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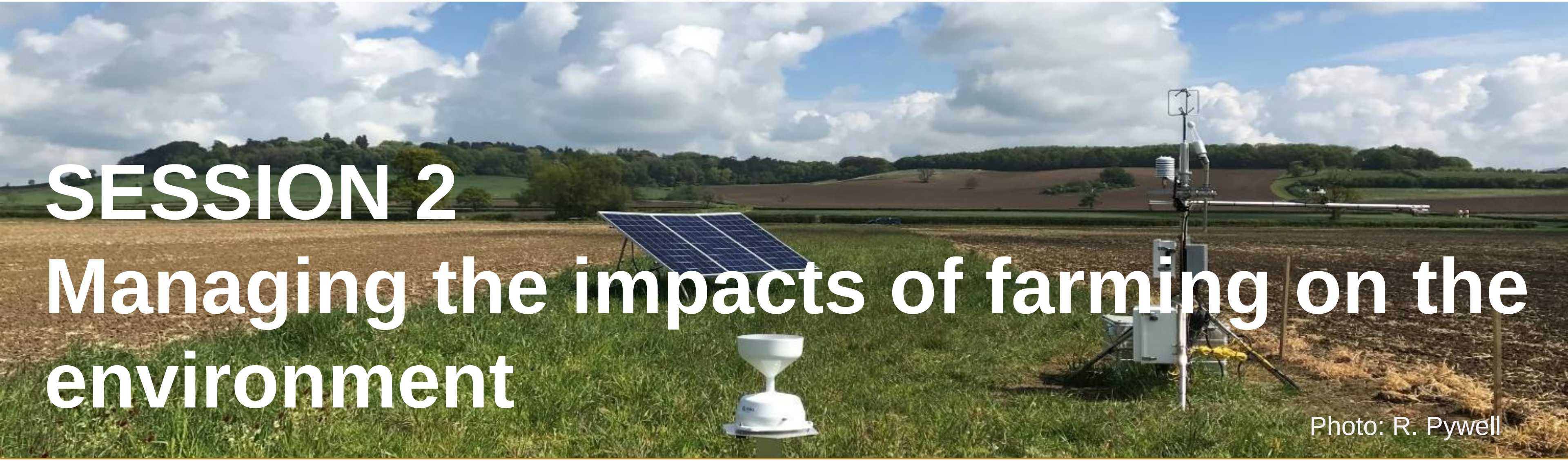

SESSION 2
Managing the impacts of farming on the environment

Photo: R. Pywell

UK Centre for Ecology & Hydrology

ROTHAMSTED RESEARCH

BGS British Geological Survey

Chair: Richard Pywell

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Mapping and modelling pesticides and fertilisers in the environment

Photo: L. Hulmes

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BGS British Geological Survey

S. Jarvis, J. Redhead, W. Fincham, A. Oliver, D. Roy, L. Newbold, G. Dos Santos Pereira, B. Woodcock, C. Schultz, D. Spurgeon, R. Pywell

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Rationale

- Pesticides and fertilisers are a significant part of agricultural impact on the environment
- To understand the size and significance of the pressure we need to know what is applied and where and the environmental fate of agrochemicals
- We also need to know how that translates into risks for biodiversity and ecosystem function

Article | OPEN

Impacts of neonicotinoid use on long-term population changes in wild bees in England

Ben A. Woodcock, Nicholas J. B. Isaac, James M. Bullock, David B. Roy, David G. Garthwaite, Andrew Crowe & Richard F. Pywell

