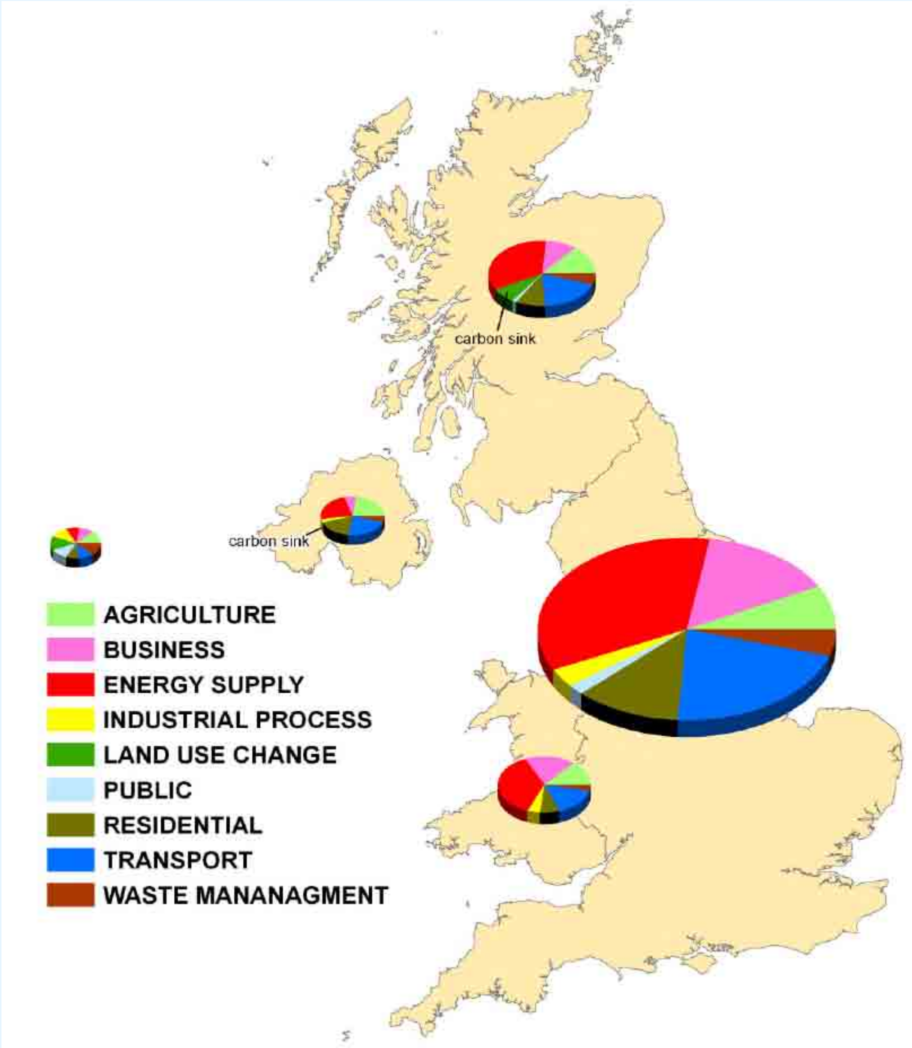
Mitigation of greenhouse gas emissions in Agriculture: A UK perspective

Rees RM, MacLeod MJ, Moran D, McVittie A, Jones G, Harris D, Anthony S, Wall E, Eory V, Barnes A, Jones J, Topp CFE, Ball BC, Hoad S and Eory L

