Climate Care Cattle Farming from Land and Soil perspective

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

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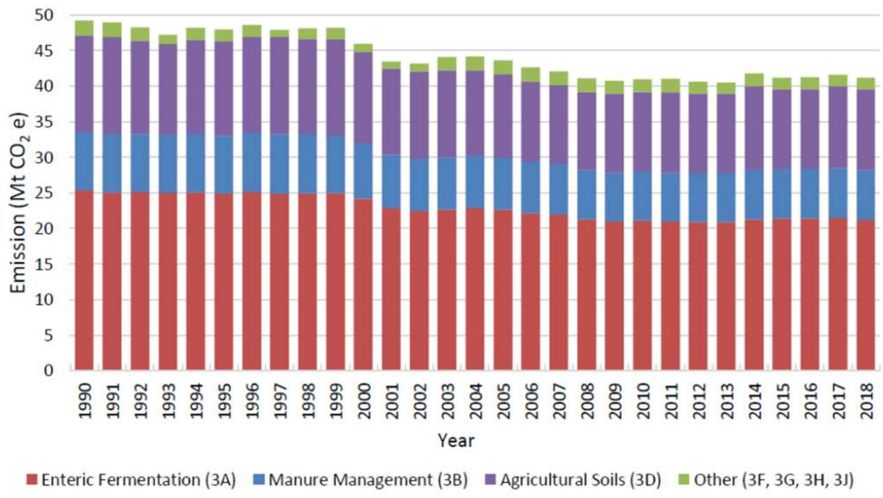
Nitrous oxide and net zero

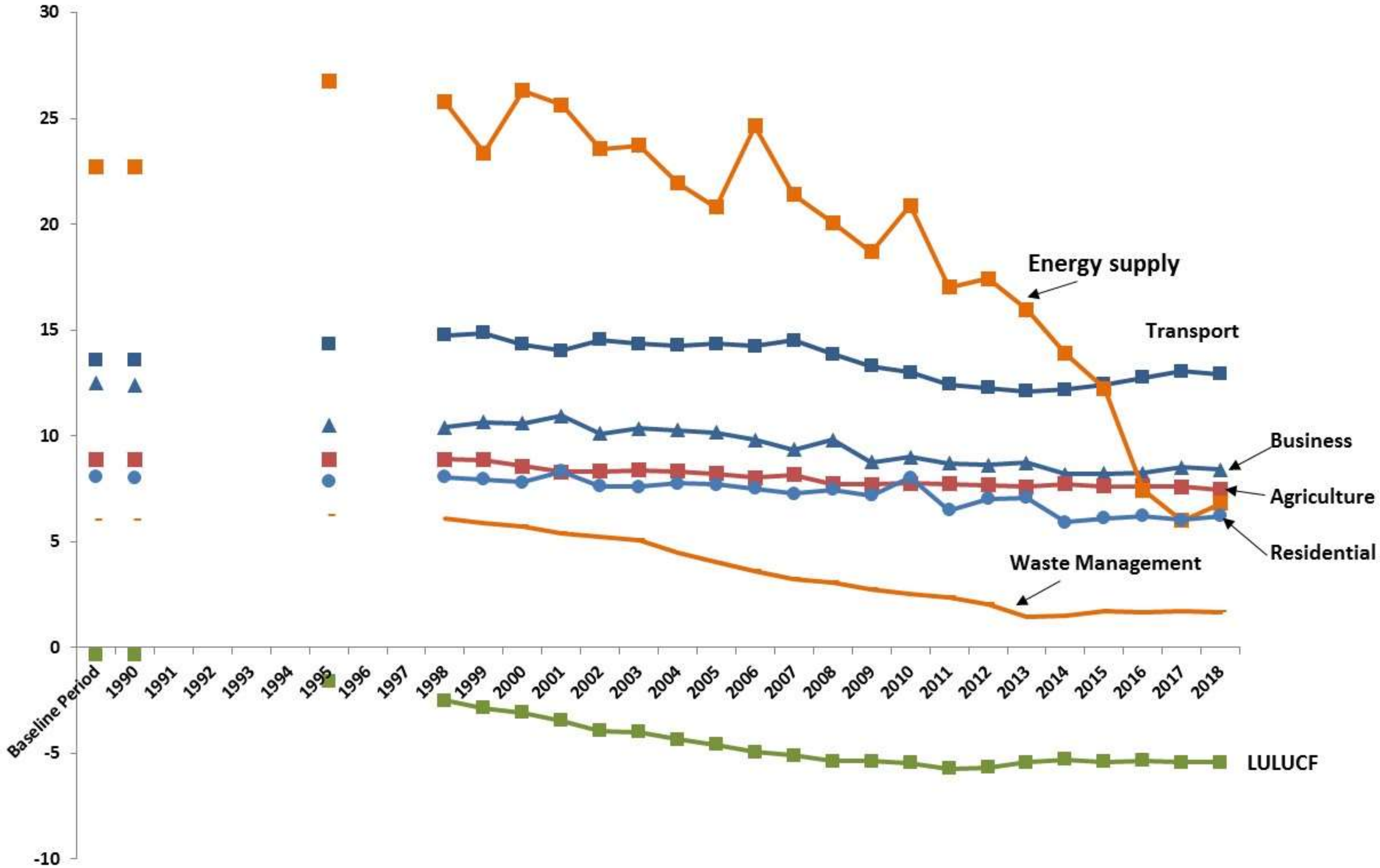
- The UK produces 21 $MtCO_{2e}$ of nitrous oxide each year
- That is 4.5% of national emissions, mostly from N applied to agricultural crops
- Net zero targets require large reductions