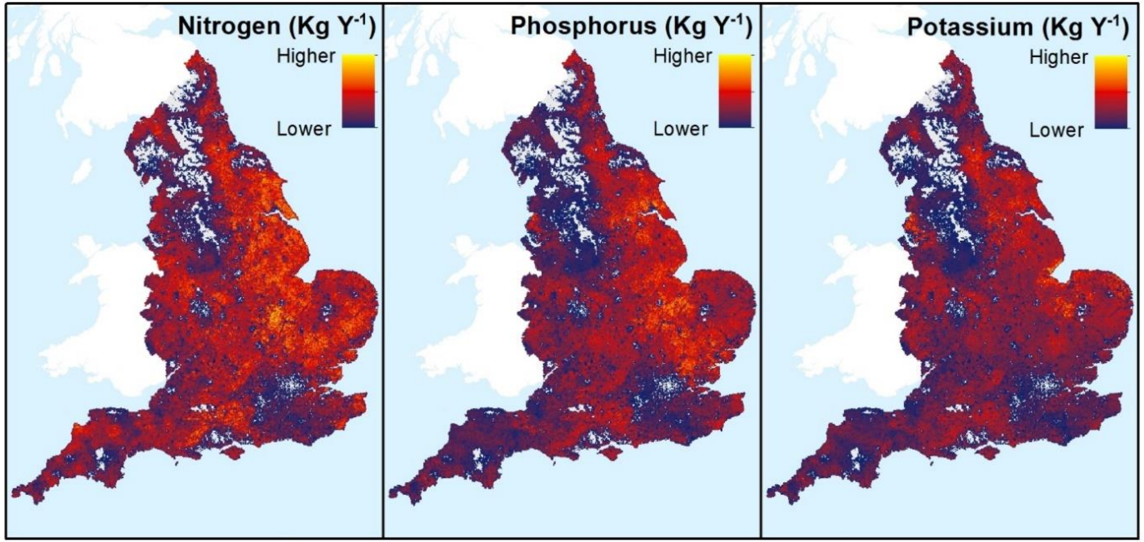
Nature Communications **7**, Article number: 12459 (2016)
doi:10.1038/ncomms12459
Download Citation

Agroecology Conservation biology
Population dynamics

Received: 07 August 2015
Accepted: 05 July 2016
Published online: 16 August 2016

CEH Land Cover® *plus*: Fertilisers

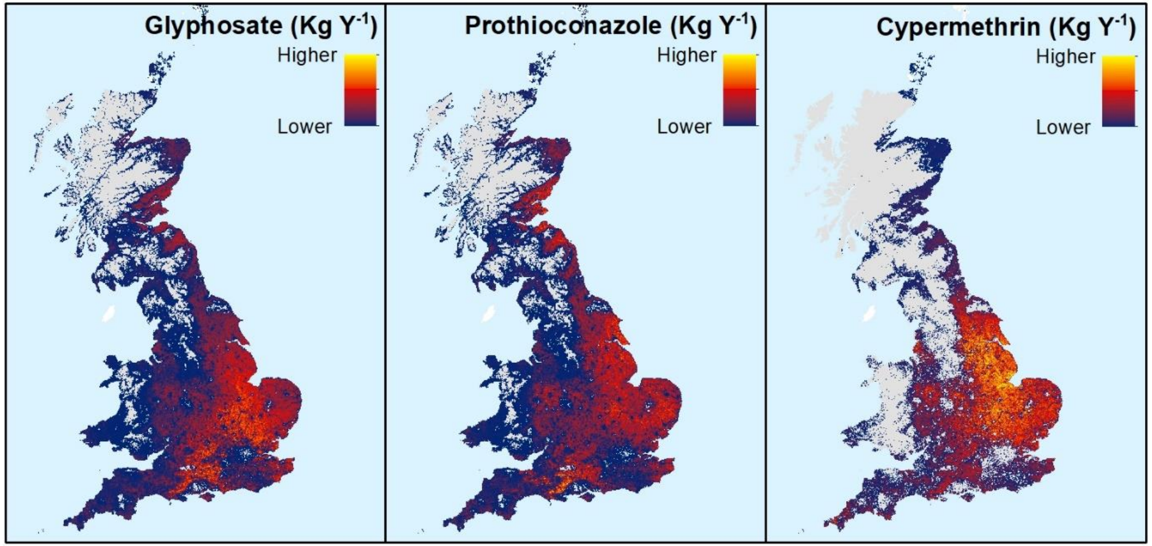
- National maps of applications for England of N, P and K, combining LC *plus* Crops and Defra British Survey of Fertiliser Practice
- 1km resolution, average annual rate of application between 2010-2015
- Inform runoff models, map risks and target management



Freely available to research community via Edina Digimap, 278 downloads last year