Dublin, 25/06/2010

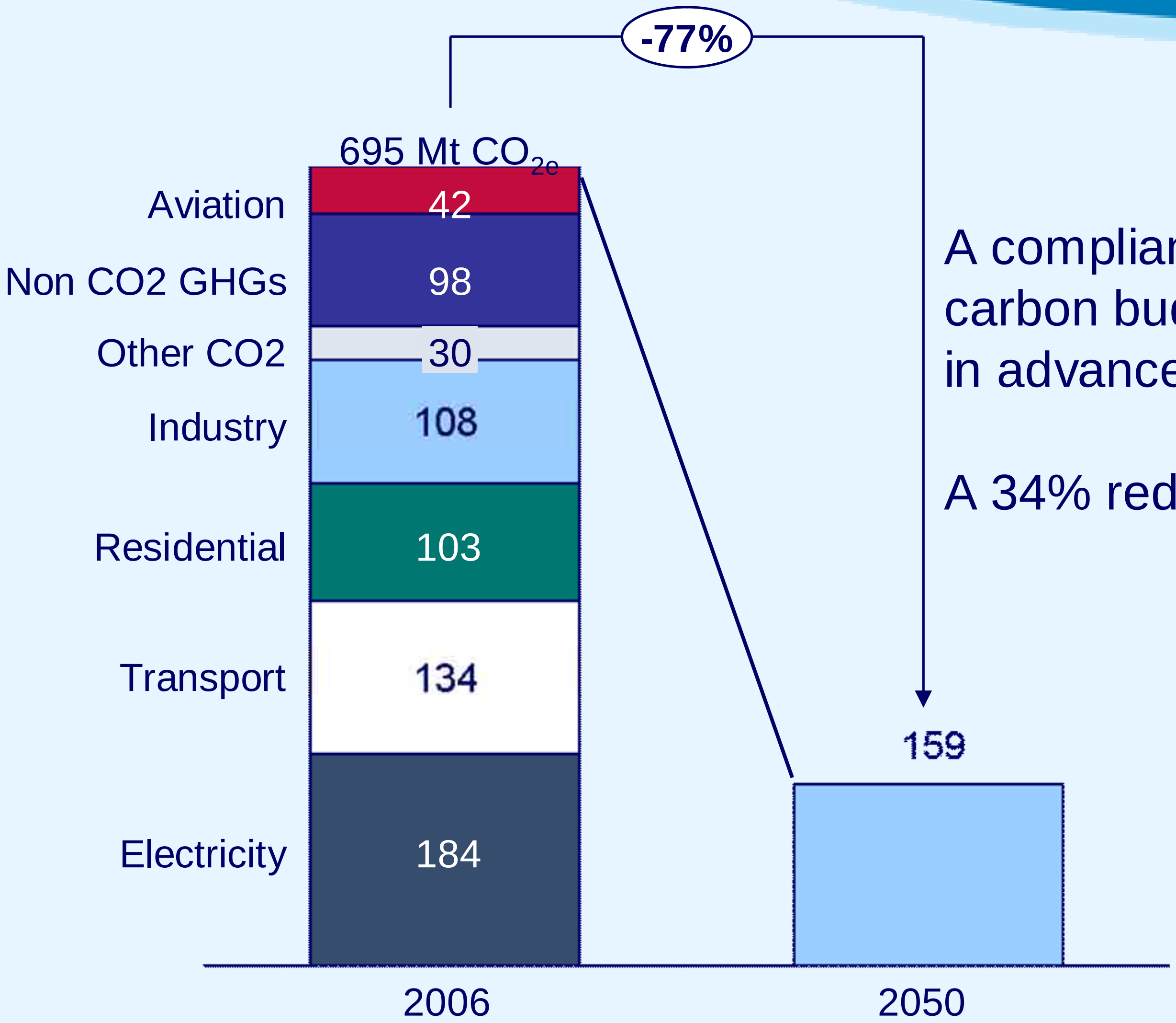
The UK's greenhouse gas inventory

- Agriculture contributes 8% of total emissions nationally
- These contributions vary with devolved authority
- The agricultural contribution is assessed by a tier 1 methodology



DECC 2009

2050 targets for GHGs



A compliance system of 5-year carbon budgets, set up to 15 years in advance

A 34% reduction required by 2018-2022

DEFRA 2009

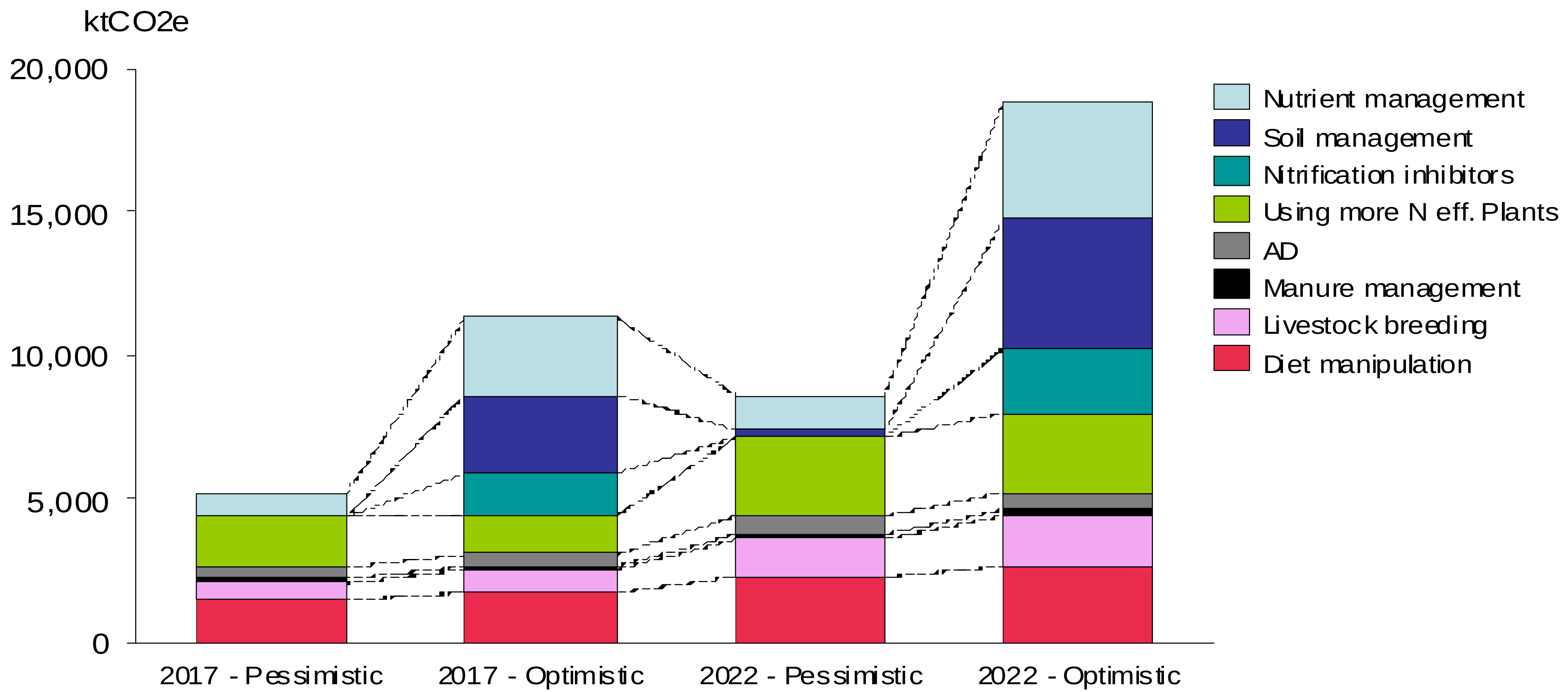
Constraints

- The need to produce food
- Emissions leakage
- Climate
- Economics
- Technical constraints

Assessing mitigation potential

- Evidence for mitigation potential of different measures was taken from
  - Reviews of relevant literature
  - Output from models
  - Expert opinion
- The above approach was also used to provide information on uncertainty

