U3A Sustainable Energy Group

Agriculture and Land Use

Andrew Partridge

March 2022

Introduction

Main sources:

- Committee on Climate Change report, Jan 2020 – *Land Use: Policies for a Net Zero UK*
- Committee on Climate Change report (undated) - *The Sixth Carbon Budget Agriculture and land use, land use change and forestry*
- National Food Strategy, July 2021

Presentation overview:

- Background science
- Land use and agriculture
- Food consumption

National Food Strategy – Background and status

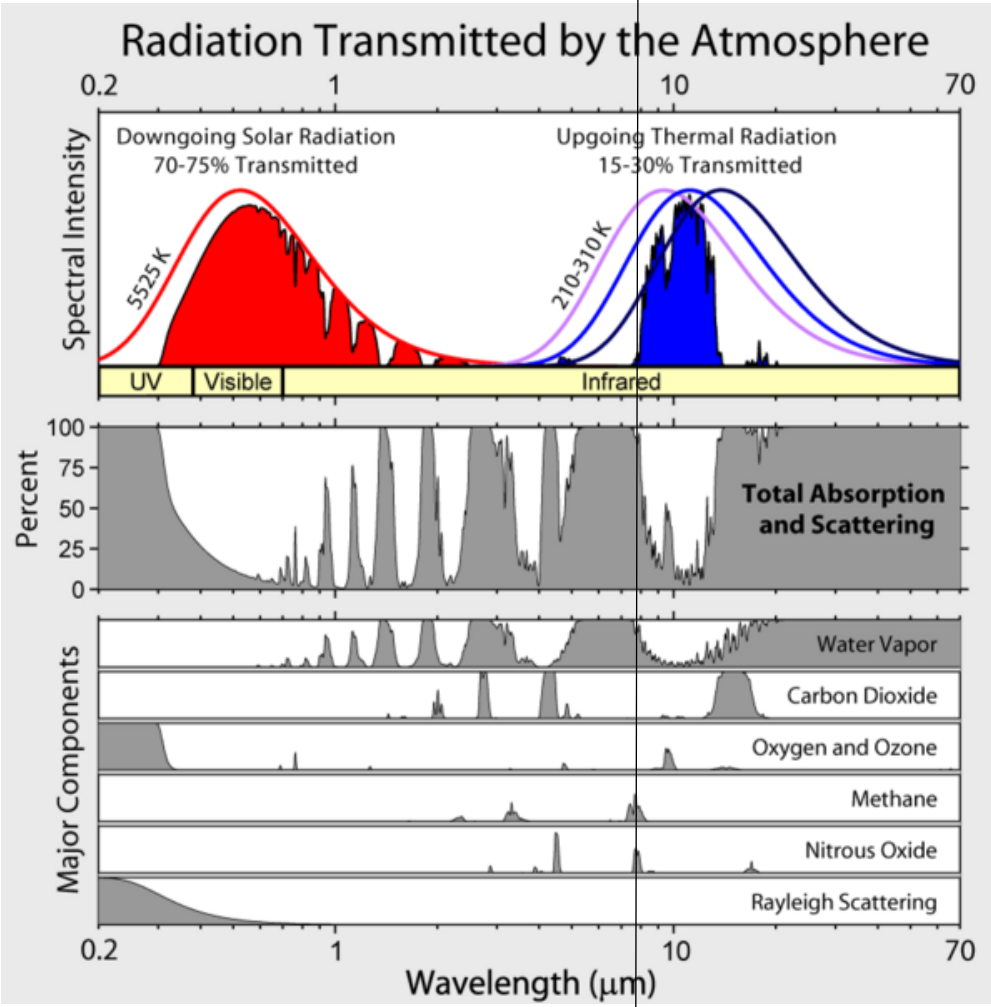
- Henry Dimbleby, with background in restaurants, food markets, and school food provision, was appointed Defra's Lead Non-Executive Director in 2018.
- He was commissioned by Michael Gove in June 2019 to carry out independent review of food system
- Part 1 of the Strategy was published in July 2020 (focussing on pandemic and Brexit issues)
- Part 2, addressing the original brief, published in July 2021
- 287 pages (45 pages of references); 14 recommendations in 4 areas:
    1. Escape the junk food cycle and protect the NHS
    2. Reduce diet-related inequality
    3. Make the best use of our land
    4. Create a long-term shift in our food culture
- Government had promised to respond with Food Strategy White Paper within 6 months (ie by end Jan 2022)
- 'No date' for a response as at 20 Jan 2022; *Dimbleby 'relaxed' about delay if meant the document turned out to be a serious and well thought out response*