The UK's National Greenhouse gas Inventory 2018

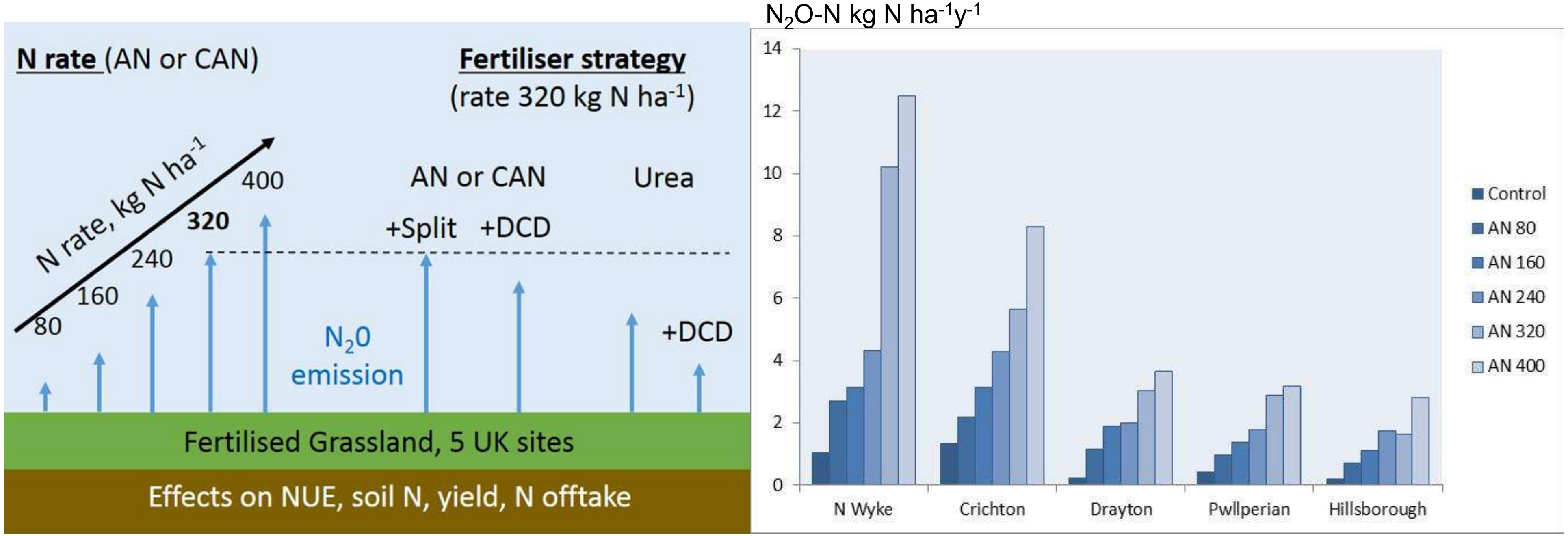
Scottish greenhouse gas emissions

Emissions of GHGs in Scotland in 2018 were higher than 2017, which has resulted in the government missing its target by 4%



Scottish Government 2020

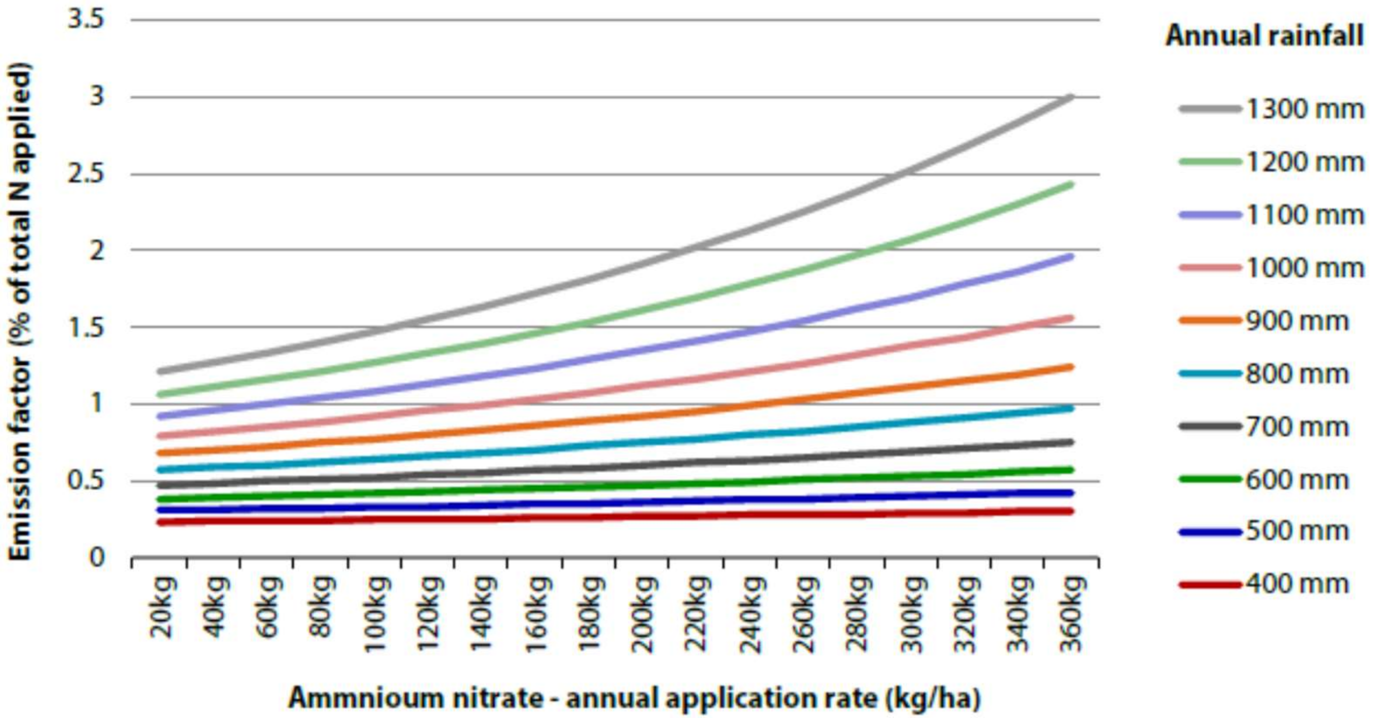
Nitrous oxide emissions respond to fertiliser applications