Abatement potential



Abatement achievable for <£100/t for categories of measures (private discount rate, new interactions method)

Source: MacLeod, M., Dominic Moran, Alistair McVittie, Bob Rees, Glyn Jones, David Harris, Steve Antony, Eileen Wall, Vera Eory, Andrew Barnes, James Jones, Kairsty Topp, Bruce Ball, and Steve Hoad and Lel Eory (2010) *Review and update UK MACCs for agriculture and to assess abatement potential during the 4th budget period (2023-2027) Final report* London: The Committee on Climate Change

Key features of the Mitigation Abatement Cost Curve method

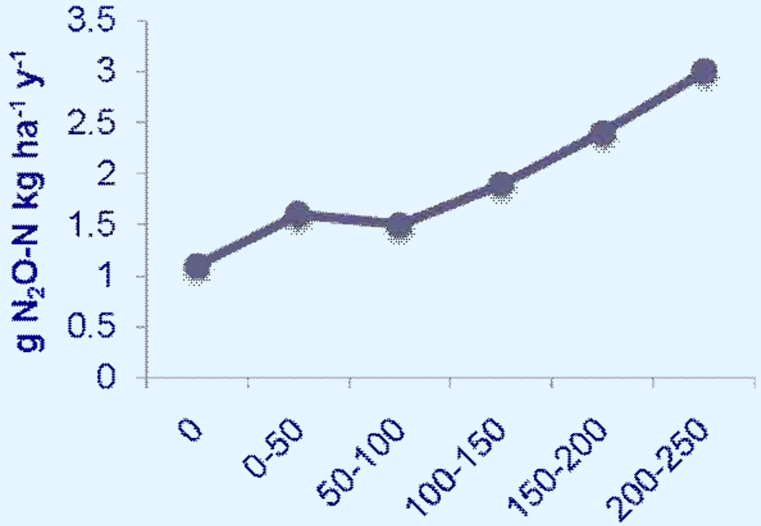
SAC

- The system boundary was drawn at the farm-gate, potential life cycle effects were noted but not integrated into the analysis
- Analysis limited to GHG effects, didn’t include wider ancillary costs/benefits (e.g. water quality, animal health/welfare)
- Simplified modelling of interactions between mitigation measures
- In order to reflect uncertainty in assumptions, 2 versions of the MACCs were produced:

Optimistic MACC	**Pessimistic MACC**
Higher estimate of area of applicability	Lower estimate of area of applicability
Higher estimate of abatement rate	Lower estimate of abatement rate
Lower estimate of cost	Higher estimate of cost

Nutrient management

- N_2O emissions are more sensitive to fertiliser application rates than any other factor
- Careful adherence to best practice and fertiliser recommendations can reduce emissions

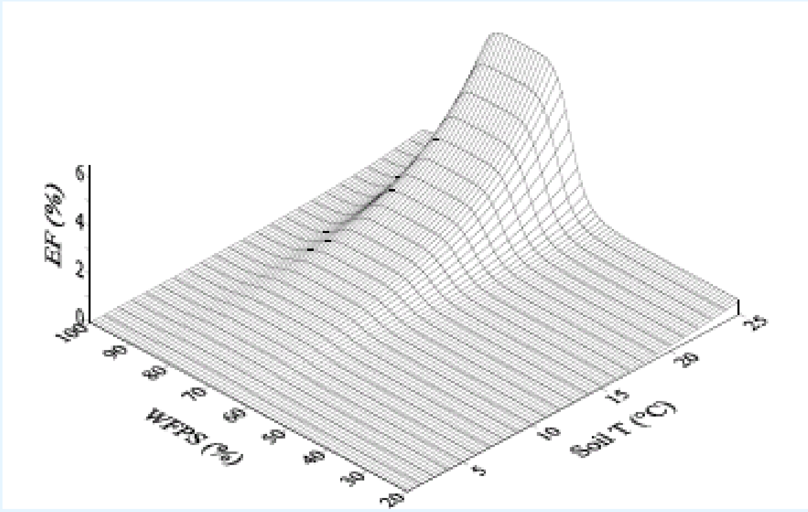


N application rate (kg ha^{-1})