Physics of Greenhouse Effect

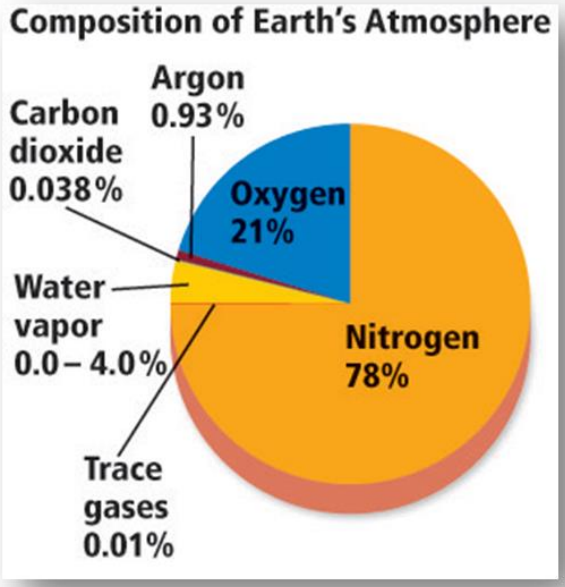
Joseph Fourier - 1827

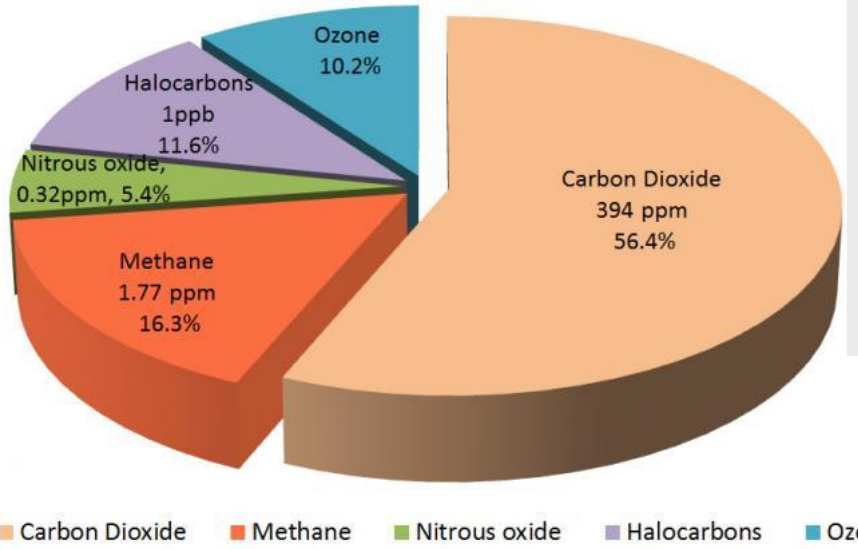
John Tyndall - 1860

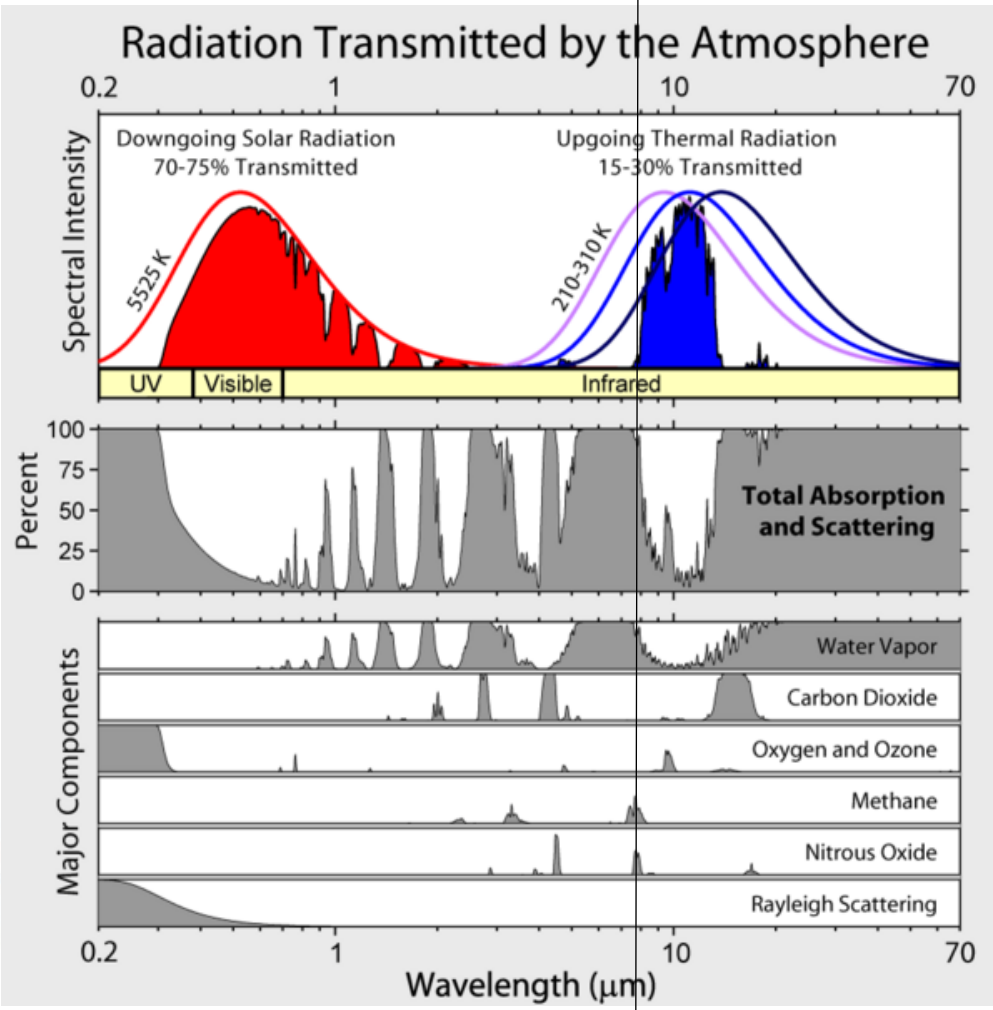
Svante Arrhenius - 1895



Gases responsible







Change in atmospheric composition

CO_2

CH_4

N_2O

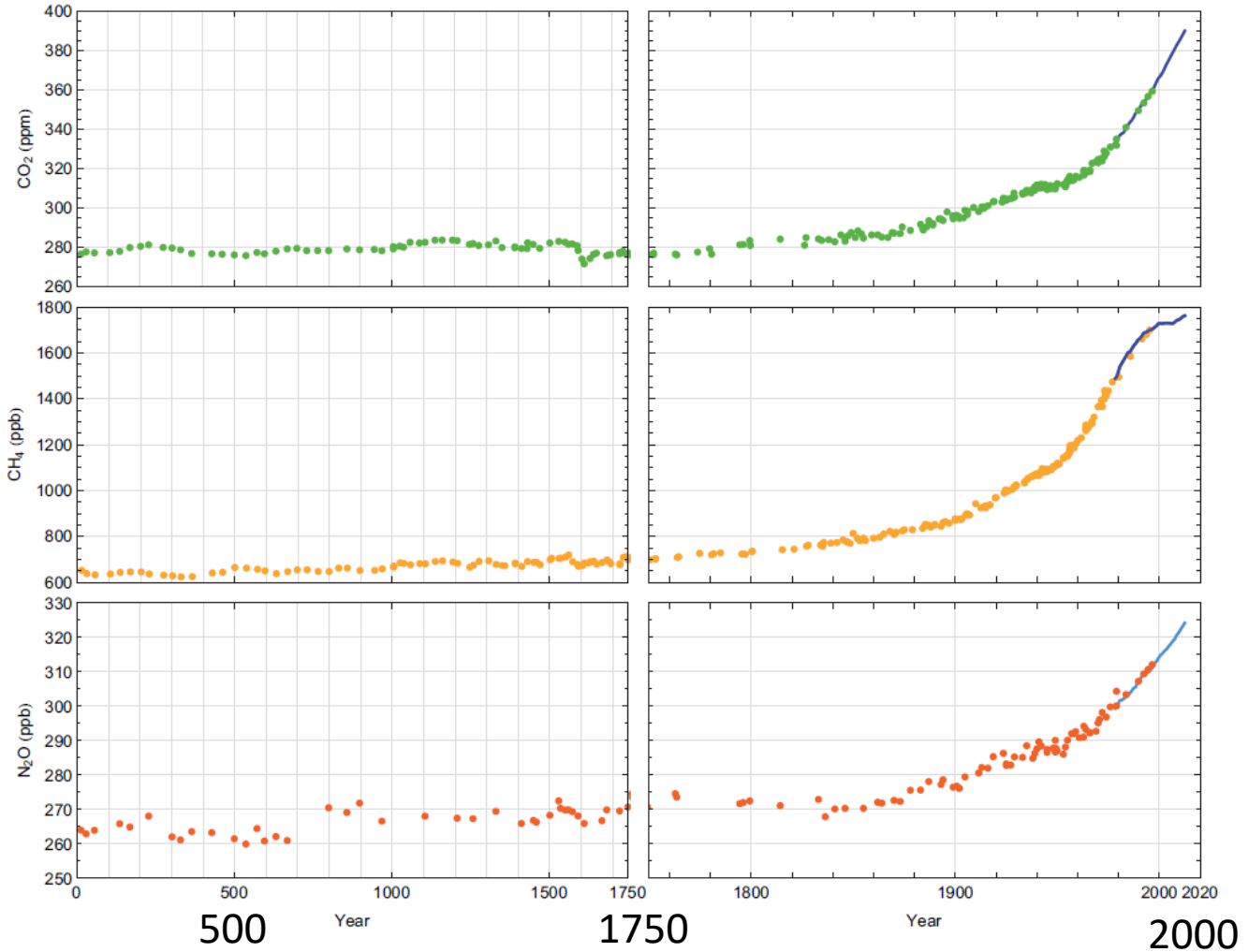
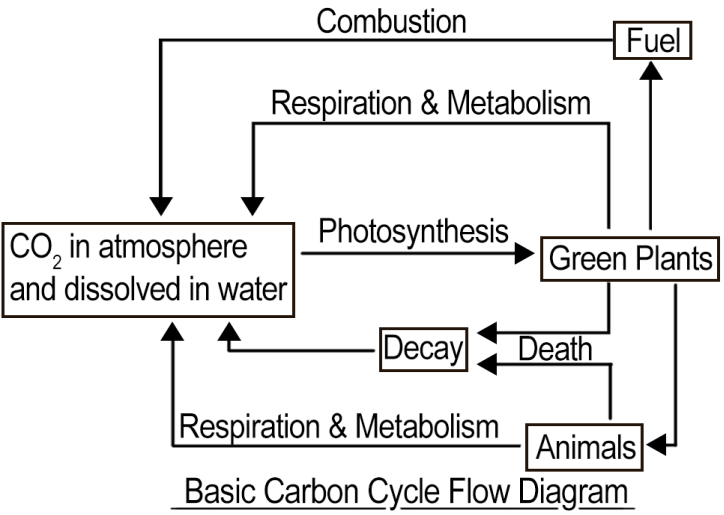
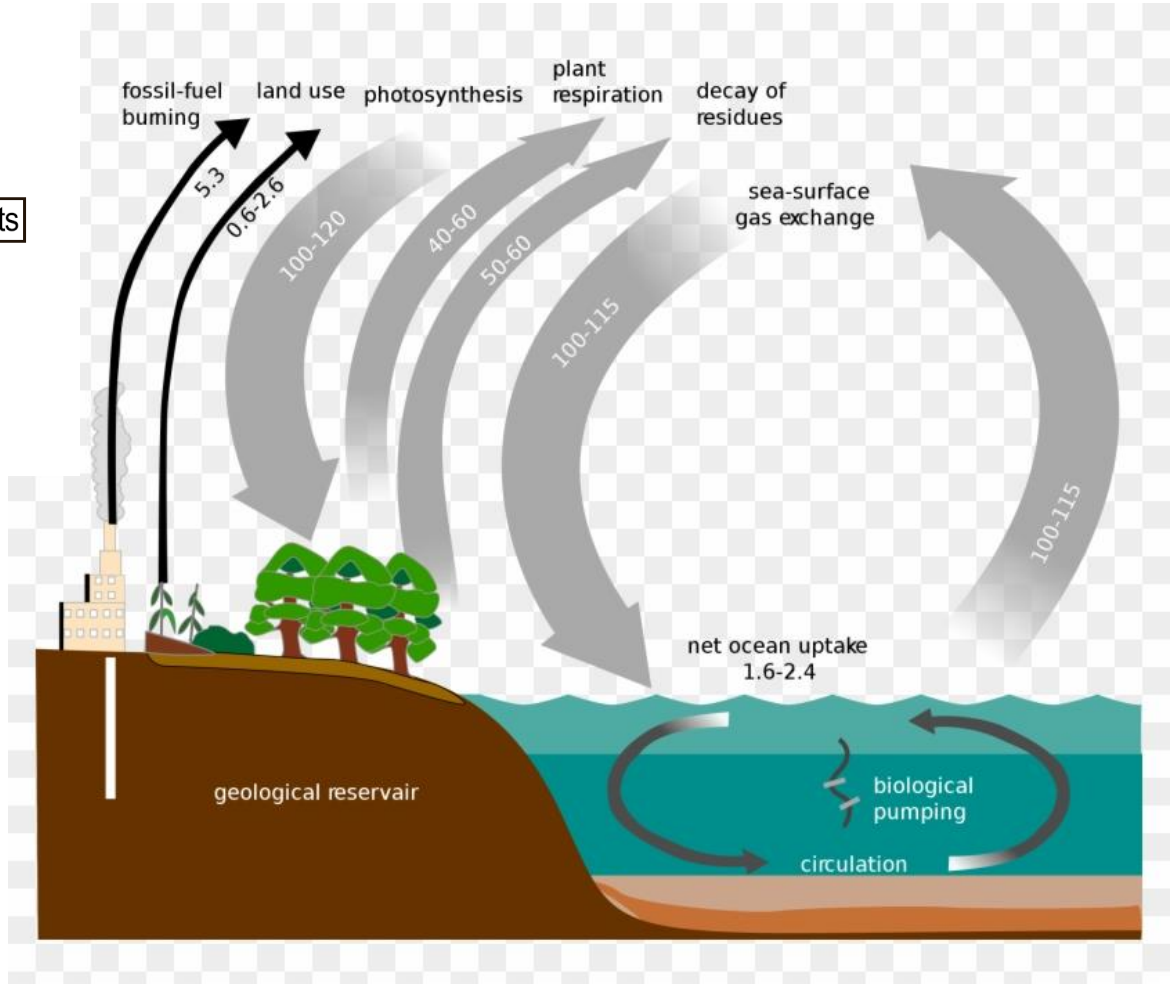


Figure 6.11 | Atmospheric CO_2, CH_4, and N_2O concentrations history over the industrial era (right) and from year 0 to the year 1750 (left), determined from air enclosed in ice cores and firn air (colour symbols) and from direct atmospheric measurements (blue lines, measurements from the Cape Grim observatory) (MacFarling-Meure et al., 2006).

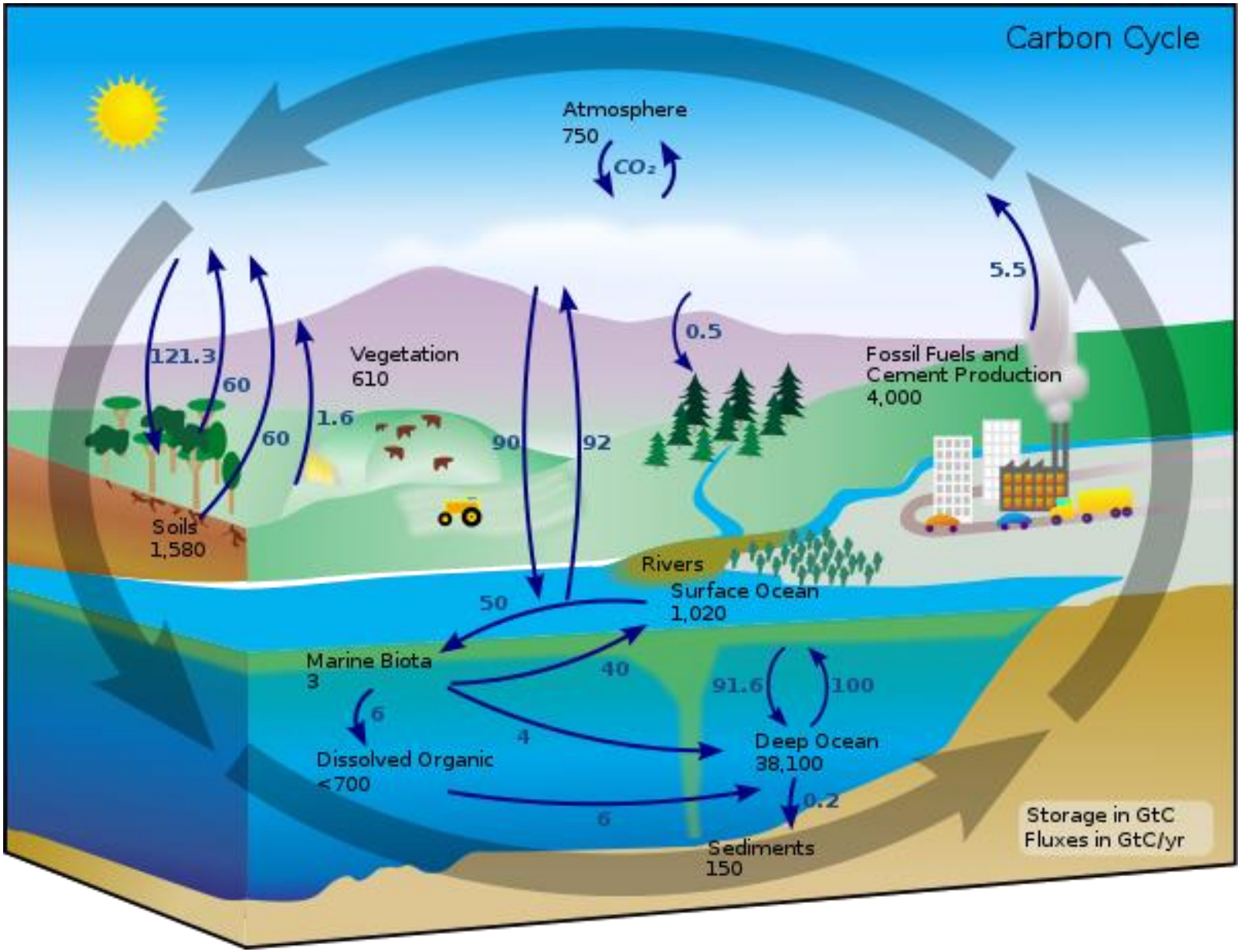
From WG1AR5 Chap 6 p493

Carbon cycle (1)

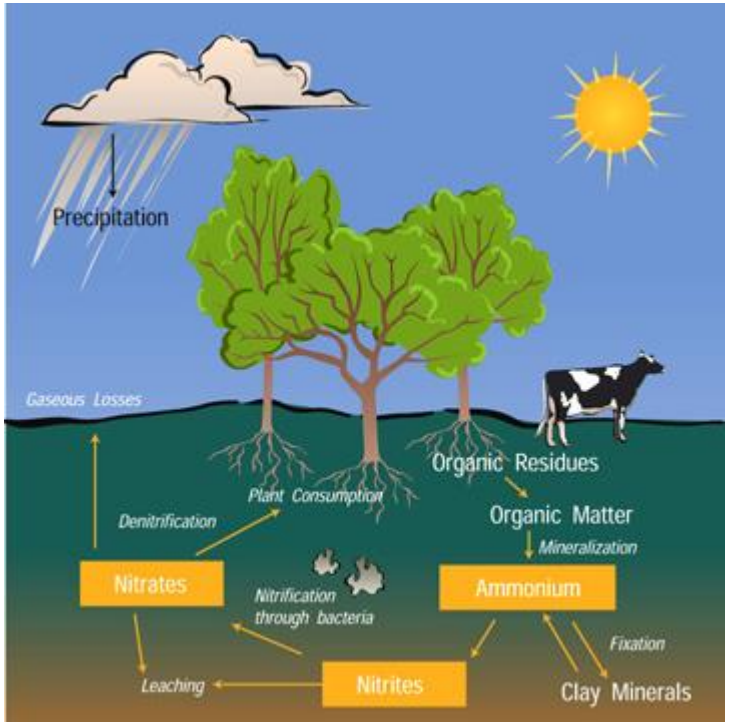


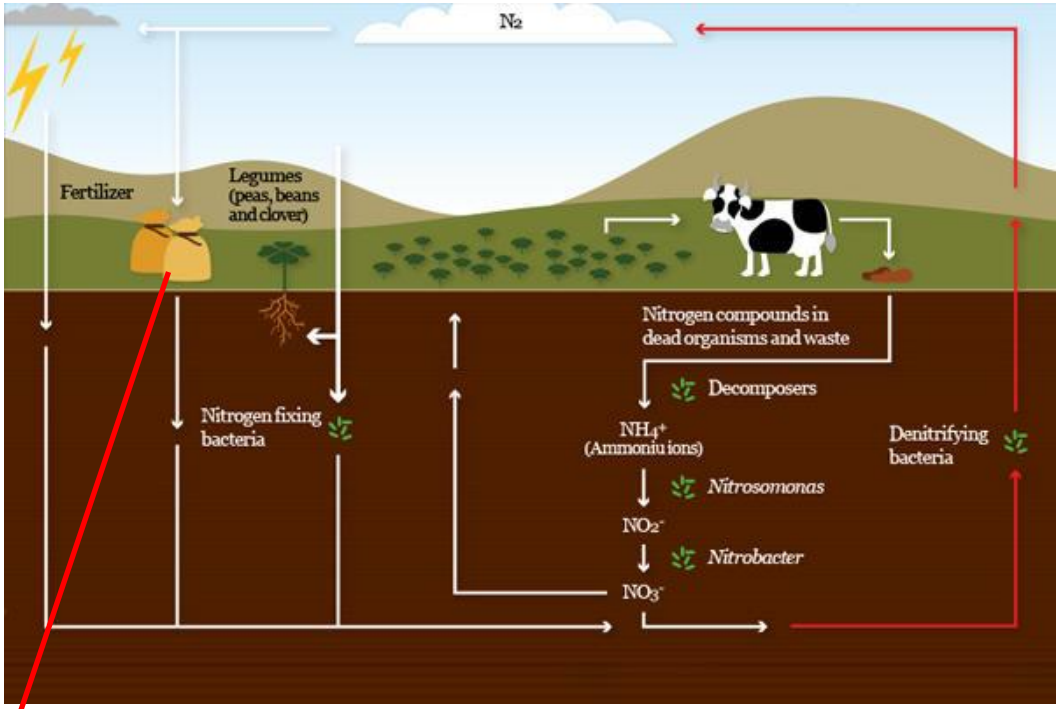


Carbon Cycle (2)



The Nitrogen Cycle





~ 50% of applied artificial fertiliser runs off into ground or surface water

Greenhouse gas emissions from food system

National Food Strategy, Chap 7: Food and Climate

Headlines:

THE food system – agriculture, food production, distribution and retail combined – releases more greenhouse gases than any other sector apart from energy. It is responsible for 25–30% of global emissions: a tally that dwarfs, say, the 3.5% contributed by air travel[1]. In the UK, the food system accounts for a fifth of domestic emissions – but that figure rises to around 30% if we factor in the emissions produced by all the food we import[2].