CEH Land Cover® plus: Pesticides

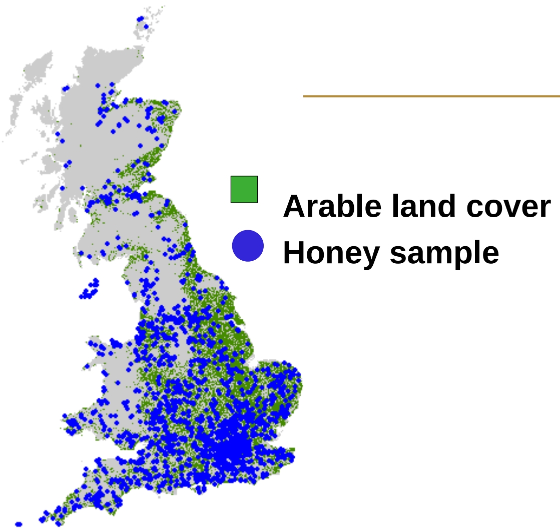
- Maps of application rates of 162 active ingredients for GB, LC *plus* Crops and Fera Pesticide Usage Survey
- 1km resolution, average annual application rate 2012-2017
- Inform exposure risk mapping, model runoff

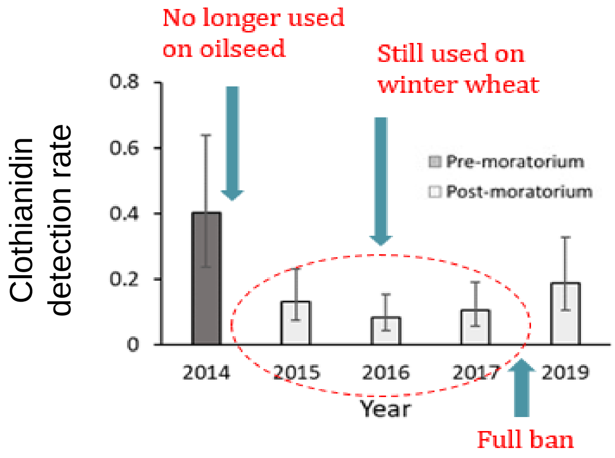


Freely available to research community via Edina Digimap, 303 downloads last year

National Honey Monitoring Scheme

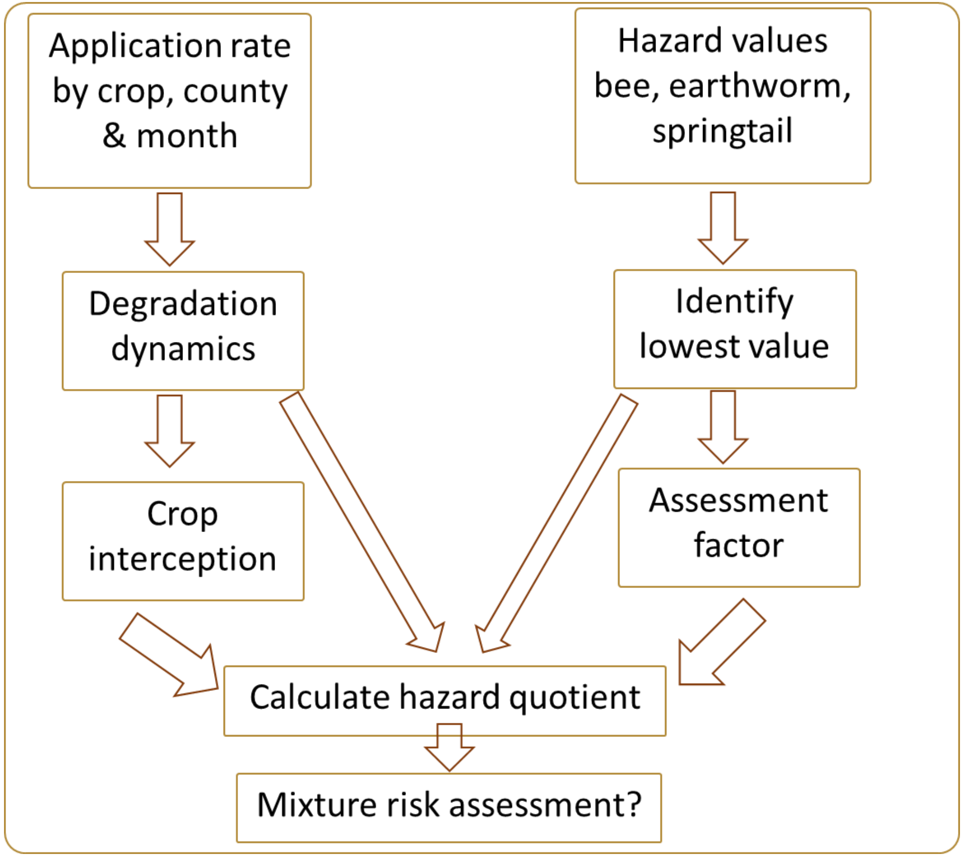
- National Archive > 3000 honey samples from 2018-2021
- Quantify environmental pressures on honeybees (and other pollinators)
- Honeybees forage widely and integrate information on pesticide exposure at landscape scale
- Metabarcoding of pollen to understand what bees feed on, land use impact on pollinator floral resource utilisation
- Pesticide residues assessed in > 600 honey samples
- Post-regulatory approval monitoring of real-world agrochemical risks