Bouwman et al, 2002

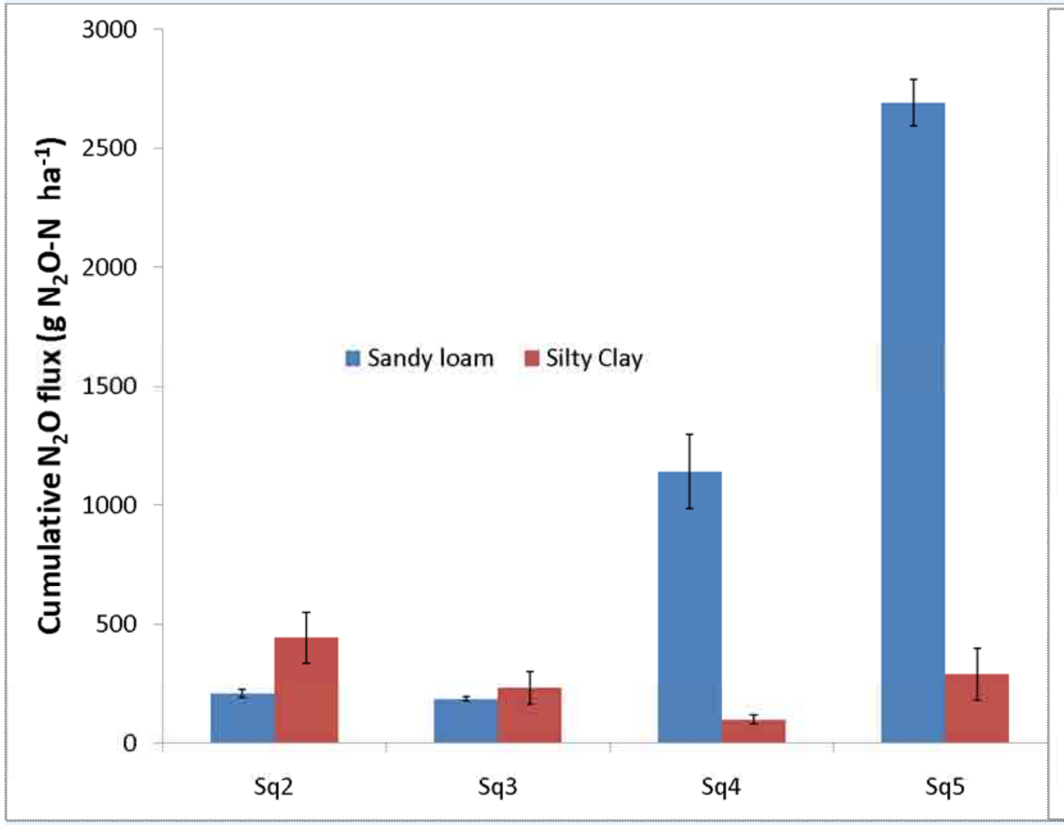
Soil Management

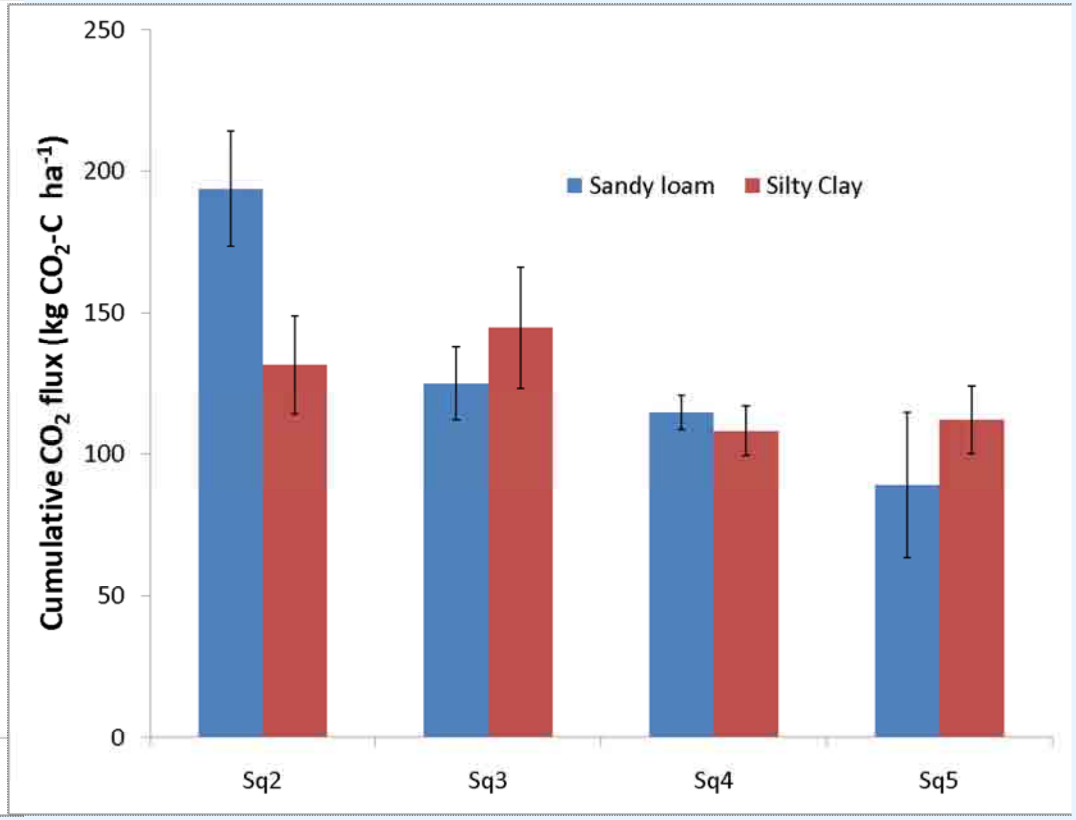
- Soil and climate interact to modify N_2O emissions from fertilisers
- Wet and mild conditions promote greater emissions and justify regional emission factors in inventory calculations



