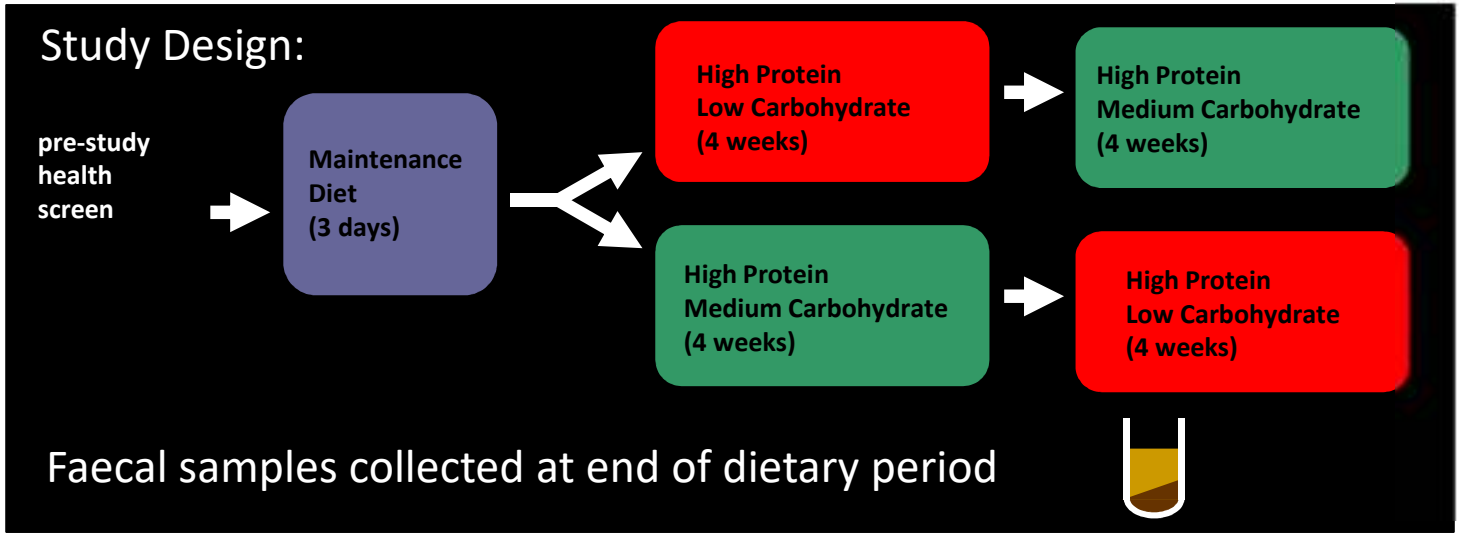


High Protein (Meat-Based) Diets

Volunteers: sixteen obese men (BMI > 27)

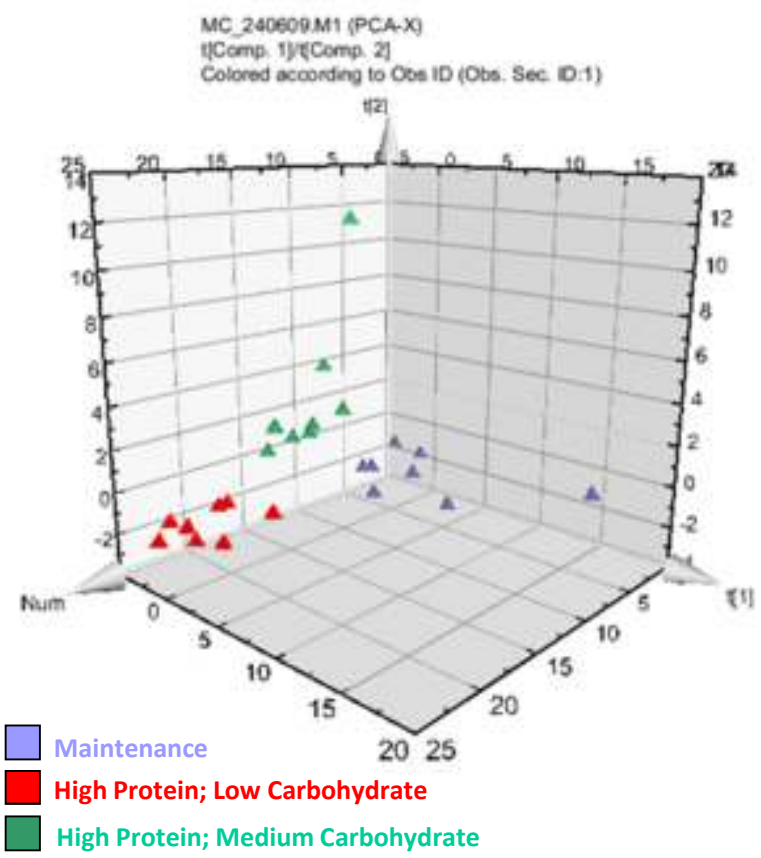
Diets: high protein (138 g/d) – low carbohydrate (23 g/d)

high protein (138 g/d) – medium carbohydrate (182 g/d)



Russell et al *American Journal of Clinical Nutrition* 2011

High Protein (Meat Based) Diets



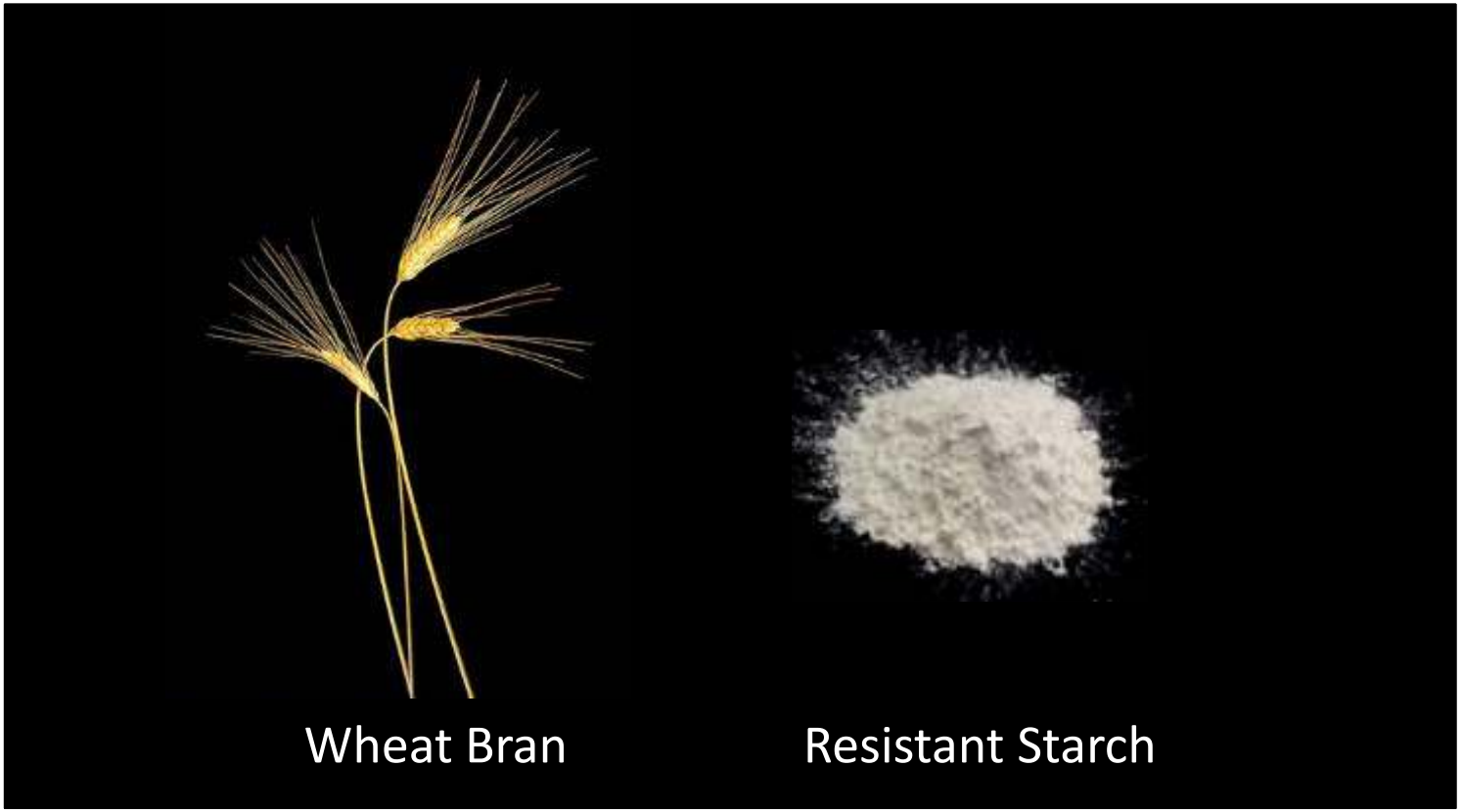
High-Protein Low-Carb vs. Maintenance

Mutagenic Nitrosamines	↑
Cancer Preventative Molecules	↓
Anti-inflammatory Molecules	↓
Protein Metabolites	↑

- increase in hazardous compounds
- decrease in cancer-preventative metabolites
- detrimental to gut health in the longer term

Russell et al *American Journal of Clinical Nutrition* **2011**

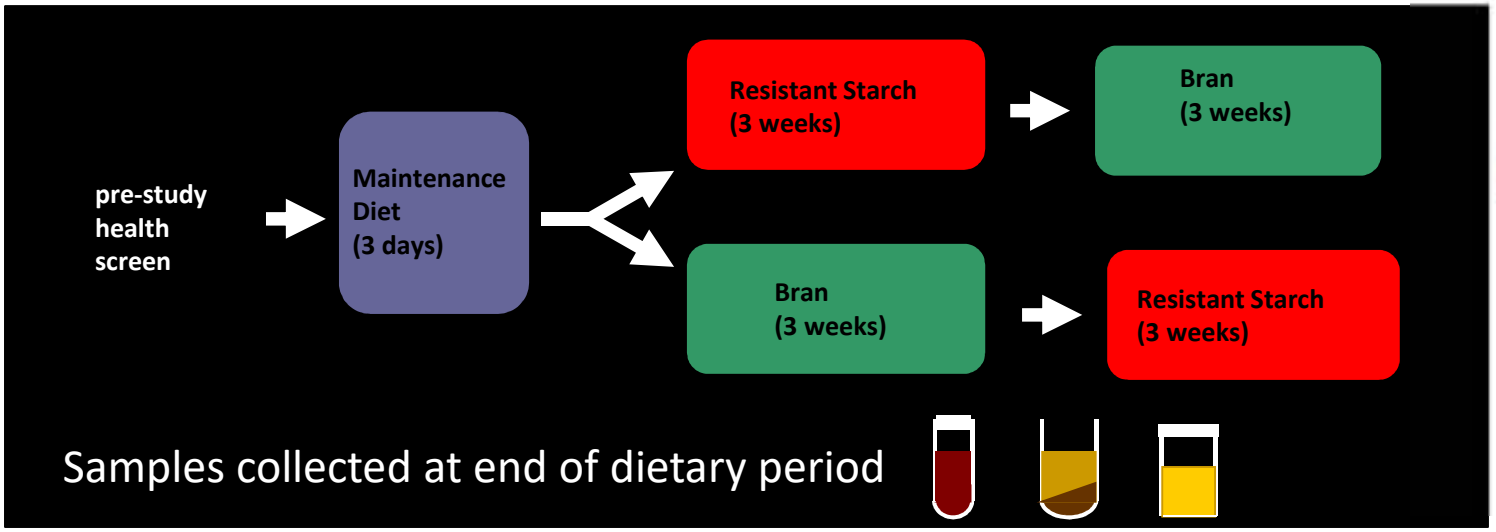
What type of fibre?



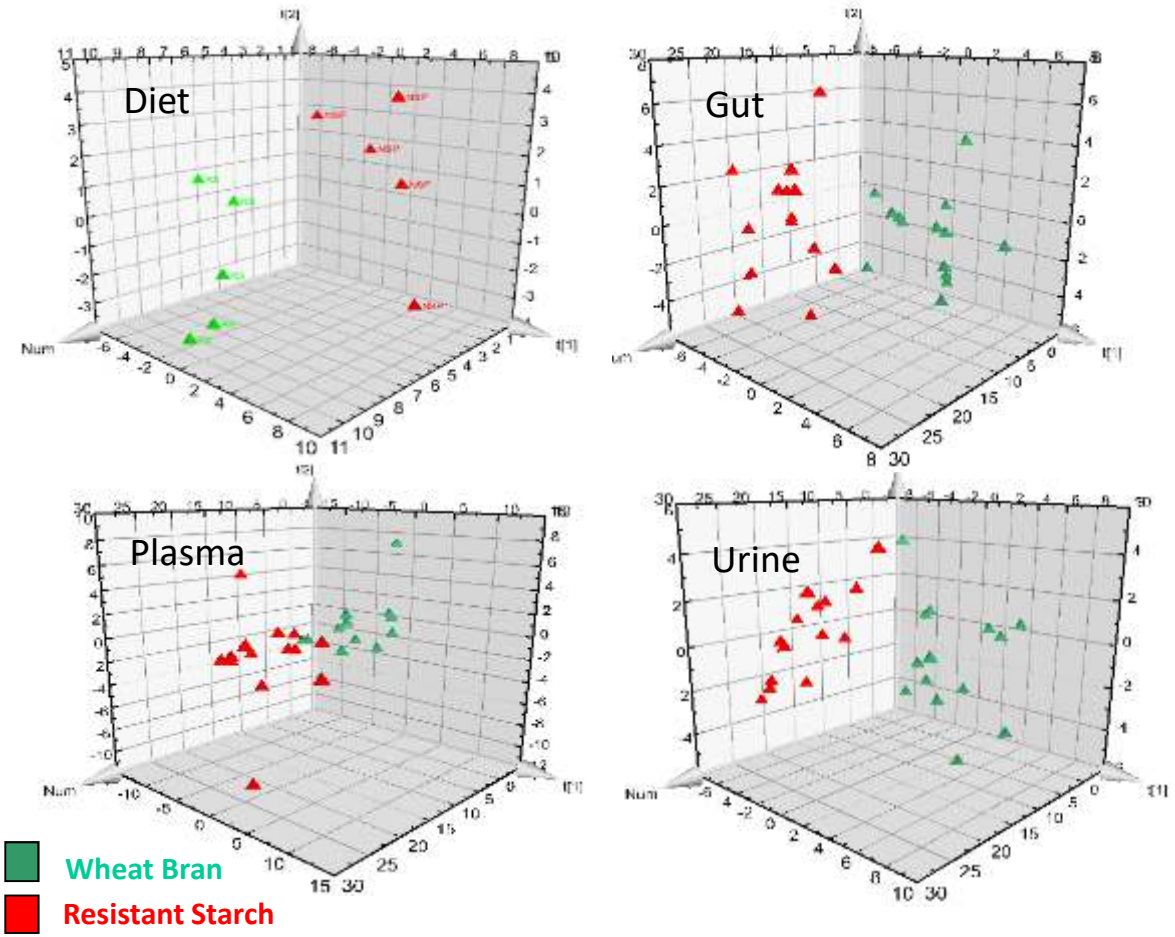
Wheat Bran vs. Resistant Starch

Volunteers: n = 14; WC >102 cm; fGlc>6.0 mmol l−1,BMI > 27 kg m^{-2}

Diets: High Resistant Starch (26 g/d; RS Type III)
High Non-Starch Polysaccharide (42 g/d; Wheat Bran)



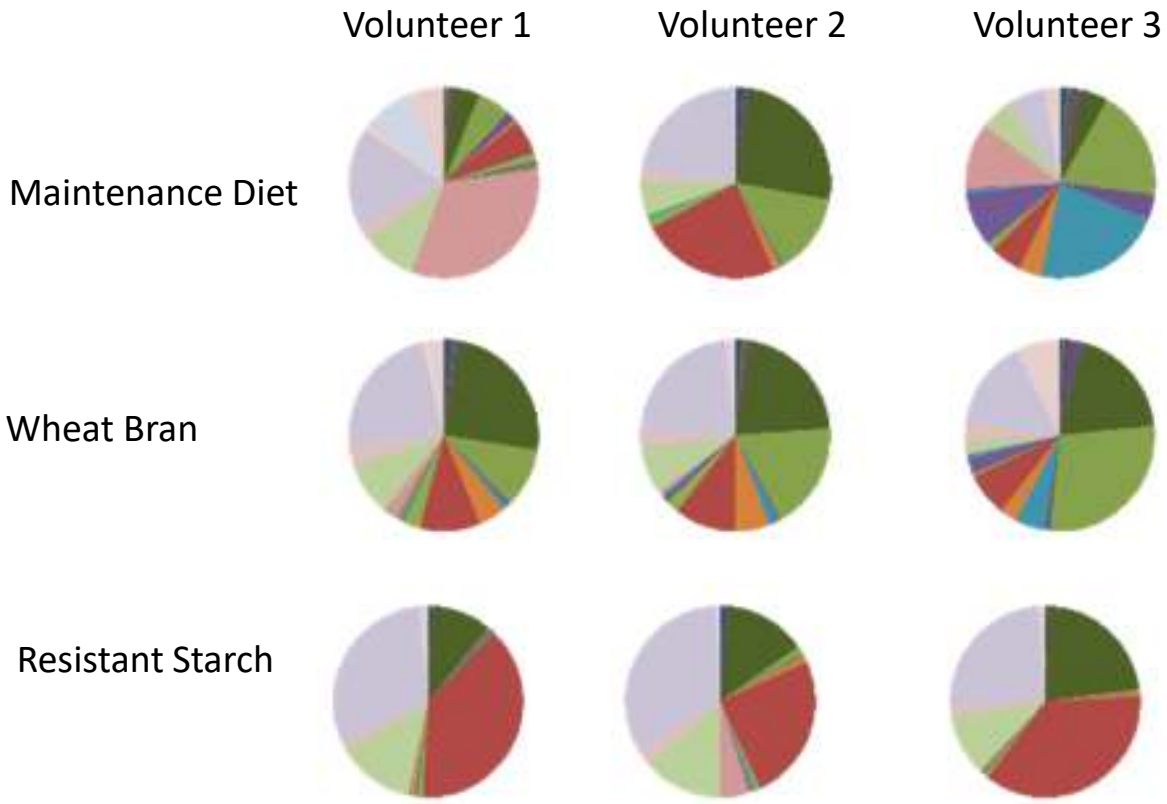
Fibre Modulation



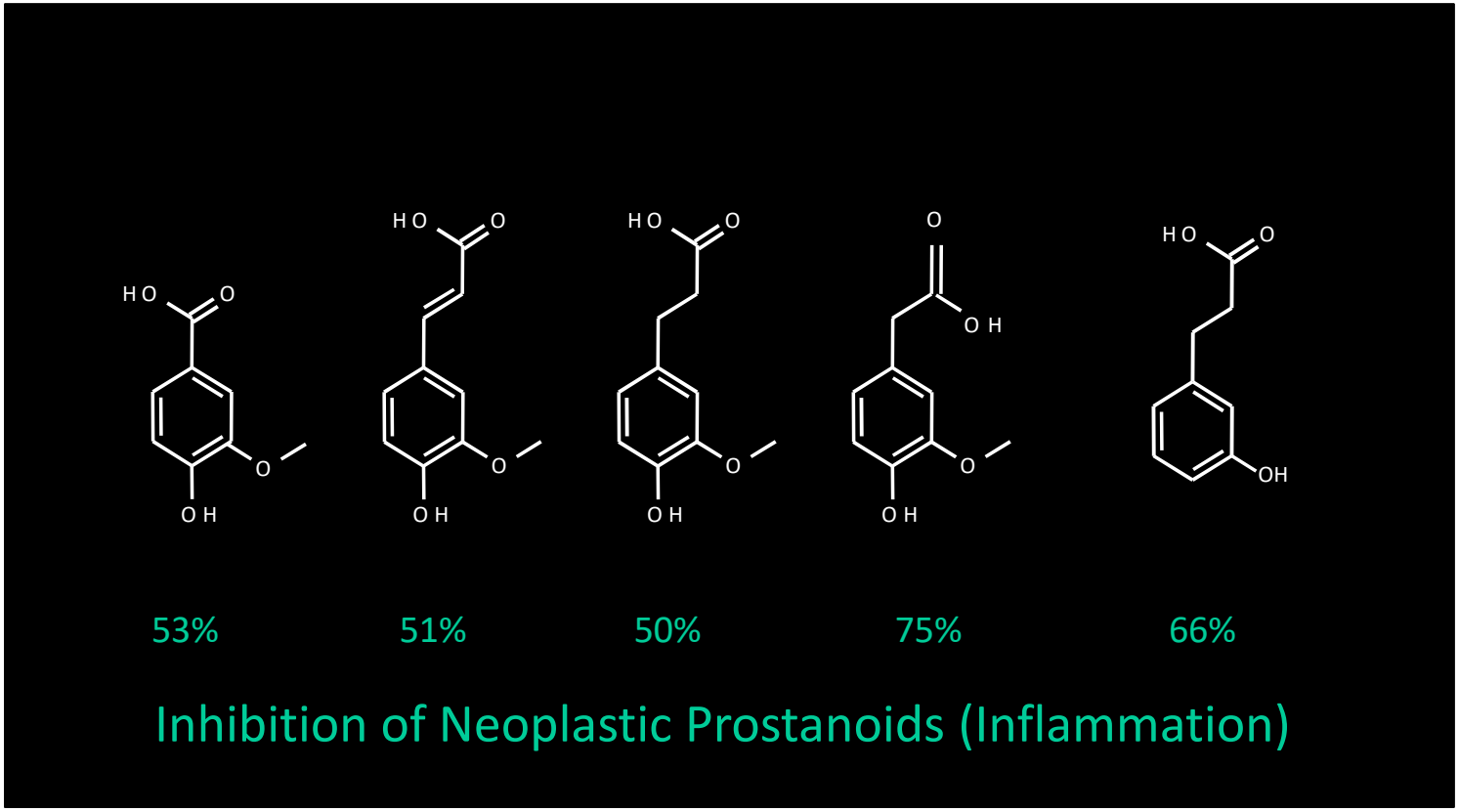
Wheat Bran vs. Resistant Starch

- carcinogenic heterocyclic amines (e.g. IQ, MeIQ) ↓
- chemopreventative indoles (e.g. indole-3-carboxylic acid) ↑
- protein metabolites (e.g. phenylacetic acid) ↓
- tumour-promoting bile acids (e.g. deoxycholic acid) ↓
- polyamines/secondary amines (e.g. pyrollidine, piperidine) ↓
- anti-inflammatory molecules (e.g. ferulic acid, vanillic acid) ↑

Fibre Modulation



Circulating Anti-Inflammatory Gut Metabolites (Wheat Bran)



Russell et al *Nutrition and Cancer* **2009**

Protein for the Future

2.7 billion people

45 billion kg meat

6.0 billion people

229 billion kg meat

>9 billion people

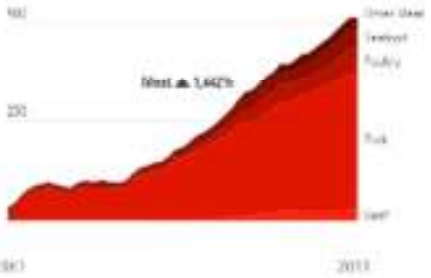
465 billion kg meat

Global Protein Supply

India

US

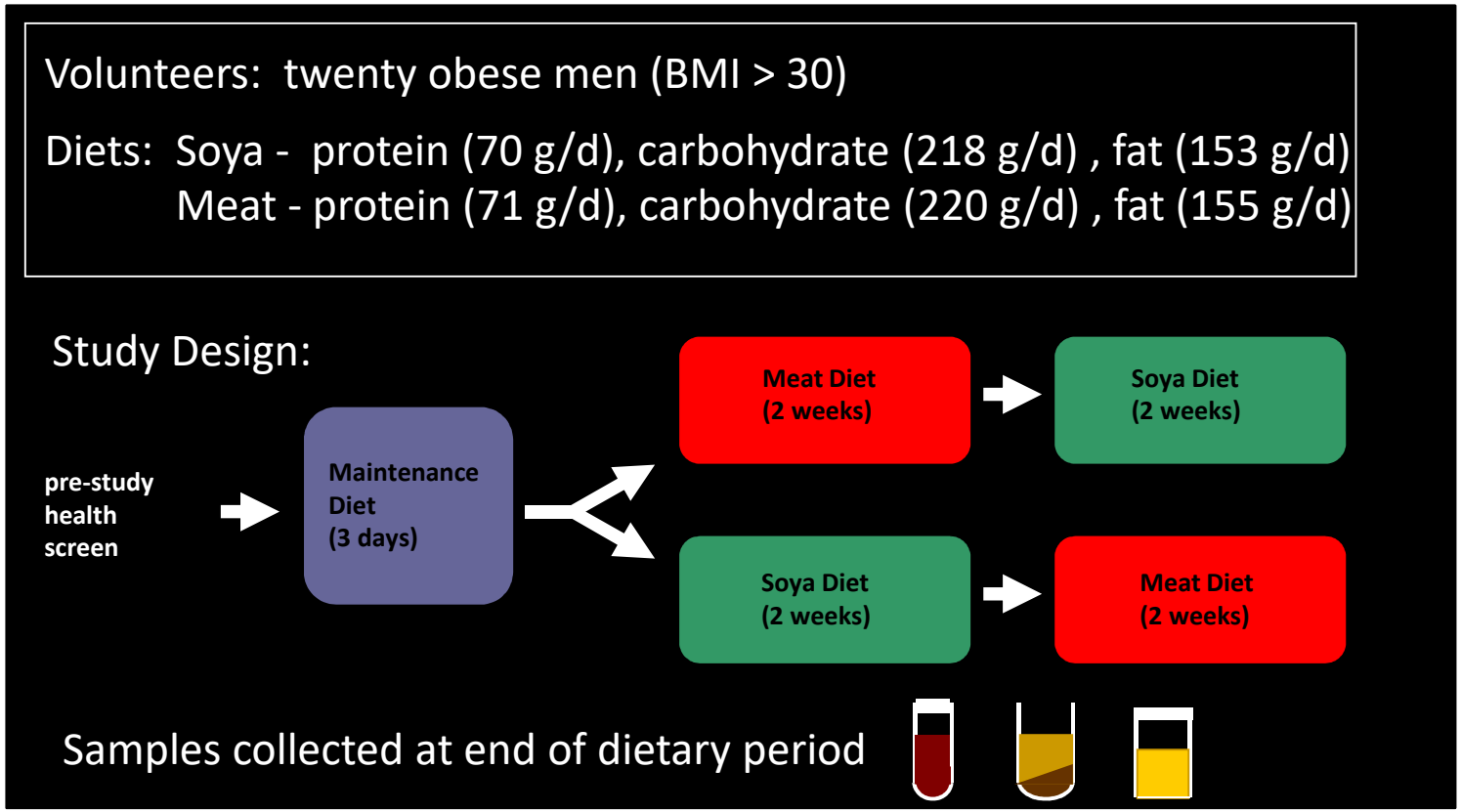
China



g/person (1961-2011)