Ref 2 – Incorrect reference – could not follow up

Recommendations from CCC report - *Land Use: Policies for a Net Zero UK*

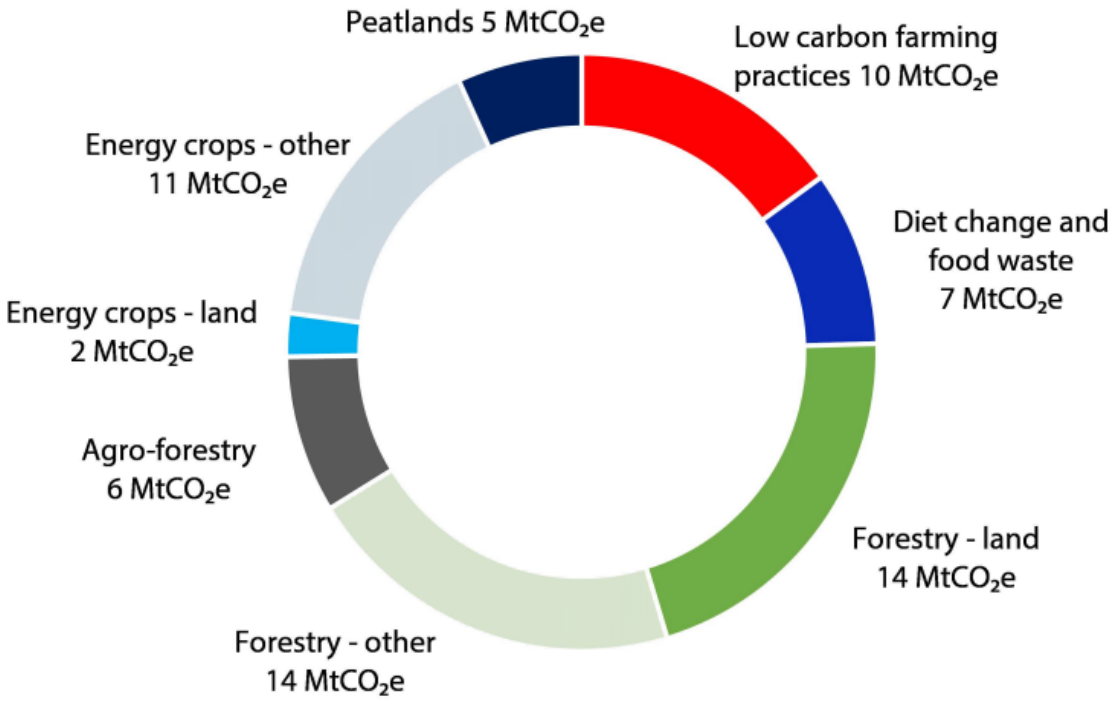
Rapid changes in farming practices and consumer behaviour by 2050

1. **Release 20% agricultural land for carbon sequestration, etc**
2. **Reduce consumption of the most carbon-intensive foods (eg beef, lamb and dairy)**
3. Strengthen regulatory baseline
4. Provide funding to support more costly measures

….

Potential reductions in greenhouse gas emission

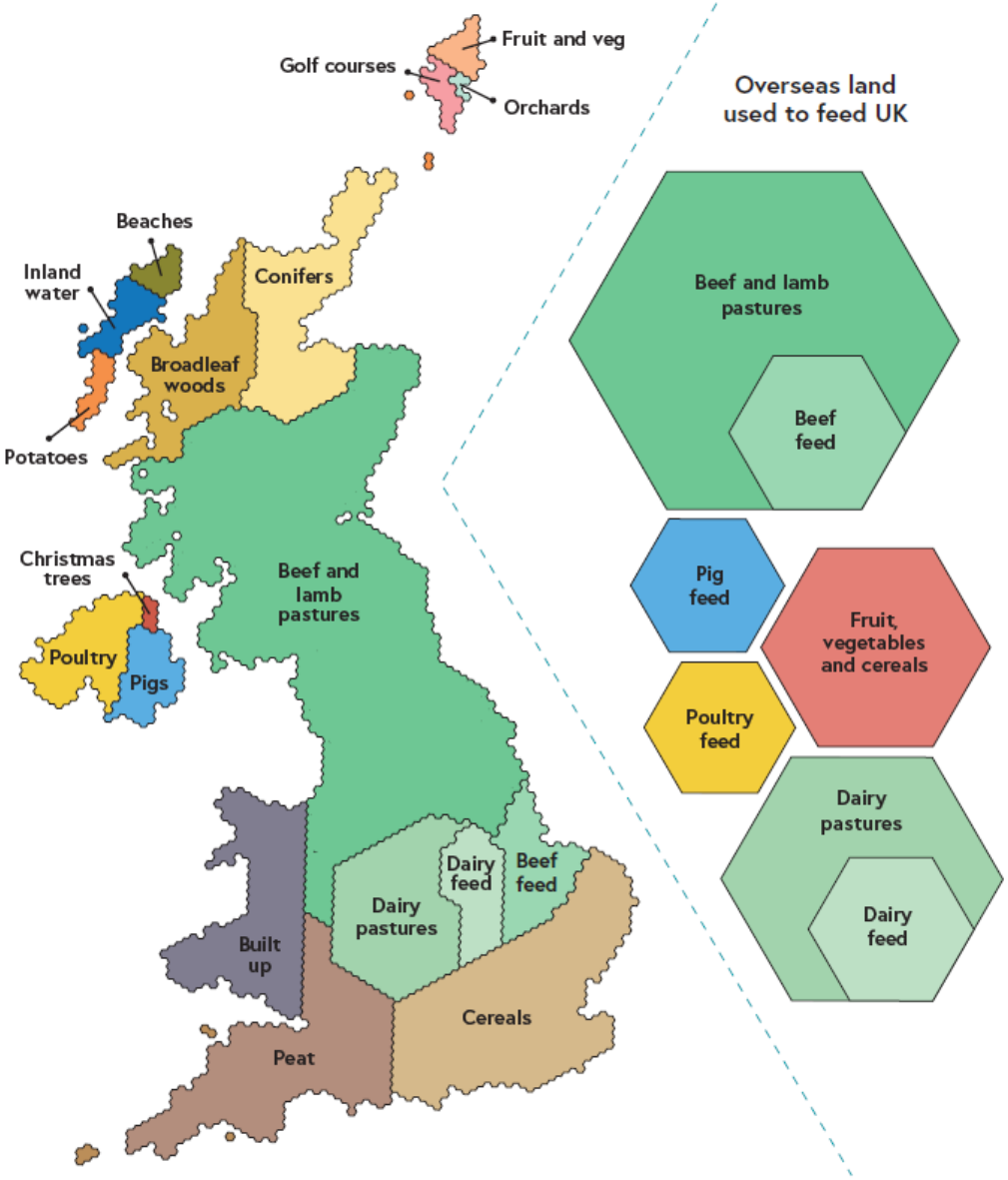
Figure 1. GHG savings from measures to reduce agriculture and land use emissions, 2050



Source: CCC analysis.
Notes: Based on the CCC 'Further Ambition' scenario in *Net Zero - The UK's contribution to stopping global warming*. These are savings compared with business as usual GHG emissions in 2050.
'Energy crops - other' and 'Forestry - other' refer to GHG savings from the use of harvested products in other sectors of the economy (e.g. with CCS).
Savings from diet change and waste reduction are from direct agricultural emissions reduction only.

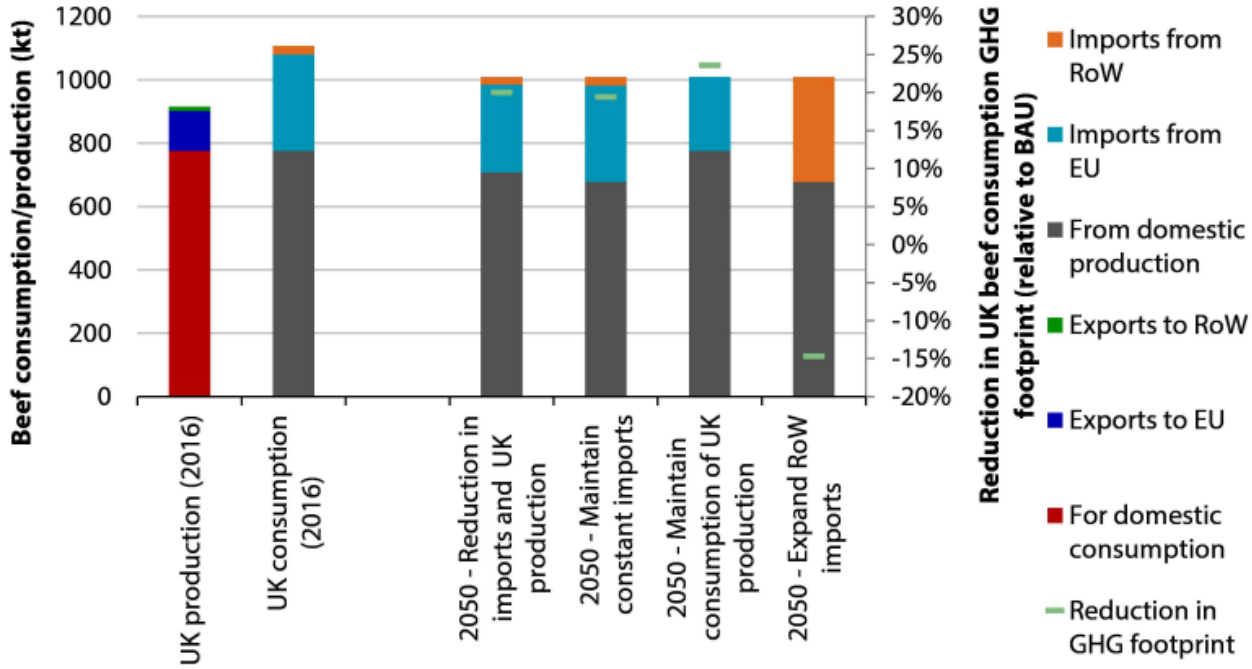
1. Land use changes

Current UK Land Use



Beef consumption options

Figure 2.9. Hypothetical scenarios of 2050 UK beef consumption (20% reduction in per person consumption) and lifecycle emissions saving



Source: CCC analysis.

UK self sufficiency in food

Figure 14.1

UK self sufficiency over time[5]

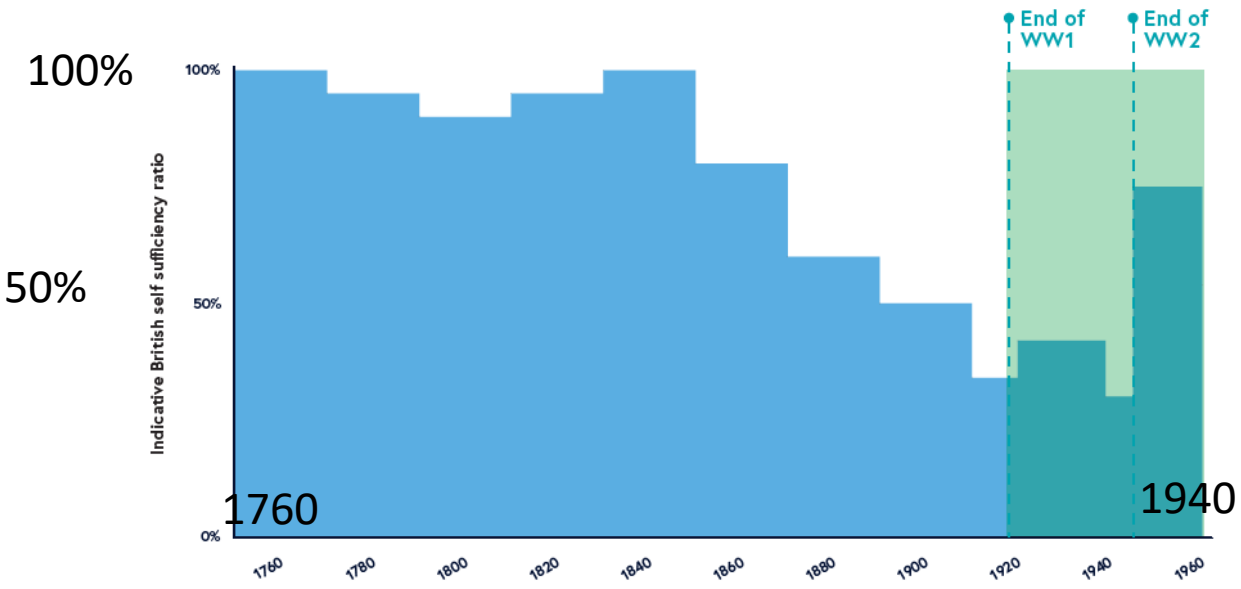
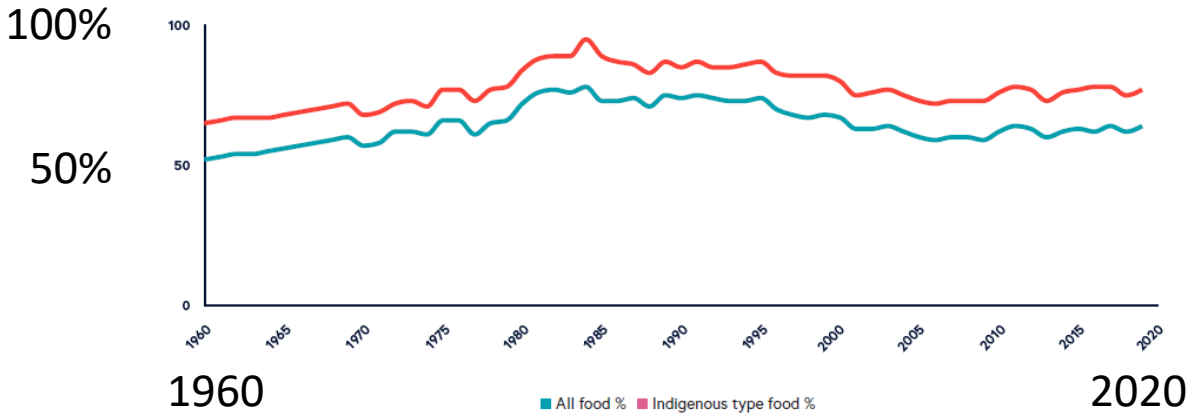