Flechard et al 2007

Soil structure and N_2O and CO_2 emissions

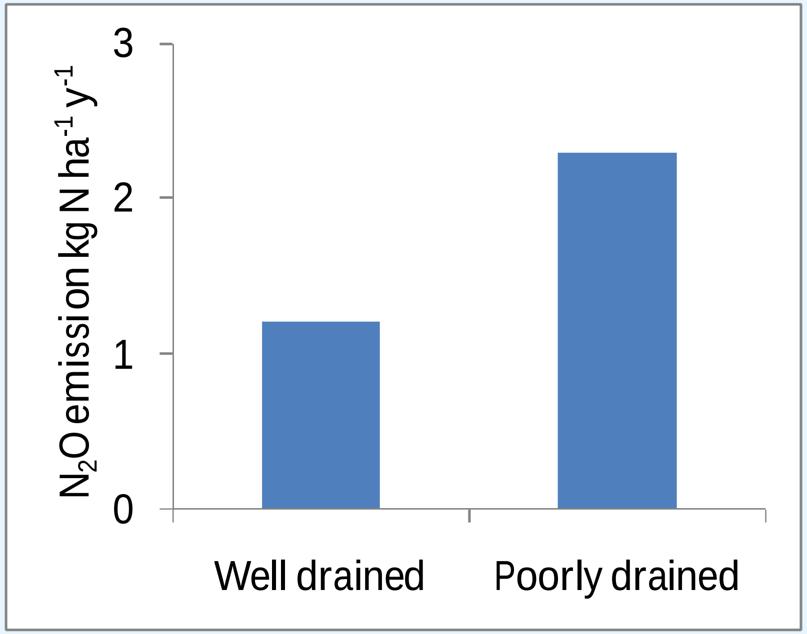




Improving soil quality

Drainage

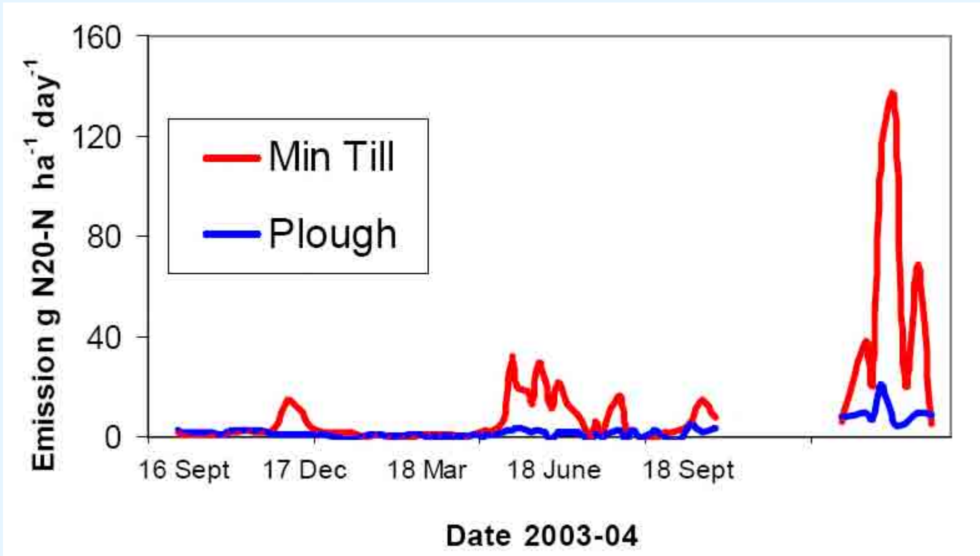
- Drainage has a complex relationship with GHG emissions
- Improved drainage reduces N_2O emissions, but probably increases CO_2 emissions and improves crop production



Bouwman et al, 2002

Tillage

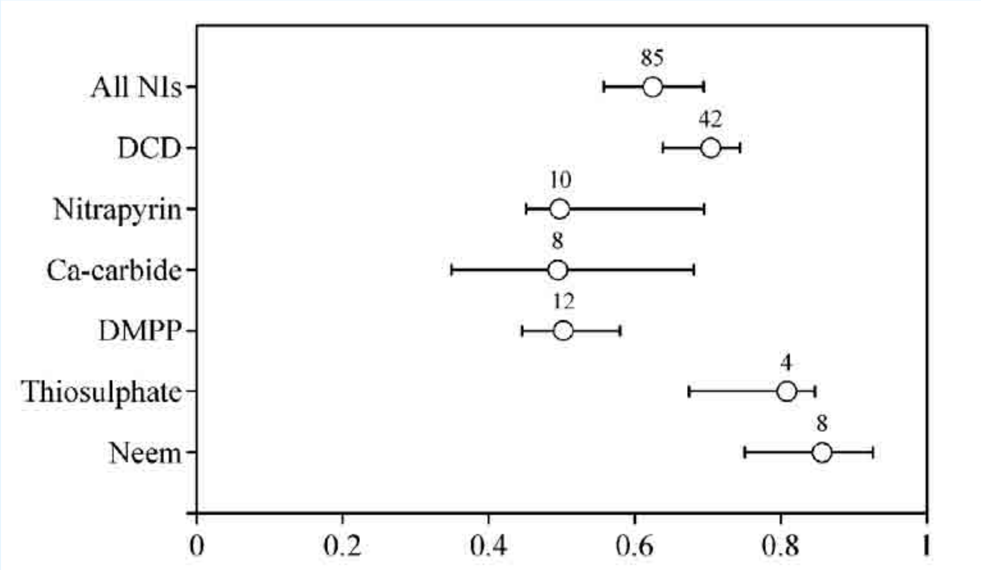
- Min till can provide small increases on soil C
- These can be offset by increased losses of N_2O
- Effects may be site specific



Goulding et al 2004

Nitrification inhibitors

- Nitrification inhibitors can be added to fertilisers to reduce N_2O emissions
- The efficiency of different inhibitors varies
- They also respond differently under different field conditions