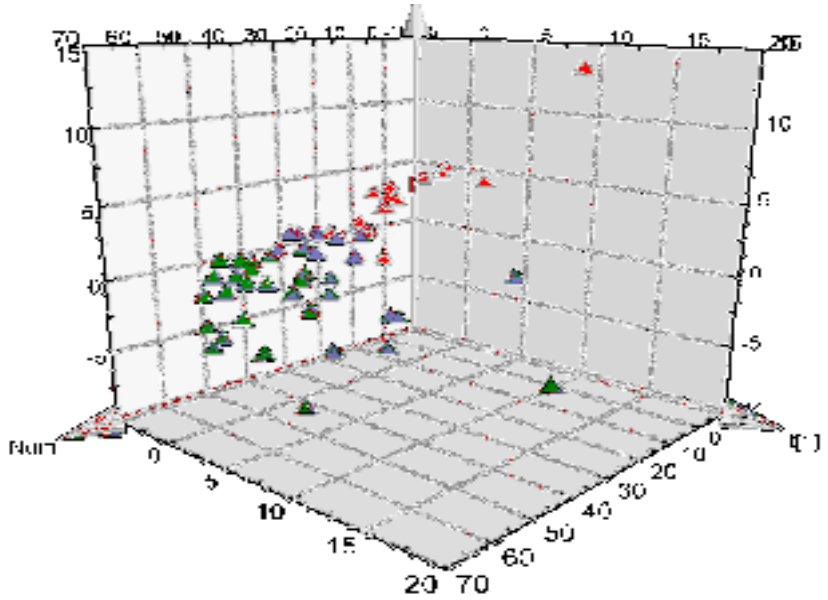
Protein Modulation

Animal vs. Plant Protein



Neacsu et al *American Journal of Clinical Nutrition* **2014**

Protein Modulation



Maintenance Diet
Meat Diet
Soya Diet

Soya vs. Meat Protein

- isoflaones ↑
  (e.g. daidzein, genstein, equol)
- carcinogenic heterocyclic amines ↓
  (e.g. IQ, MeIQ, MeIQx)
- total mutagenic nitrosamines ↓
- polyamines/secondary amines ↓
  (e.g. cadaverine, spermidine)
- anti-inflammatory molecules ↑
  (e.g. vanillic acid and others)

Sustainable Protein Sources (UK)

	Protein	Fibre (soluble)	Fibre (insoluble)
Fava	20.17± 0.03	0.51± 0.09	8.57± 0.27
Lupin	39.93± 0.16	1.49± 0.08	21.87± 1.02
Hemp	35.45± 0.29	0.15± 0.00	23.44± 0.00
Pea	21.97± 0.08	0.56± 0.01	6.21± 0.15
Buckwheat	17.82± 0.05	0.74± 0.14	6.28± 0.01

% per 100 g; mean ± standard deviation

Multari et al *Journal of Agriculture and Food Science* **2016**

Sustainable Protein Sources

…micronutrients and non-nutrient phytochemicals

Na All plant proteins < steak

P Fe Mg Ca Mn Se Zn Cu All plant proteins > steak

Lupin is the richest source of Mn Se

Pea is the richest source of Zn Fe

Hemp is the richest source of P Mg Ca K

isorhamnetin, 39.22±2.66
sinapic acid, 16.66±2.89
ferulic dimer 5-5, 39.99±1.10
kaempferol, 333.25±37.92

quercetin, 371.84±9.03
ferulic acid, 231.26±36.89
ferulic dimer 8-5, 58.20±6.71
p-coumaric acid, 22.15±3.66

kaempferol, 253.21±23.81
quercetin, 102.72±35.70
tyrosol , 201.00±2.19
ferulic acid, 13.18±0.66

prorotocatechuic acid, 12.64±1.20
sinapic acid, 11.28±0.87
4-hydroxybenzoic acid, 9.28±0.73
vanilic acid, 4.76±0.53

scopoletin, 21.33±5.14
quercetin, 38.10±11.17
luteolin, 33.79±8.93
tyrosol, 354.31±112.26

p-coumaric acid, 84.03±8.41
protocatechuicaldehyde, 41.18±5.39
gentisic acid, 31.67±1.75
protocatechuic acid, 27.6±2.23

kaempferol, 49.97±7.37
quercetin, 2698.87±171.55
tyrosol , 165.66±18.65
isorhamnetin, 49.01±4.29

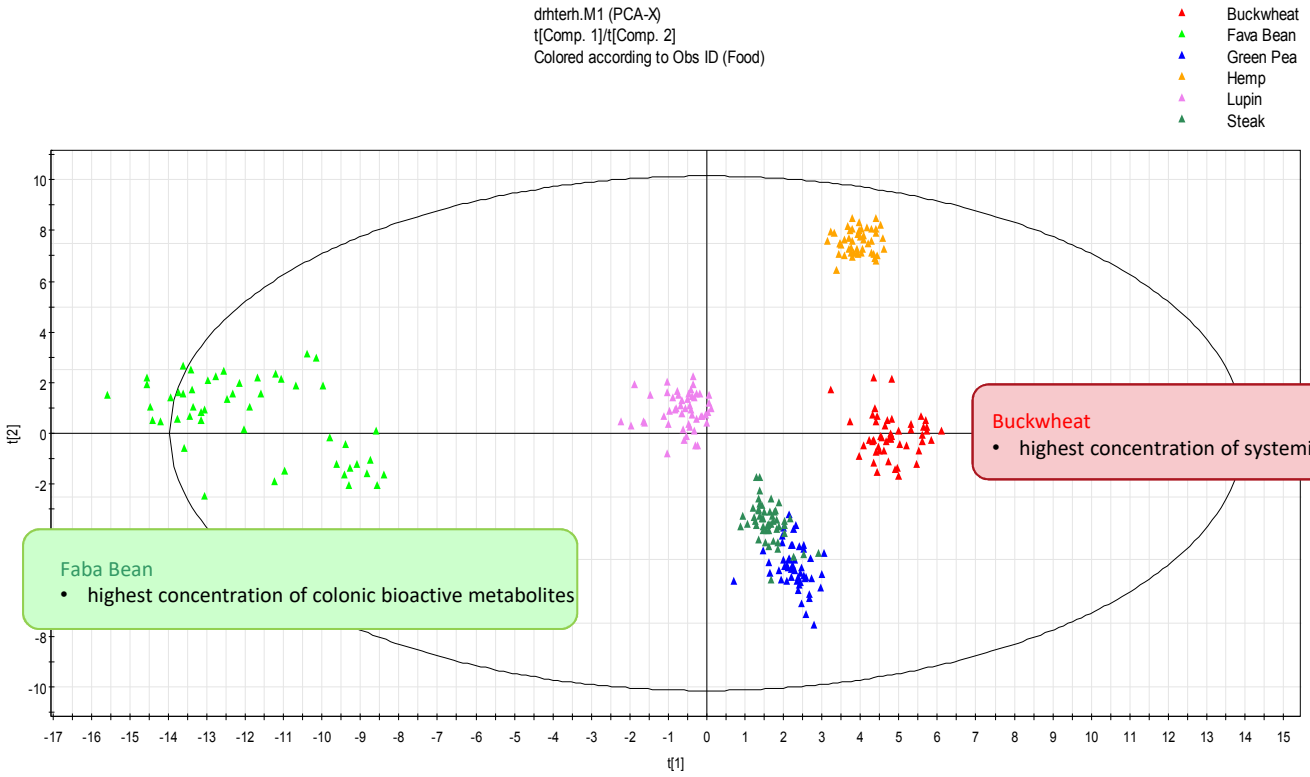
naringenin, 45.62±5.56
luteolin,90.26±1.09
3-hydroxyphenylacetic 64.49±36.29
caffeic acid, 42.05±22.55

tyrosol , 1485.26±28.03
luteolin, 44.30±6.06
apigenin, 63.81±1.96

4-hydroxybenzoic acid, 8.74±1.03
ferulic acid, 3.65±0.61
naringenin, 14.81±1.77

Multari et al *Comp Rev Food Sci* **2015**

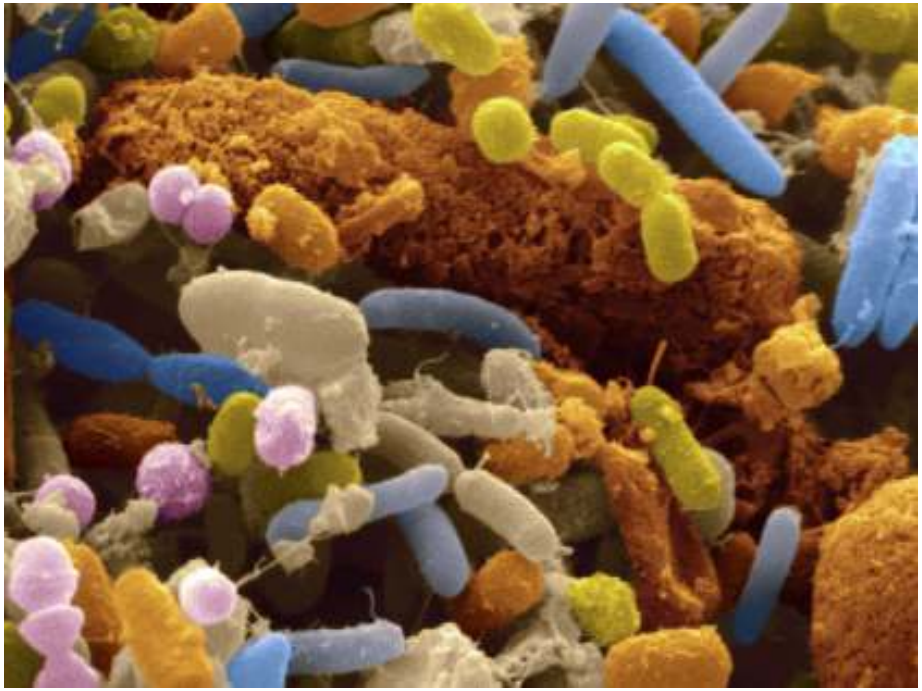
Metabolite Profiles



Buckwheat
- highest concentration of systemic bioactive metabolites

Faba Bean
- highest concentration of colonic bioactive metabolites

Crop Diversity = Microbial Diversity



Crop Domestication

Agricultural Timeline

8500-3000BC (Neolithic Revolution)

3000BC-607 (Antiquity)

1700- (Agricultural Revolution)

1913 

Haber-Bosch Process

Fritz Haber and Carl Bosch (BASF)

1938 

DDT

Paul Hermann Müller (Geigy)

1942 

Semi-Dwarf Wheat

Norman Borlaug (DuPont)

2019

Current Agri-Food System

Reliance on fertiliser, pesticide and extensive irrigation

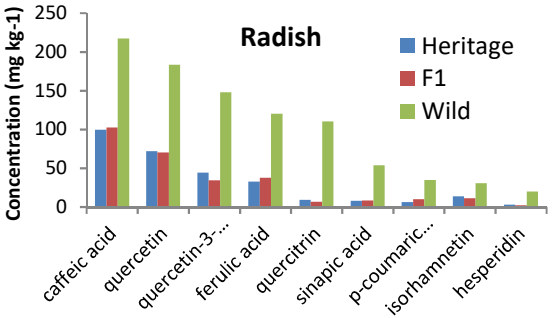
Dietary diversity substantially reduced

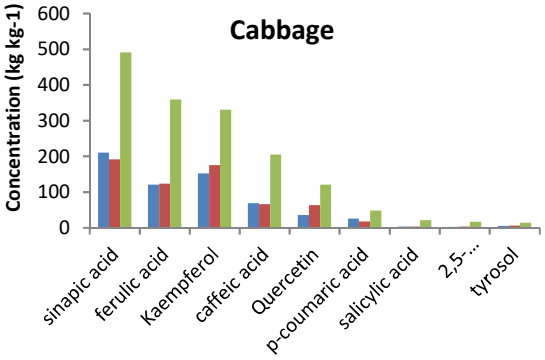
Estimated that ¾ of our genetic material lost

More than 50K edible plants, only 250-300 consumed

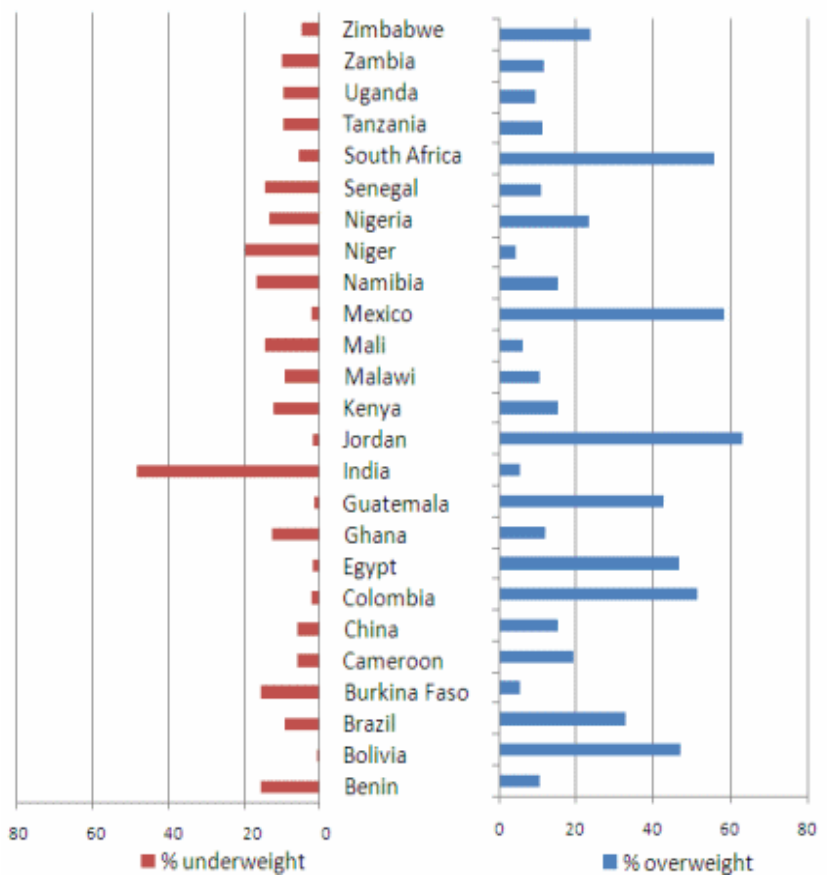
75% of the world's food form 12 plants/5 animals

Wild Relatives of Modern Veg.

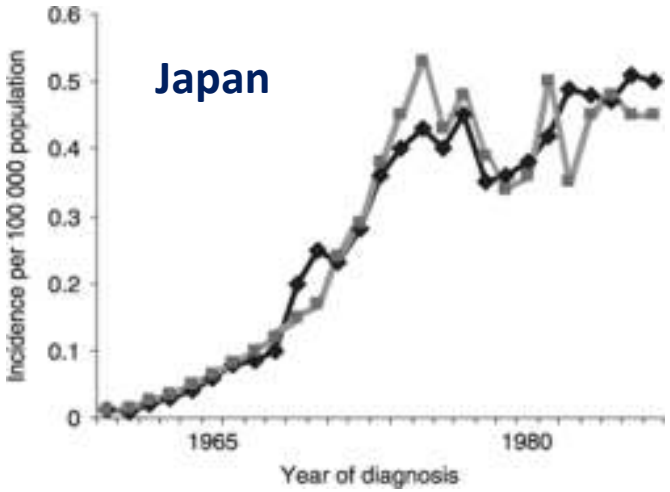


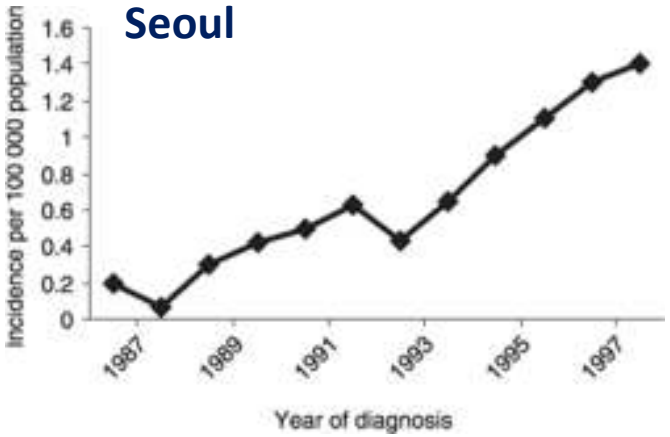


Diet Transition



Diet Transition and IBD





Why our Diet needs to Change (Global)

"when all people at all times have (physical and economic) access to sufficient, safe, nutritious food to (meet their food preferences, prevent disease) and maintain a healthy and active life"

Scotland Dinner Plate 2050?

Reduce

Beef and veal 12-9g/day
Pork 5-3g/day
Lamb 4-3g/day
Poultry 26-18g/day
Processed meat 29-21 g/day
Dairy 180-158g/day
Cheese 12-6g/day
Eggs/Egg products 5-4g/day

Replace

Fish wild-caught 12-5g/day
Fish aquaculture 2-35 g/day

Develop

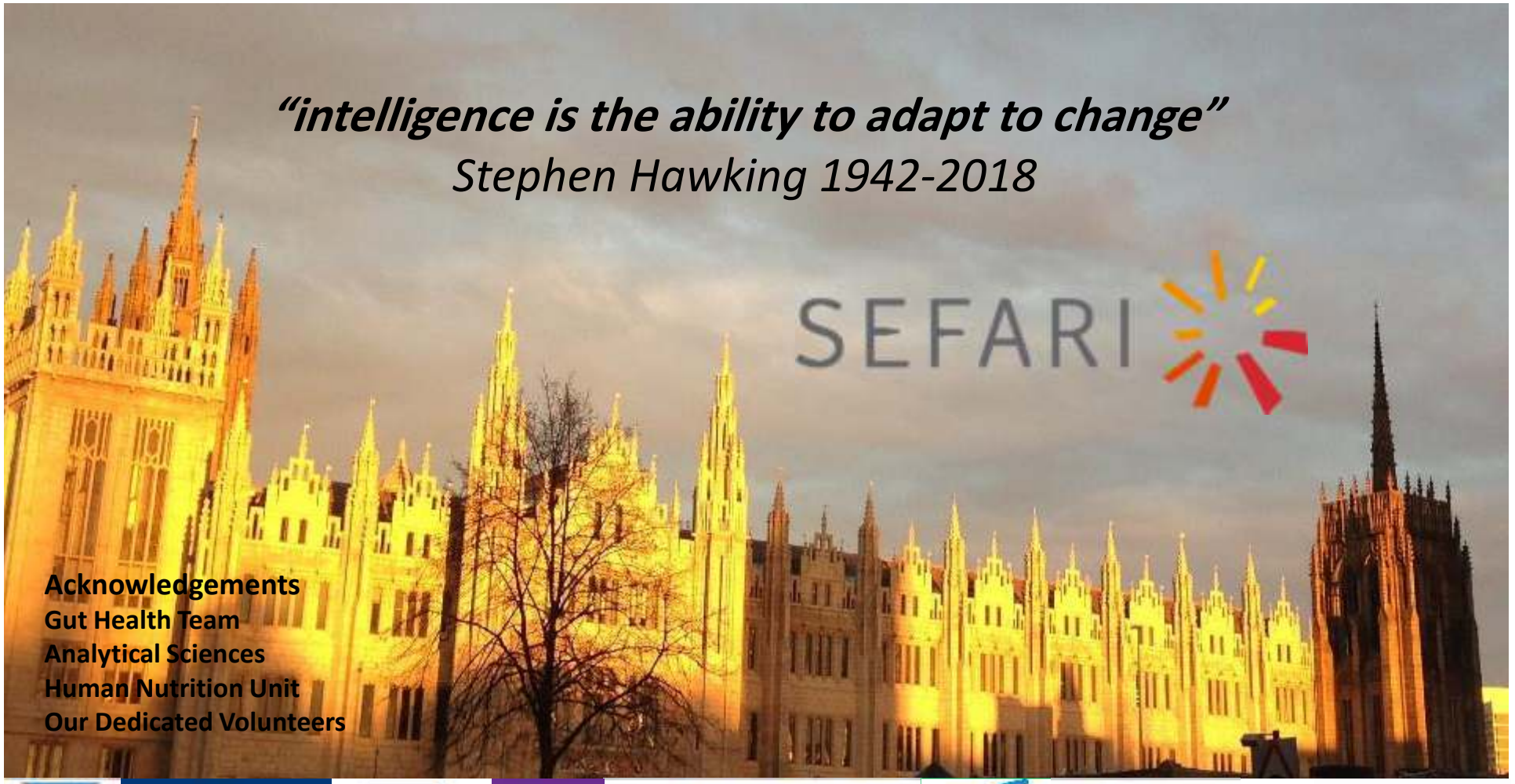
Meat replacers 1-6 g/day
Dairy replacers 1-20 g/day

Increase

Legumes, nuts and oilseeds 6-17 g/day
Grains and grain-based products 198-245g/day
Starchy roots and tubers 90-175 g/day
Vegetables and vegetable products 86-336 g/day
Fruit and vegetable juices 98-117g/day
Herbs, spices and condiments 27-37 g/day

Livewell Plates – Eating for 2 Degrees

WWF 2017



Acknowledgements
Gut Health Team
Analytical Sciences
Human Nutrition Unit
Our Dedicated Volunteers

Scotland's dinner plate 2050

Food innovation: home and abroad

May 2019

NewNutrition Business

Presentation

Who we are

- Founded in 1995, **New Nutrition Business** is the world's number 1 provider of strategic and market insights into the business of food, nutrition and health.
- From **global giants to start-ups**, our clients include the world's most **innovative** food, beverage and ingredients companies.
- **Expertise** in global markets and across multiple food and beverage categories.

So what did the Scottish dinner plate look like in the 1950s?

"*For dinner at one o'clock there was a plateful of thick meat and vegetable broth. Maybe a ham bone with lentils or the stock from a boiling chicken thickened with leeks and rice. Always a small amount of the cheapest cut of meat. Fresh vegetables such as carrot, turnip, onion, leek and parsley were always a feature, as was some cereal. Always a warming meal-in-a-plate*.

"Meat and potatoes were for Sundays. Perhaps an oxtail stew, tender meat sliding of its own accord from the sculptured bones left on the plate. Or it might be a plateful of rich brown oniony mince topped with misshapen mounds of fluffy suet dumplings instead of potatoes. Sometimes it was a plateful of chewy tripe surrounding a mound of mealy tatties."

Source: Catherine Brown, *Scottish Cookery*

And as for snacks?

Innovation has shaped the way we shop and eat…

Online

On-the-go

…and revolutionized the food industry.