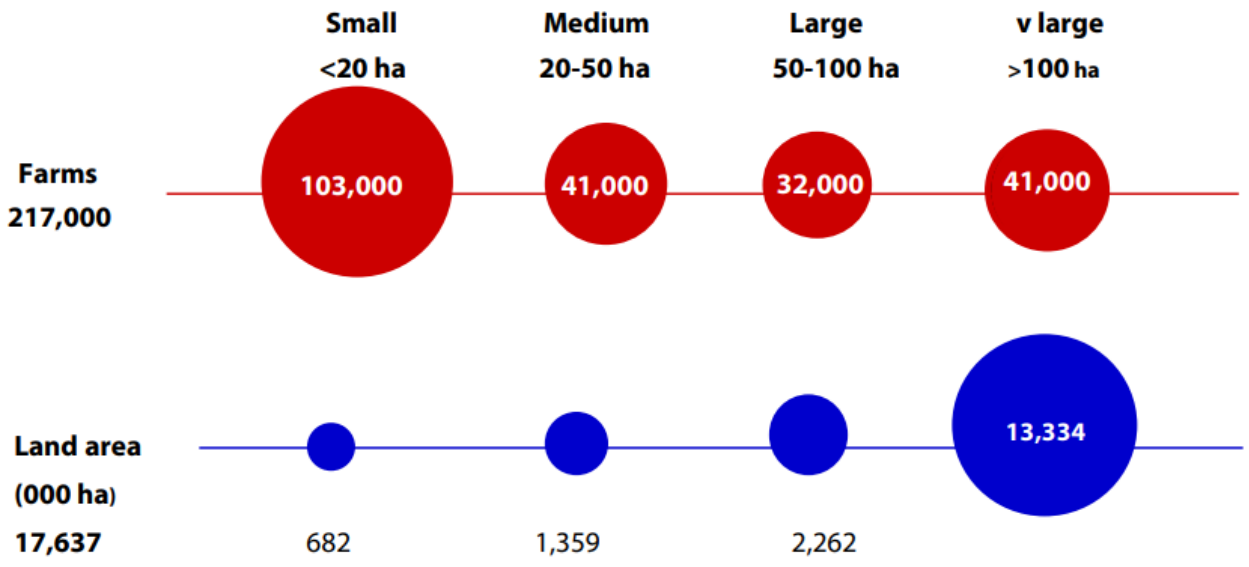
Figure 14.2

The UK is 77% self-sufficient in foods that can grow in our climate, and 64% self-sufficient overall[12]



Farms and areas farmed

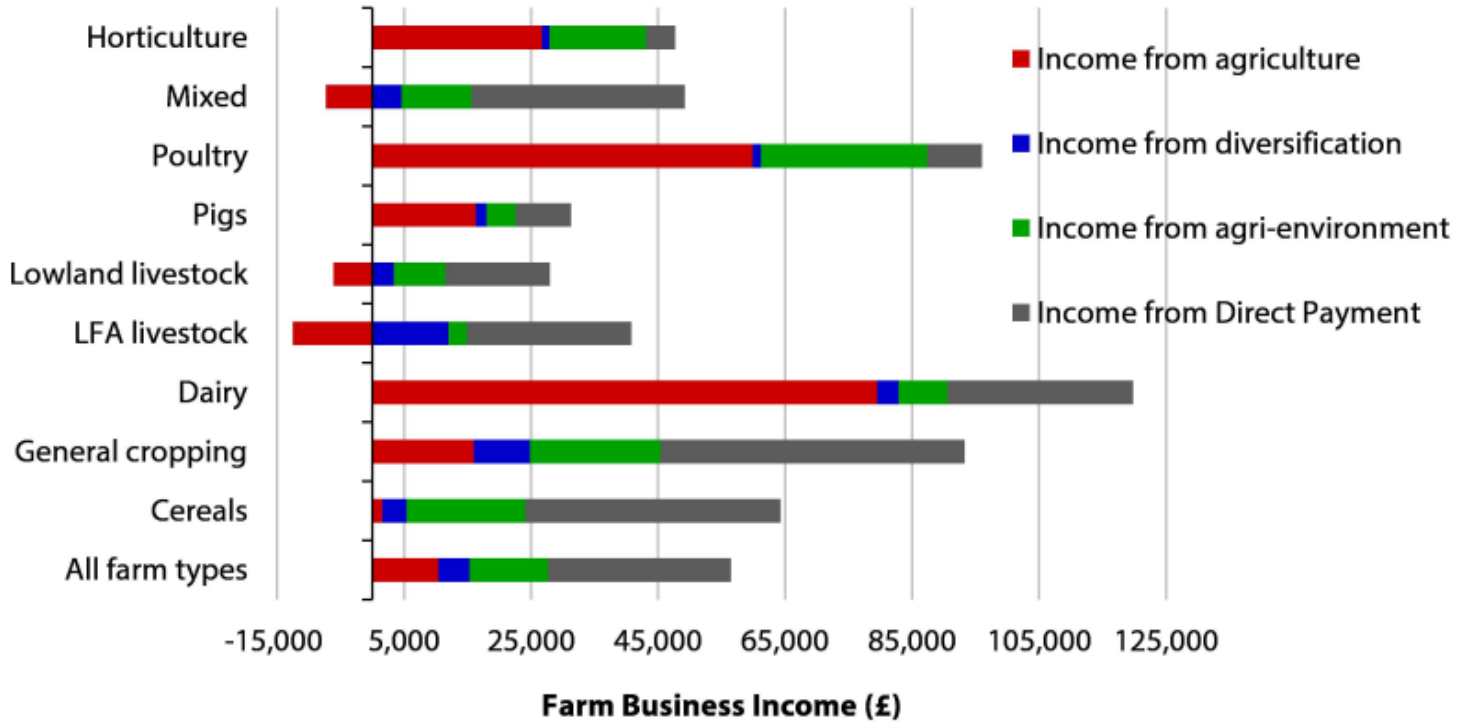
Figure 1.3. Number of farms and area farmed in the UK, 2017



Source: Defra (2017) *June Agricultural Census*.

Income by farm type

Figure 2.4. Farm business income by farm type and source, England (2017/18)



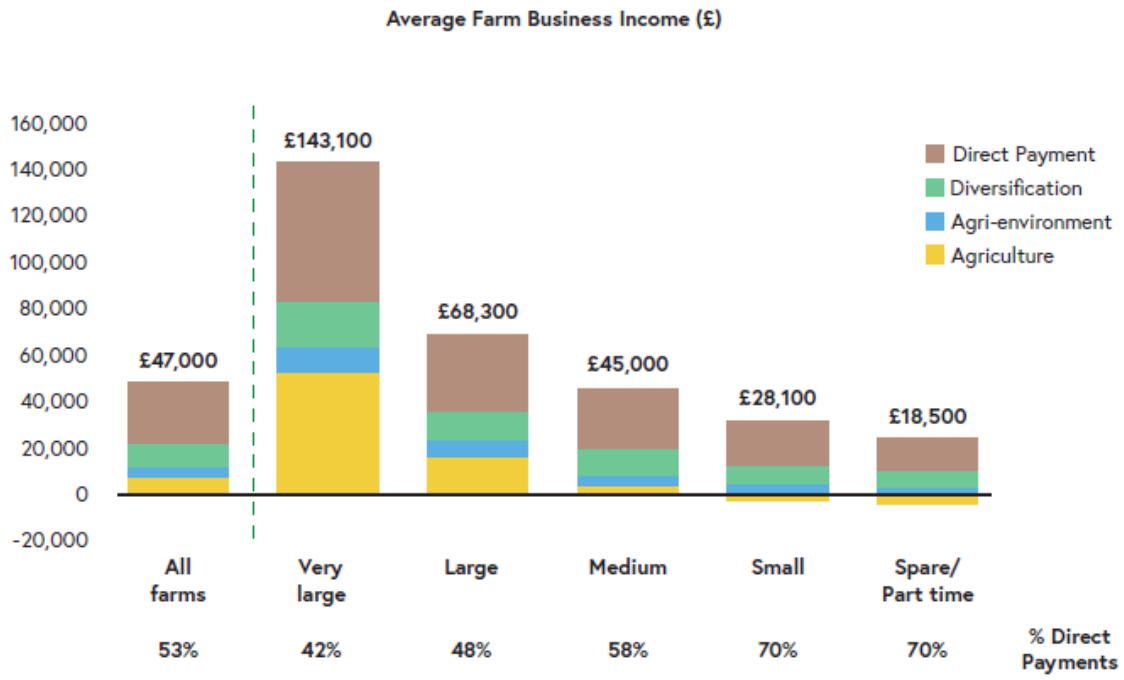
Source: Defra (2018) *Farm Business Survey for England.* CCC analysis.

Farm profits

Figure 10.6

Average farm business income

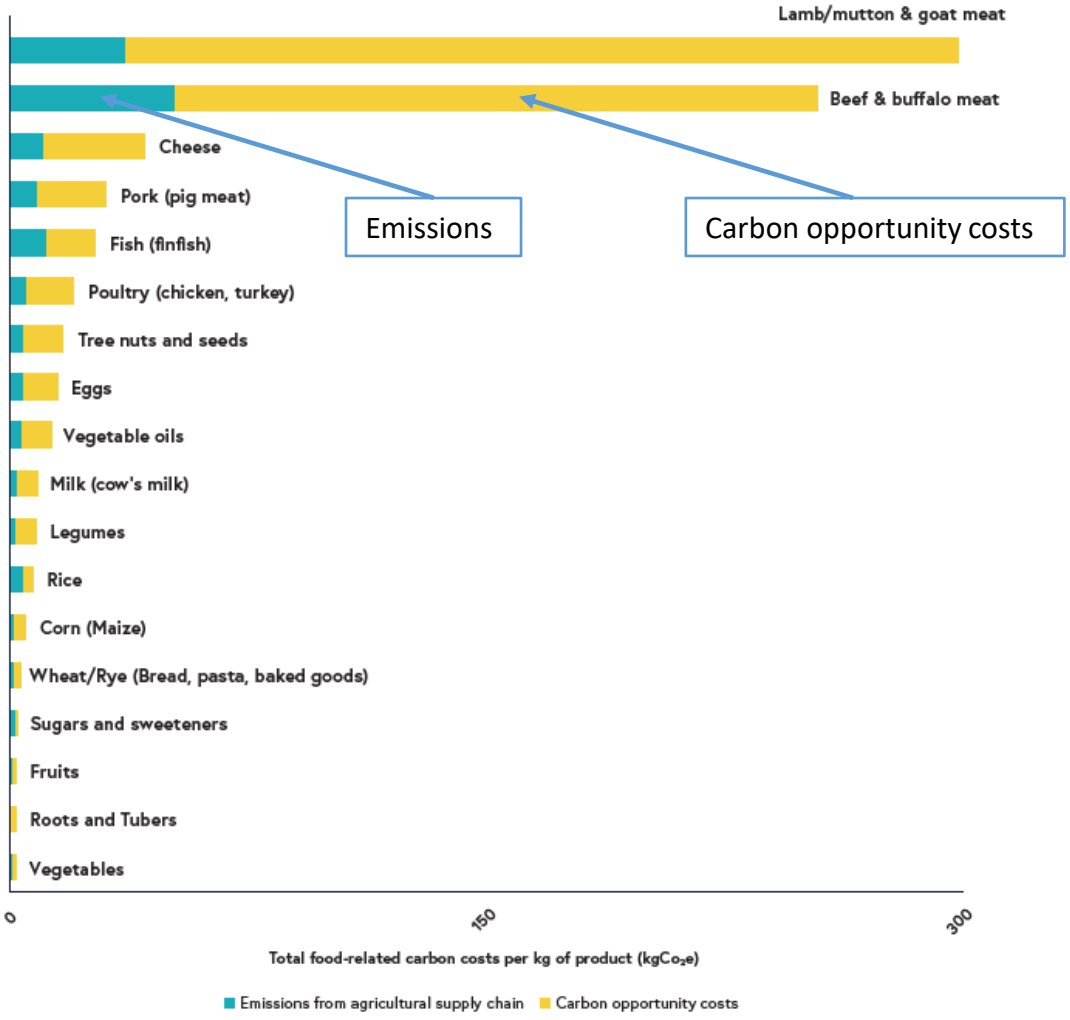
On average small and part time farms make a loss on their agricultural activities. Large farms receive a greater share of direct payments.