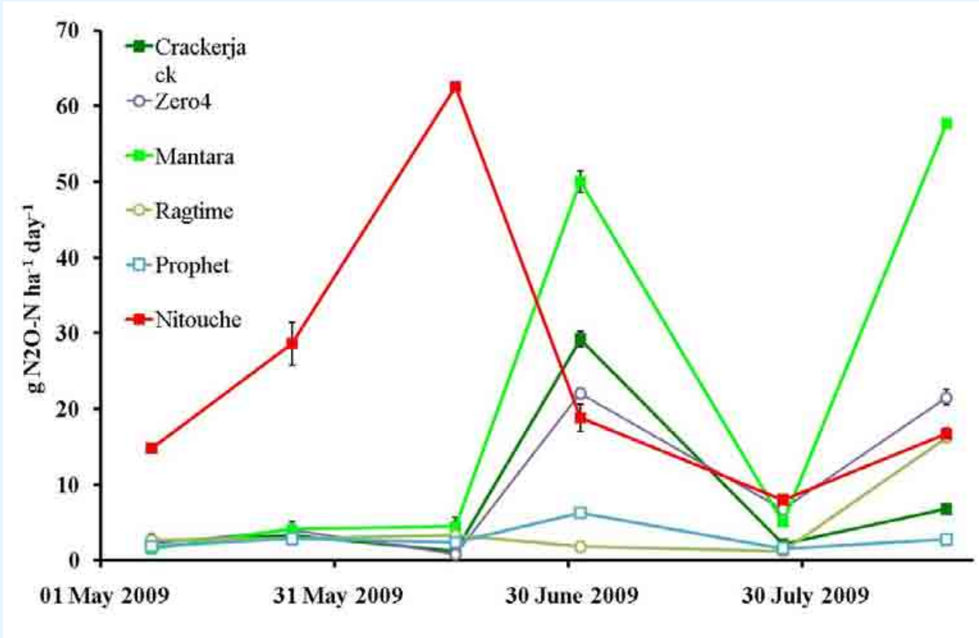


Relative N_2O emission

Akiyama et al 2010

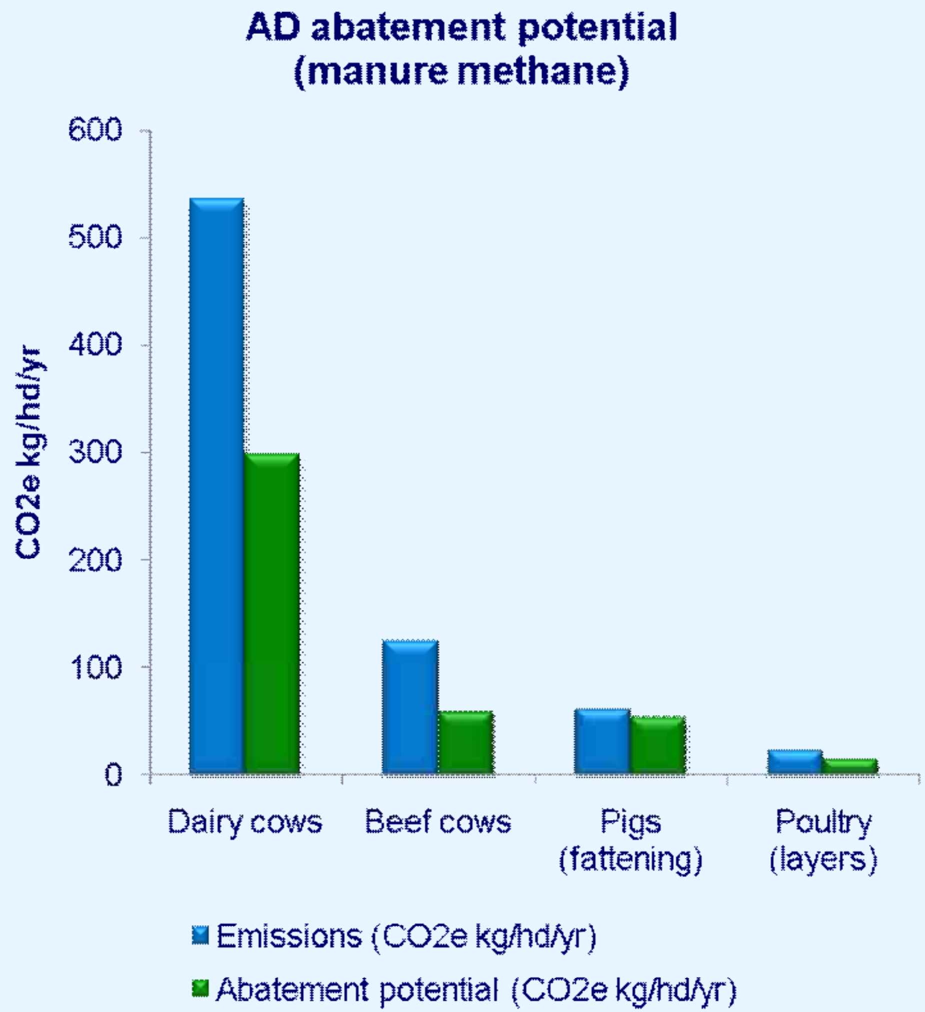
Using more efficient plants

- Existing crop varieties vary in their N use efficiency
- This is probably associated with differences in N_2O emissions
- Screening and plant breeding could exploit this



Anaerobic digestion

- Captures CH_4 from manure/slurry to generate power and heat
- On-farm or centralised using additional feedstock e.g. food waste
- Digestate used as N source – potential biosecurity and waste issues



Manure management

- Improved timing
- Full allowance for nutrient value
- Avoidance of combined applications of slurries and manures