Refrigeration

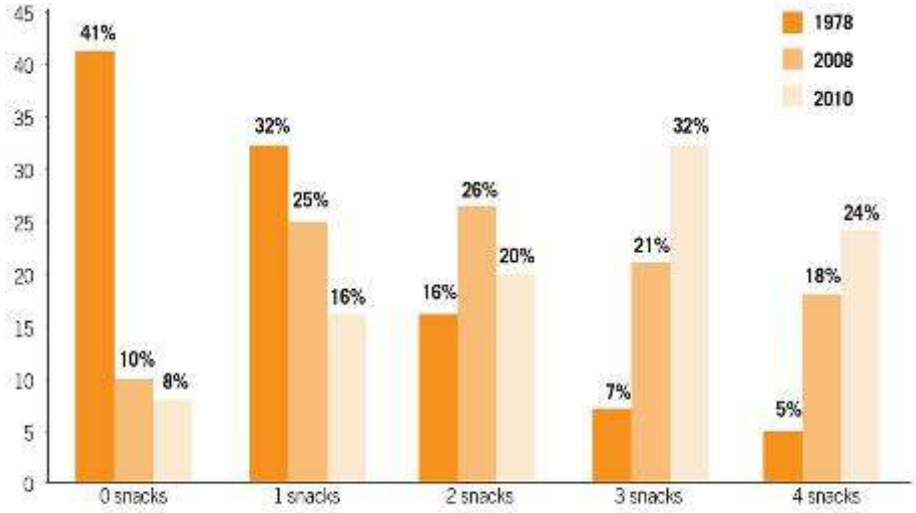
We are all “food explorers”. People are open to trying more types of foods and drinks for health

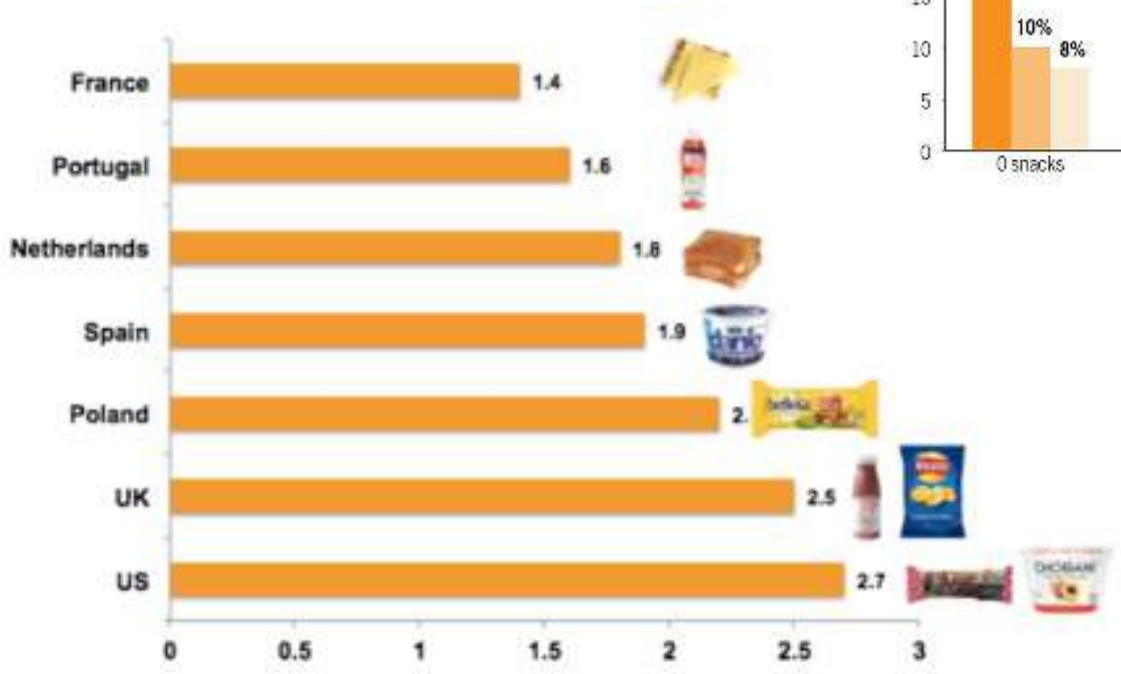
Kombucha, from traditional Chinese medicinal tea to trendy “digestive wellness” drinks

GLK Foods, the largest producer of Sauerkraut in the world has put the fermented cabbage product – traditionally found in jars – in resealable packs.

Frequency of snacking has increased

Over the last decade there has been a 44% increase in people having at least 3 snacks per day in the US





UK's snacking culture:

- **96%** eats between meals
- This is a daily habit for **69%** of those people
- Only **39%** of snackers look for healthy options
- **10%** of snackers eat to replace a meal

KEY TREND 2: PLANT-BASED
EASY GREENS

Not just for vegetarians!

We are NOT all turning into vegetarians or vegans.

NPD is making it easier for people to choose more plant-based meals and snacks, but it doesn't mean people will stop eating animal food.

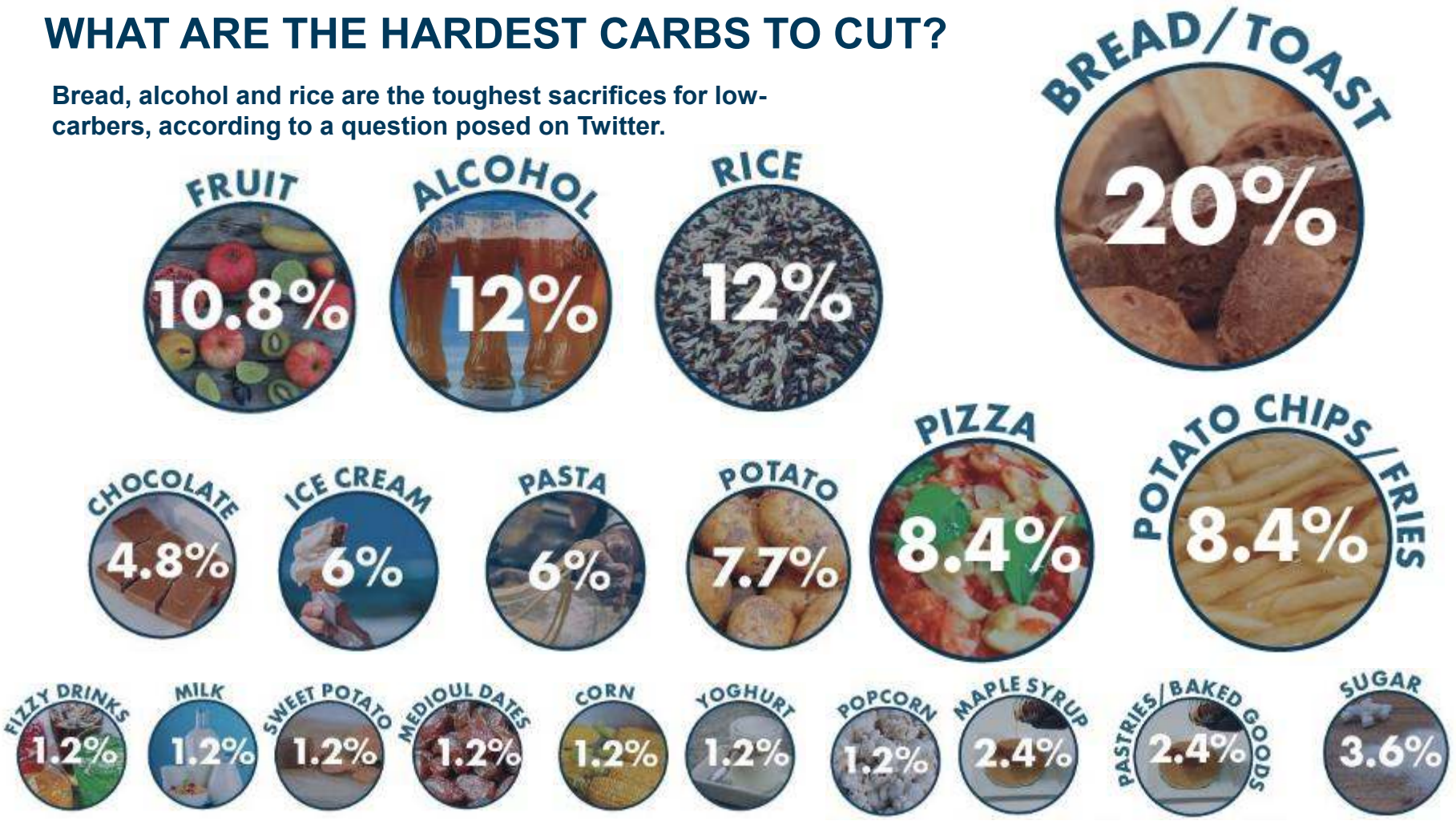
of consumers say they are trying to reduce their meat consumption.

of consumers claim to be vegetarian.

People's motivations to eat more plants are many and varied - wanting more plant protein in their diet, using plants to replace "beige" carbs, connecting plant foods with weight loss, and much more...

WHAT ARE THE HARDEST CARBS TO CUT?

Bread, alcohol and rice are the toughest sacrifices for low-carbers, according to a question posed on Twitter.



Based on replies to a question posted on Twitter:
(https://twitter.com/BelindaFettke/status/1012252760438394880?cn=ZmxleGlibGVfcmVjc18y&refsrc=em ail)

KEY TREND 2: PLANT-BASED
EASY GREENS

People want to eat more plants, and creative NPD is making it easier than ever.
Plant-based is an opportunity for every type of business!

NEW NUTRITION BUSINESS

The Impossible Burger is a plant-based “meaty” looking and tasting burger

- The Impossible Burger includes an ingredient from soybeans – leghemoglobin - which is a protein that is chemically bound to a non-protein molecule called heme that gives leghemoglobin its blood red color.

- Heme gives the Impossible Burger the appearance, cooking aroma and taste of beef.

- The heme in Impossible Burger is made using a yeast engineered with the gene for soy leghemoglobin:
    1) The yeast is grown via fermentation
    2) The soy leghemoglobin (containing heme) is isolated from the yeast
    3) It is added to the Impossible Burger, where it combines with other micronutrients.

Vegetables are popping up in unlikely places

Start-up Peekaboo contains vegetables such as spinach and broccoli – but has the taste and appearance of an indulgent ice-cream.

Start-up offering indulgent bakery bites that offer “40% of your daily veggies in each pack”.

Dr Oetker’s new Yes It’s Pizza range of vegetable dough base pizzas contain 35% pure beetroot or spinach in the dough. It retails in major UK supermarkets Waitrose, Asda, Sainsbury’s and online at Ocado.

KEY TREND 9: FAT REBORN
A BRIGHTER FUTURE

New science continues to back the redemption of fat – particularly dairy fat – and consumers are learning that not all fat is bad.

11% of Americans think "fat is not bad", an increase of **50%** compared to 2017

15% of Australians think "fat is not bad"

24% of Americans rate butter as a "good fat"

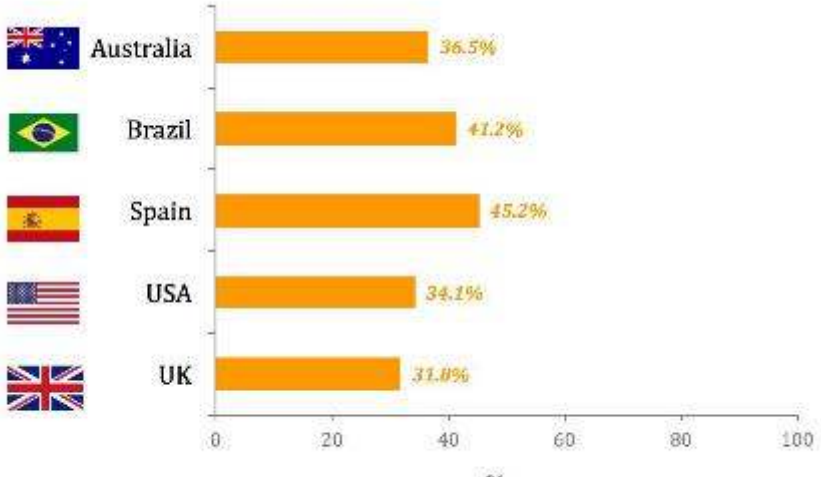
% OF CONSUMERS TRYING TO EAT MORE HEALTHY FATS:

- 36.5%
- 41.2%
- 45.2%
- 34.1%
- 31.8%

Some people will continue to avoid fat. Others will pick and choose according to their personal definition of "good fats" → **The future is a highly-fragmented approach to fat consumption!**

NEW NUTRITION BUSINESS

CHANGING CONSUMER PERCEPTIONS OPEN UP NEW PRODUCT OPPORTUNITIES



% of consumers trying to eat more healthy fats

One size does not fit all with fats. Some consumers will include in their own, personally-defined “good fats” category red meat, others dairy fat, others coconut oil, and will combine the good fats in whatever way makes most sense to them. Other consumers will continue to avoid fat.

NEW NUTRITION BUSINESS

KEY TREND 8: BEVERAGES REDEFINED
A FLOW OF FRESH IDEAS

WHERE ARE THE OPPORTUNITIES?

ALCOHOL - FREE

The alcohol-free market is a global growing trend fuelled mostly by Millennials' health motivations.

73%

Of Millennials admit to be trying to reduce their alcohol intake.

But only 49% of consumers aged >69 say the same.

COFFEE

The "energy drink" for adults is taking a leading place in the strategy of more companies, particularly RTD coffee drinks.

La Colombe coffee RTDs are made with lactose-free milk or coconut milk and cold-pressed espresso. It's now a $30m brand in the US.

Bigger players like Nestle are also investing in the format.

KOMBUCHA

Kombucha is a fermented drink with few barriers to entry and already an established niche in the US, but still emerging in other markets.

Digestive Wellness is a key health concern for consumers everywhere - it will keep fueling the growth of fermented drinks, from kombucha to kefir.

BUT... other categories are showing signs of stalling or even failing.

- Smoothies & fruit juices → sugar concerns overshadowing benefits like vitamins, fibre or even protein!
- Plant waters → except for coconut water, other plant waters have failed to create a point of difference and get consumer acceptance.

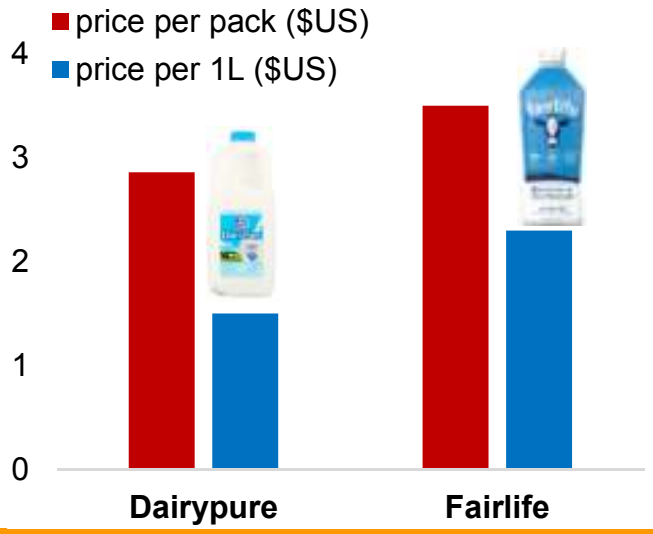
NEW NUTRITION BUSINESS

Technology innovation can be a route to successfully disrupt health and food categories

Fairlife uses technology to get a milk which is:

- ✓ lactose-free
- ✓ higher in protein
- ✓ lower in sugar milk

Coca-cola's FairLife ultra-filtered milk launched in 2015 achieved **€267million in sales** despite selling at a 50% premium to regular milk.



A2 milk – what some thought was “too weird” now has 10% of market share in Australia’s fresh milk market

- A2 is the world’s most profitable dairy company - a 68% jump in sales to €547 million in 2018.
- In China the brand’s value share of the infant formula market is 5.1%.
- The key message is associating its A2 protein only milk with easier digestion and not causing any digestive discomfort both in adults and children.

Using AI to produce plant-based alternatives with improved taste & texture

- Chilean company NotCo started with an investment of €222m in 2015 to develop a software (Giuseppe) capable of formulating food products based in plant ingredients that mimic the taste & texture of the foods.
- The software uses an AI algorithm that search for patterns in traditional foods and replicates it using plant-based ingredients to achieve the perfect combination.
- Recently received a €27m invested from Jeff Bezos.

~~TRANSGÉNICOS~~
~~LACTOSA~~
~~GLUTEN~~
~~COLESTEROL~~
~~HUEVO~~
~~SOYA~~

3D food printing aims at getting a place on consumers' kitchen counter

- Foodini is a system that pushes food down a capsule, through the nozzle, and prints it. A precision control system moves the capsule in an accurate way, creating shapes which then can be stacked layer upon layer to become 3D creations.
- Creations can be served or plated directly, baked in the oven, frozen, dehydrated.
- Available for €3600.

What lessons can be learned?

Innovation by itself is not a strong motivation for purchase – the key is to connect technology innovations to the trends and benefits that consumers want

Taste & texture are always king

NewNutrition Business

OUR PRODUCTS

Healthy food and beverage is undergoing massive change. We help companies around the world, large and small, stay ahead of developments.

10 Key Trends in Food, Nutrition & Health

What trends will create opportunities and challenges for your business in the years ahead? What strategies can you adopt? You'll find the answers here.

New Nutrition Business

Case studies and strategic analysis.

Kids Nutrition Report

Case studies and insights into the market for children's food and drink.

Tailored consultancy

Every business is unique. We know that what works for one company doesn't work for another.

We provide food and drink companies with practical insights that support strategy and new product development.

www.new-nutrition.com

allene.bruce@new-nutrition.com

Will we still be wasting food in 2050?

Luiza Toma, M. March, B. Thompson, M. Haskell, J. Ferreira - SRUC

D. Stewart - JHI

SCOTLAND'S DINNER PLATE 2050

14 May 2019, Dynamic Earth, Edinburgh

Leading the way in Agriculture and Rural Research, Education and Consulting

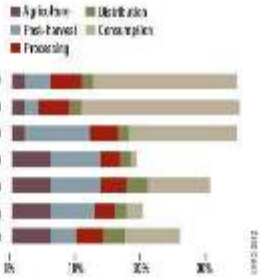
Food waste and loss – global context

SRUC

30%
CEREALS FOOD LOSSES

In industrialized countries, consumers throw away 286 million tonnes of cereal products.

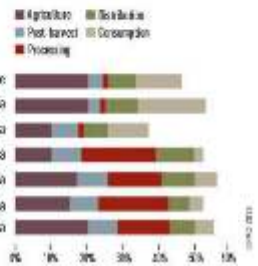
763 billion boxes of pasta



45%
FRUIT & VEGETABLES FOOD LOSSES

Along with roots and tubers, fruit and vegetables have the highest wastage rates of any food products; almost half of all the fruit and vegetables produced are wasted.

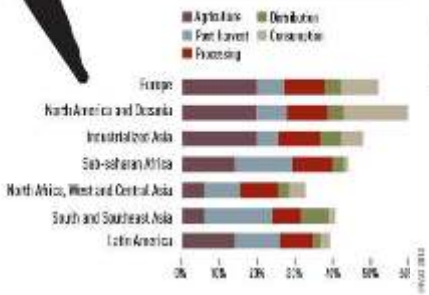
3.7 trillion apples



45%
ROOTS & TUBERS FOOD LOSSES

In North America & Oceania alone, 5 814 000 tonnes of roots and tubers are wasted at the consumption stage alone.

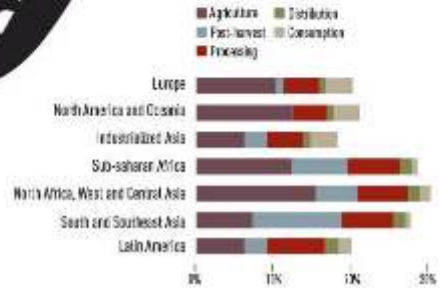
This equates to just over 1 billion bags of potatoes.



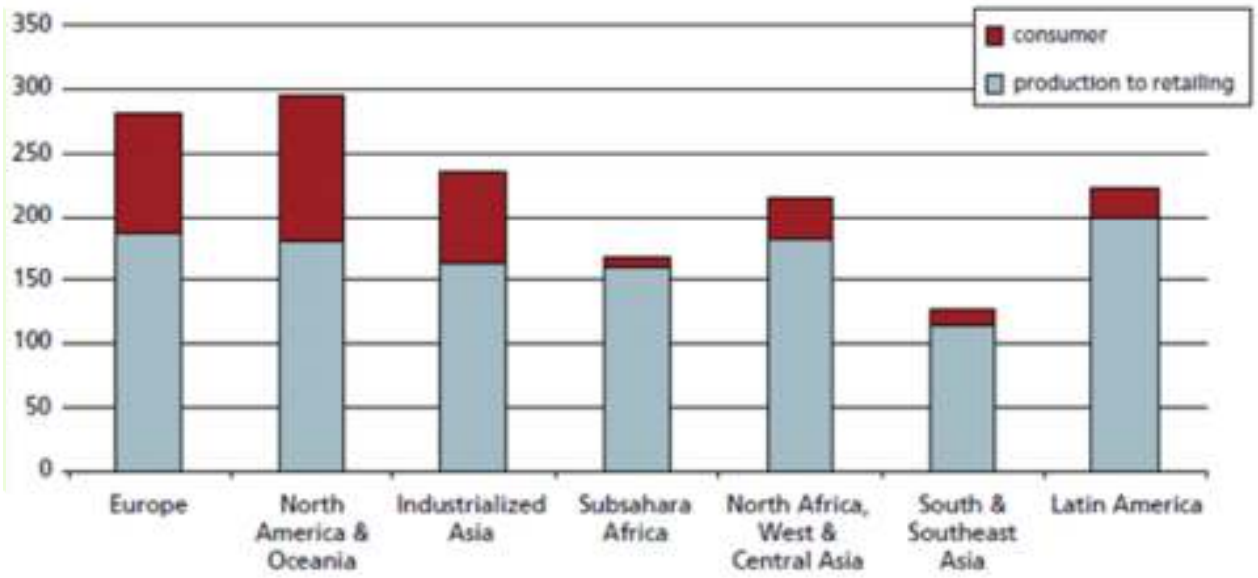
20%
OILSEEDS & PULSES FOOD LOSSES

Every year, 22% of the global production of oilseeds and pulses is lost or wasted.

This is the same as the olives needed to produce enough olive oil to fill nearly 11 000 Olympic-sized swimming pools.



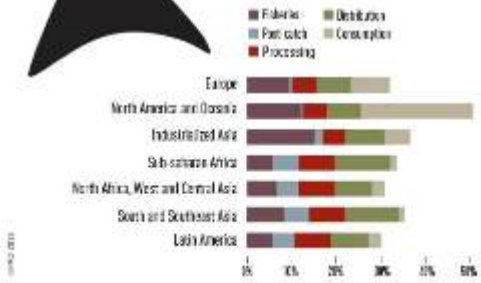
Per capita food losses and waste, at consumption and pre-consumptions stages, in different regions



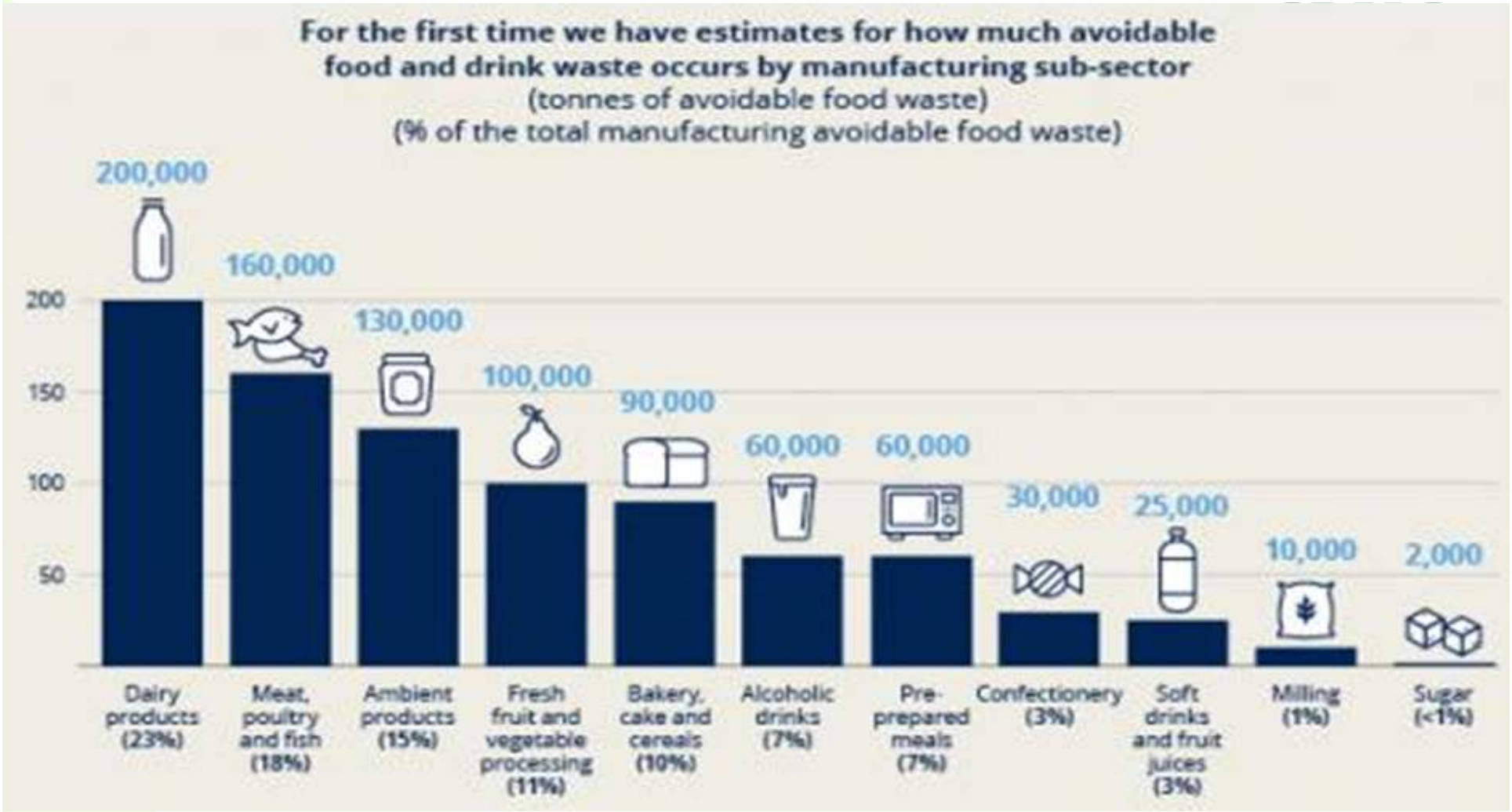
35%
FISH & SEAFOOD FOOD LOSSES

8% of fish caught globally is thrown back into the sea. In most cases they are dead, dying or badly damaged.