Nitrous oxide emissions increase with increasing fertilise applications

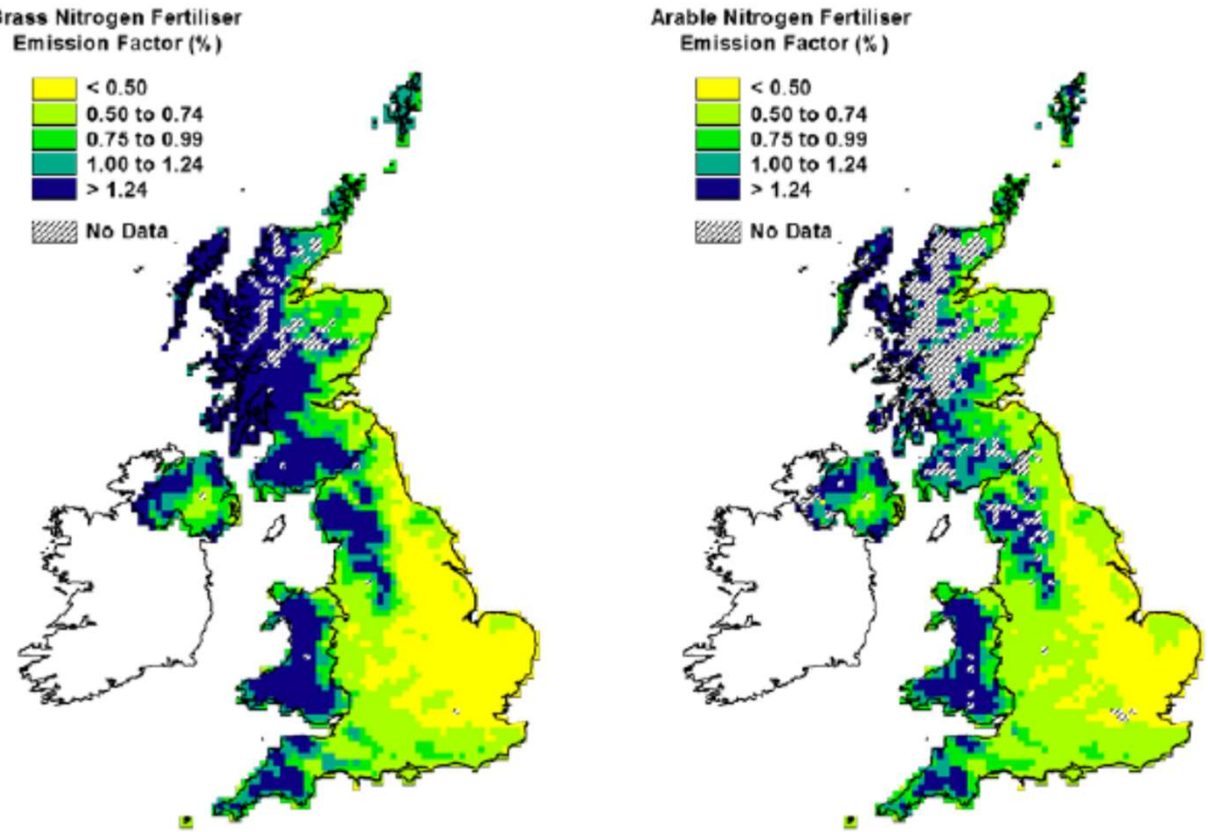
Cardenas et al 2019, Nitrogen use efficiency and nitrous oxide emissions from five UK fertilised grasslands. Science of the Total Environment 661, 696-710

Nitrous oxide responses to fertiliser rate and rainfall



Anthony et al 2019, UK National Inventory 2017, Technical Annexe

New spatial emissions maps



Anthony et al 2019, UK National Inventory 2017, Technical Annexe

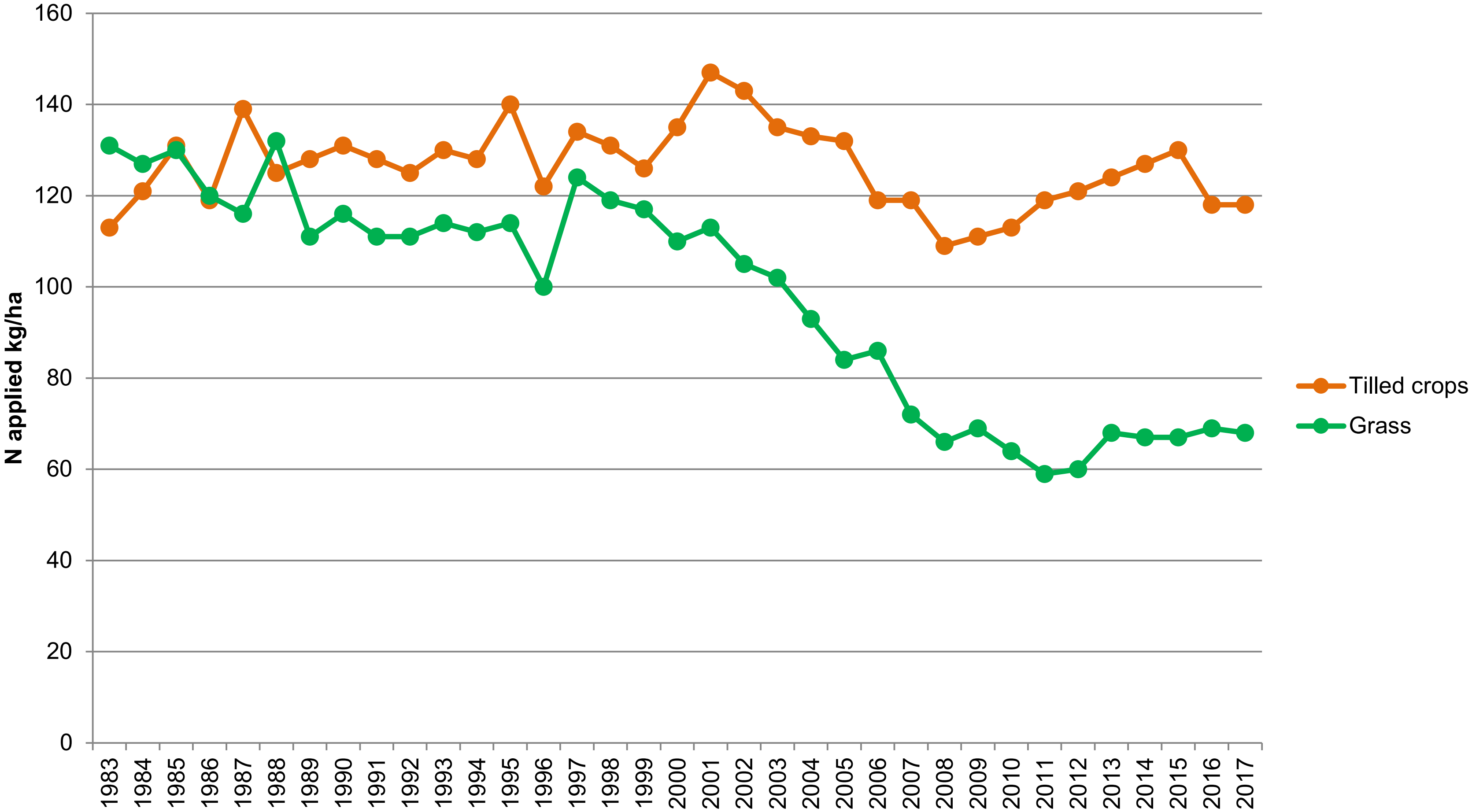
On farm mitigation – how much?