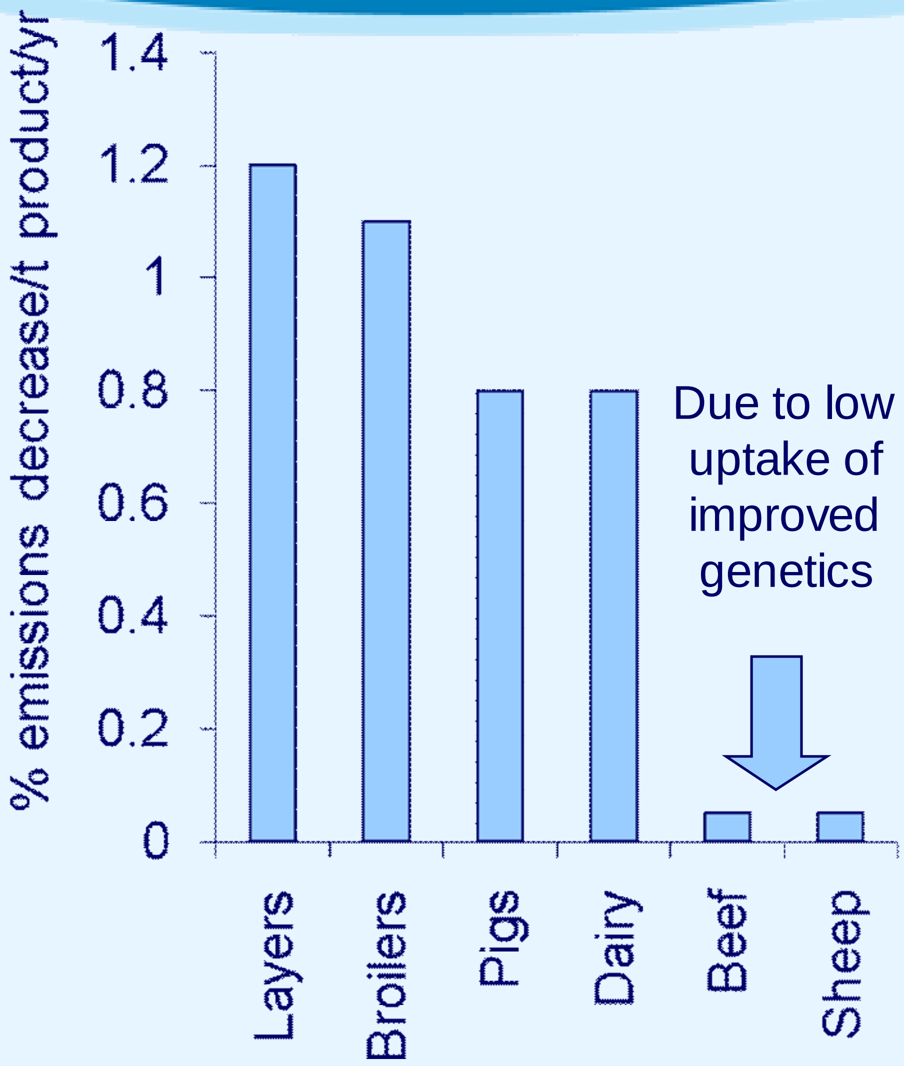
Livestock genetic improvement

SAC

- Genetic improvement is a tool that can be used to reduce emissions
- 3 modes of action
  - Breeding for improved efficiency of the animal (indirect)
  - Breeding for improved efficiency of the system (indirect)
  - Breeding for reduced GHG emissions (direct)

Genetic improvement in livestock

- Selection on improved feed conversion efficiency can help to reduce emissions
  - Broilers reach 2 kg in 36 days(1999) vs 63 days(1976)
  - Dutch Landrace: FCR is 2.8 kg/kg (1990) vs. 3.5 (1930)
- Beneficial effect on reducing the emissions per unit of product