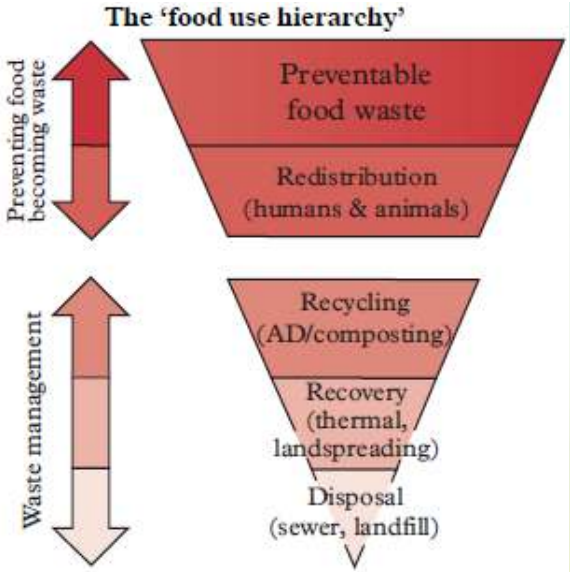
This is equal to almost 3 billion Atlantic salmons.

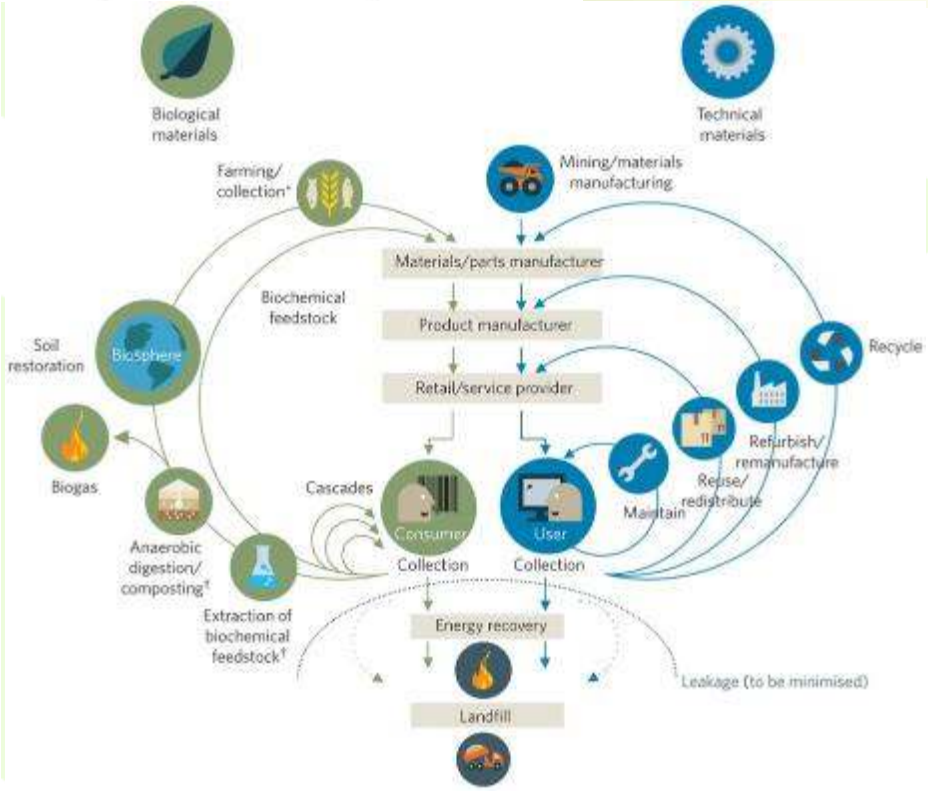


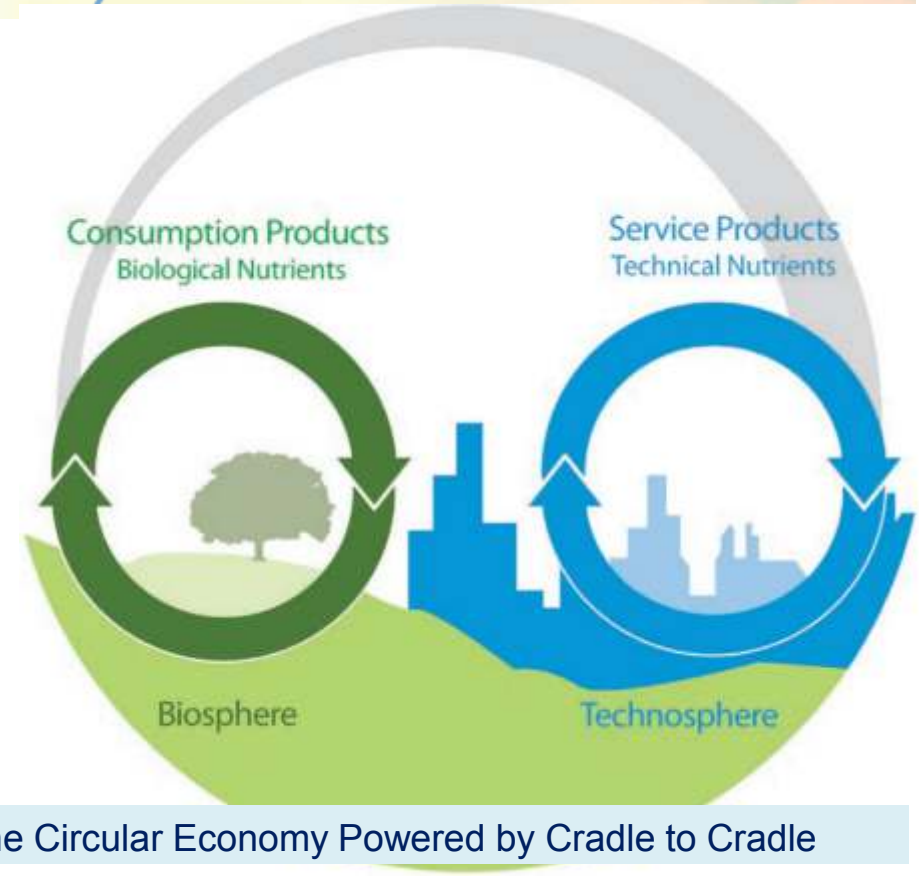
Sources of Food Waste (UK)



Zero Waste Scotland, 2016

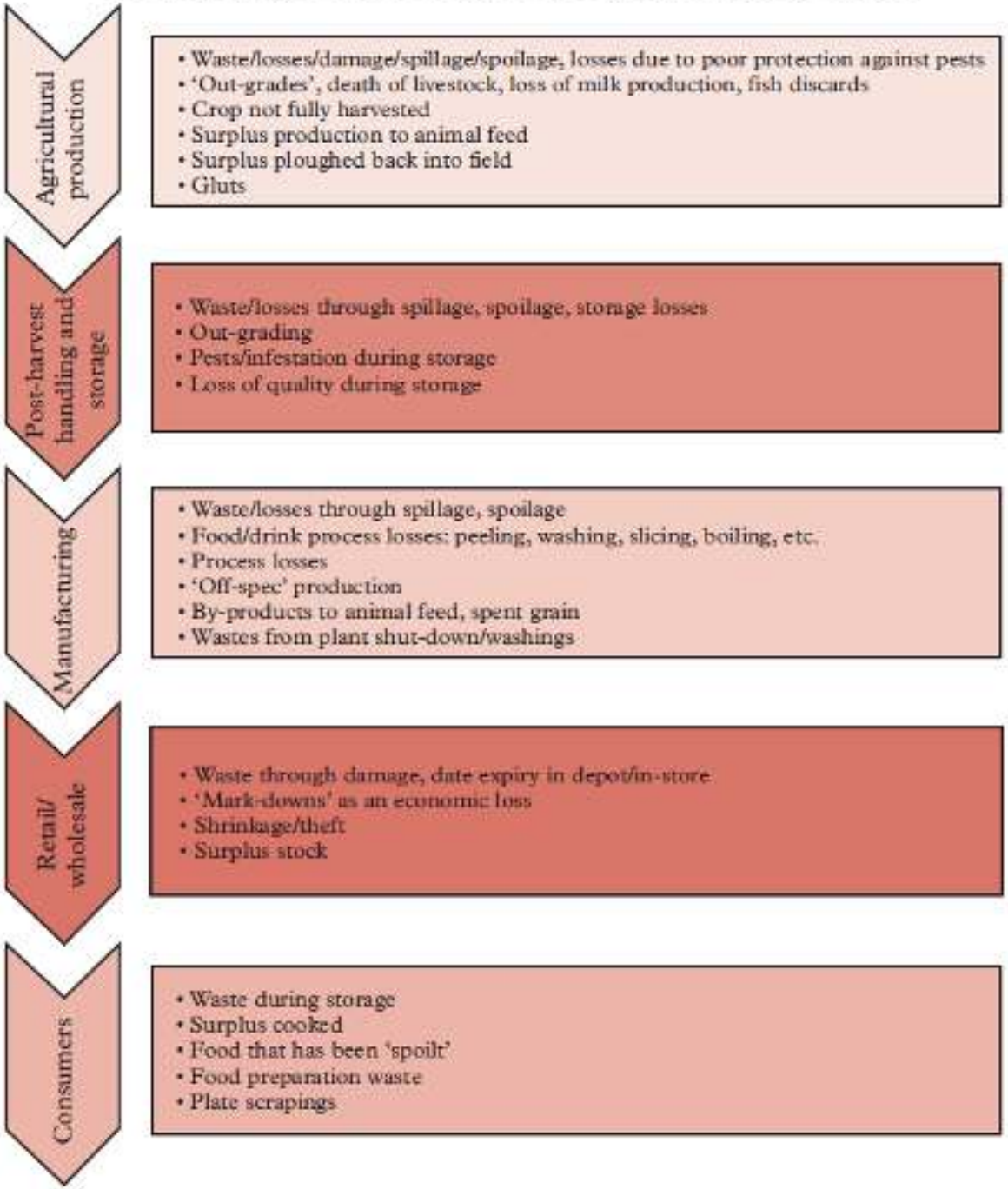






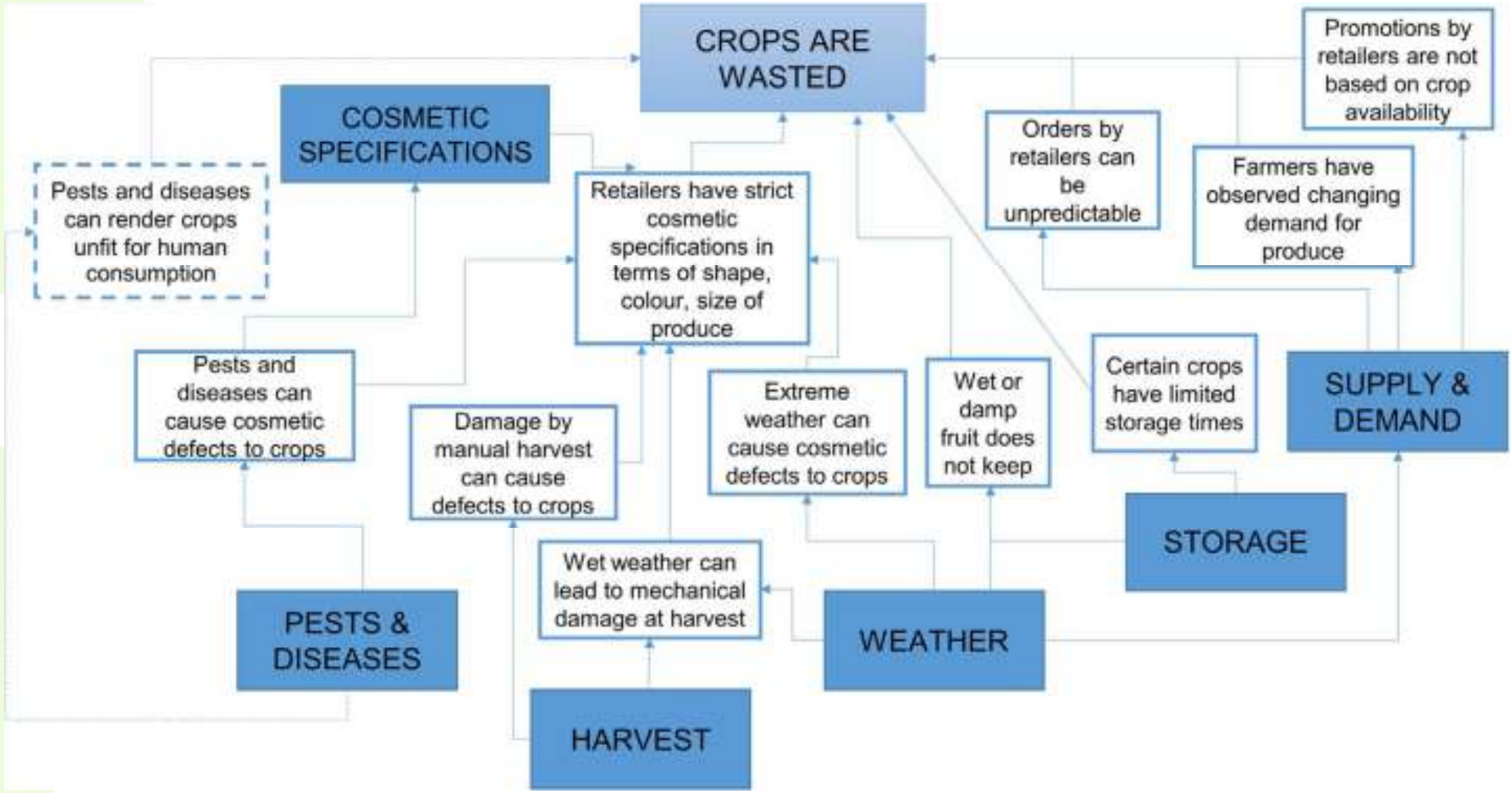
EPEA, The Circular Economy Powered by Cradle to Cradle

The language of food waste along the supply chain



SRUC

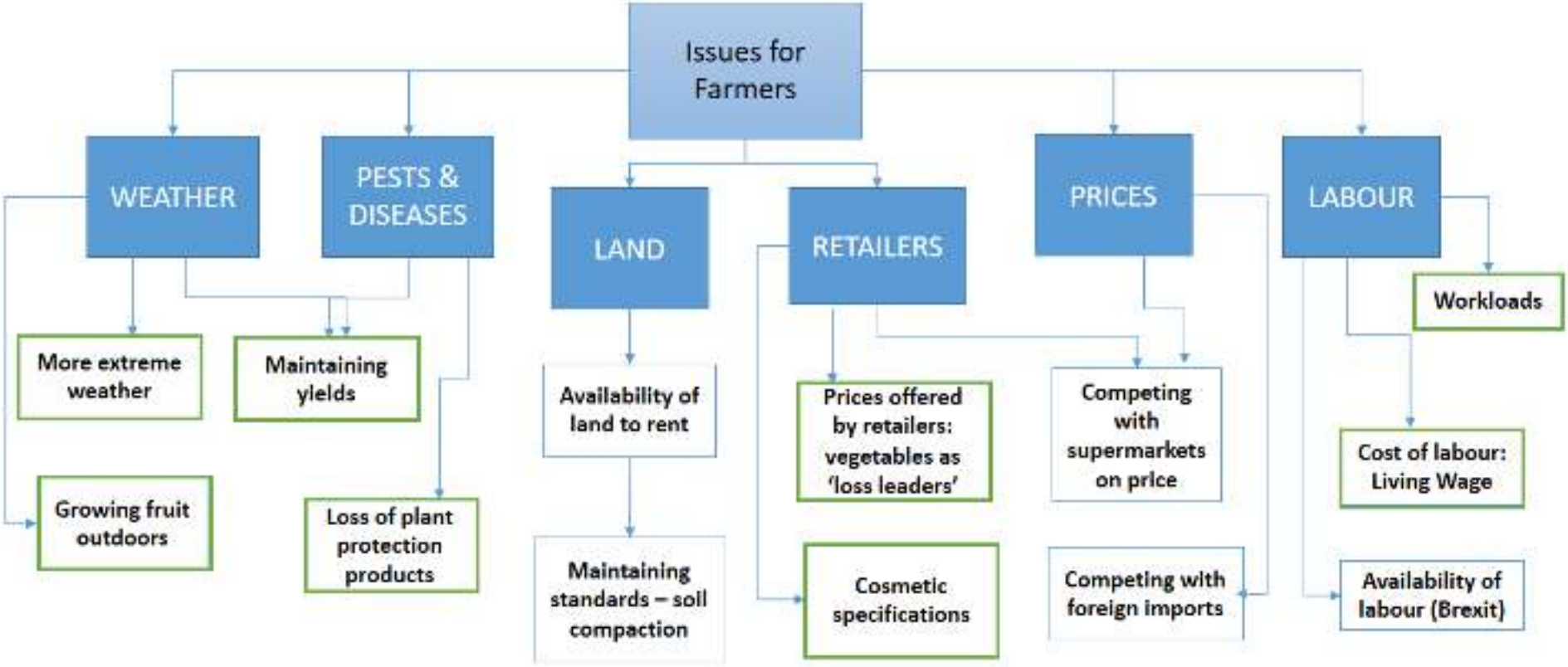
FWL in primary production - causal map in fruit & vegetable industry



Beausang, Hall, Toma, *Resources, Conservation & Recycling*, 2017

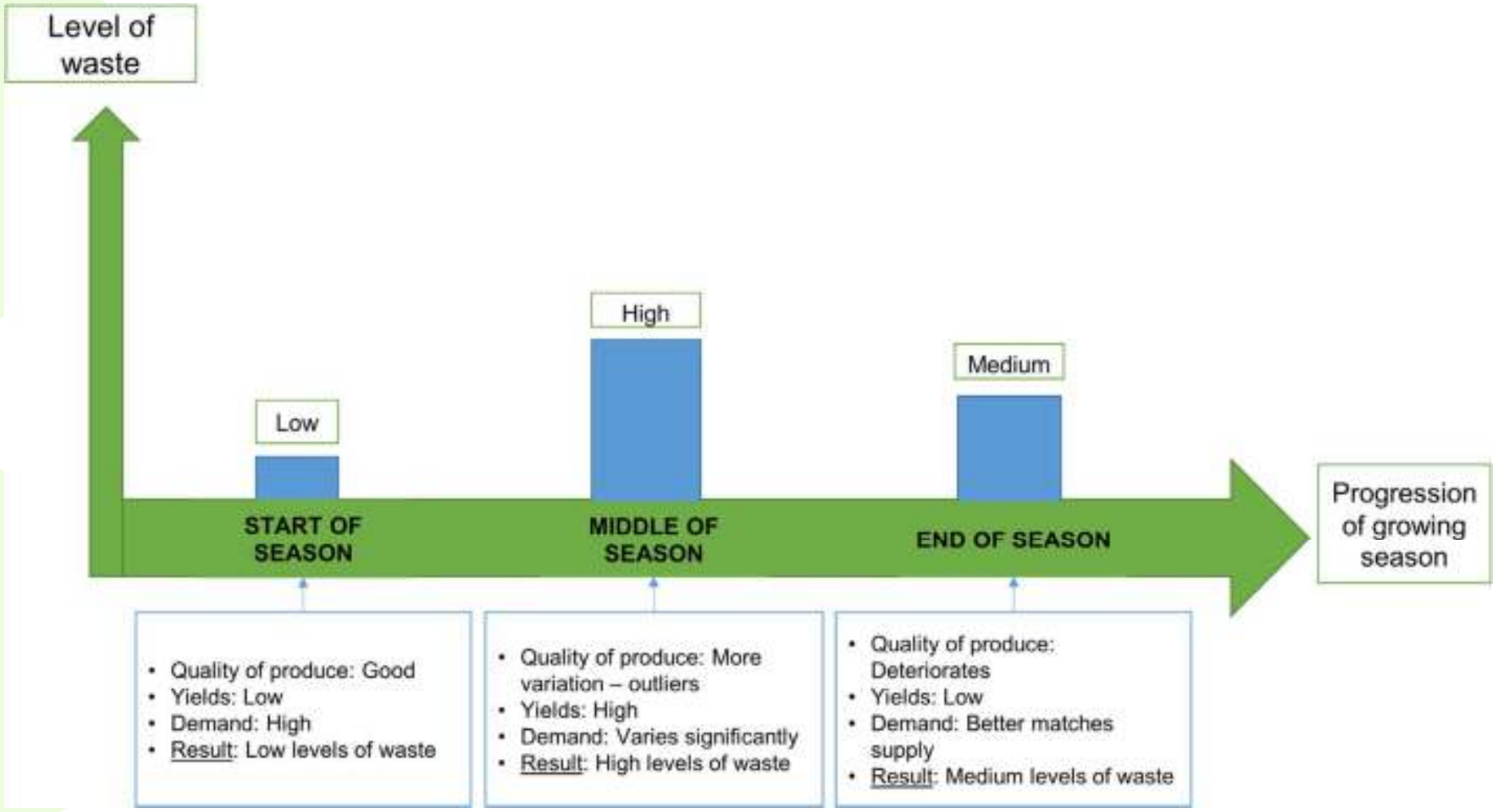
FWL in primary production – main issues for fruit & vegetable growers

- **In-depth interviews with fruit & vegetable producers**
- **different crops/size/access to market (2016)**



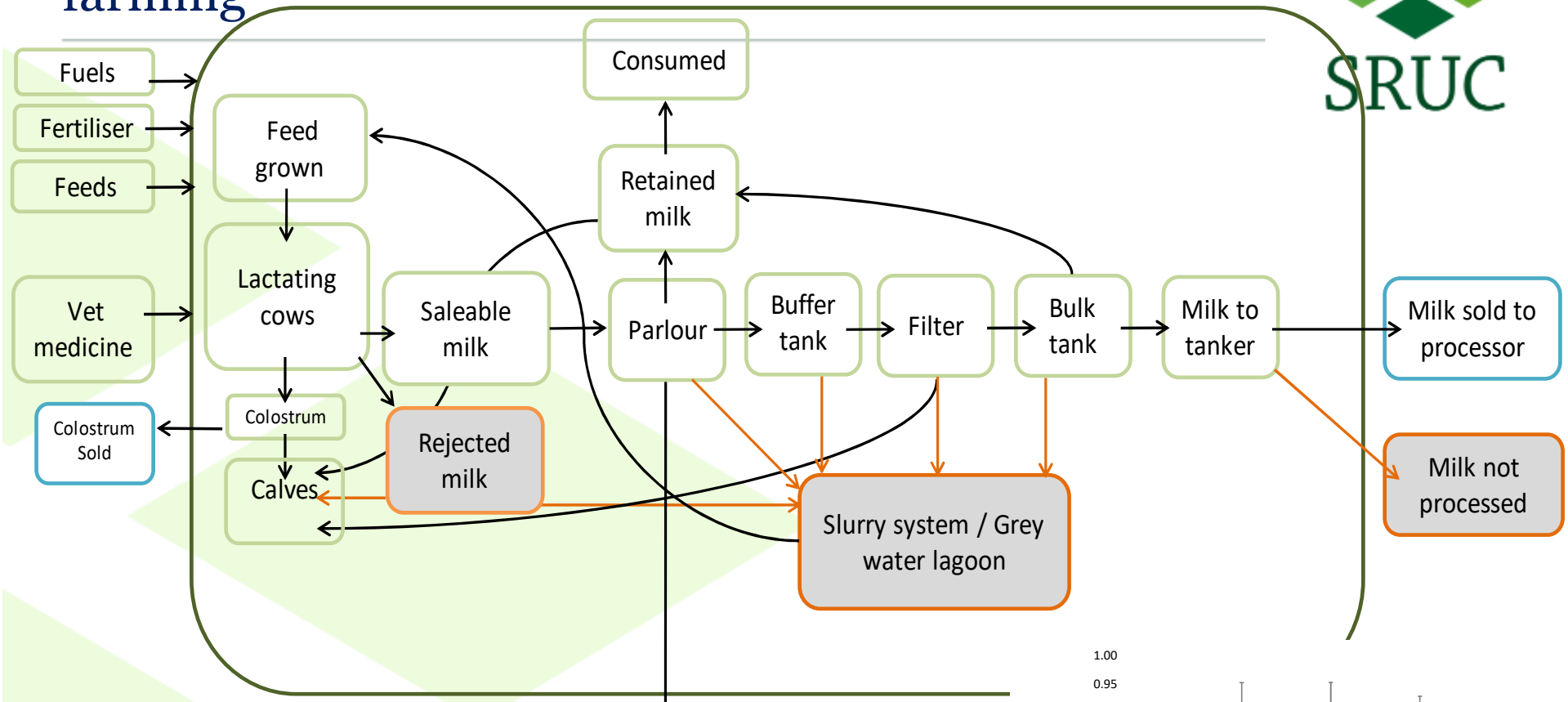
Beausang, Hall, Toma, *Resources, Conservation & Recycling*, 2017