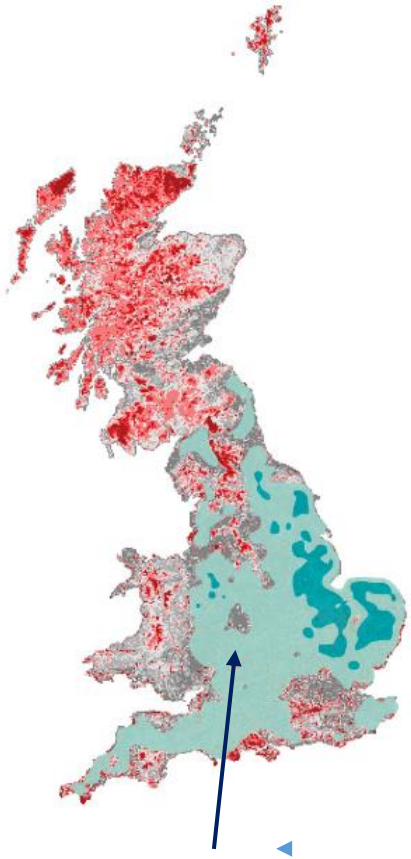
Sequestering potential

Figure 9.5

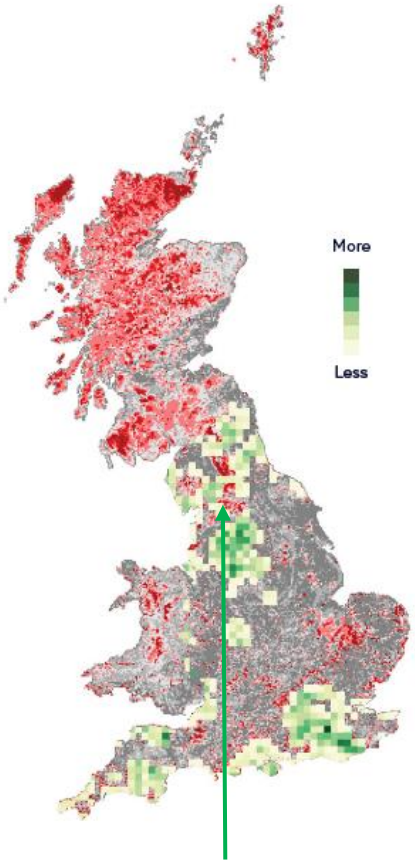
The biggest potential carbon benefit of eating less meat is the opportunity to repurpose land to sequester carbon[15]



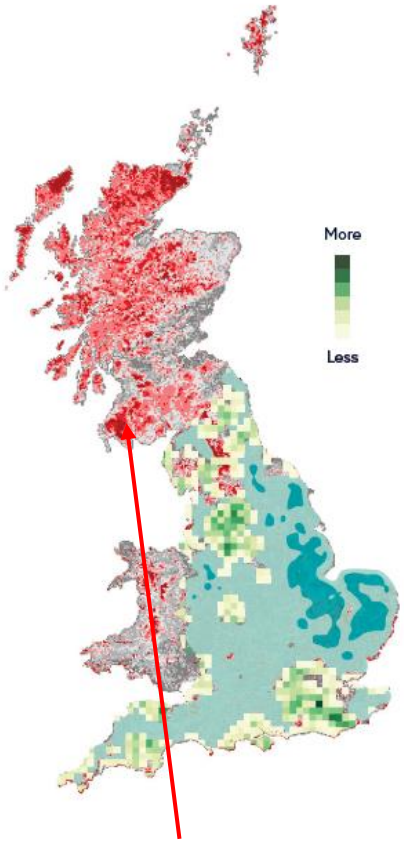
Areas for possible land use change



This area produces ¾ of total calories produced in England



Shows share of least productive farmland suitable for forest creation in England

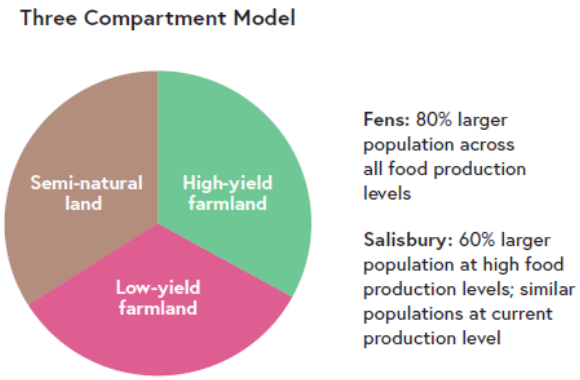


Shows high priority carbon storage and nature priority areas

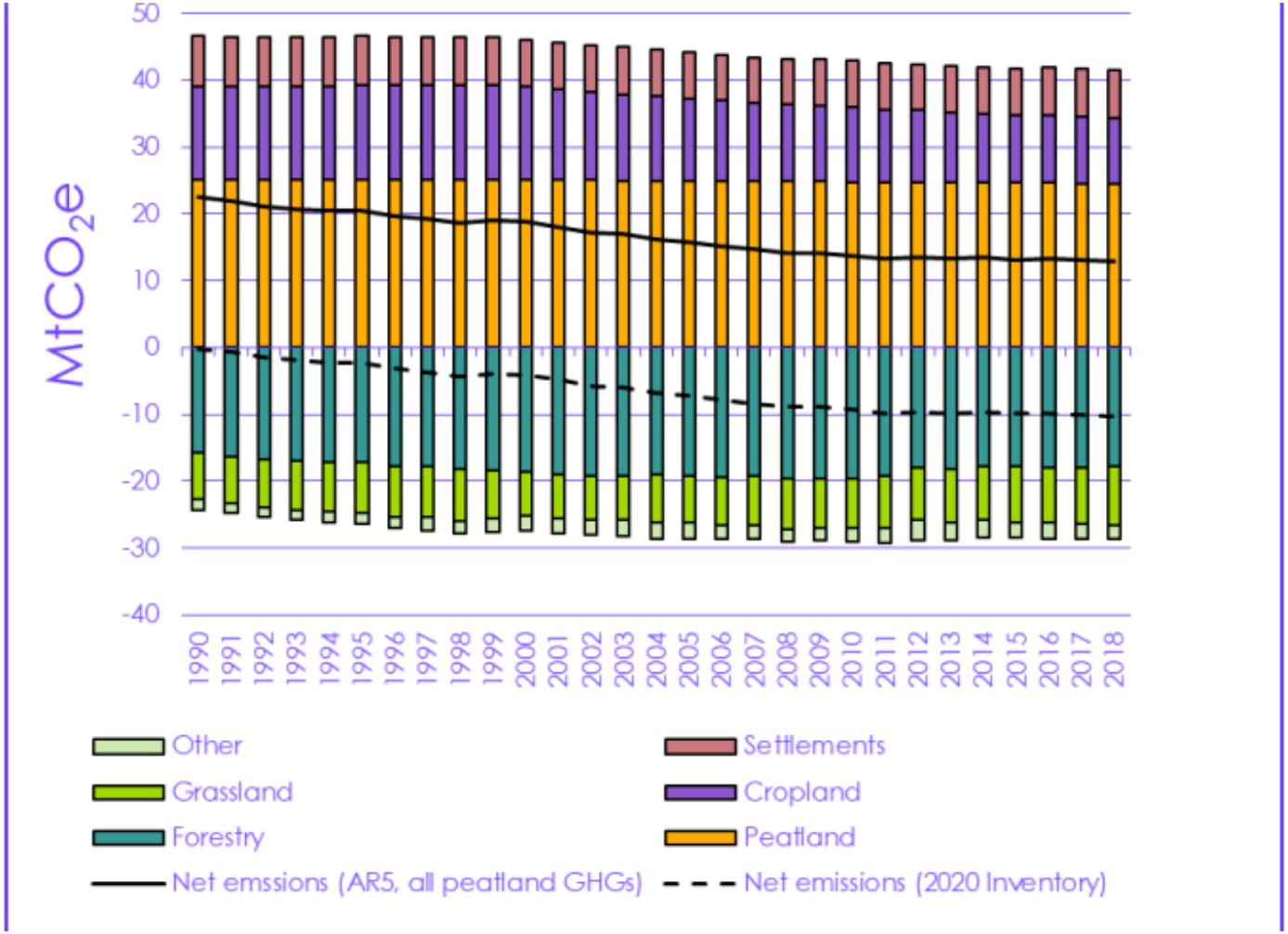
Proposed 3-compartment model

Figure 10.1

A combination of land sparing and land sharing produces the best outcomes for nature[6]

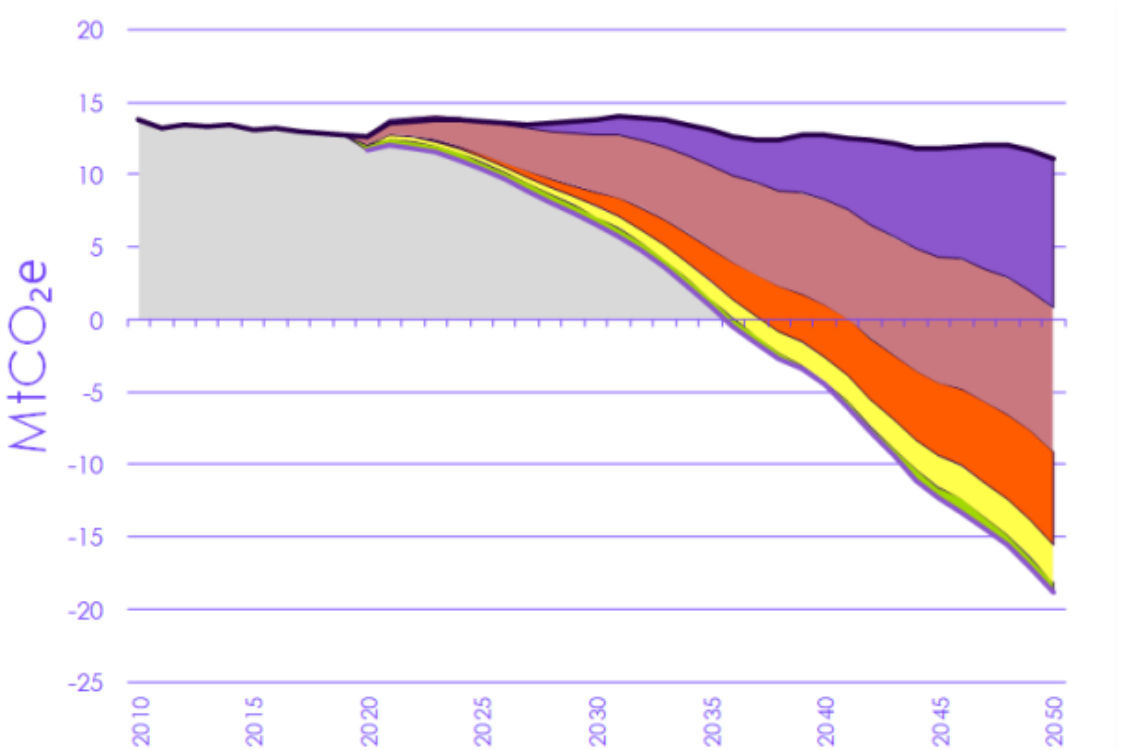


Land-based emissions and removals



Balanced Net Zero Pathway – anticipated outcomes

Figure A.3.6.d Sources of abatement in the Balanced Net Zero Pathway for the LULUCF sector



Land use change - observations

- Large number of small farms on subsistence earnings likely to be affected
- May allow some to escape from low-income treadmill
- Not just change of job – change of life
- Very careful organising of grants required

  National Food Strategy recommendation 8: Guarantee budget for agricultural payments until at least 2029 to help farmers make transition

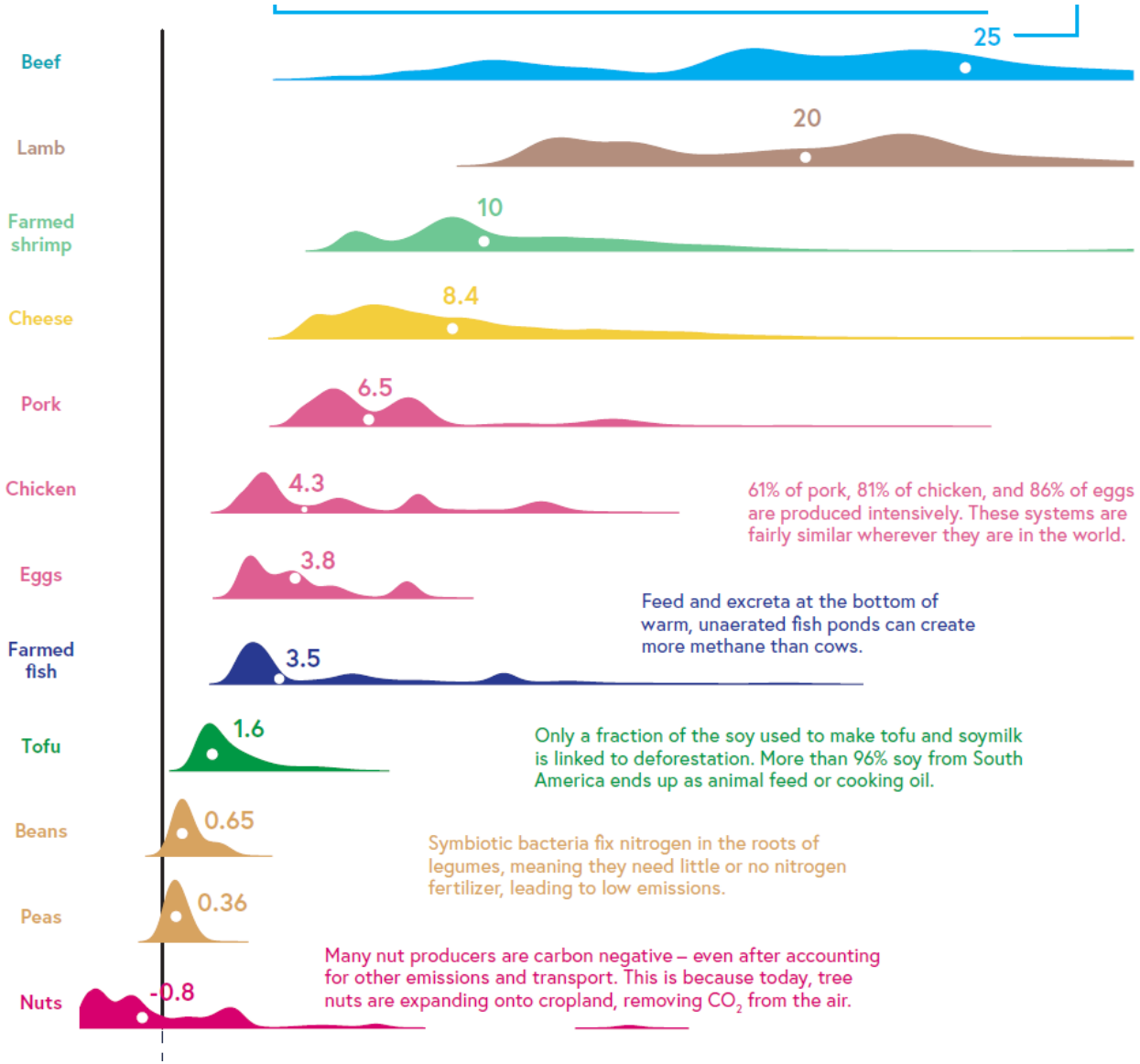
- Incremental approach, year by year
  - Monitor effects
  - Unintended consequences
  - '3 compartment' proposal arises from one computer model