- Farming for a Better Climate focus farms: 10%- 11% mitigation over a three year period
- Whole farm modelling exercises estimated 3-17% mitigation in cattle farms (Adler *et al*. 2015, Beauchemin *et al*. 2011, Lengers *et al*. 2014)
- National level estimates: 10-20% cost-effective mitigation, including carbon sequestration
  - UK 15%, Ireland 13%, France 33% (Eory *et al*. 2015, Pellerin *et al*. 2013, Schulte *et al*. 2012)

Is there a solution?

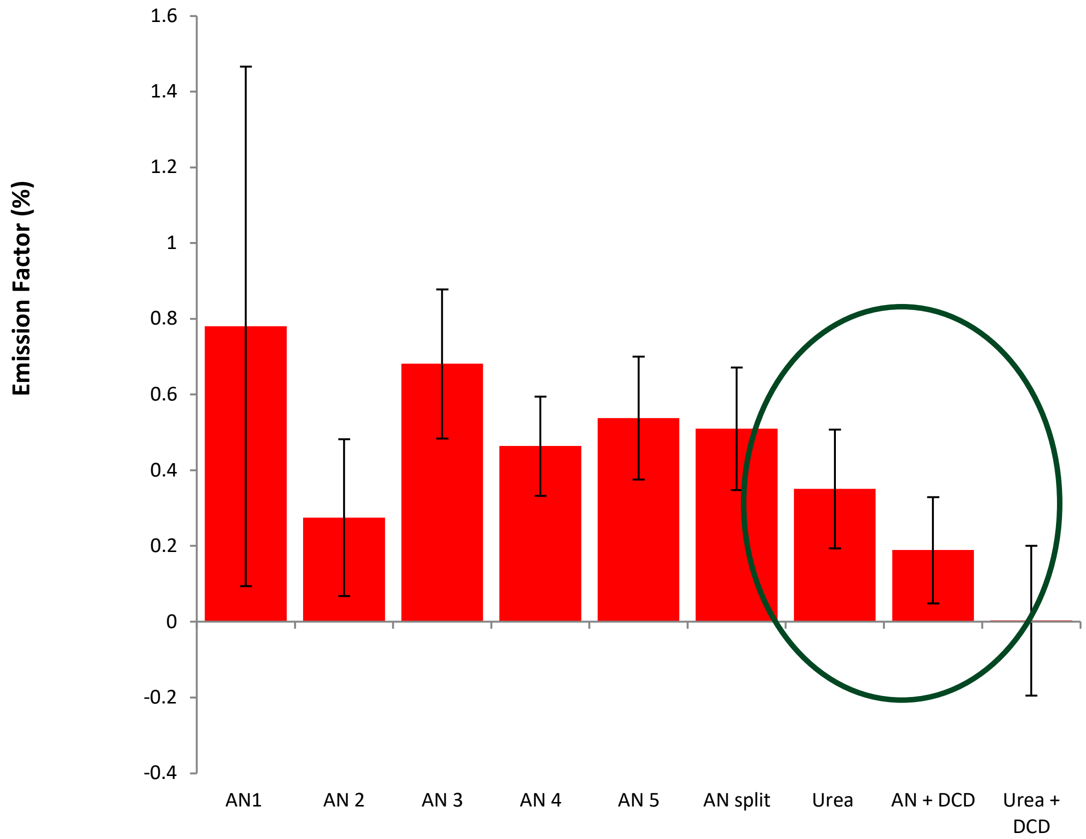
- Use less N
- Use N more efficiently
- Switch to lower emission products
- Inclusion of legumes in rotations
- Precision management