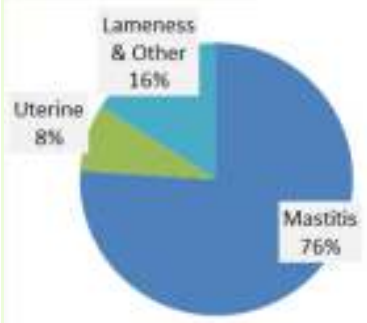
FWL in primary production – intensity during fruit & vegetable growing season

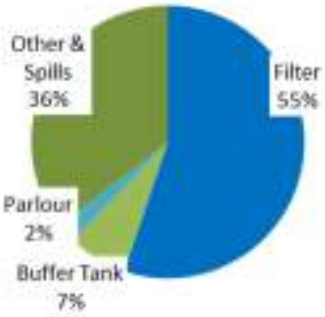


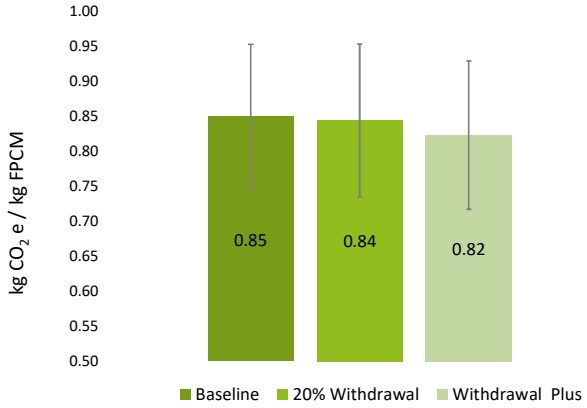
Beausang, Hall, Toma, *Resources, Conservation & Recycling*, 2017

FWL in primary production – causes and flows in dairy farming



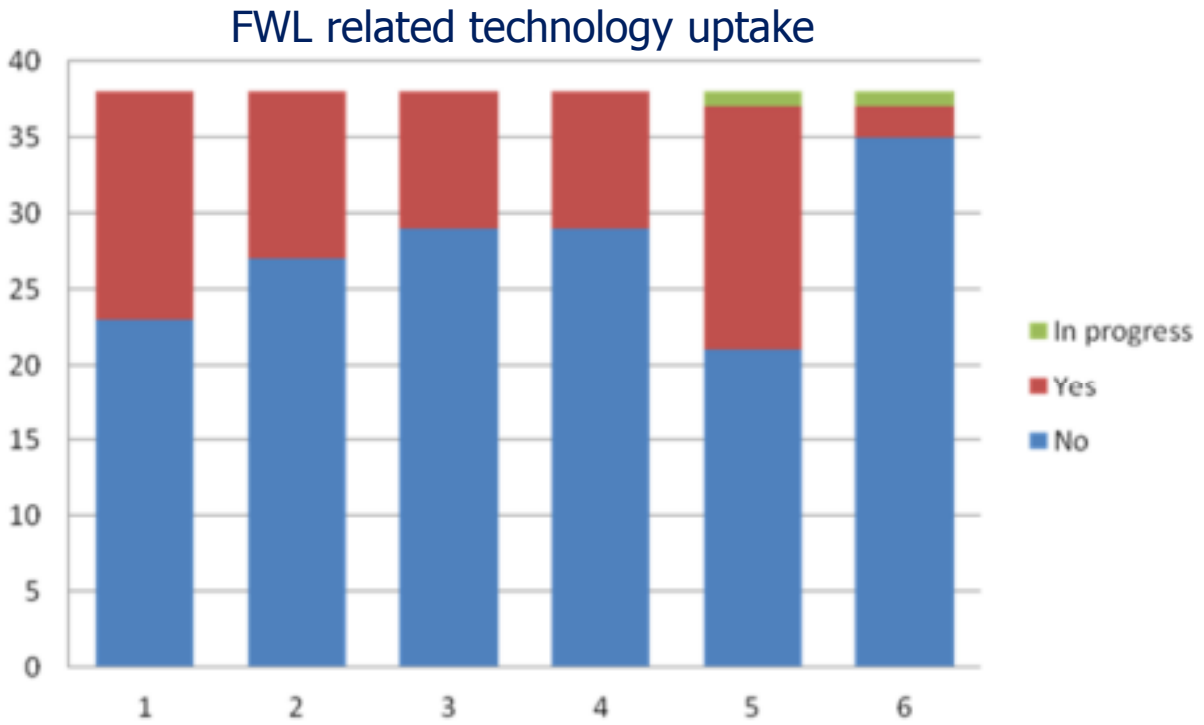






March, Thompson, Haskel, Toma, AES Warwick 2019 (under review at *Frontiers*)

How to prevent food waste at primary production stage?



1. **Sensor technology that measures milk characteristics such as colour, temperature, electrical conductivity**
2. **Management information system that interprets sensor data for health condition diagnosis**
3. **Management information system that integrates sensor information with farm financial information to support decision making**
4. **PCR for mastitis strain detection**
5. **Milking equipment to reduce residual milk left in the system**
6. **Robotic milking**

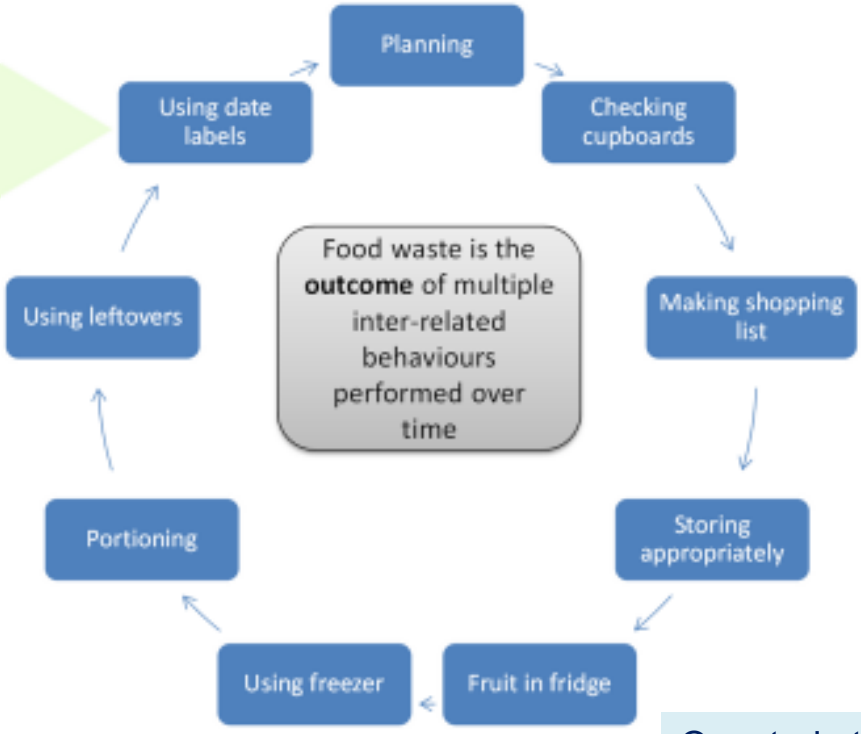
Thompson, RD3.1.4 stakeholder meeting, Edinburgh, 2017

FWL at consumption stage

- Is food waste simply a consequence of everyday life and the constraints faced by modern households?

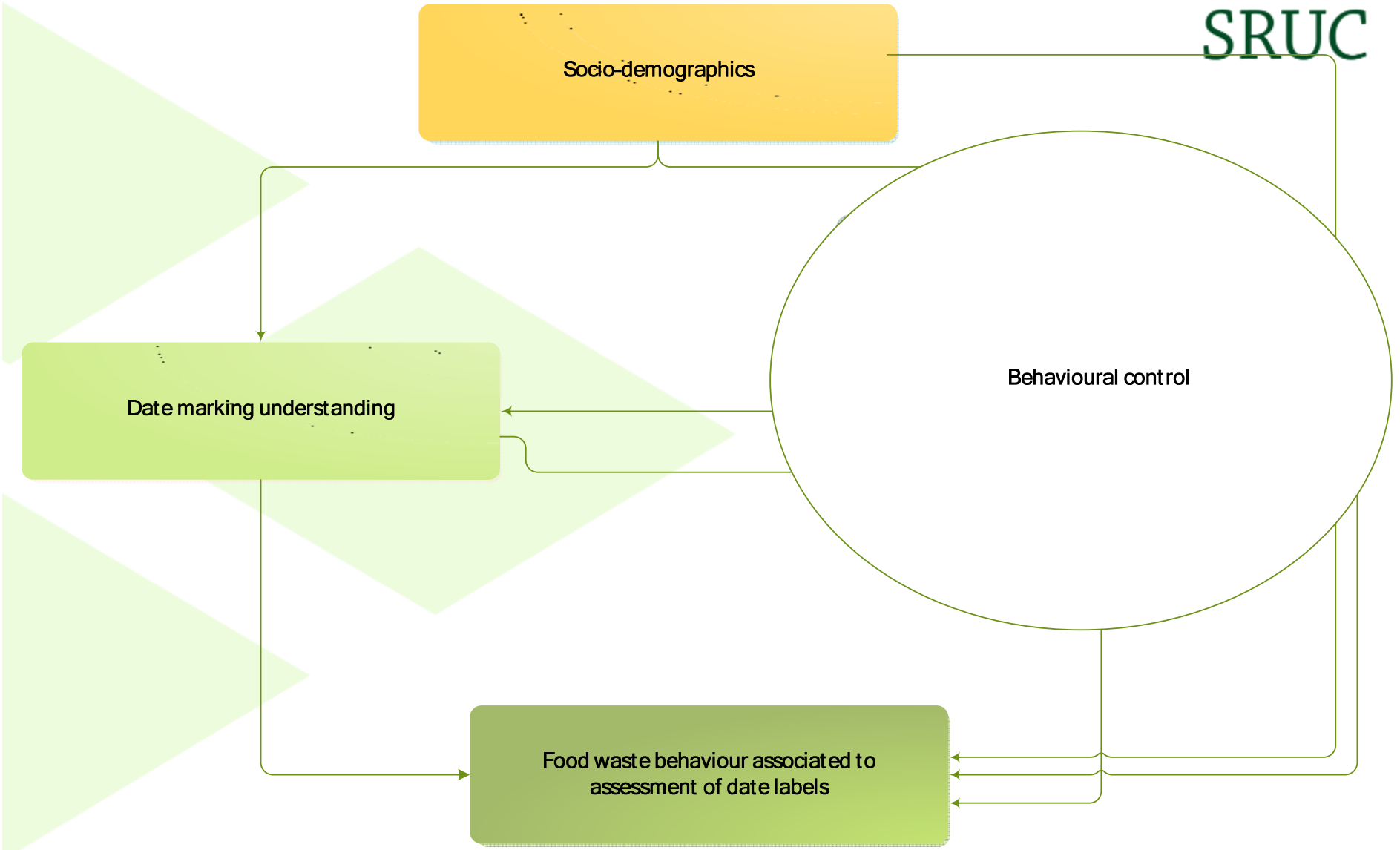
  or

- is there a number of inter-related behaviours (over which households have control) associated with lower levels of food waste?

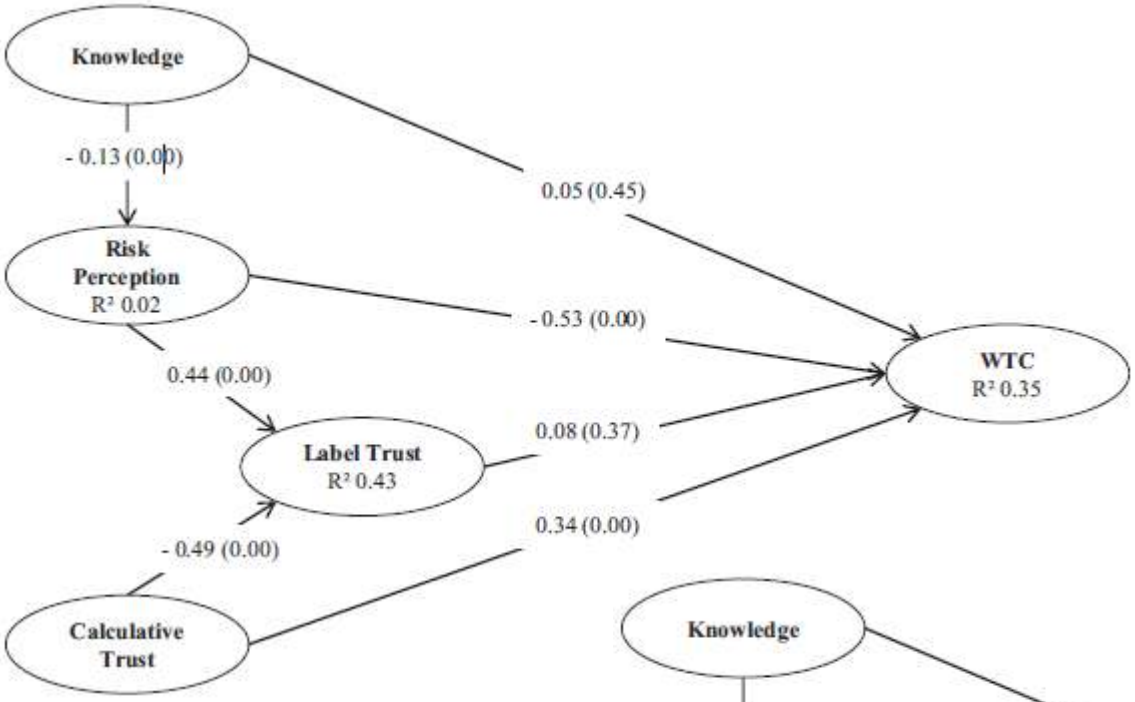


Quested et al. 2013

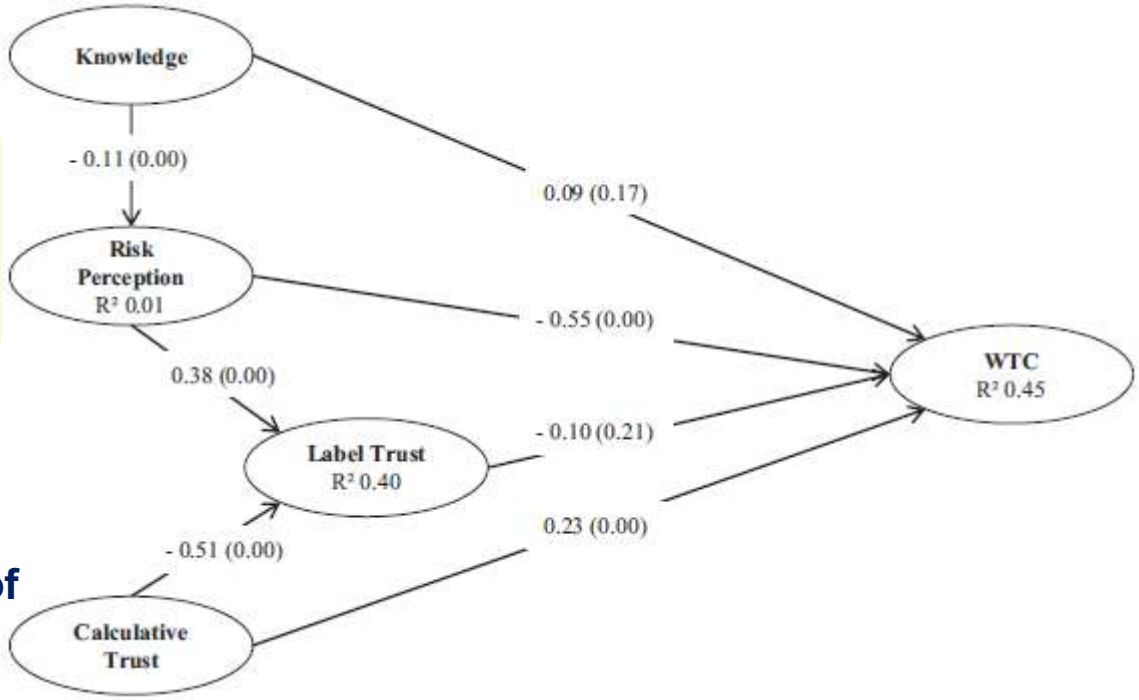
How to prevent food waste at consumption stage?



Toma, Costa Font, Thompson, *Operational Research* 2017

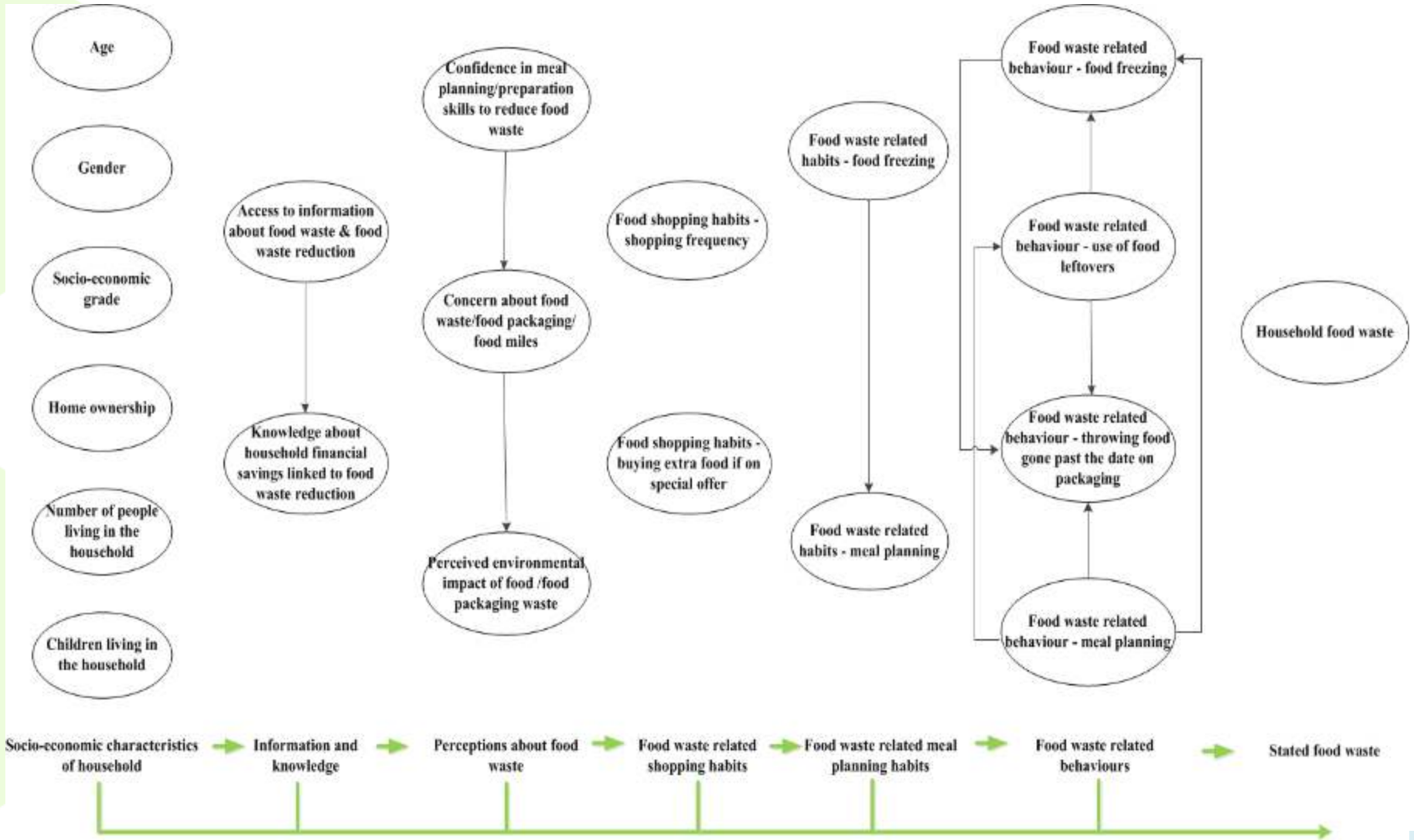


SEM – WTC yoghurt/cheese (best-before date) 'consumer communication that goes beyond improving expiry-date knowledge and addresses the multifaceted nature of related risk perceptions and conceptions of date-label trust will be required'

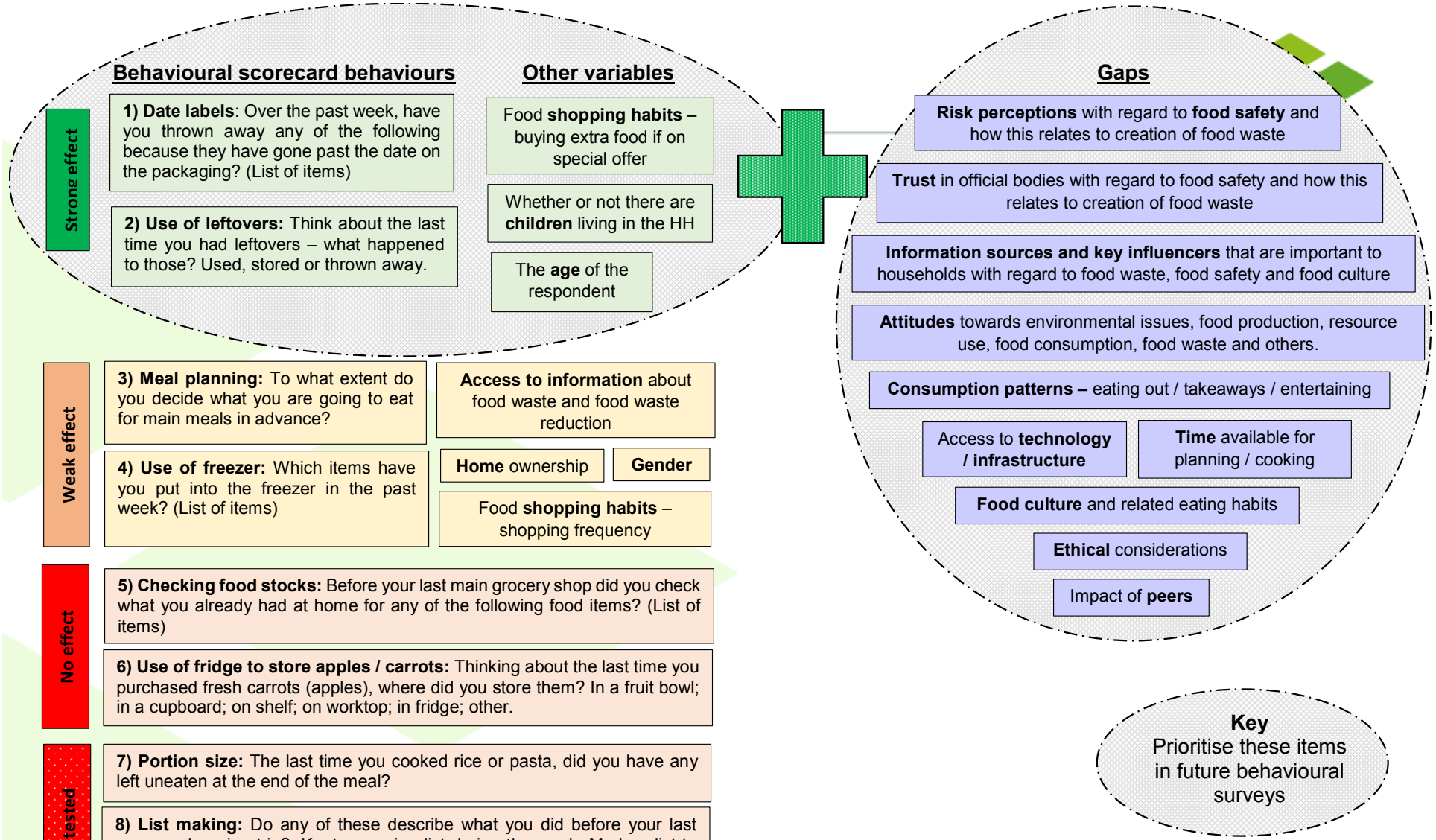


Thompson, Toma, Barnes, Revoredo-Giha, *Waste Management*, 2018

Data: WRAP Household Food Waste Tracker – Scottish sample (5 waves autumn/spring 2012-2016) & SEM (DWLS)
Similar variance explained (48% in four waves & 38% in one wave) & ranking of determinants in models (date labelling related behaviour, age, children, special offer related behaviour, use of leftovers)

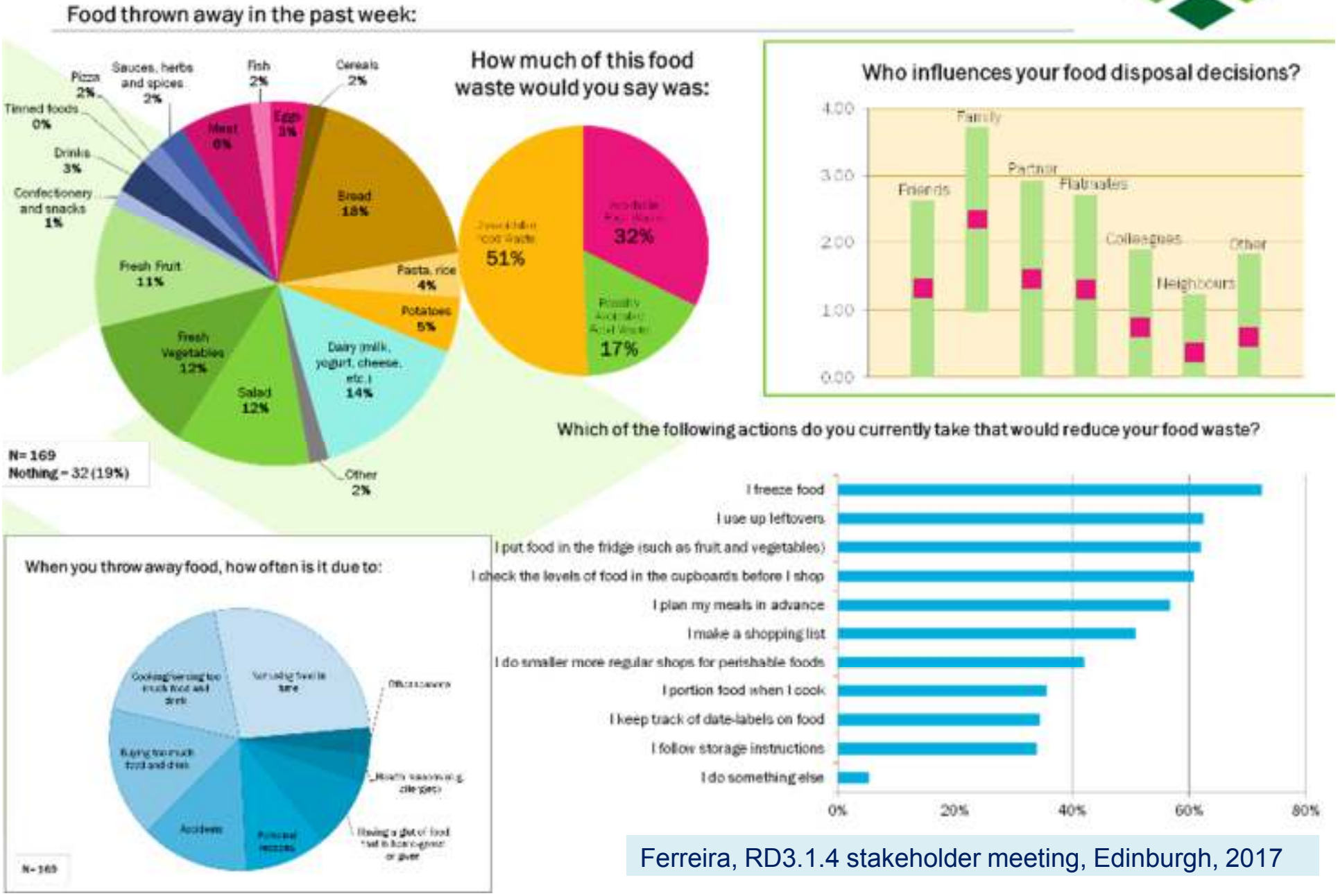


Toma, Hall, Thompson, EAAE Parma 2017



Note: The scorecard behaviours listed against 'Could not be tested'
If these behaviours are to be included in future surveys they need to be worded differently and the response scales need to be better structured.