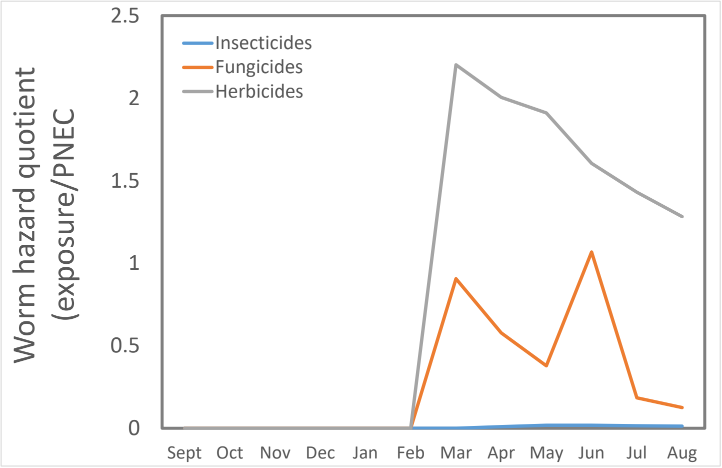


National Honey Monitoring Scheme

Pesticide Risk Assessment Tool



- Tool to translate pesticide applications into relative risks to biodiversity endpoints
- Can use real world pesticide regimes
- Earthworm risk in spring barley:



Acknowledgements

CEH Land Cover® plus: Fertilisers

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- Linda May

CEH Land Cover® plus: Pesticides

- Hannah Risser
- Pete Henrys
- Oliver Robertson
- Claire Wood

Honey Monitoring Scheme

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- Ujala Syed
- Dan Read
- Jodey Peyton
- Jim Bacon
- John Van Breda
- Mike Brown
- Emily Upcott
- Kath Turvey

Pesticide Risk Assessment Tool

- Alex Robinson

www.assist.ceh.ac.uk #ASSISTagri

funded by UKRI Biotechnology and Biological Sciences Research Council UKRI Natural Environment Research Council

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Mitigating Impacts of Pesticides

Photo: R. Pywell

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BGS British Geological Survey

H. Metcalfe, J.M. Bullock, A.E Milne, A.P Whitmore, ***J. Storkey***

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Anticipating consequences of banning pesticides

- Agrochemicals can have adverse effects on the environment and can negatively impact non-target organisms.
- The negative impacts of pesticides tend to be scrutinised on a case by case basis.
- If an active ingredient is banned, what are the alternatives for controlling pests, weeds and diseases?
- Is the net effect negative or positive (using multiple criteria)?


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Weedkiller glyphosate a 'substantial' cancer factor