  National Food Strategy recommends this as future pathway. Recommendation 9: Create a Rural Land Use Framework based on the three compartment model - *modest supporting evidence?....*

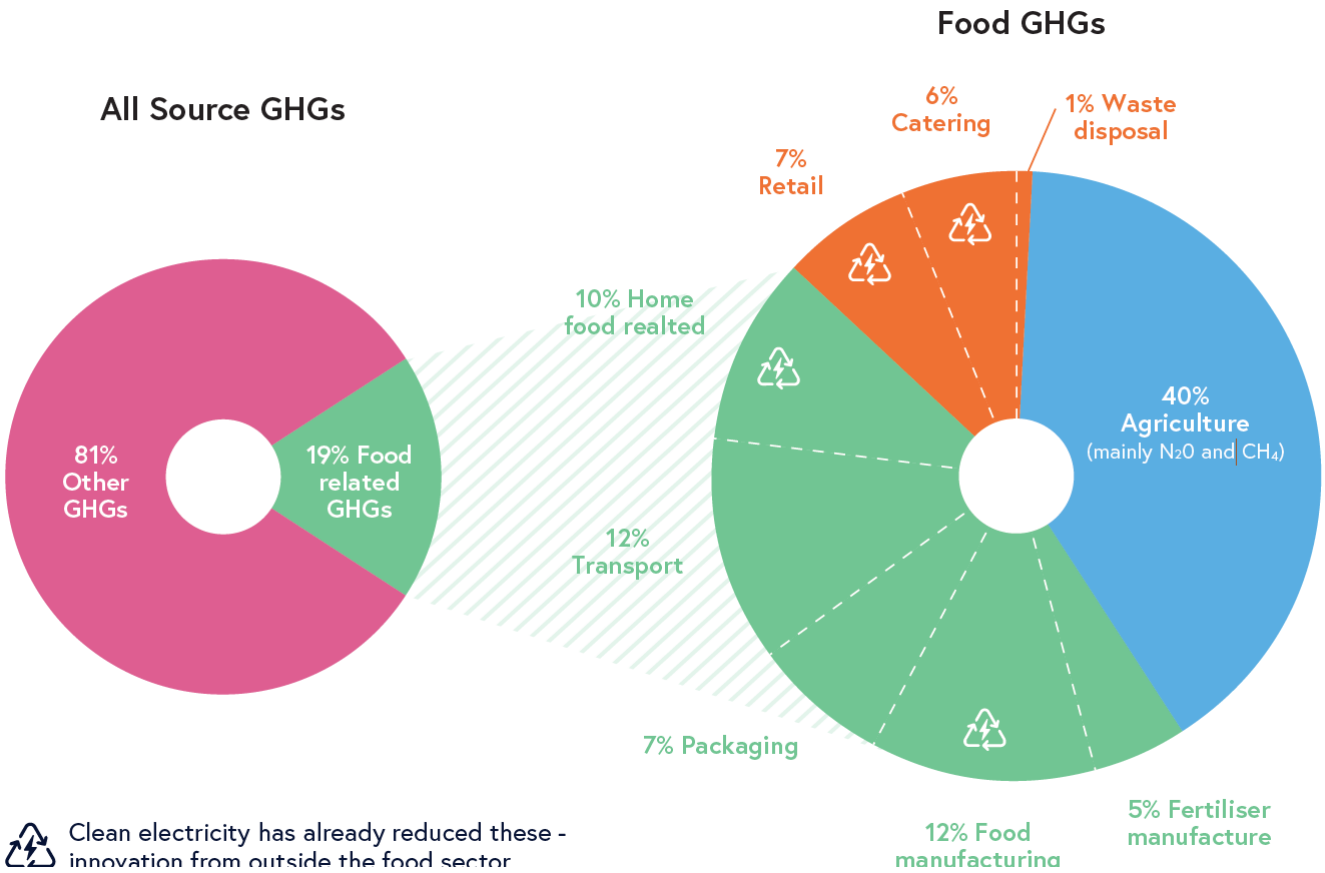
  …but also more support to agroecological (ie less-intensive) farming methods (in supporting text of Recommendation 11: Invest £1 billion in innovation to create a better food system)

2. Reduce consumption of carbo-intensive foods

Carbon footprints of different foods

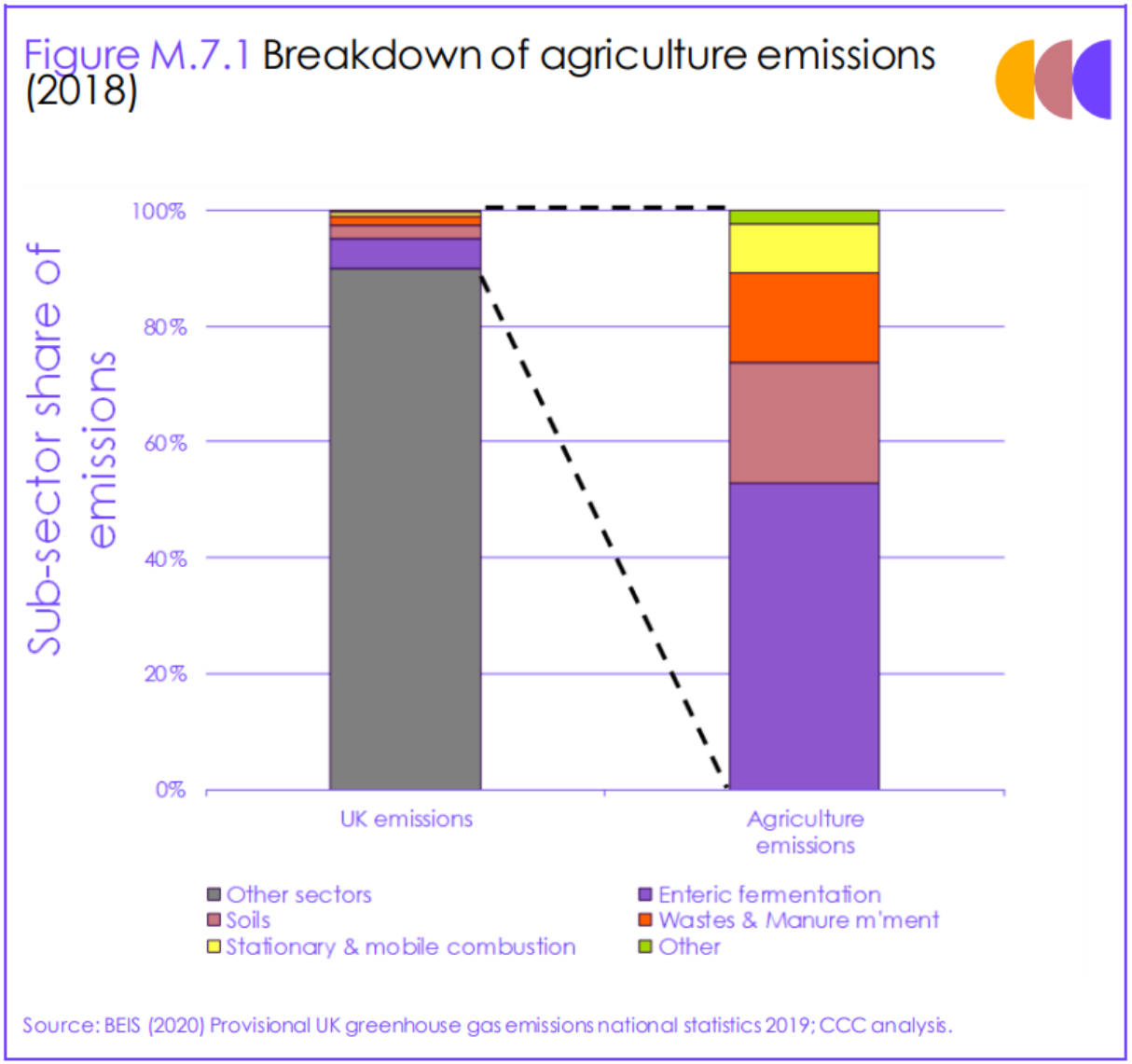


Greenhouse gas emissions from food system



Contribution of CH_4 emissions calculated using GWP100: 1 tonne of CH_4 equivalent to 34 tonnes of CO_2 over 100 yr period
For N_2O, GWP is 265

Breakdown of agriculture emissions



Methane – atmospheric exchanges

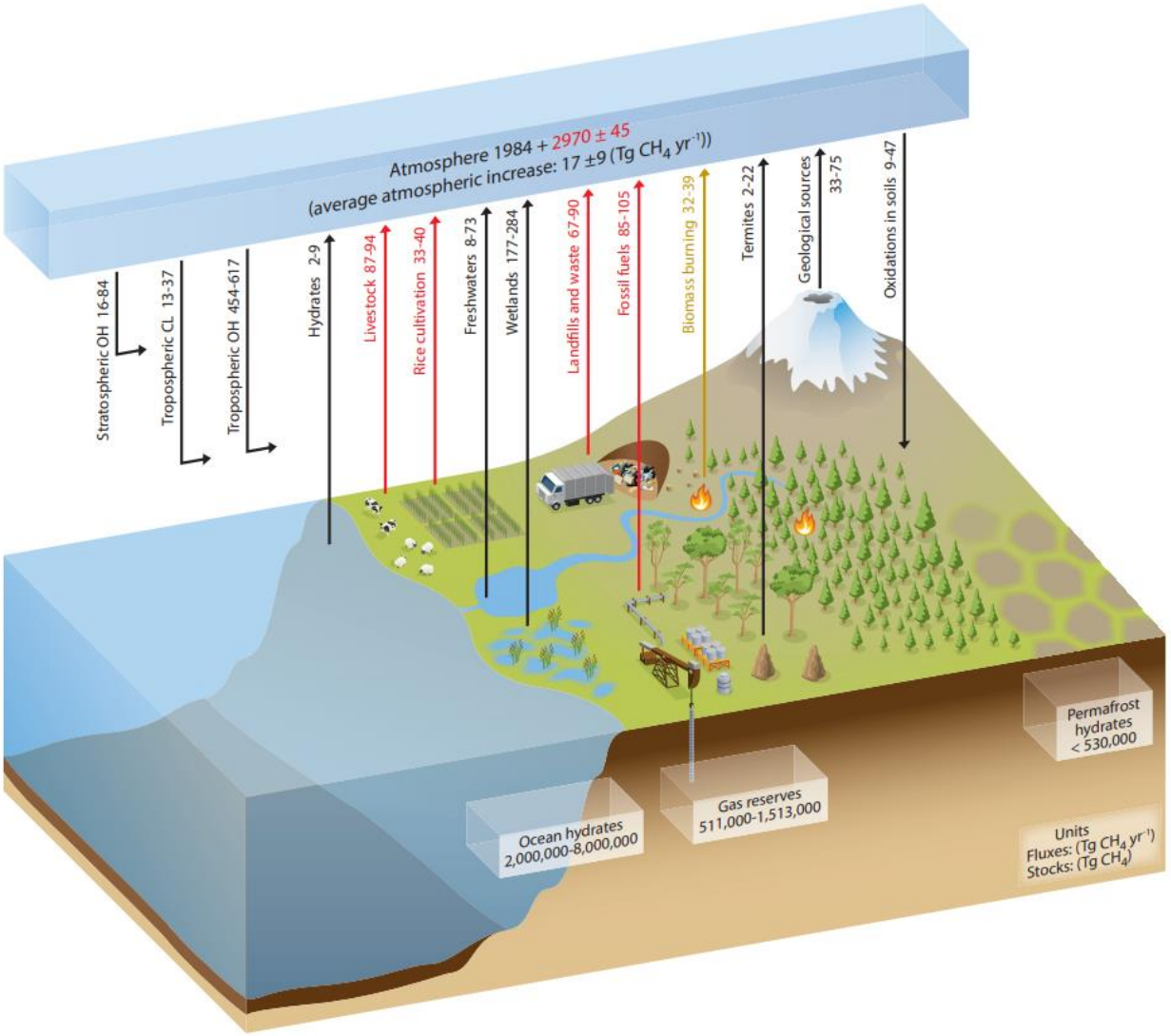
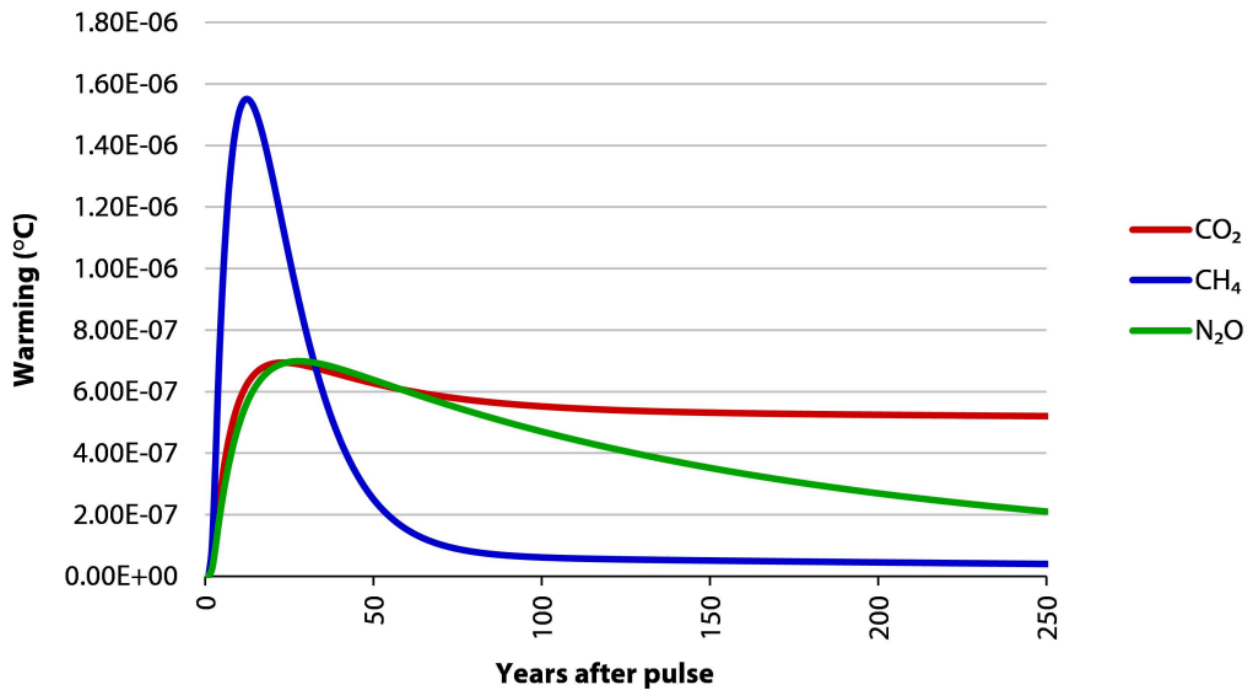