How to prevent food waste at consumption stage?



Ferreira, RD3.1.4 stakeholder meeting, Edinburgh, 2017

How to prevent food waste at consumption stage?

KNOWLEDGE EXCHANGE AND PUBLIC AWARENESS

SRUC

Passport

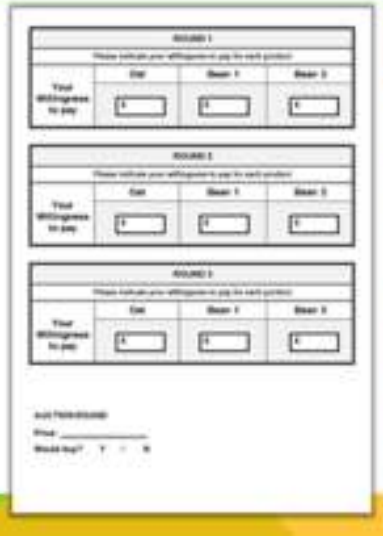
- Food waste recycling activity passport
- Sticker as incentive for correct food waste recycling

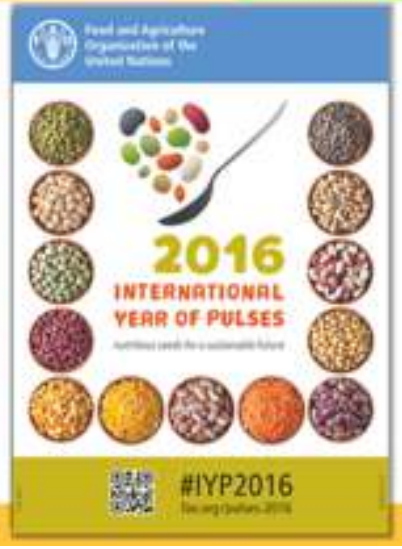
Sticker

Over 70 passports were distributed to children.

FOOD WASTE REDUCTION LABEL AUCTION GAME

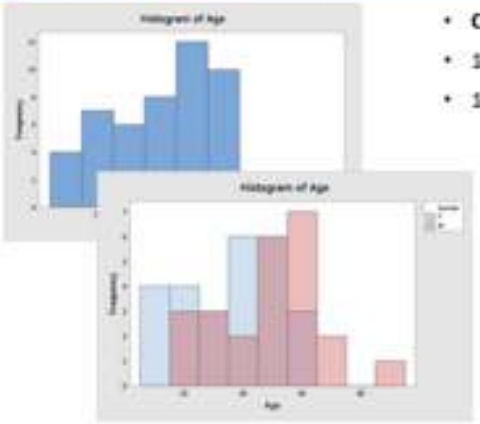
SRUC





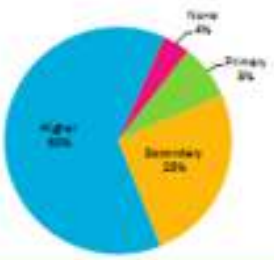
FOOD WASTE REDUCTION LABEL AUCTION GAME

SRUC



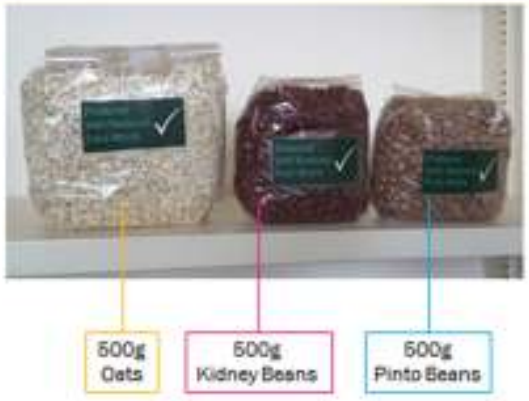
- **Over 50 participants for auction**
- 11 to 93 years of age
- 1:1 gender ratio

Education



FOOD WASTE REDUCTION LABEL AUCTION GAME

SRUC



Round 1: Base Price

- 3 unlabelled packages of 500g of oats, dry kidney beans, dry pinto beans

Round 2: Label

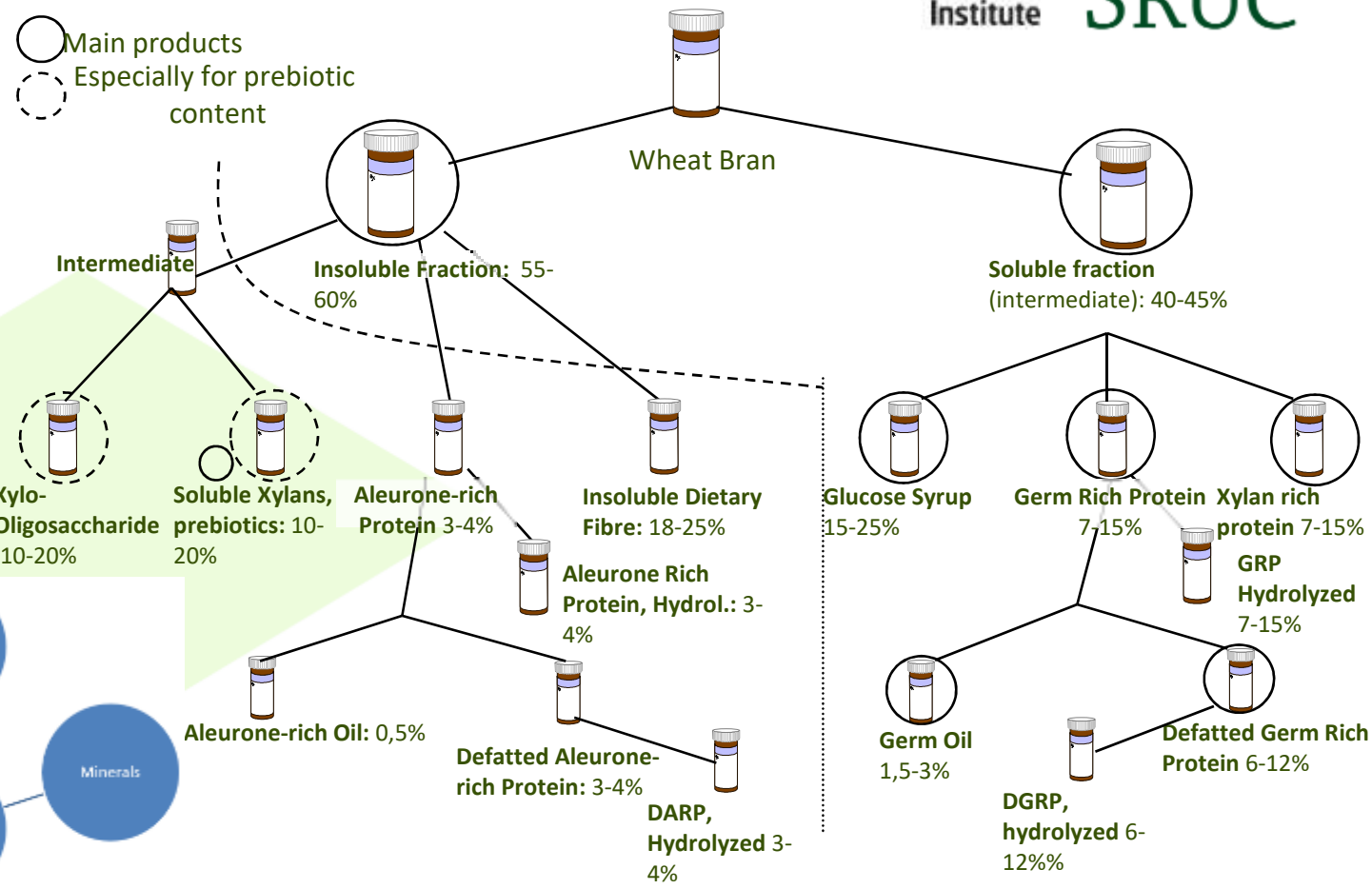
- same 3 packages, but now with a "Produced with Reduced Food Waste" label

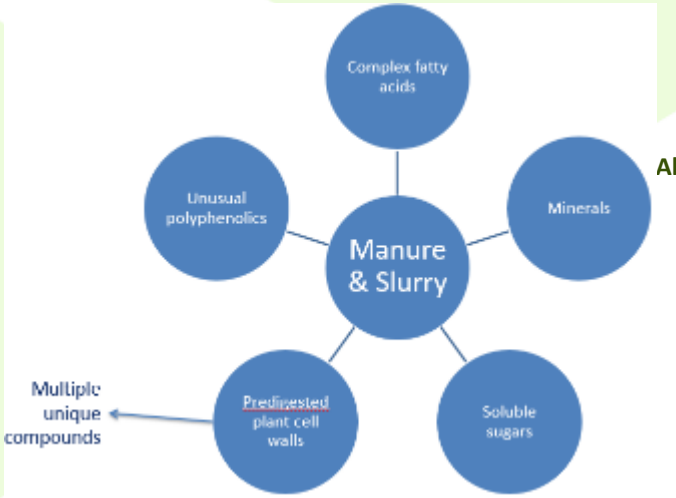
Round 3: Information

- short explanation about the label

Ferreira, Akaichi, RHS 2016

Urban food and horticultural wastes as value sources of sustainable chemicals ingredients and feedstocks



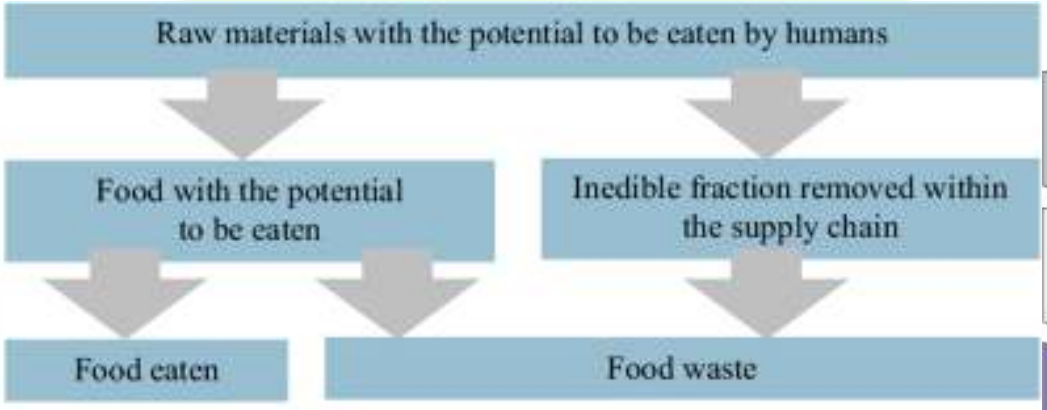


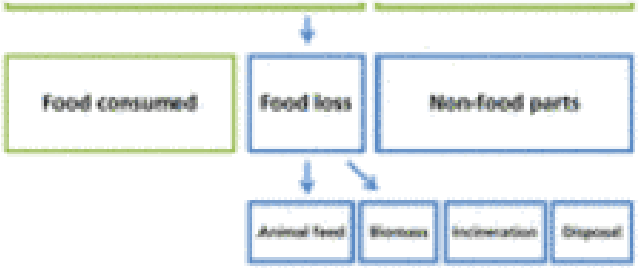
Stewart, RD3.1.4 stakeholder meeting, Edinburgh, 2017

'Food Loss' (FAO 2011)
'Post-harvest Losses' (Bourne 1977, Prusky 2011)

'Food Waste' (FAO 2011)

"Food Waste" (Parfitt et al 2010)
"Food loss and waste" (Smil 2000)





Production (including post-harvest handling and storage)	Mortality of animals (on-farm or during transport); Fish discards; Loss of milk due to mastitis; Crops not fully harvested or green-harvested; Product damage during harvest, storage or transport; Products sorted out due to cosmetic requirements; Unpredictable changes of contract terms
Processing	Process losses (peeling, washing, slicing, boiling, etc.); Wastes from plant shut-down/washings, spillage, spoilage; Product damage during storage; Suppliers having to take back products that were not sold
Retail	Date expiry in depot/in-store; Products not sold despite 'mark-downs'; Surplus stock; Product damage or quality/weight reduction during storage; Products sorted out due to cosmetic requirements
Consumers	Waste during storage; Surplus cooked; Food that has been 'spoilt'; Food preparation waste; Plate scrapings

- FWL definitions (FAO, WRI, WRAP, FUSIONS, FEEDBACK, NORDIC FOOD WASTE…) are to be used based on measurement purpose – waste management/valorisation, food security (FLW Standard by FLW Protocol - UNEP, WRAP, WRI)

- WHERE-based definitions – loss if closer to primary production end, waste if at retail, consumption
  - (and further variations e.g. harvest level/preharvest/postharvest)
- SAFE-based definitions – loss if less safe, waste if still safe to eat
- AVOIDABLE vs UNAVOIDABLE (edible/inedible – by-products?)
- INTENDED vs UNINTENDED USE (even if still reaching human consumption after redistribution?)

- Economic justification (‘not profitable to harvest’) included as ‘loss’ in some definitions
- Ethical aspects (consumption of food surplus to caloric requirements?)
- Technological development aspects – may lead to lower FLW but confuse measurement
- Cultural aspects – truly by-product, what’s edible?
- Food safety – beyond agreed set(s) of guidelines, how safe is safe?
- Perceptions & sensitivity – what 'sounds’ better – waste or loss?

To supplement Directive 2008/98/EC of the European Parliament and of the Council as regards a **common methodology** and minimum quality requirements for the **uniform measurement** of levels of food waste.

https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2018-705329_en

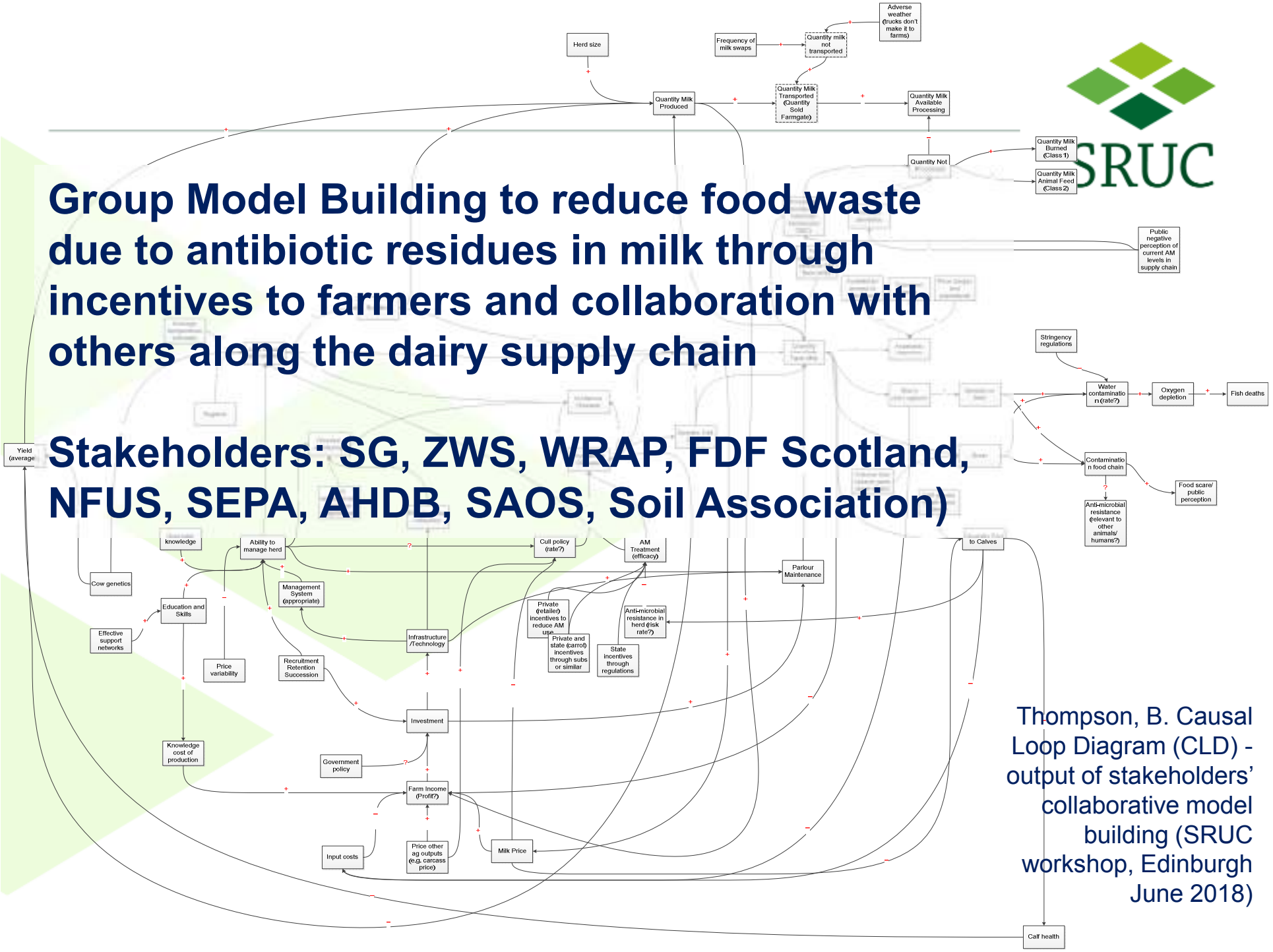
The Revised EU Waste Legislation, adopted on 30 May 2018 by co-legislators, calls on the EU countries to take action to reduce food waste at each stage of the food supply chain, monitor food waste levels and report back regarding progress made.

‘4a. “food waste” means all food as defined in Article 2 of Regulation (EC) No 178/2002 of the European Parliament and of the Council (*) that has become waste;

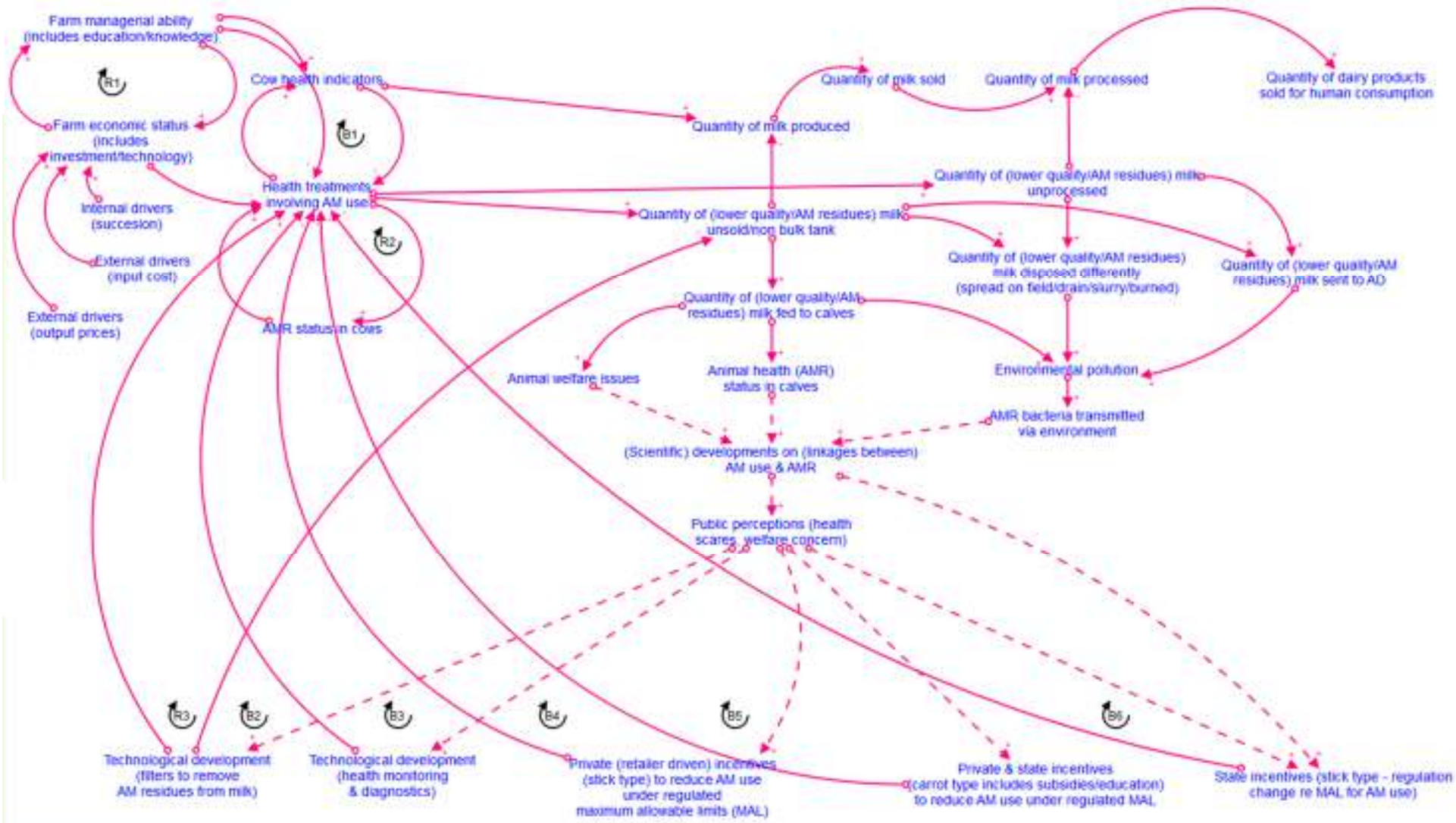
(*) Regulation (EC) No 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food safety (OJ L 31, 1.2.2002, p. 1).’;

Group Model Building to reduce food waste due to antibiotic residues in milk through incentives to farmers and collaboration with others along the dairy supply chain