20 March 2019

Quantifying impacts of alternatives to glyphosate

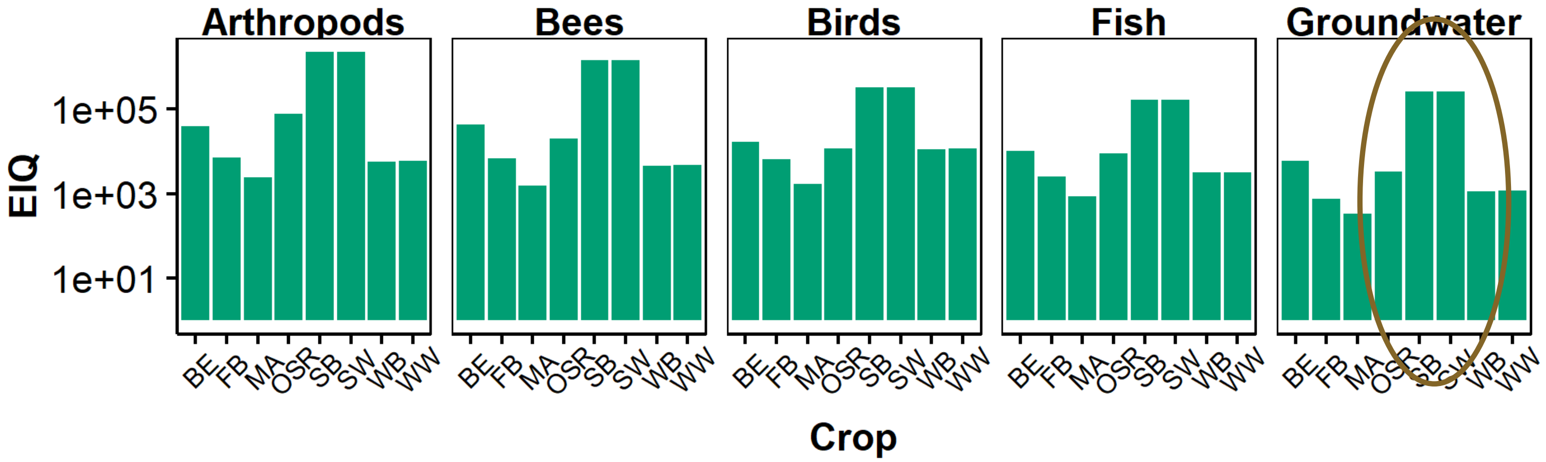
- A trait-based weed community model was developed* to allow impacts of *alternative scenarios* to be tested.
- Loss of a herbicide further incentivises uptake of **Integrated Weed Management:**

  1) increased crop diversity, 2) strategic tillage

*Metcalfe *et al.* (2020) Ecology **101**
DOI: 10.1002/ecy.3167

We assessed alternatives in terms of the Environmental Impact Quotient EIQ)

- EIQ accounts for the toxicity to the target organism and the risk of the active ingredient reaching the target.
- For each crop we took a standard pesticide program and calculated EIQ for:



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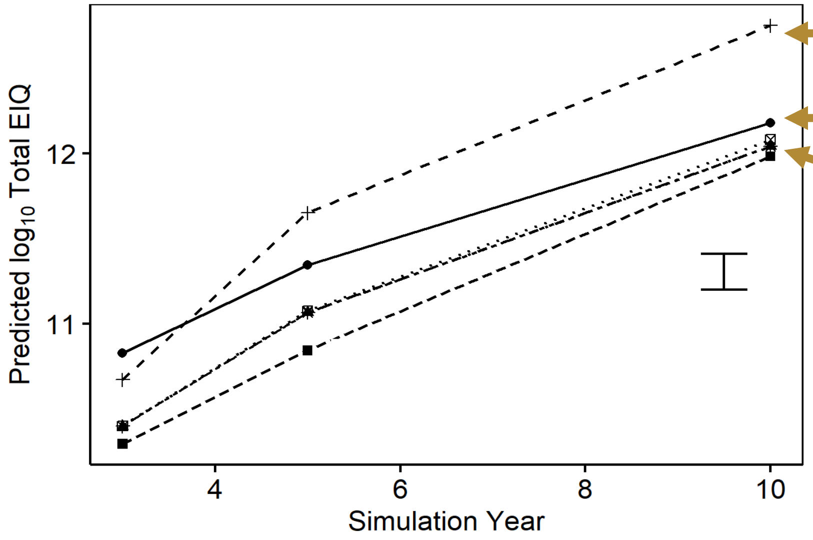
Initial results

- Increasing crop diversity by including more spring crops is worse *for environmental impact of pesticide programme.*