Figure 6.2 | Schematic of the global cycle of CH_4. Numbers represent annual fluxes in Tg(CH_4) yr^{-1} estimated for the time period 2000–2009 and CH_4 reservoirs in Tg (CH_4): the

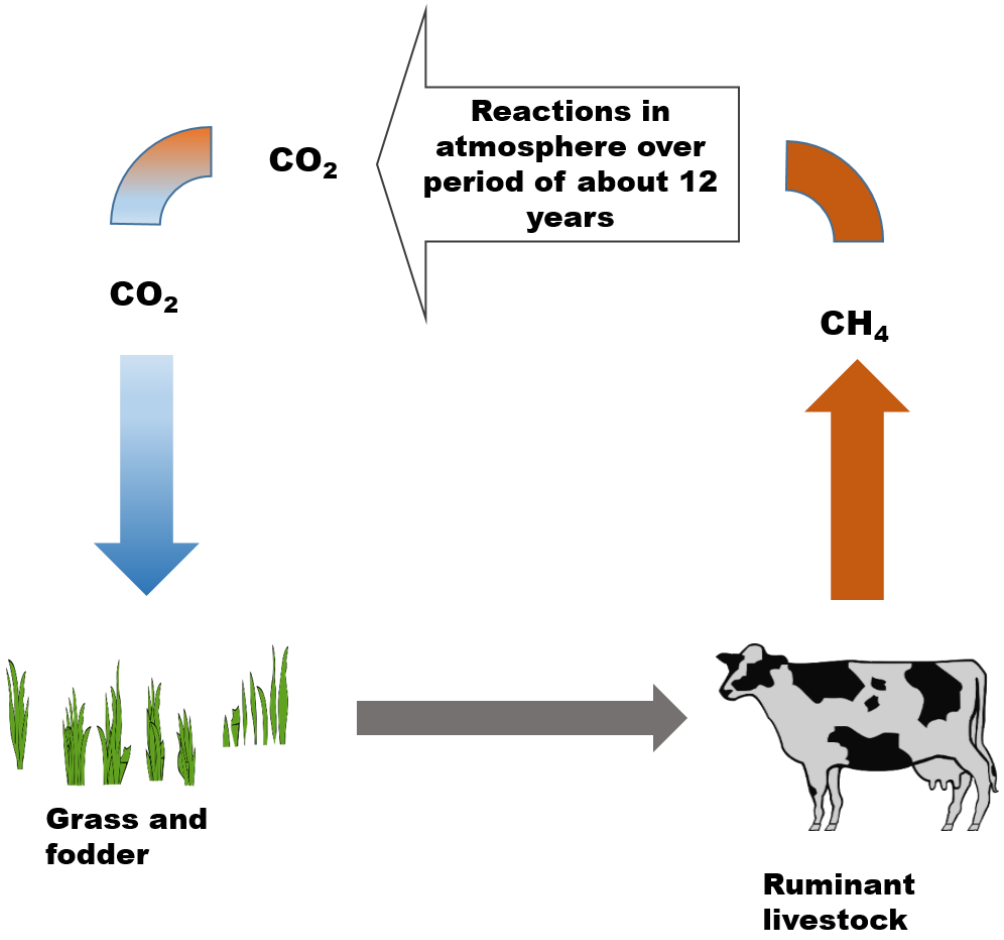
The issue of methane emissions (1): Lifetime of greenhouse gases compared

Figure 2.5. Global warming response to a one-off pulse emission of 1 $MtCO_2e$



Source: CCC analysis.
Notes: Warming responses to the pulse emissions are calculated using the response functions for calculating emissions metrics in the IPCC 5th Assessment Report.

The issue of methane emissions (2): Cyclical nature of ruminant emissions



The issue of methane emissions (3): Emission metrics

GWP100 – equivalent no of tons of CO_2 to give same total heat trapping over 100 years (34 – or 28?)

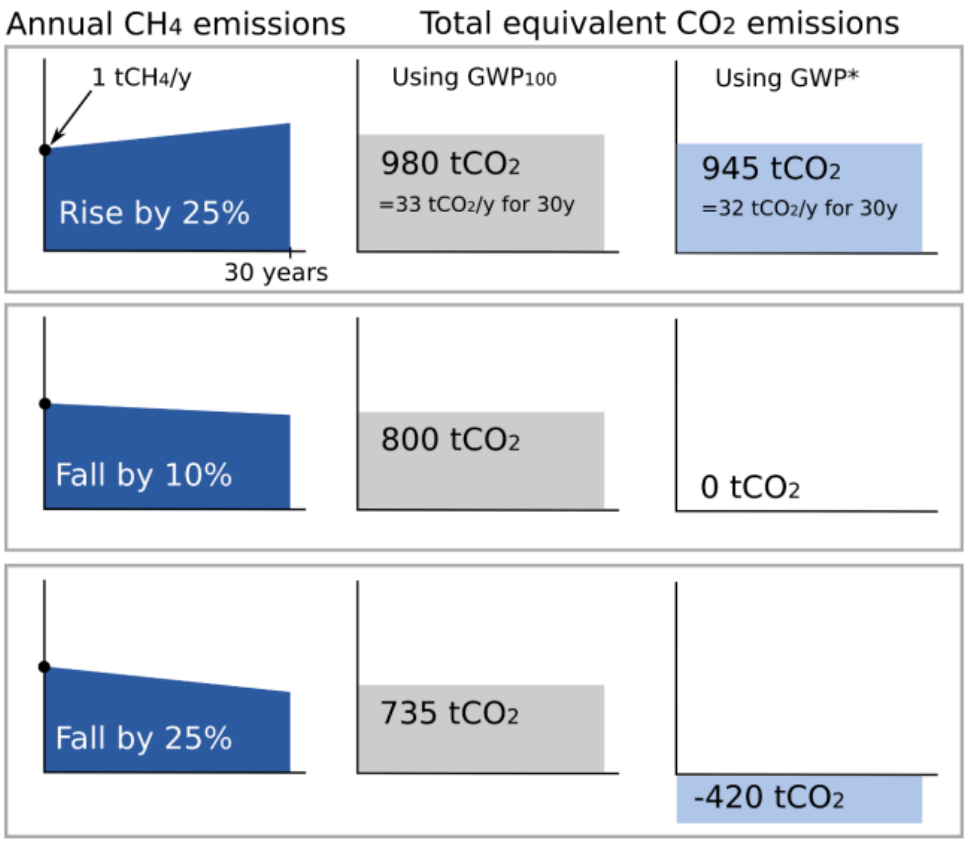
- The most commonly used metric, recommended in IPCC reports before 5th
- UK Climate Change Act requires metrics consistent with international reporting practice – ie GWP100

GWP* - measure developed to reflect short lifetime of methane

- Growing interest in alternative methane emission metrics for setting agricultural targets
- New Zealand Zero Carbon Bill has separated out methane reductions
- GWP* shows warming from methane emissions only if they are increasing

The issue of methane emissions (4): GWP100 and GWP* compared

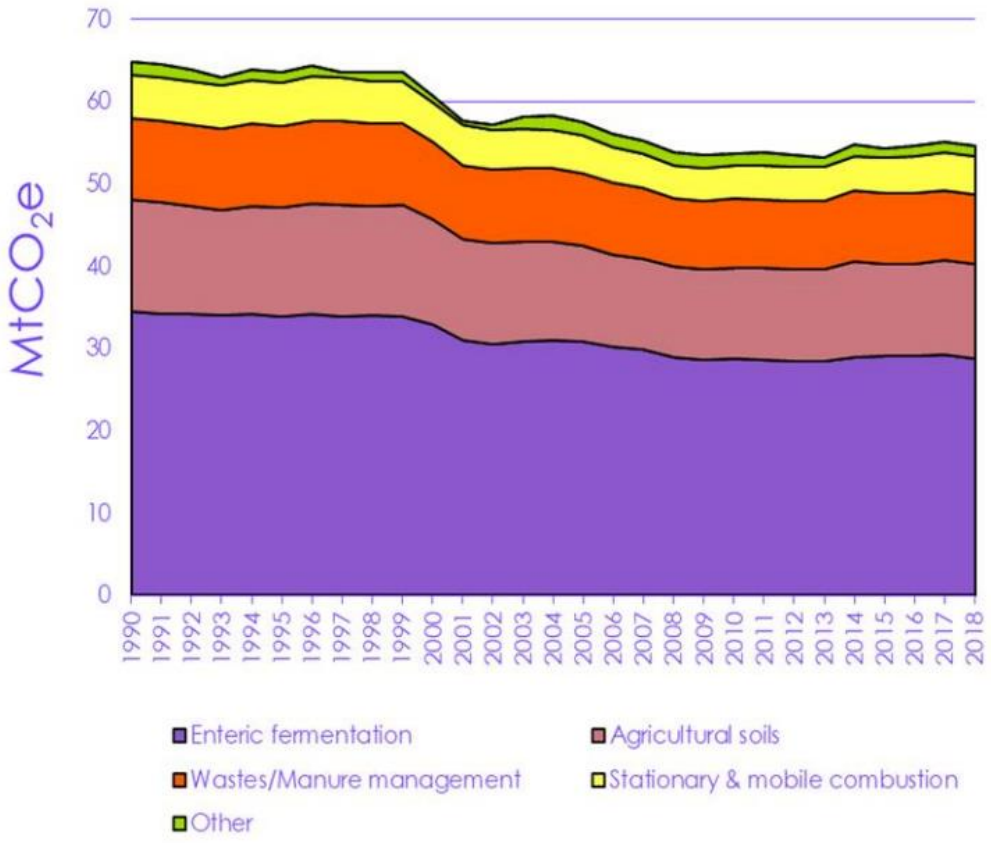
Figure 2.6. Methane emissions accounting under GWP_{100} (middle column) and GWP* (right column)



Source: Oxford Martin School (2018) *Climate metrics for ruminant agriculture.*

The issue of methane emissions (5): UK Agricultural emissions over time

Figure M.7.2 UK agricultural emissions (1990-2018)



Source: BEIS (2020) Provisional UK Greenhouse Gas National Statistics for the UK; CCC analysis.