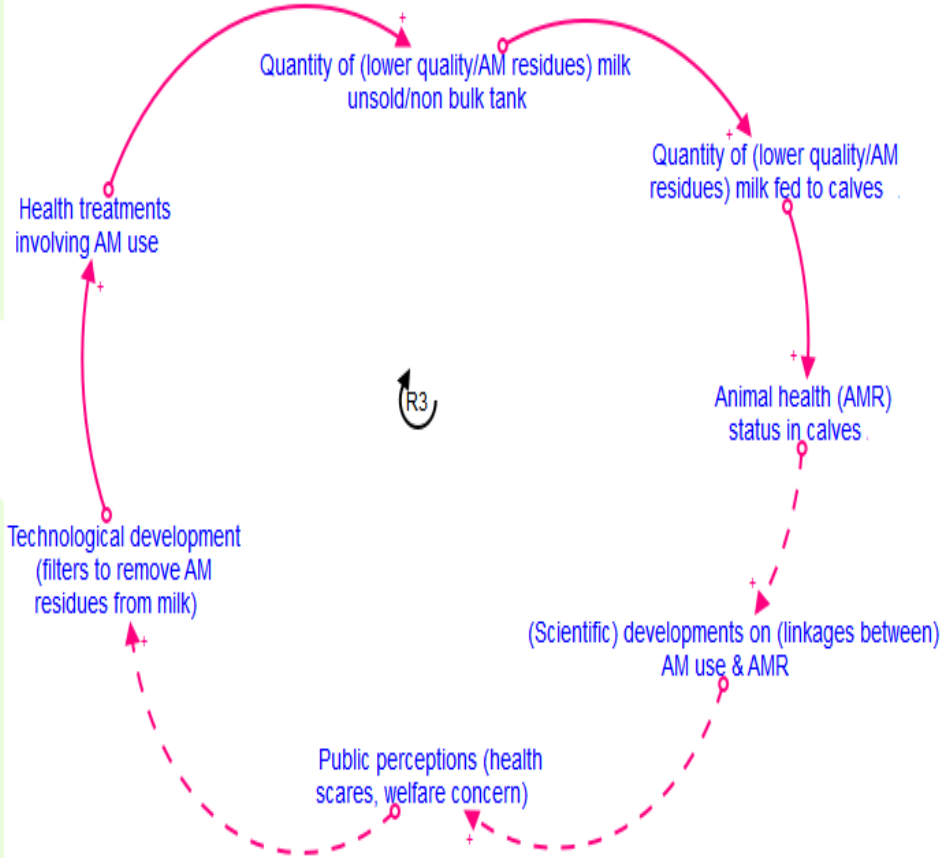
Stakeholders: SG, ZWS, WRAP, FDF Scotland, NFUS, SEPA, AHDB, SAOS, Soil Association)

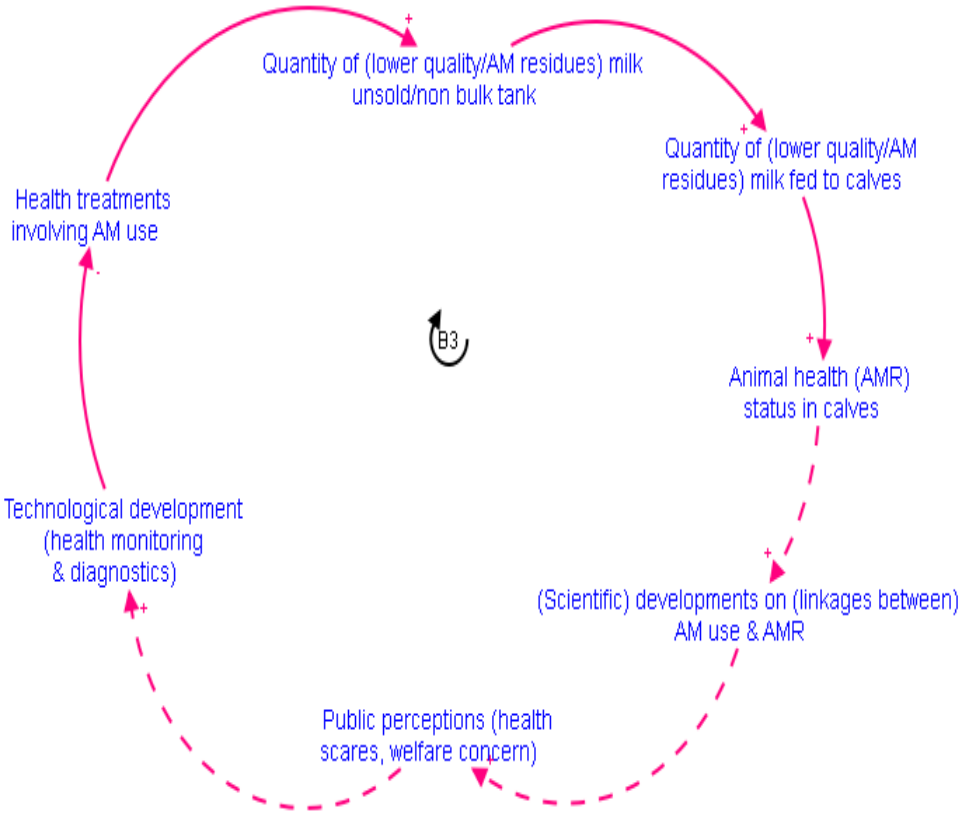


Thompson, B. Causal Loop Diagram (CLD) - output of stakeholders' collaborative model building (SRUC workshop, Edinburgh June 2018)



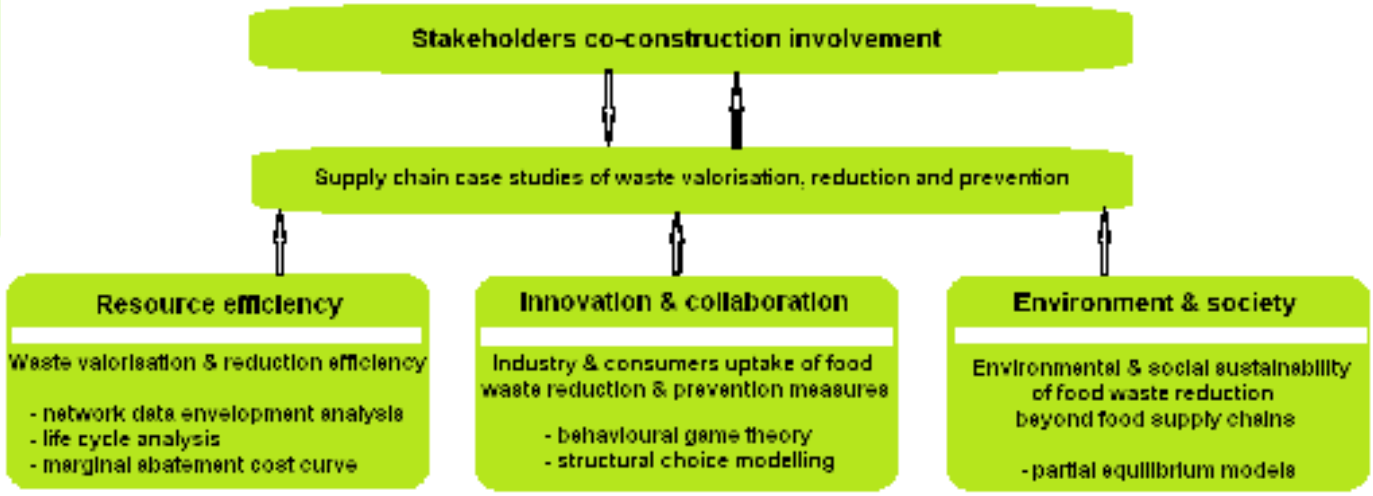
Toma, Thompson, March, Haskel, 2018. Dairy waste and AM use – GMB Causal Loop Diagram (Stella Architect software)


Quantity of (lower quality/AM residues) milk unsold/non bulk tank
Quantity of (lower quality/AM residues) milk fed to calves
Health treatments involving AM use
R3
Animal health (AMR) status in calves
Technological development (filters to remove AM residues from milk)
(Scientific) developments on (linkages between) AM use & AMR
Public perceptions (health scares, welfare concern)


Quantity of (lower quality/AM residues) milk unsold/non bulk tank
Quantity of (lower quality/AM residues) milk fed to calves
Health treatments involving AM use
B3
Animal health (AMR) status in calves
Technological development (health monitoring & diagnostics)
(Scientific) developments on (linkages between) AM use & AMR
Public perceptions (health scares, welfare concern)

Will we still be wasting food in 2050?

- Likely, but less
- Harmonisation of FWL definitions and assessment methodologies at global level
- Supply chain collaboration - clear distribution of responsibilities, sharing innovation & knowledge



SRUC & JHI, RD3.1.4 'Preventing food waste; - forecasting simulation analysis of wider impacts of FWL prevention/reduction (2019-2021)

Acknowledgements

- Scottish Government funded research (RESAS SRP RD3.1.4 Preventing food waste, 2016-21) & SEFARI
- Zero Waste Scotland & WRAP for access to the datasets, comments on survey questionnaires
- Respondents to farmer & consumer surveys
- Participants at GMB supply chain workshops

Scotland's Dinner Plate 2050: Emergent safety threats and solutions

Nicola Holden

The James Hutton Institute

Food Safety threats: Where are we now?

The James Hutton Institute

Global situation (WHO):

- 1:10 fall ill annually
- 420,000 deaths
- 1:3 child deaths
- Unsafe food causes more than 200 diseases

Tedros Adhanom Ghebreyesus discusses socio-economic inequalities from his perspective as director general of the World Health Organization. Photo by WHO/Pierre Albouy.

WHO chief calls for food safety focus

By **Joe Whitworth** on April 30, 2019

GENEVA — There is no such thing as one type of food safety for the rich and another for the poor, according to the head of the World Health Organization (WHO).

Food Safety News

Food Safety threats: Where are we now?

The James Hutton Institute

Jan - Apr 2019: 21 global food safety investigations

Salmonella Poona

E. coli O26

INFOSAN

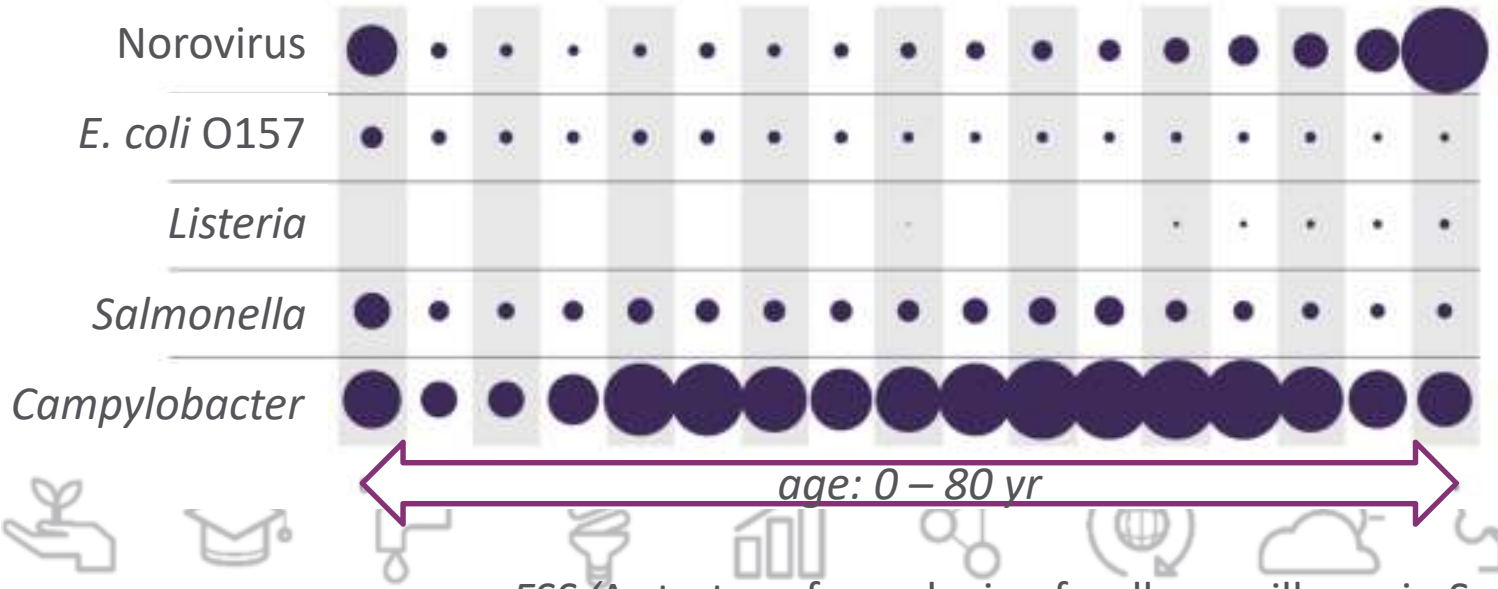
Food Safety threats: Where are we now?

European region:

- 23M cases annually
- 5,000 deaths
- 15M cases Norovirus
- 5M cases *Campylobacter*

Scotland:

- 43,000 cases annually
- 5,800 GP presentations / 500 hospital admissions



FSS 'A strategy for reducing foodborne illness in Scotland' Apr-2017

UK notable outbreaks

Impact on business

E. coli
1 May 2019

Recalls (Q1 2019) n=34

- Allergens = 27
- Harmful microbes = 3
- Chemical = 2
- Metal/Plastic = 2

Salmonella
25 April 2019

Salmonella
25 April 2019

What has the response been?

NEWS

Manchester abattoir fined over £18,000 for failings

Manchester Abattoir Ltd (formerly Cheshire Halal) fined £18,285.92 after pleading guilty to breaching regulations.

9 April 2019

FSA webpage > News

Search all publications

GUIDANCE 3 May 2019
Guidance for Local Authorities – Cheese made from Unpasteurised Milk - May 2019

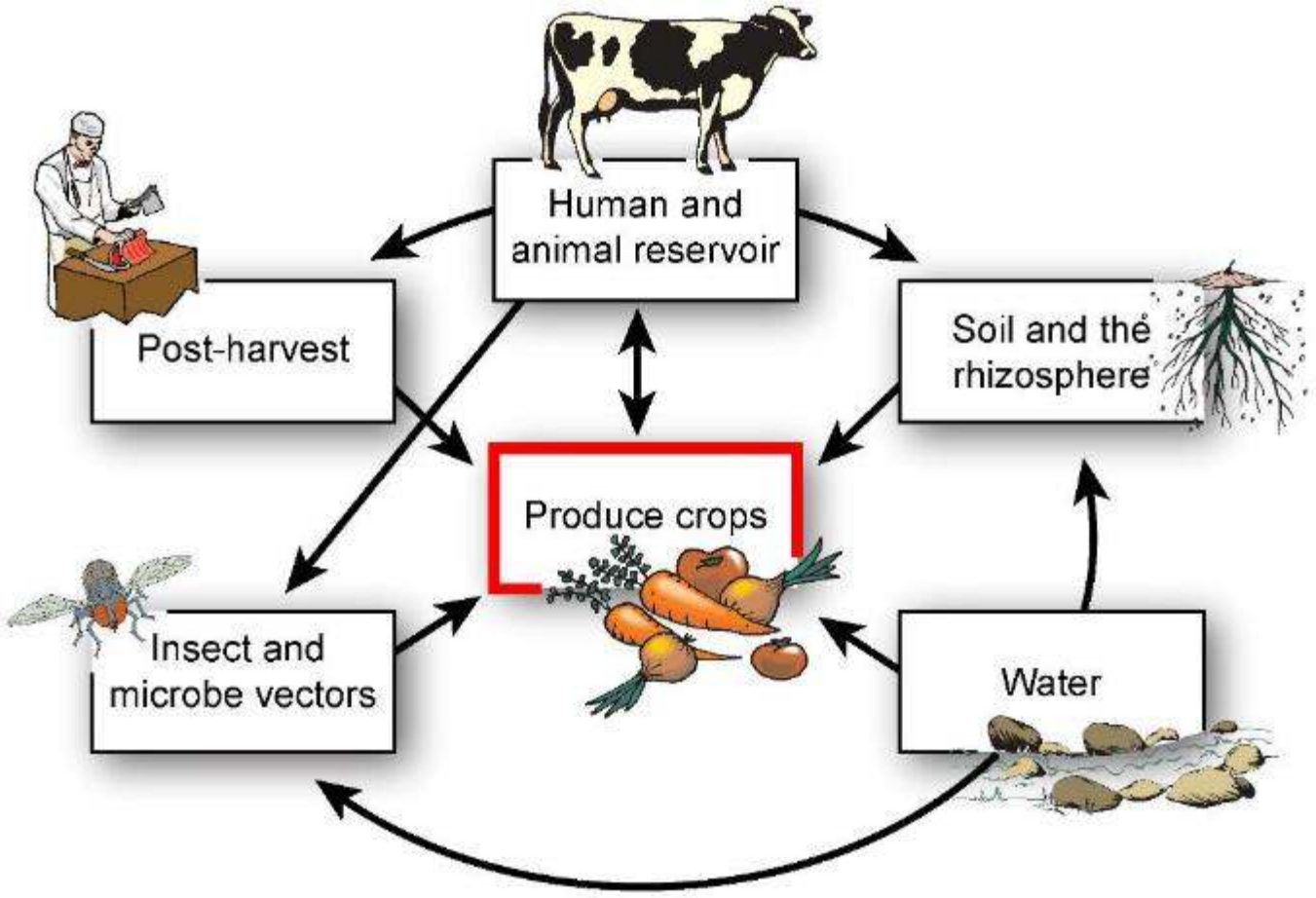
GUIDANCE 19 February 2019
Advice on measures required to protect consumers from infection with Shiga toxin-producing E. coli (STEC)

PUBLICATION 26 November 2018
E. coli O157 Super-shedding in Cattle and Mitigation of Human Risk

PUBLICATION 1 December 2016
Employing source attribution and molecular epidemiology to measure the impact of interventions on human campylobacteriosis in Scotland

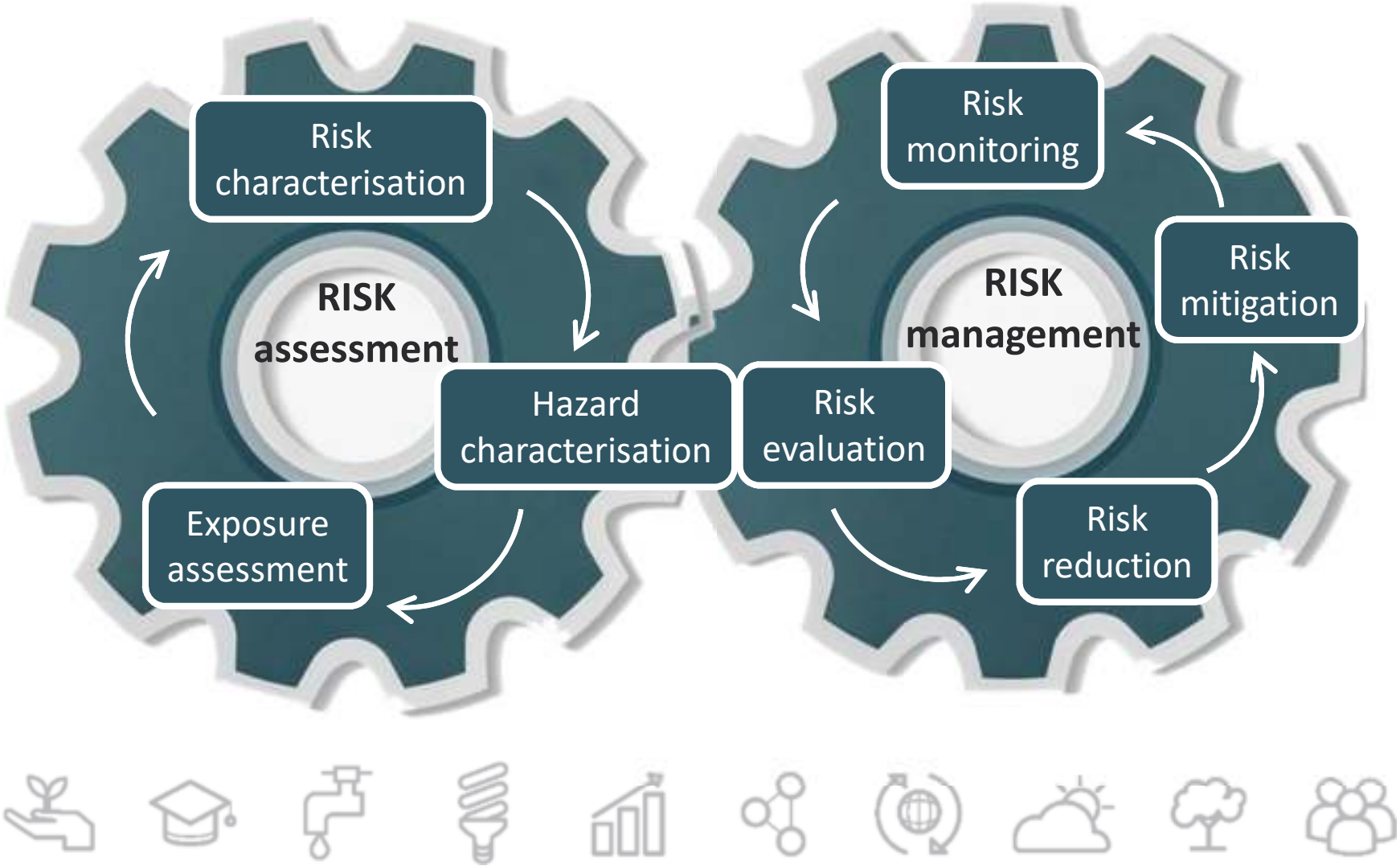
FSS webpage > Publications

Where are the food safety hazards?



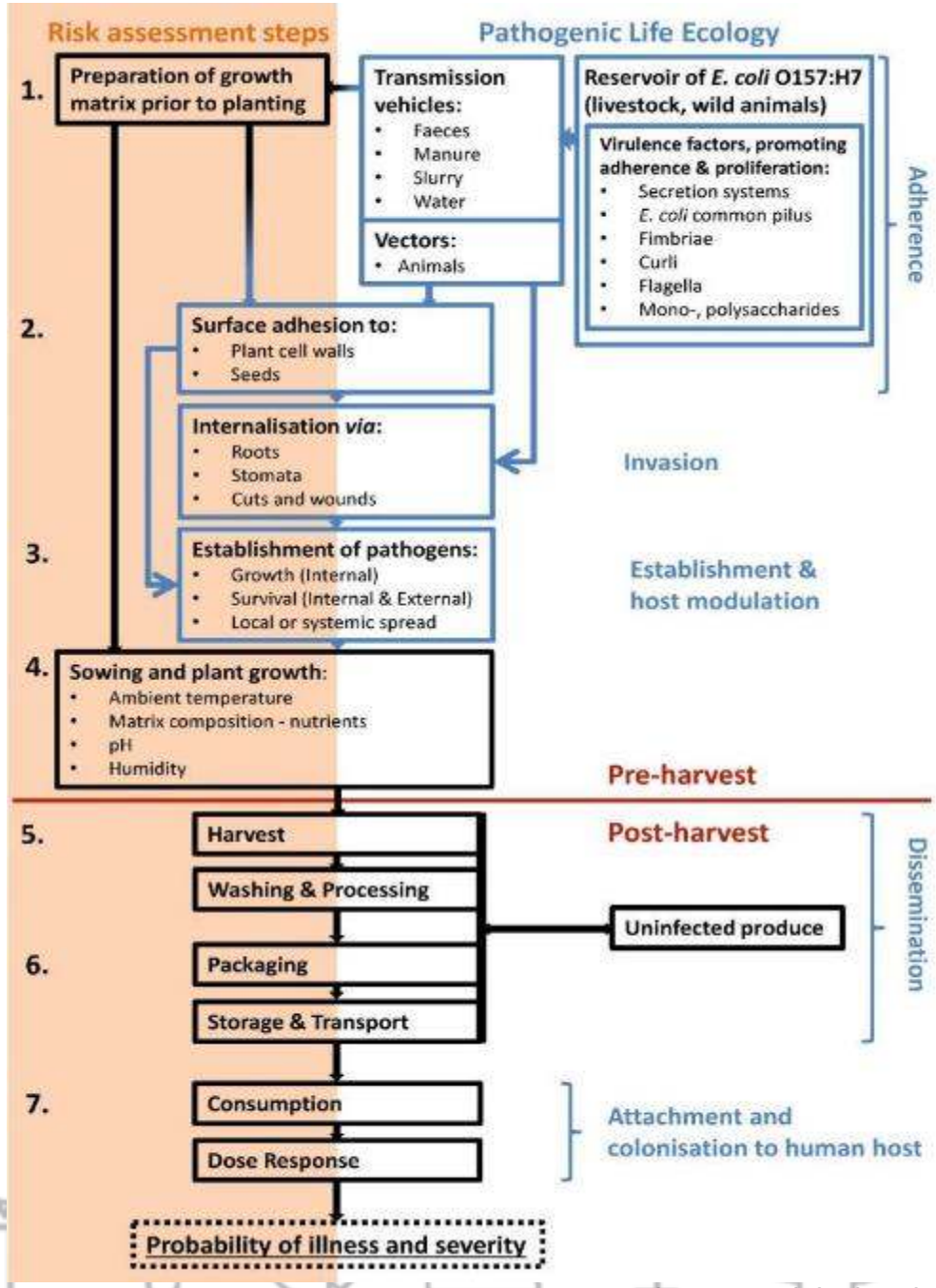
Holden, N. J. 2010. CAB Rev DOI: 10.1079/PAVSNNR20105047

How do we currently deal with hazards



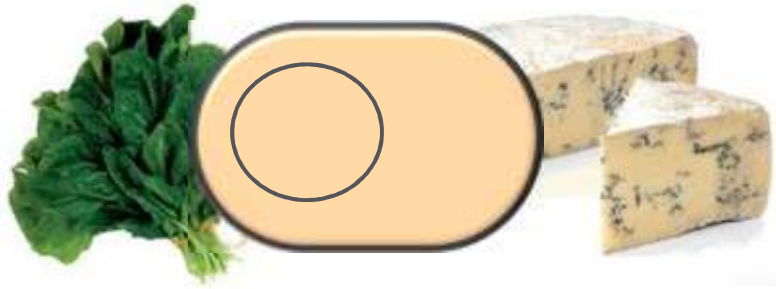
Risk assessment

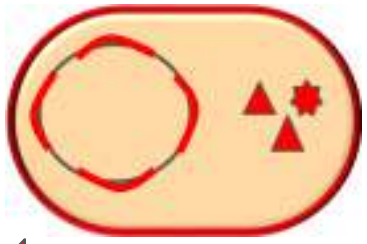
QRA

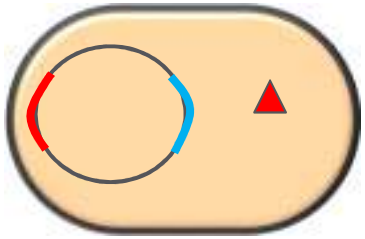


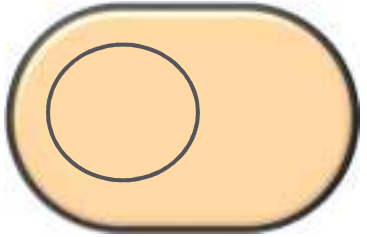
Merget et al., unpublished

When is a pathogen pathogenic?