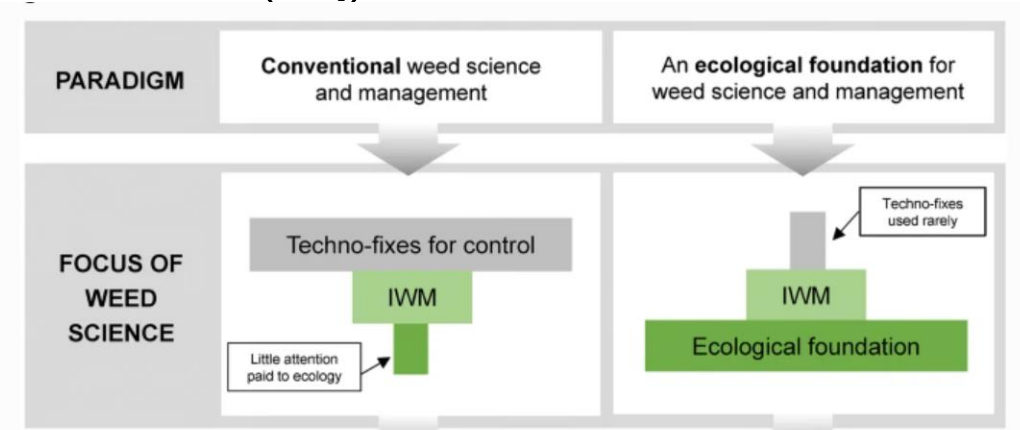
Increased frequency of spring crops

BAU using glyphosate

EIQ is lower if perennial leys are included or with increased tillage

Conclusions

- Can't simply remove a pesticide group without considering unintended consequences as these can jeopardise ecological benefits – the weeds still need controlling.
- *But* only one criteria has been presented here (EIQ)!
- IWM may not be the most sustainable destination.
- A truly agro-ecological approach to crop protection should focus on designing resilient systems that effectively regulate pest and weed populations*.



*McLaren *et al.* (2020) *Agronomy for Sustainable Development* **40** DOI: 10.1007/s13593-020-00631-6

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The contribution of agriculture to nutrient pollution in rivers

Photo: R. Pywell

UK Centre for Ecology & Hydrology

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BGS British Geological Survey

V.A. Bell,

D.M. Cooper, R. Sharp, H.N. Davies, A.E. Milne, A.P. Whitmore

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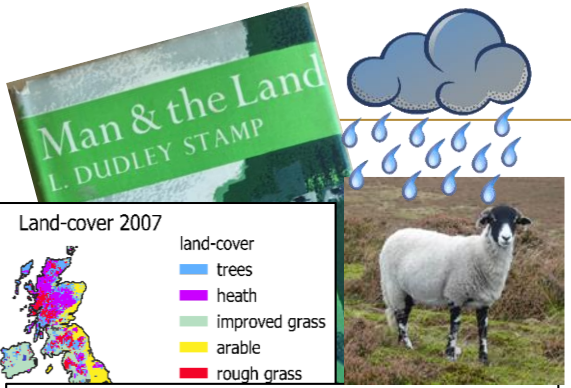
How does agriculture impact on UK river nutrients?

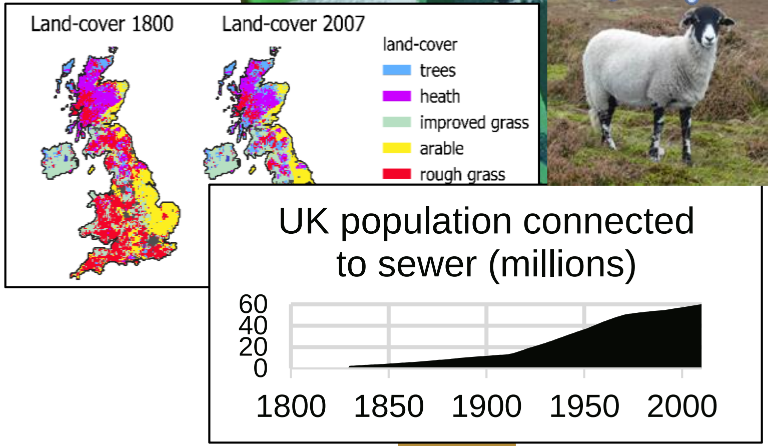
- Over the past 200 years the UK landscape has been transformed by the growth of agriculture.
- We have built on previous NERC-funded work (LTLS: www.ltls.org.uk) to investigate how landscape changes affect the quality of our rivers historically and in the future.

Photos: D. M. Cooper

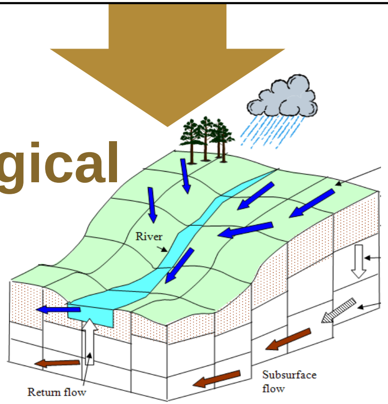
How do we study river nutrient pollution scenarios?