The issue of methane emissions (6): Recognition in National Food Strategy and CCC

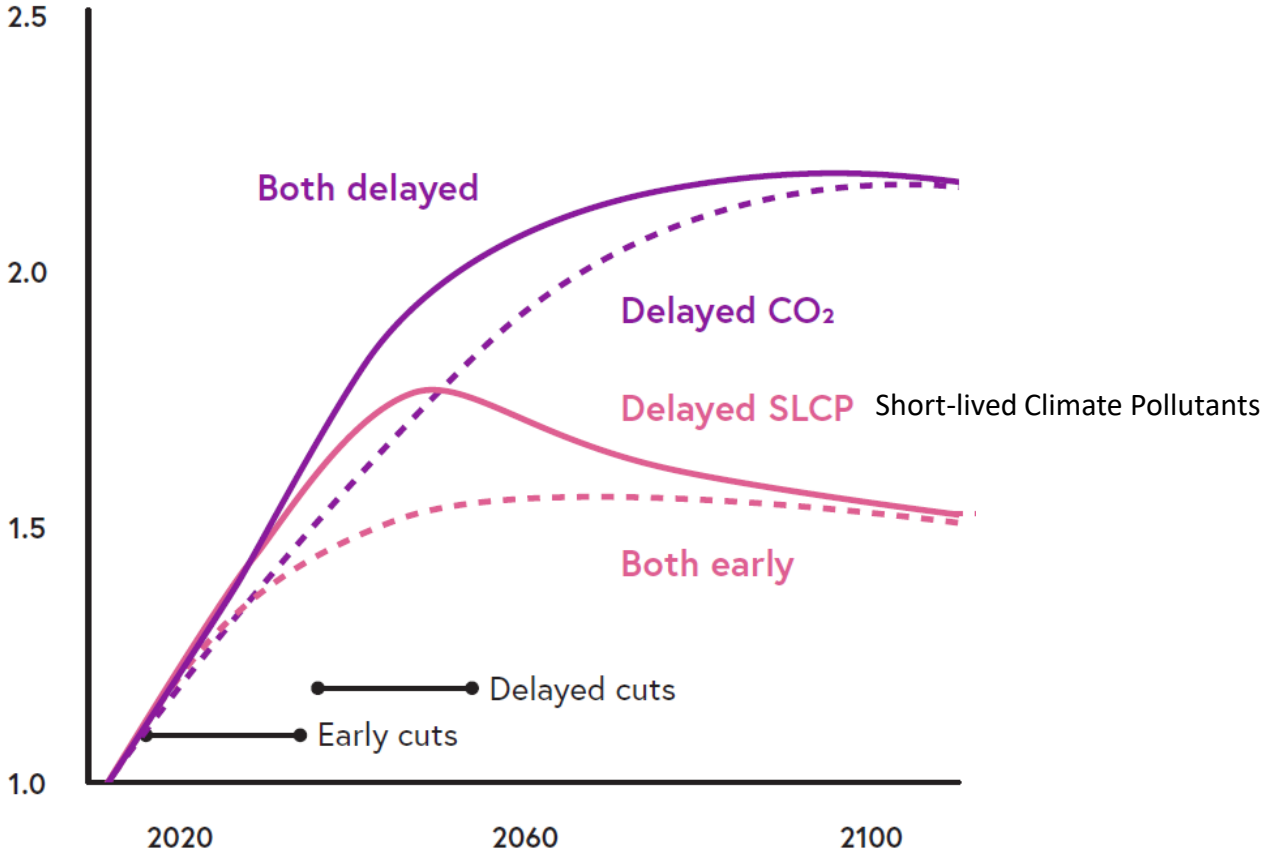
National Food Strategy, Ch 7, p76:

> It follows from this that if we actually reduced the number of ruminants on the planet (or the methane produced by each ruminant), over time the quantity of methane in the atmosphere would reduce. This would have a cooling effect….
>
> …Only methane can disappear like this. Cutting back on methane is therefore *one of the very few methods by which we could put a relatively sharp brake on climate change*…
>
> …This is why, in recent years, meat-eating has risen up the environmental agenda.

UK CCC 'Land use policies for a Net Zero UK', p45

- Global 'cost-optimal' models for meeting Paris Agreement temperature goal propose global reductions in short- and long-lived gases
- Reducing methane emissions to counter continuing increases in CO_2 emissions in short term
- Around 40% reduction in methane by 2050 proposed in CCC 'Further Ambition' scenario to prevent overshoot of 1.5^{o}C goal

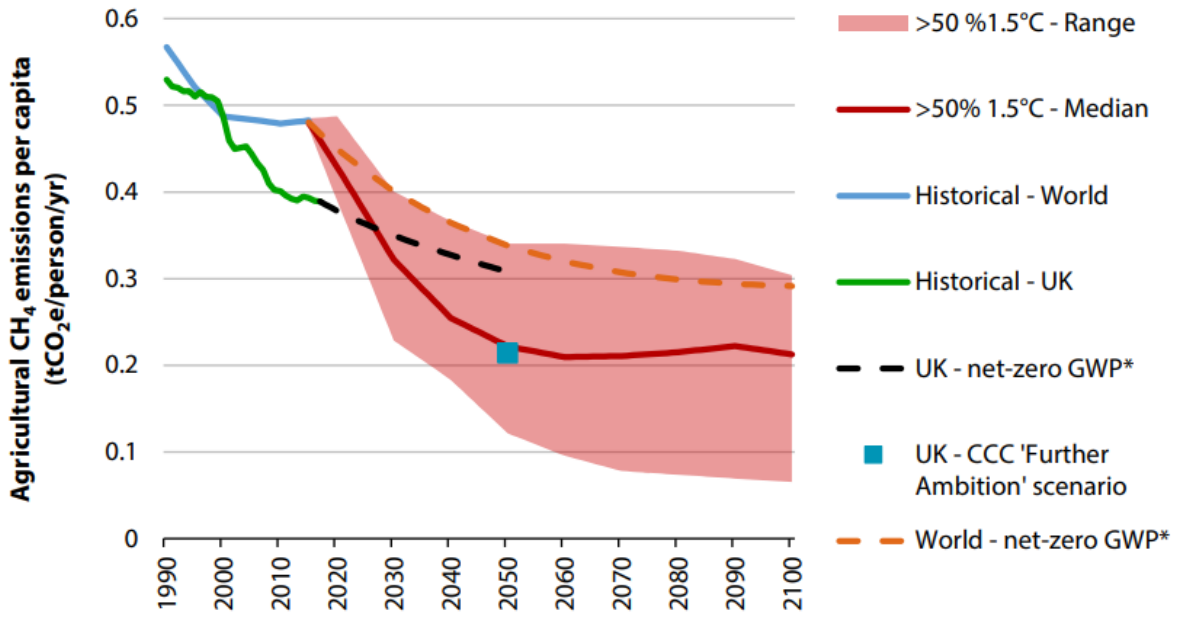
The issue of methane emissions (7): Offsetting short-term CO_2 overshoot



Short-lived Climate Pollutants

The issue of methane emissions (7): meeting Paris Agreement target

Figure 2.7. Per person agricultural methane emissions in pathways consistent with the Paris Agreement



Source: IPCC-SR1.5; Hoesly, R. et al. (2018) Historical (1750–2014) anthropogenic emissions of reactive gases and aerosols from the Community Emissions Data System (CEDS). *Geoscientific Model Development*, 11, 369–408; CCC analysis.

Notes: Methane emissions are expressed using the GWP_{100} metric (values from the IPCC 4th assessment report). The plume shows the full range of 1.5°C no or low overshoot scenarios from IPCC-SR1.5, harmonised to observed emissions from Hoesly et al. in 2015. Global average population is projected forward using the SSP2 scenario for the 'World - net-zero GWP*' case and the UK population using the ONS principal long-term projection (until 2050 only) for the 'UK - net-zero GWP*' case. The net-zero GWP* cases are consistent with reducing methane emissions only so far as to not add additional methane-induced warming.

Food carbon footprint - reflection

- Reduction of methane emissions from ruminants is probably a necessary part of an overall 'net-zero' pathway
  - as a short-term carbon sink, like planting trees
- Simplistic use of the GWP100 measure gives distorted conclusions, eg:
  - **THE** food system – agriculture, food production, distribution and retail combined – releases more greenhouse gases than any other sector apart from energy. It is responsible for 25–30% of global emissions: *a tally that dwarfs, say, the 3.5% contributed by air travel.*

  (BUT a herd of cows could persist for millennia with no net change to the carbon in the atmosphere; not true of aviation)
- All agricultural options involving increased use of fertiliser or transport increase the level of carbon in the atmosphere, which cattle-raising doesn't
- Risk of erroneous 'carbon-benefit' comparisons between alternative land-use strategies when GWP100 is used
- New Zealand approach of treating CO_2 and CH_4 separately is preferable?
- Expedient to let misapprehension about beef carbon footprint persist, to achieve desired reduction in consumption?

Beef farmers – unfairly vilified?

From National Food Strategy, p127:

> Our team has spoken to many livestock farmers – especially those on tenant farms – who feel that red meat is being unfairly vilified, and that their jobs and way of life are at risk.

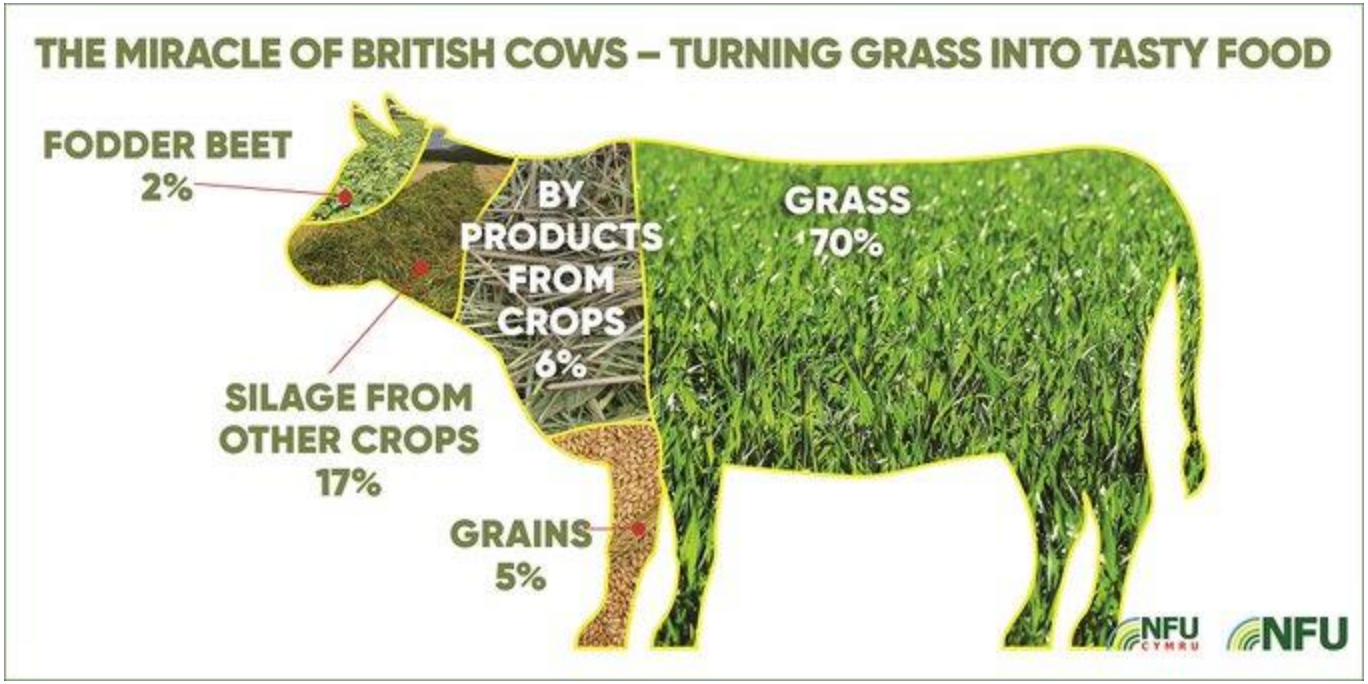
Reduction in meat and dairy emissions portrayed as cleaning up a dirty act, rather than contributing to carbon-capture-type activities

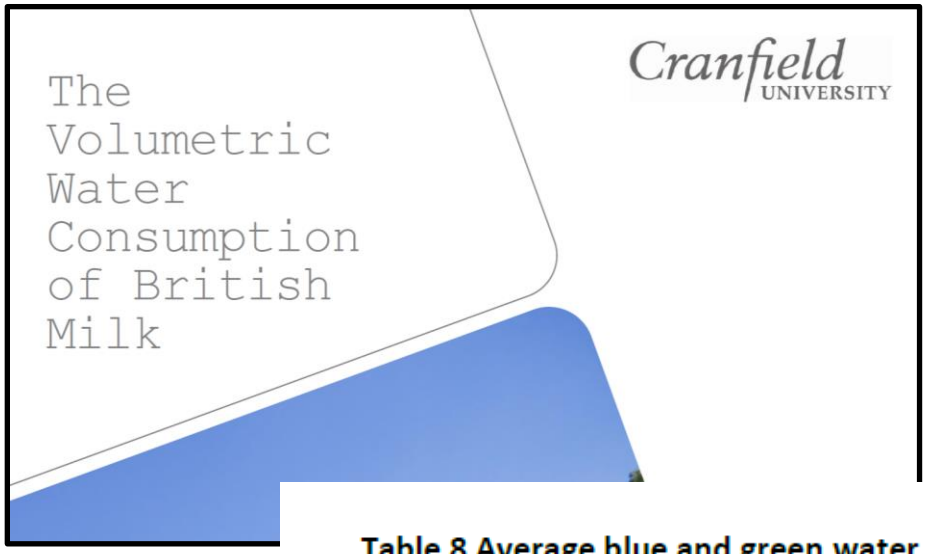
'Snowball effect' of negative assertions

- Deforestation to provide feed
- Water use

Deserve significant financial support and recognition from Govt of their valuable offsetting of others' emissions

British livestock feed use – from NFU





Department of Environmental Science and Technology,
November 2012

Table 8 Average blue and green water use for British dairy systems, litres per kg FPCM

Production system	Blue water, l/kg FPCM	Green water, l/kg FPCM	Total water use, l/kg FPCM
Spring calving	7.4	678	685
Autumn calving	7.5	683	691
All-year calving	7.5	681	688
Zero grazing	7.6	706	713
Organic	8.1	1,006	1,014
Values for green water use would normally be rounded to 2 significant figures, but the whole values have been shown to illustrate the relatively small effect of blue water and be arithmetically correct.			