Historical N applications in GB



British Survey of Fertiliser Practice

Inhibitors reduce emissions

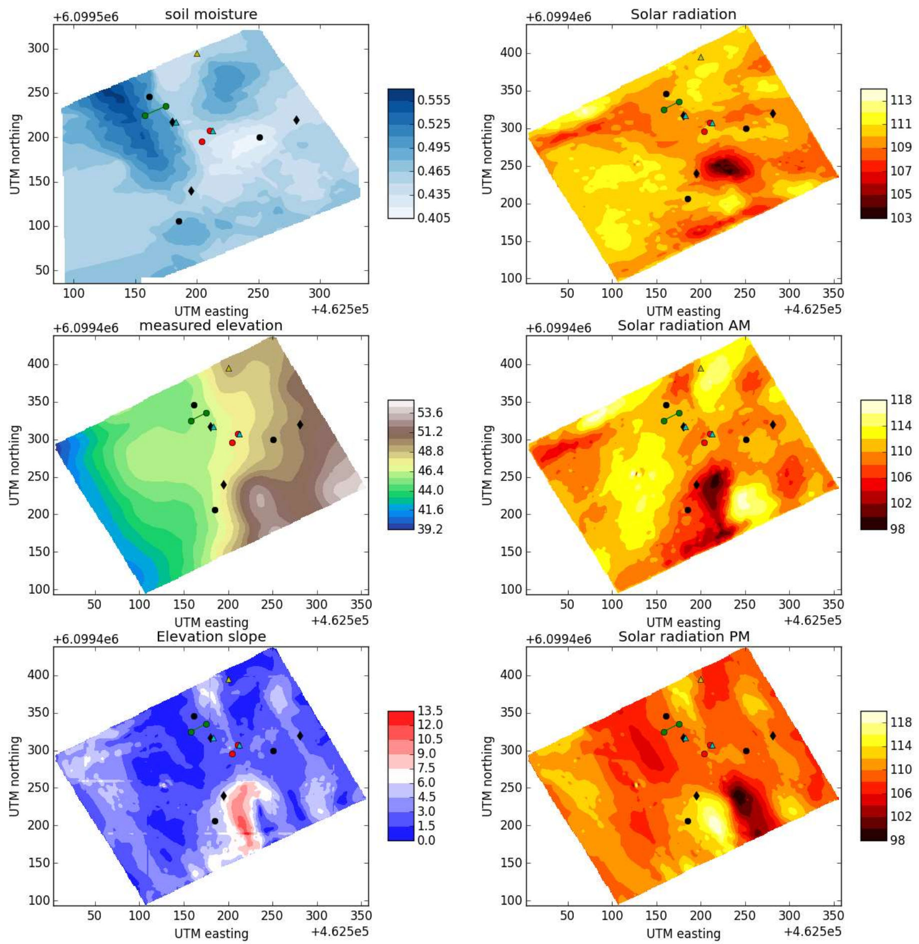


Bell et al, 2015 Nitrous oxide emissions from fertilised UK arable soils: Fluxes, emission factors and mitigation. Agriculture Ecosystems and the Environment, 212, 134-147

Precision technology

- Crop and soil observation
- Automation and robotics
- Carbon footprinting
- Decision support tools