Pathogen

Opportunist

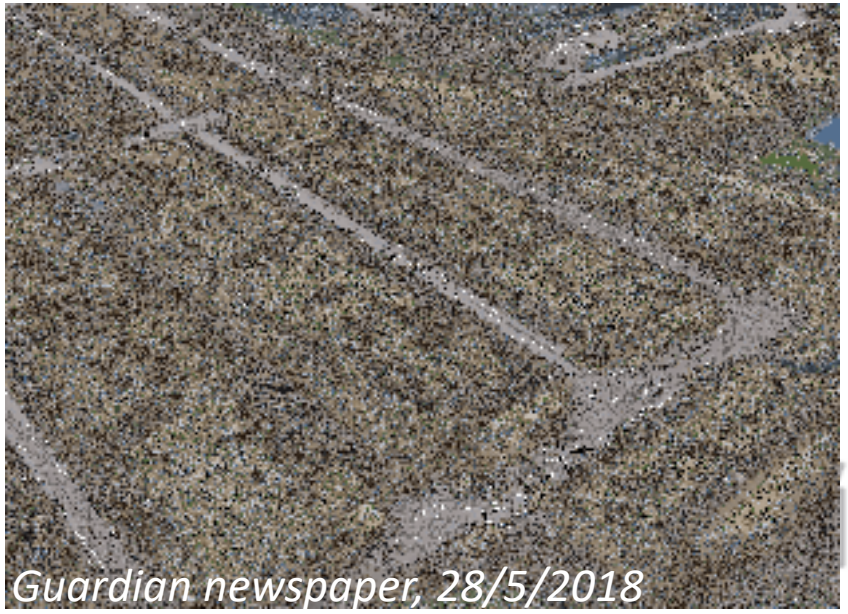
Commensal

Requirement to understand pathogenic potential and extent of virulence

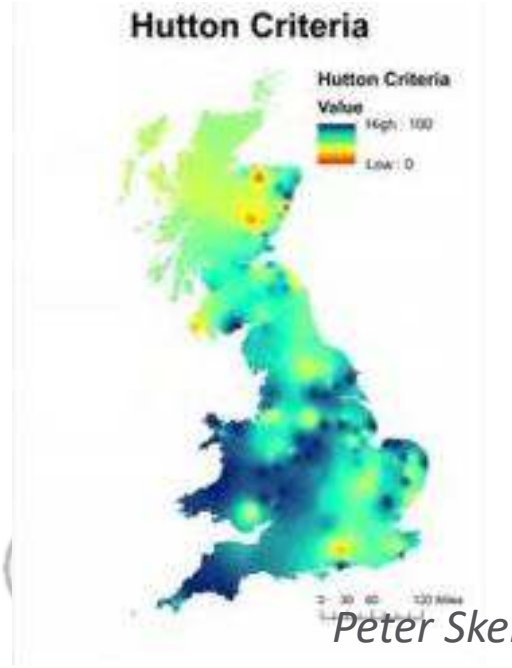
How will changing agriculture impact the hazards?

IGS website, 10/04/2019

RT website

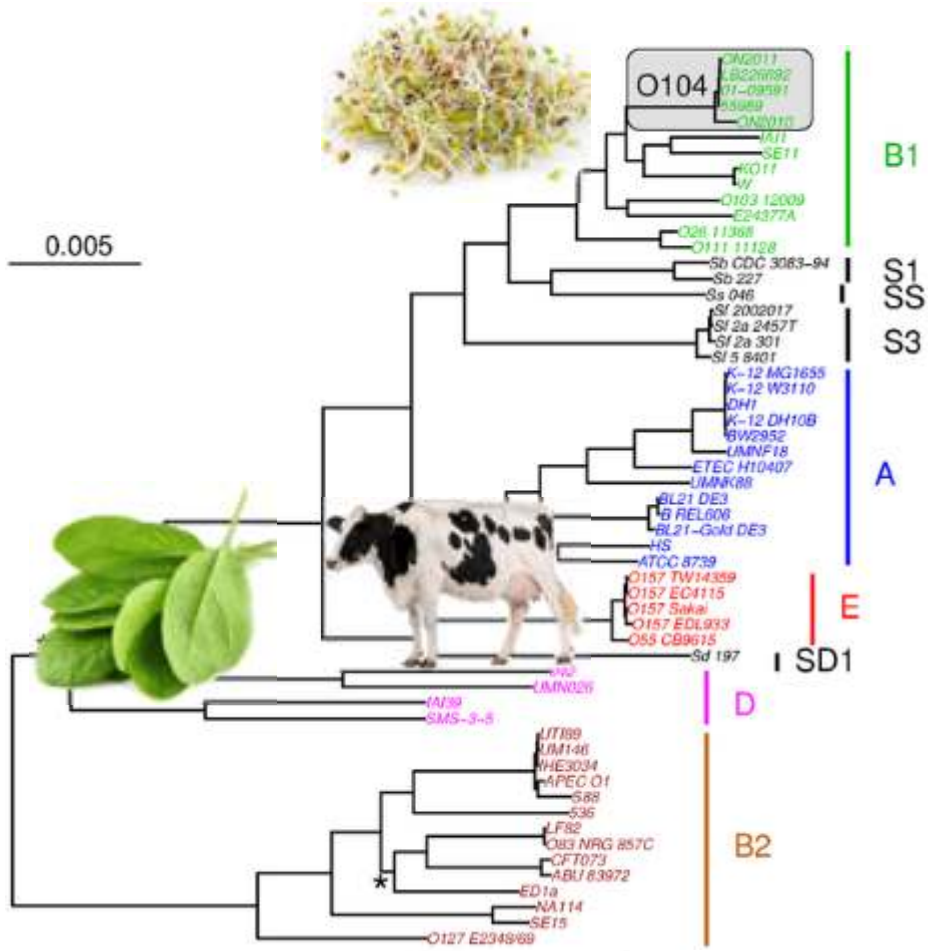


Guardian newspaper, 28/5/2018



Peter Skelsey, Hutton

What are the emerging threats?

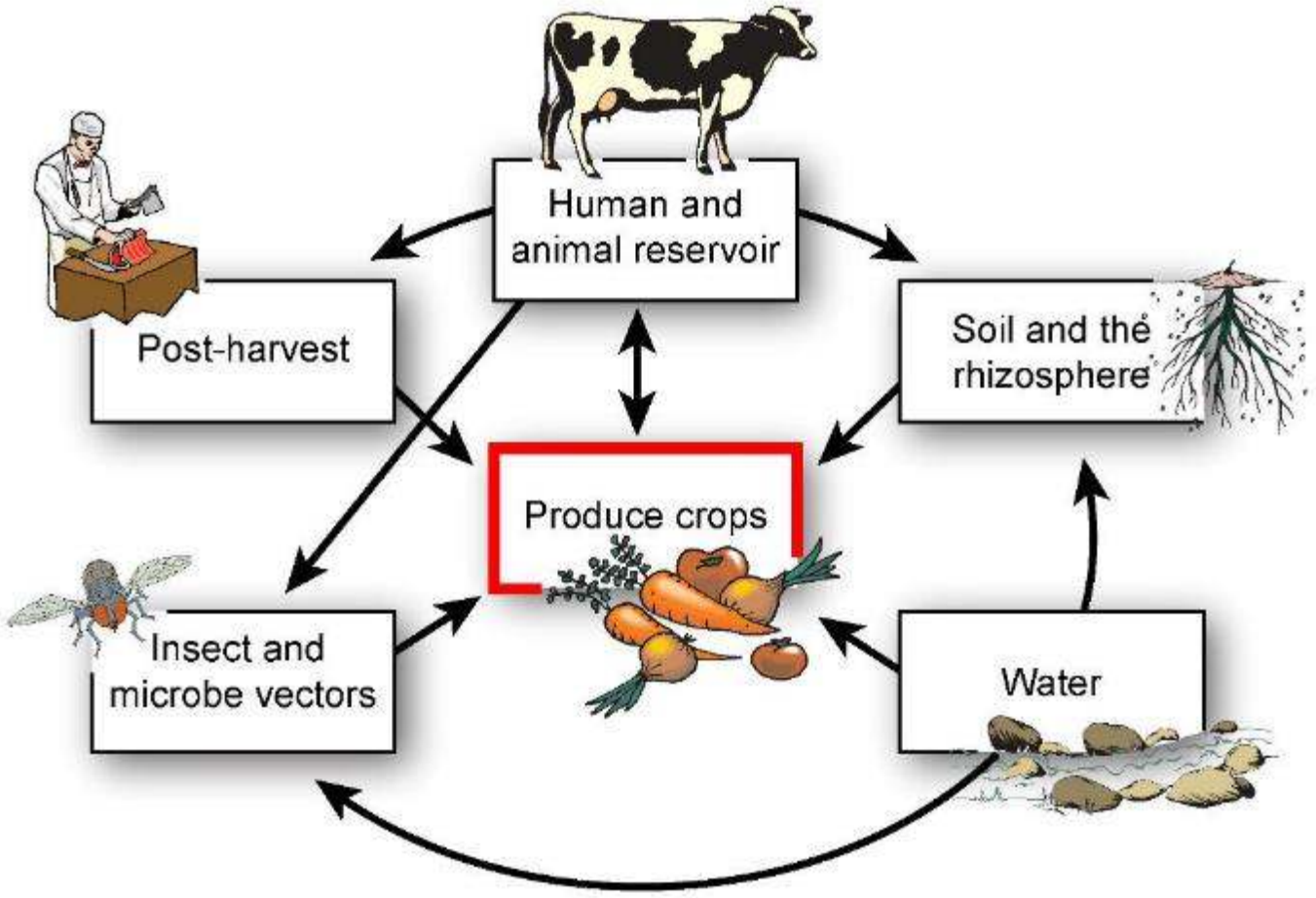


Hao (2012) PLoS ONE. doi: 10.1371/journal.pone.0033971

Multistate outbreak of Shiga toxin-producing *Escherichia coli* infections linked to flour

CDC Centers for Disease Control and Prevention
CDC 24/7: Saving Lives, Protecting People™

And where are they likely to come from?



Industry drivers

The James Hutton

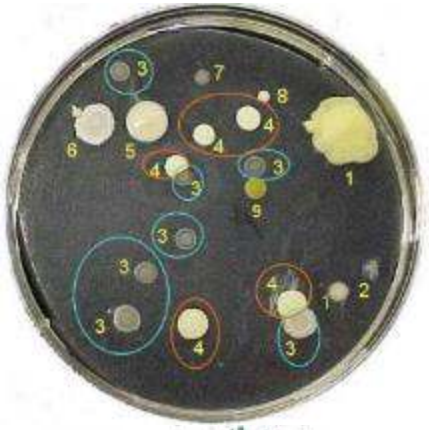
http://www.westlandswow.co.uk

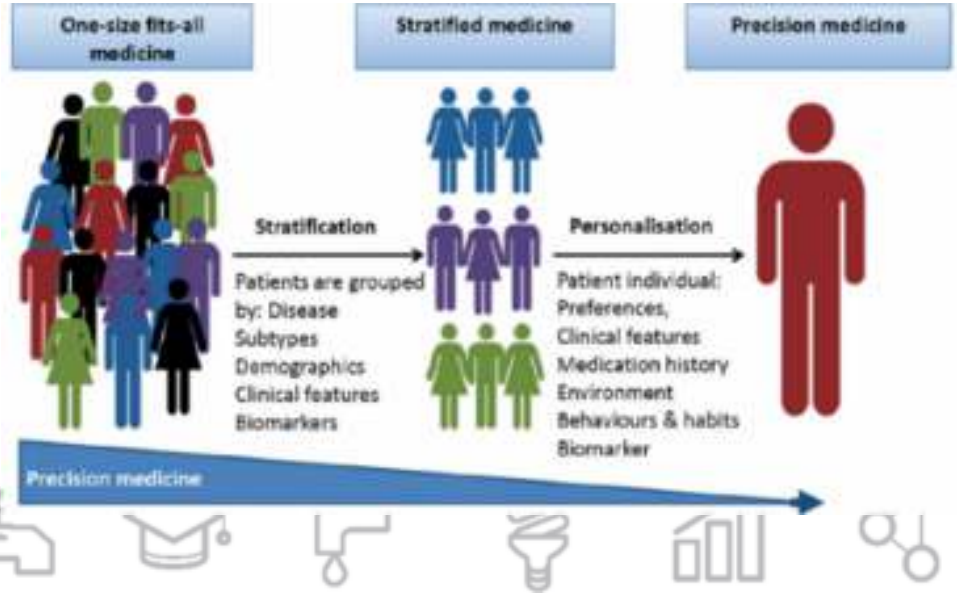
‘Consumer Conscience’

** Ambition 2030 document*

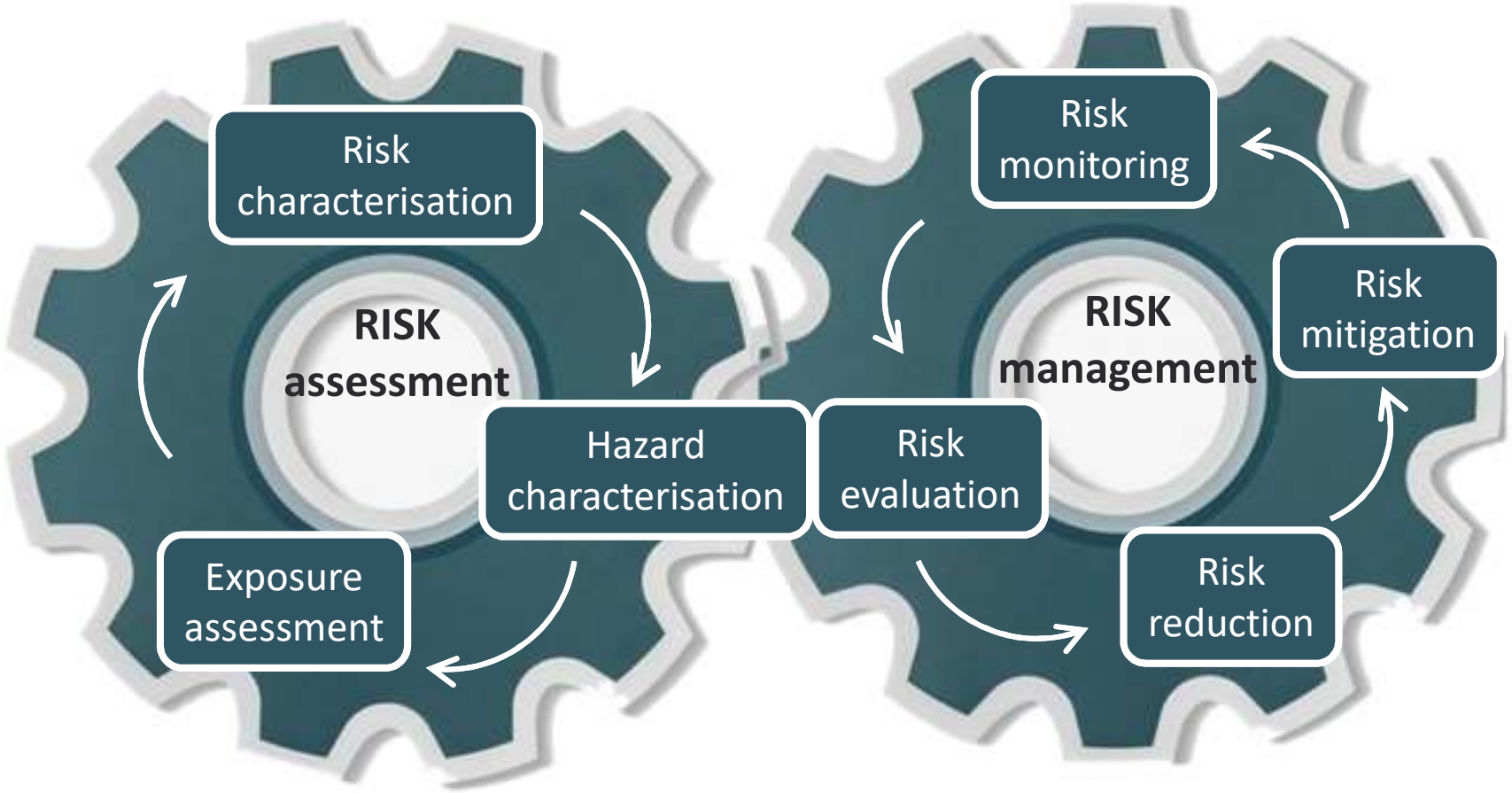
How will be deal with threats in 2050?

The James Hutton Institute





How will be deal with threats in 2050?



Need for networks

The James Hutton Institute

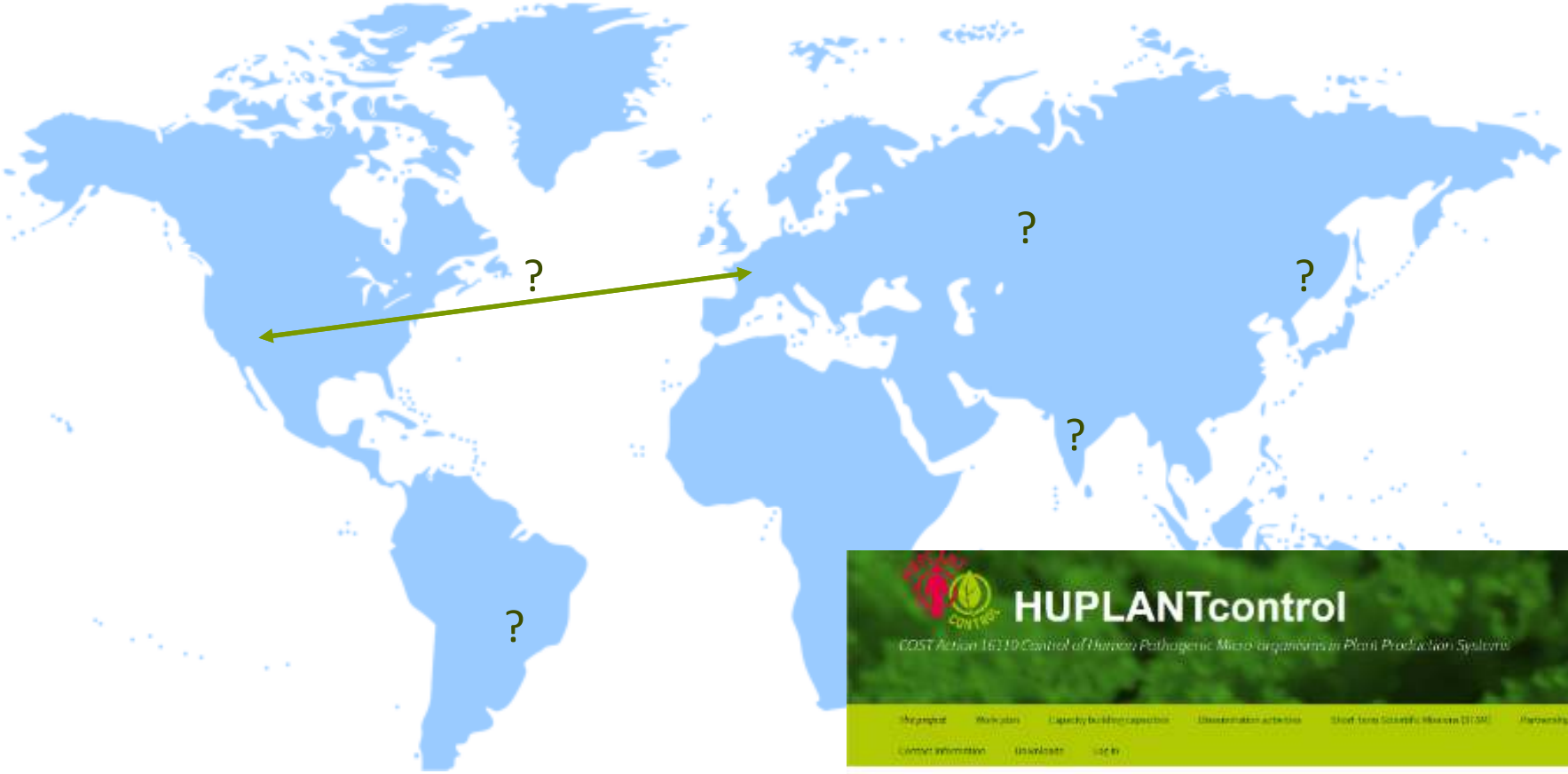
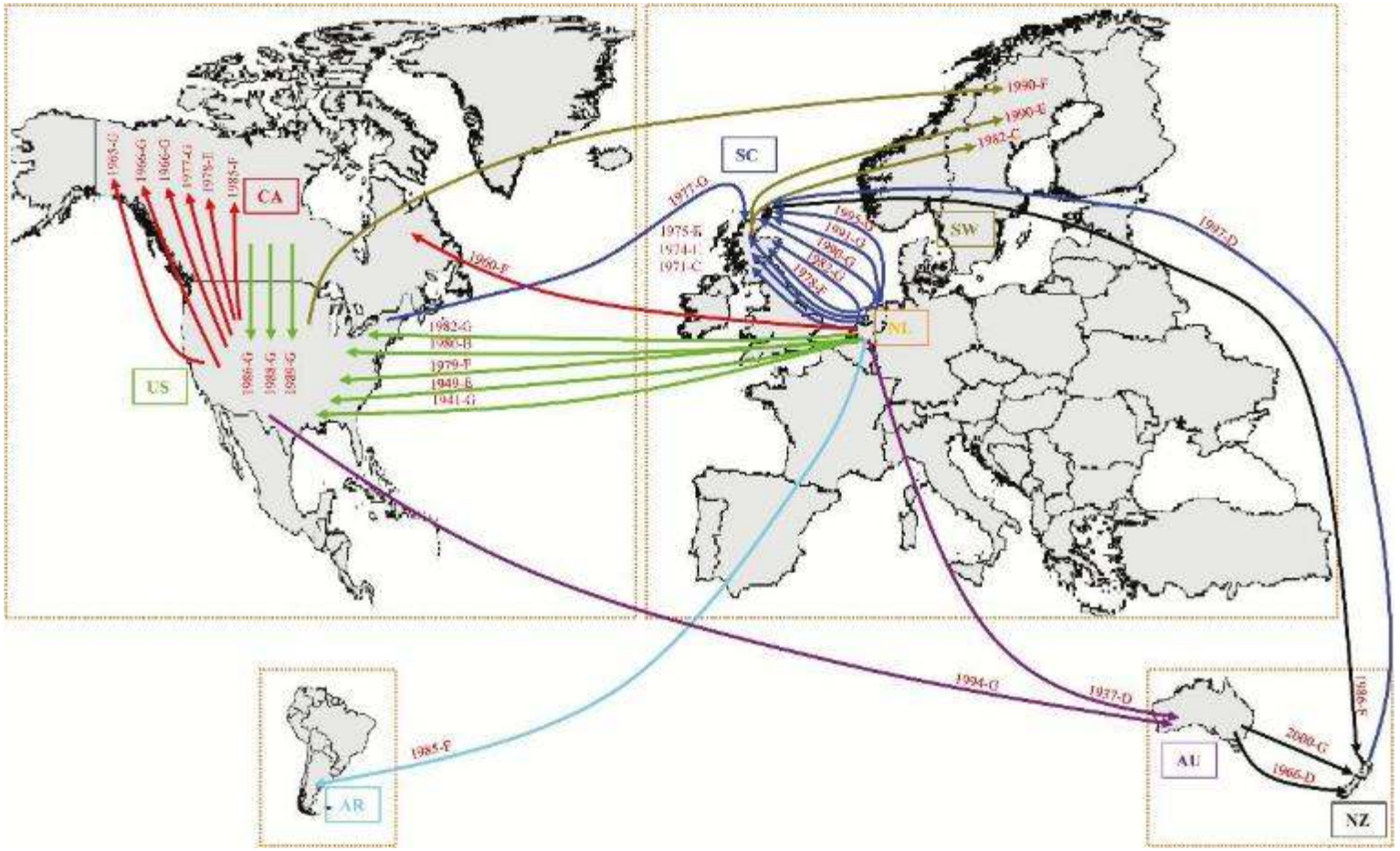


Figure 5. Geographic dynamics of the time to transmission of *Escherichia coli* O157:H7 (34 major transmission events)



Clinical Infectious Diseases, ciy919, https://doi.org/10.1093/cid/ciy919

Summary

Food safety hazards will change, evolve and emerge…
Technologies will change, evolve and emerge…

Control strategies will grounded in risk-based analysis

McCoy with his medical tricorder | Photo: CBS Home Entertainment

Acknowledgements:

Food Standards Scotland & Food Standards Agency
Hutton, Rowett & Moredun institute colleagues in Food Safety (RESAS SRP)
Intelligent Growth Solutions
HuPlantControl consortium