Jones et al., EAAP, 2008

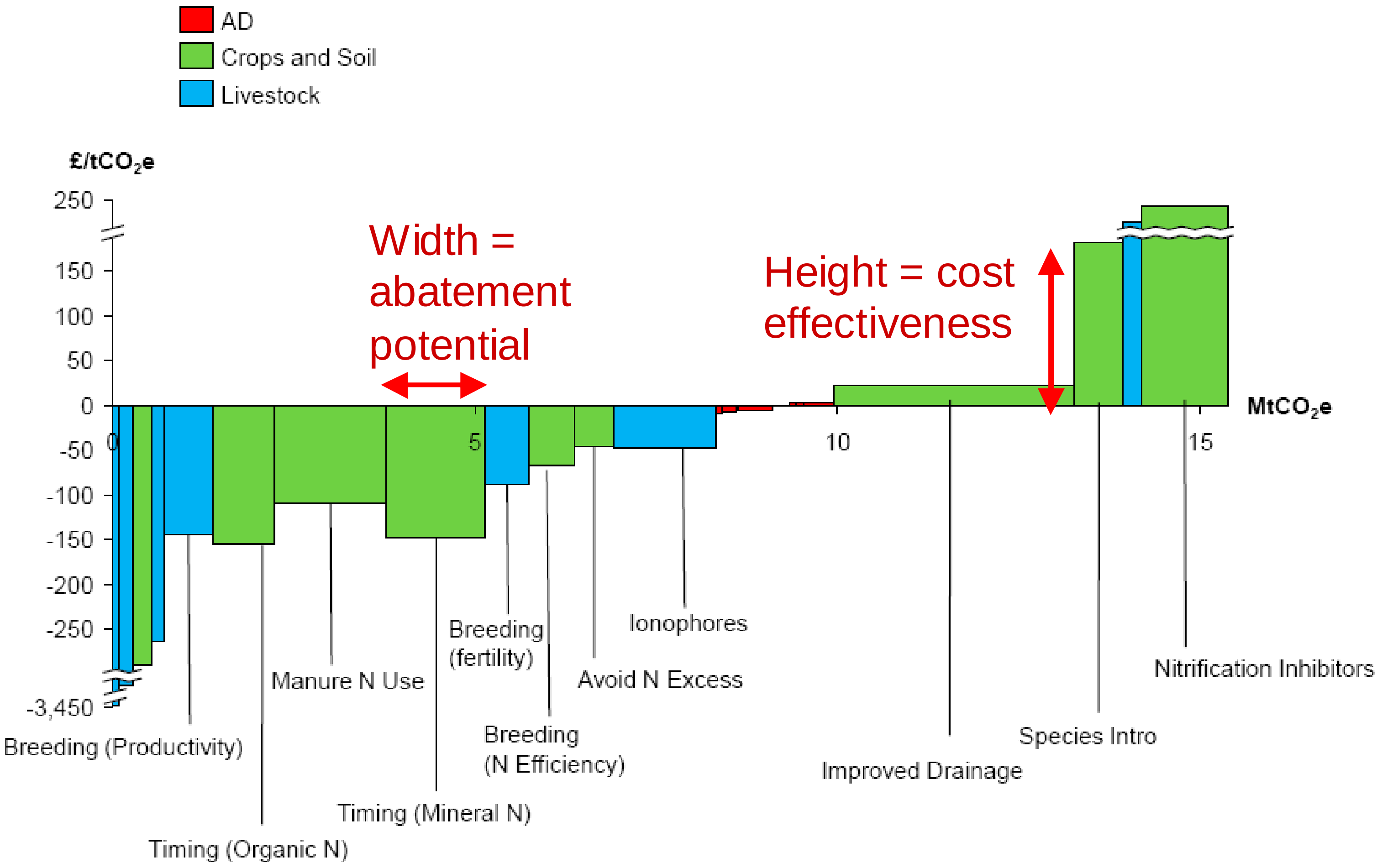
Animal nutrition/diet options

- Main target enteric methane from ruminants improving the efficiencies in utilising diet
  - Changing feed: better quality to improve efficiency of feed utilisation (↑ starch/rapid fermentable carbs)
  - Feed additives: help animal utilise energy or the way in which the rumen works
  - Targeting rumen bugs: impact on the rumen population to control methane bugs

Soil C sequestration

- Soils offer important opportunities for C sequestration
- Often these are included with other mitigation methods e.g. manure and slurry management

Mitigation Abatement Cost Curves



Source: CCC modelling

Notes: N = Nitrogen, AD = anaerobic digestion

Measures do not appear in exact cost-effectiveness order due to interactions between options. More details and a full measures list is available in the accompanying technical papers.

Building a low-carbon economy – The UK's contribution to tackling climate change. 1st Report of the CCC, Dec, 2008

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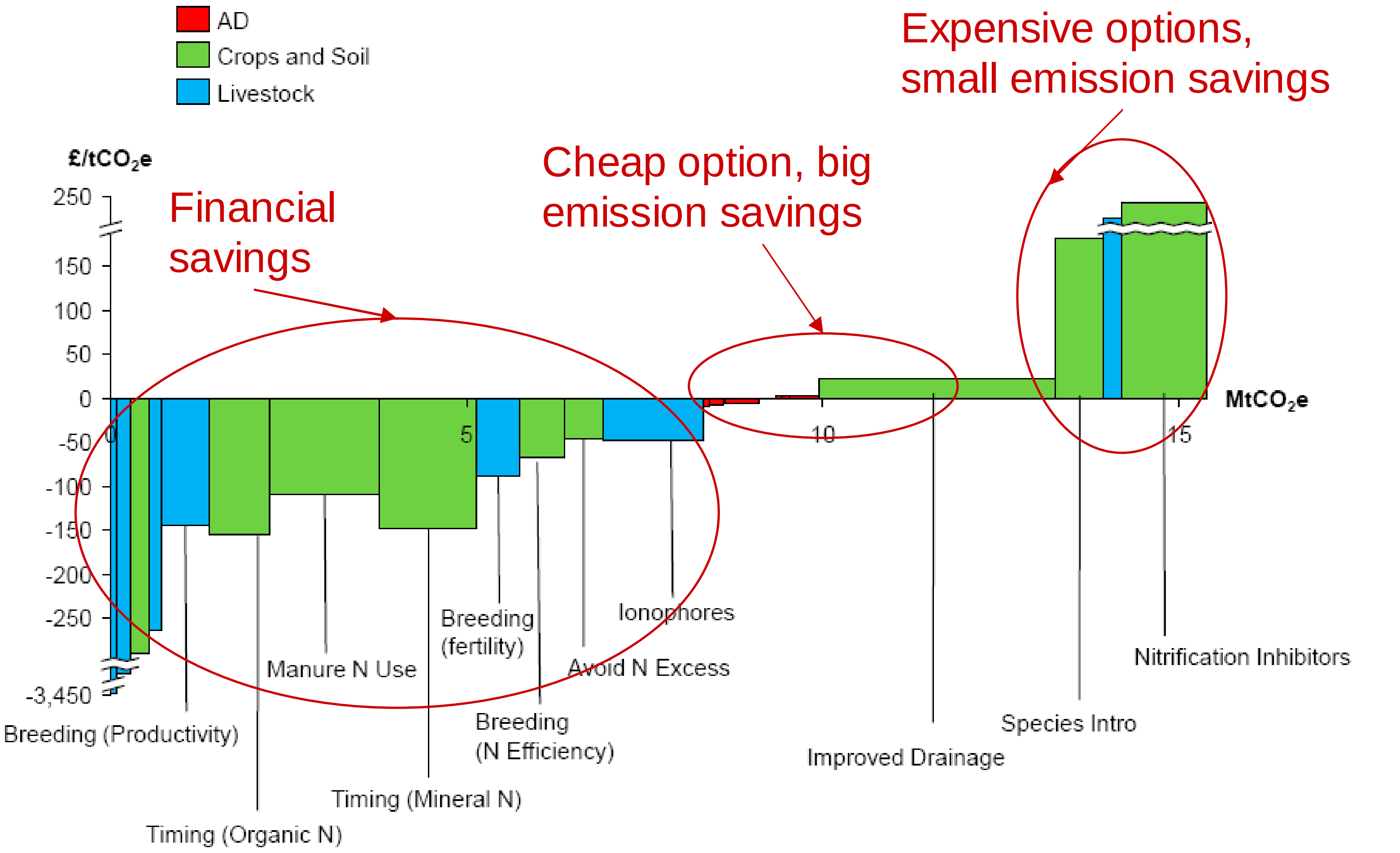

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Conclusion

- Agricultural landscapes are an important source of greenhouse gases in the UK
- Grasslands are a particularly important of emissions of both N_2O (soils) and CH_4 (livestock)
- Manipulation of systems through management offers a major opportunity for mitigation
- We need more information on effectiveness of mitigation methods and improved reporting systems that will reflect actual emissions and mitigation

Acknowledgements

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