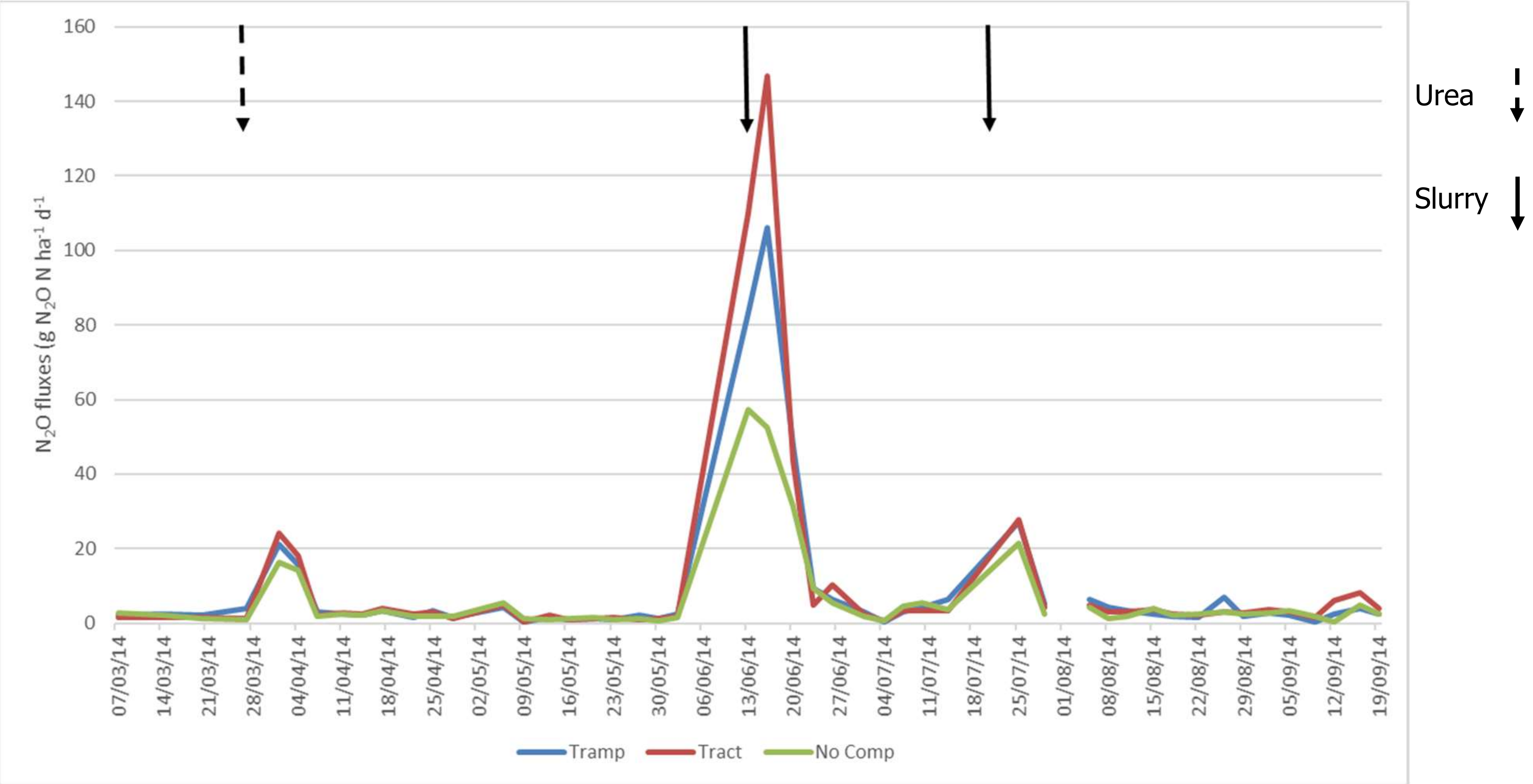
Underlying heterogeneity



Crichton Dairy Research Centre

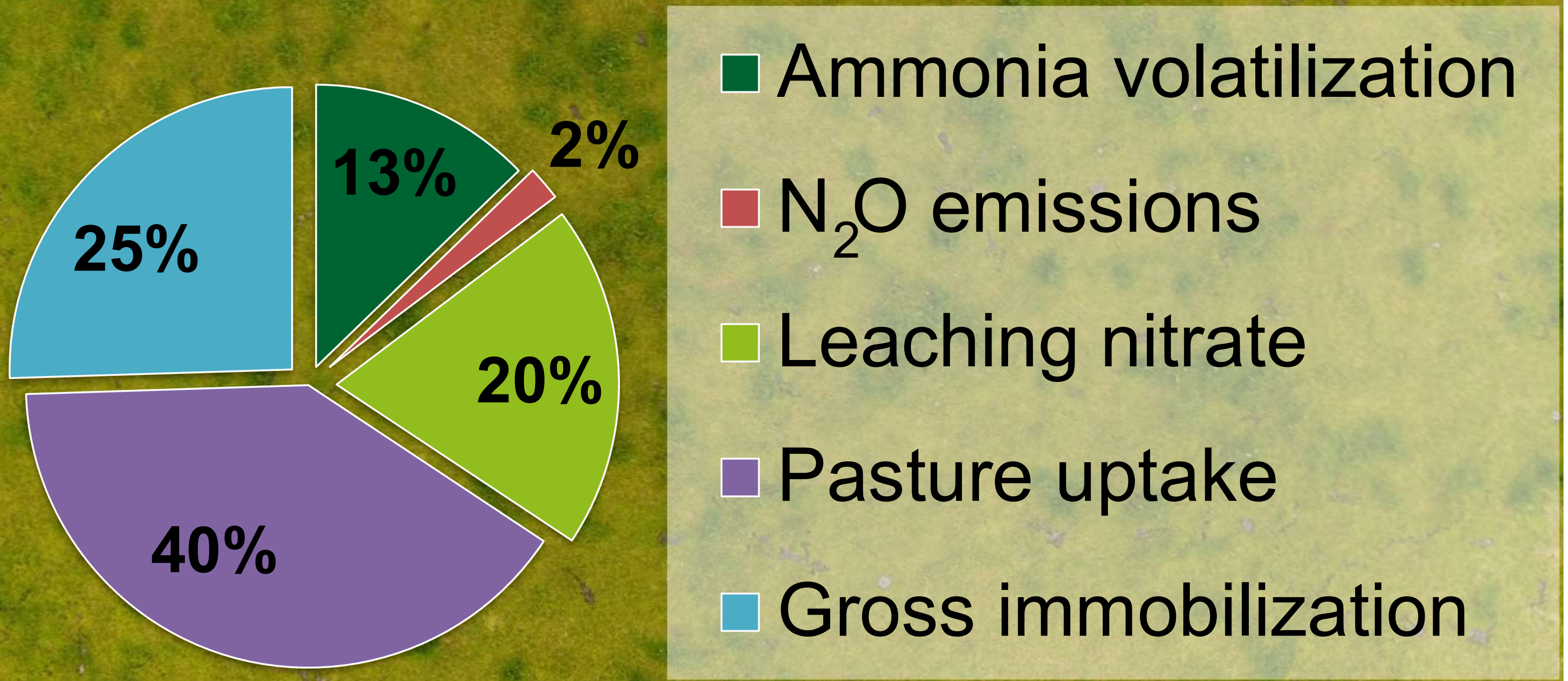
Spatial and temporal heterogeneity drive emissions

Nitrous oxide emissions are sensitive to soil compaction

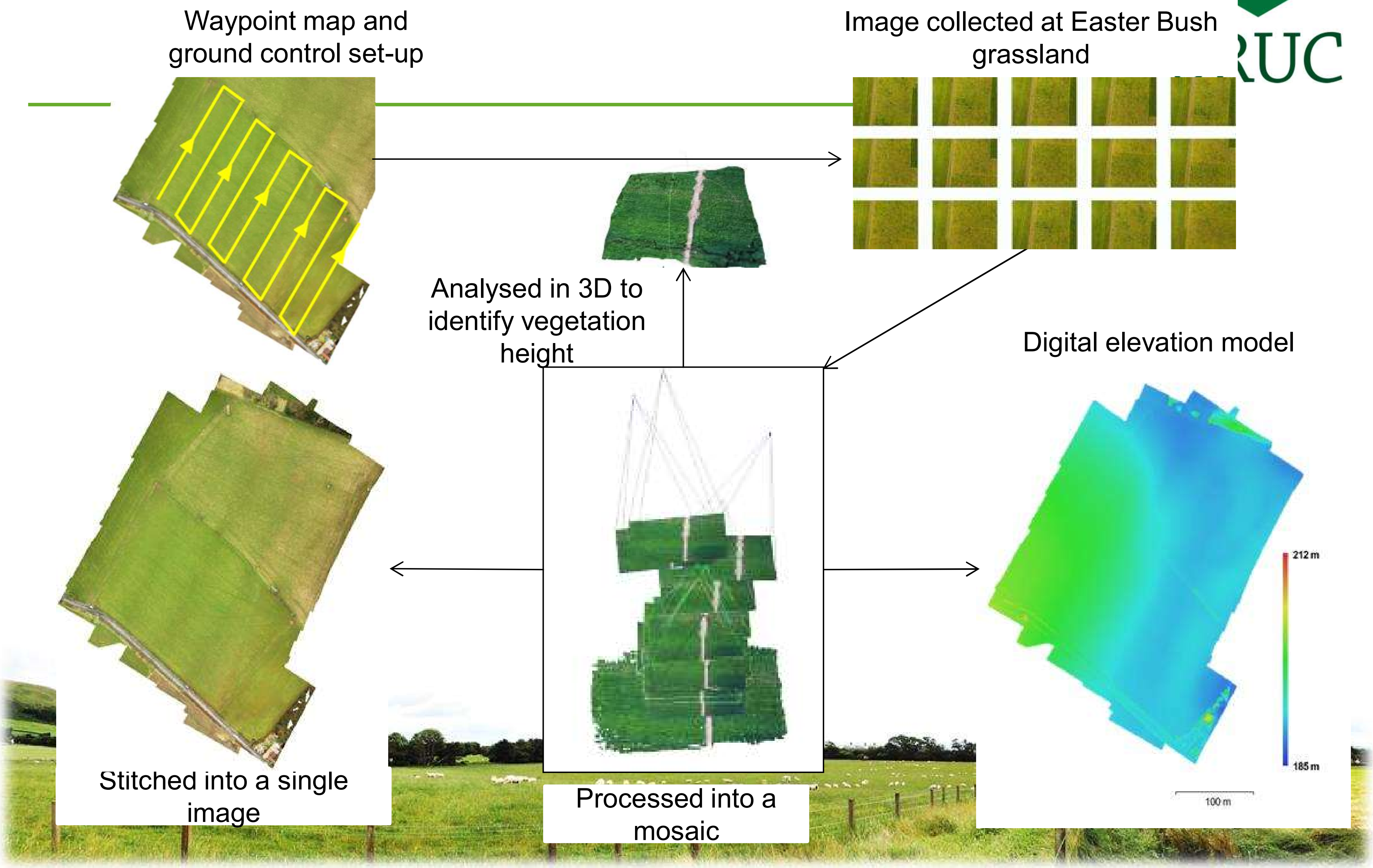


Hargreaves, P.R., et al, 2021. Agriculture, Ecosystems and Environment, 310, 107307

Managing nutrient inputs

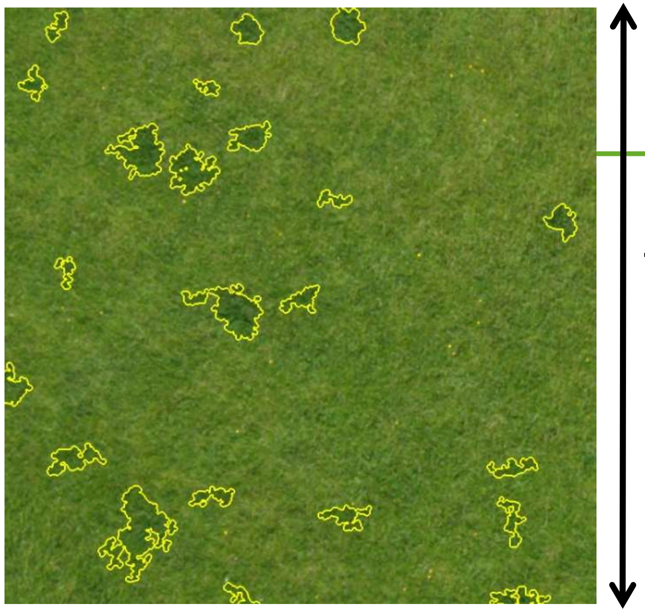


UAV Methodology



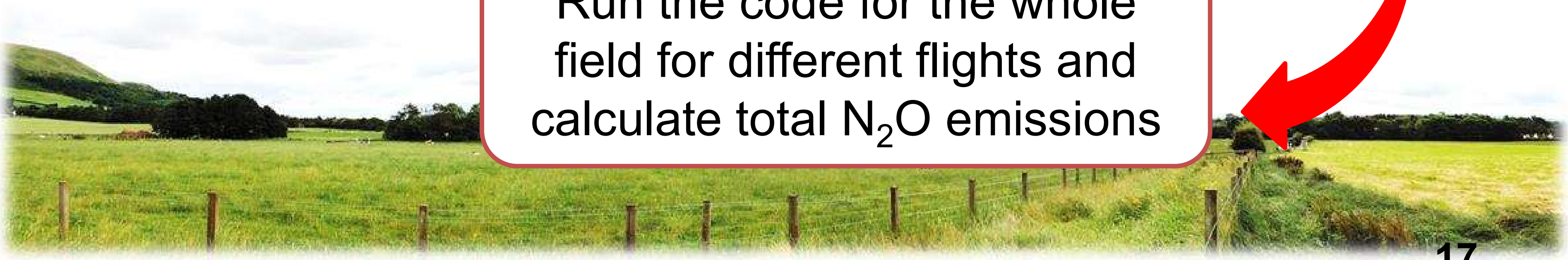
Maire et al 2018

UAV Results



Patch area (pixel)	Patch area (m²)
5385	0.44
3592	0.30
2982	0.25
2578	0.21

Size Field (m^2)	52.61
Total Patch area (m^2)	2.61
Patch coverage (%)	4.96
Mean Patch area (m^2)	0.11
Max Patch area (m^2)	0.44
Min Patch area (m^2)	0.03
Number Patch detected	44
Number Patch Selected	23



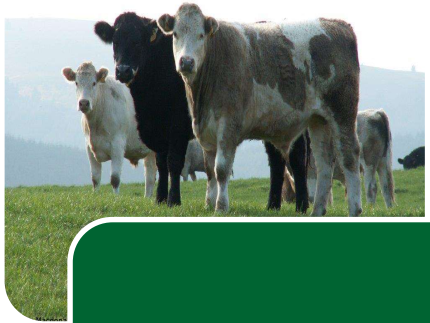
Run the code for the whole field for different flights and calculate total N_2O emissions

Maire et al 2018

Decision support to manage grazing

T van der Weerden, S Laurenson, I Vogeler, P Beukes,
S Thomas, R Rees, C Topp, G Lanigan, C de Klein. AgResearch, New Zealand. Plant and Food Research, New Zealand. Scotland's Rural College, UK Teasgasc Ireland

Setting the rules



Assess background environment

Monitor soil wetness and compare against threshold values

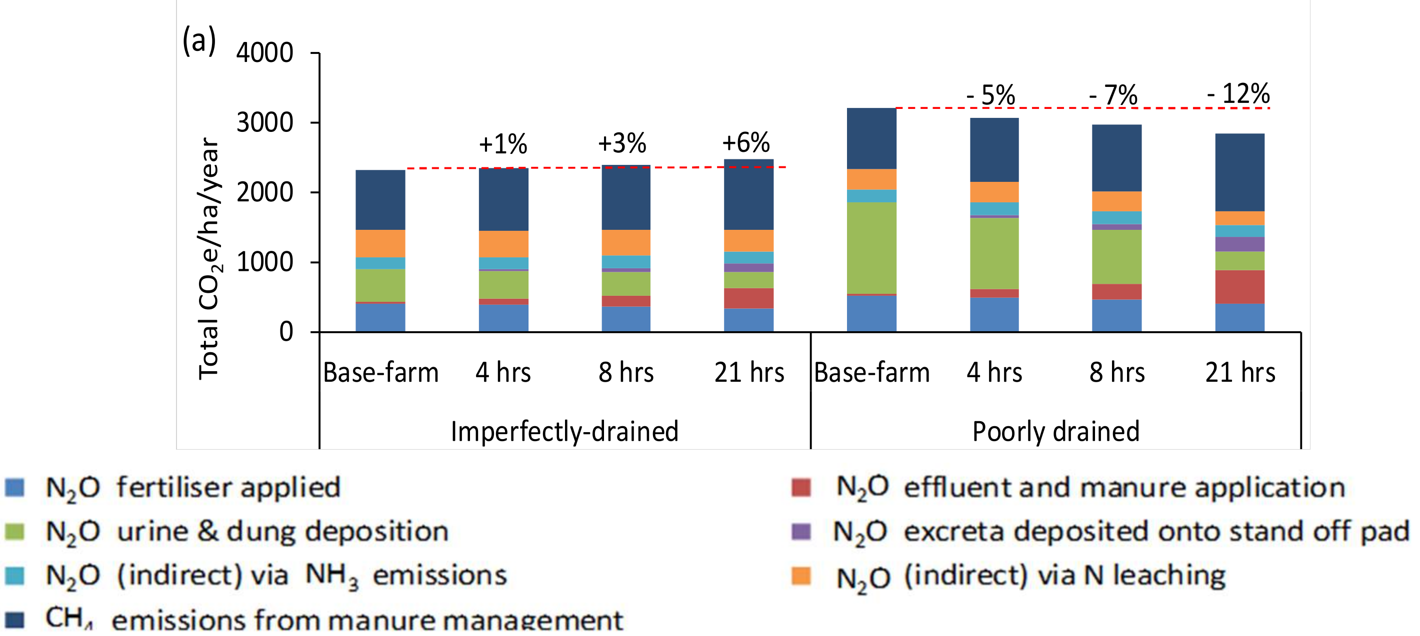
Move cattle when soil wetness exceeds threshold value

van der Weerden et al, 2017

Decision support approach

Imperfectly drained		Poorly drained	
If VWC ≤ CWC	If VWC > CWC	If VWC ≤ CWC	If VWC > CWC
Safe to graze	Remove stock	Safe to graze	Remove stock

VWC = soil water content, on a volumetric basis; CWC = critical water content, for imperfectly drained soils CWC= 105% of field capacity (FC) and for poorly drained soils CWC = 85% of field capacity (FC).



van der Weerden et al, 2017

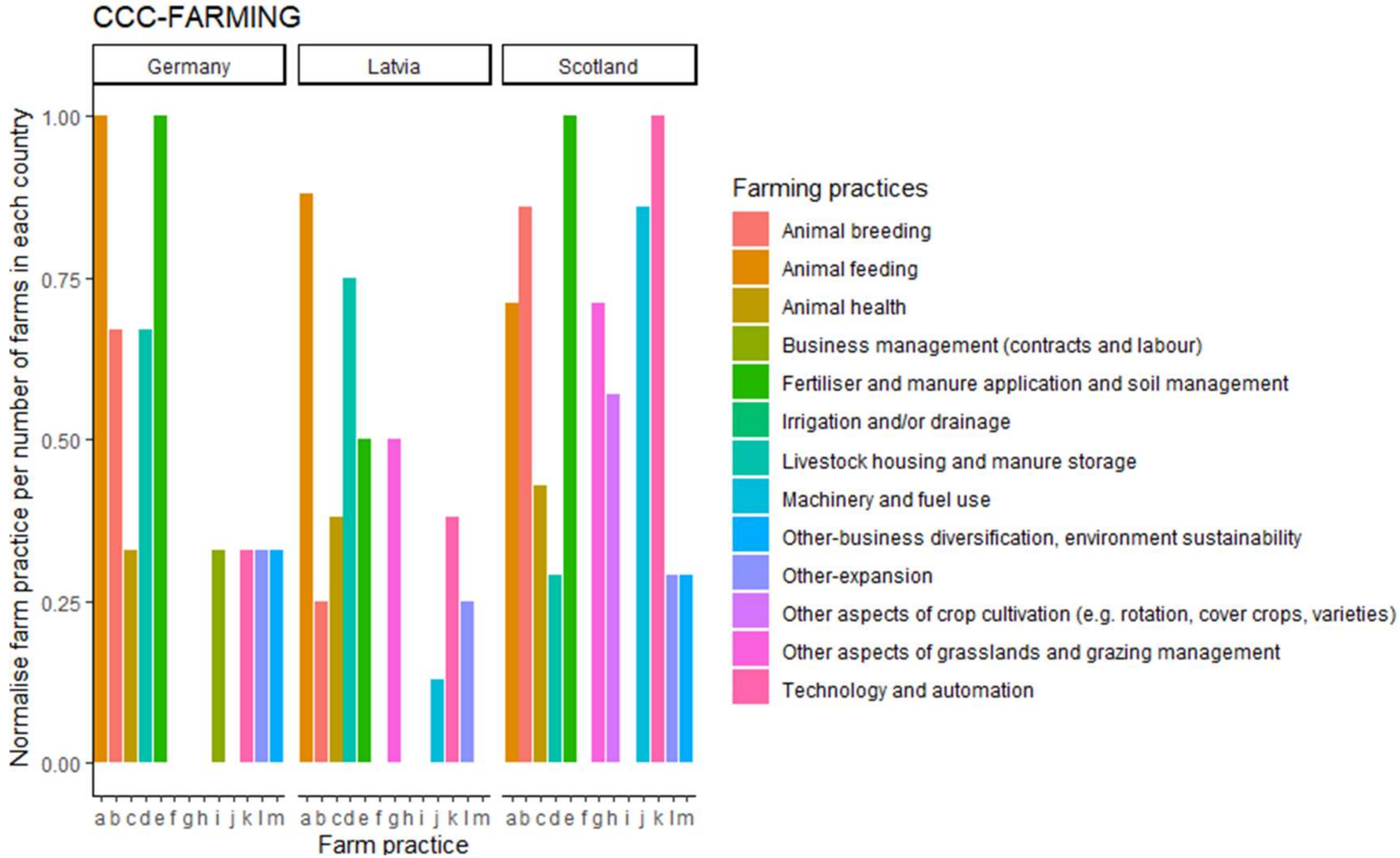
For effective action we need…

… farmers' willingness

- Clear definition of technologies
- Robust GHG emission calculation methods which are valid at the farm level (link to inventories)
- Consideration of other environmental goals
- National priorities reconciled with global mitigation and environmental goals
- Understanding farmers' decisions

CCC Farming: first questionnaire

How important are the following management activities in the long-term financial viability of your farm? (partial, preliminary results)



Conclusions

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- Nitrous oxide emissions from farming systems have been difficult to quantify
- New measurement and modelling approaches are allowing better spatial and temporal estimates of emissions
- Such approaches open the way to the use of precision technologies for mitigation
- But for this to work we need to engage with the farming community

Thankyou

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