- There are few water quality measurements go back further than 1960
- So UKCEH and Rothamsted Research built a computer model of the UK landscape…
- …to quantify historical influences on water quality
- …and to quantify the impact of future climate and agriculture we used scenarios (UKCP18 and ASSET-tool scenarios of land-sharing/sparing)





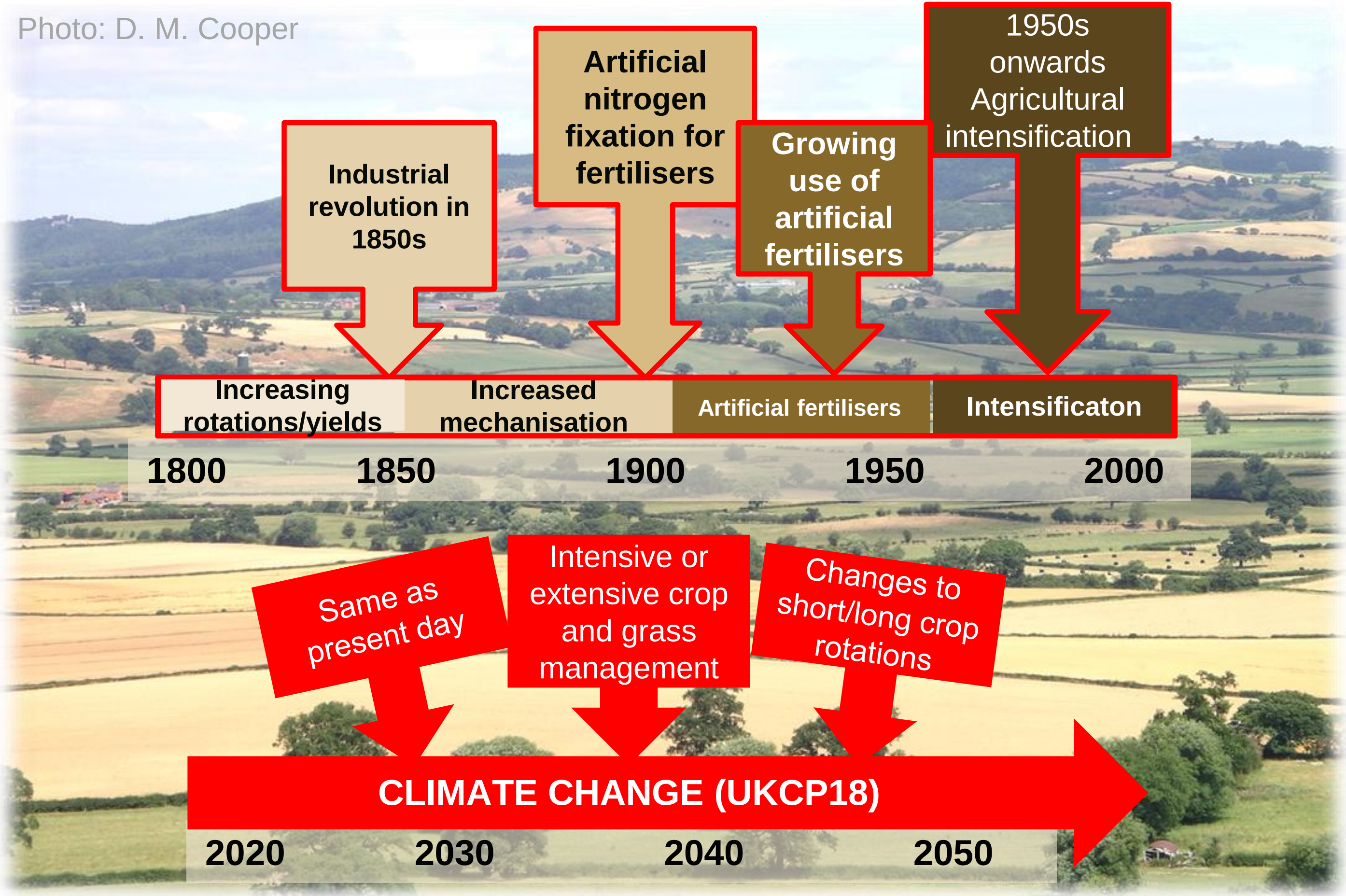
Hydrological model



Past and future AGRICULTURAL inputs to UK rivers

Reconstructed past agriculture

Future agriculture



How much C, N & P does agriculture CURRENTLY supply to UK rivers?

C = Carbon
N = Nitrogen
P = Phosphorus

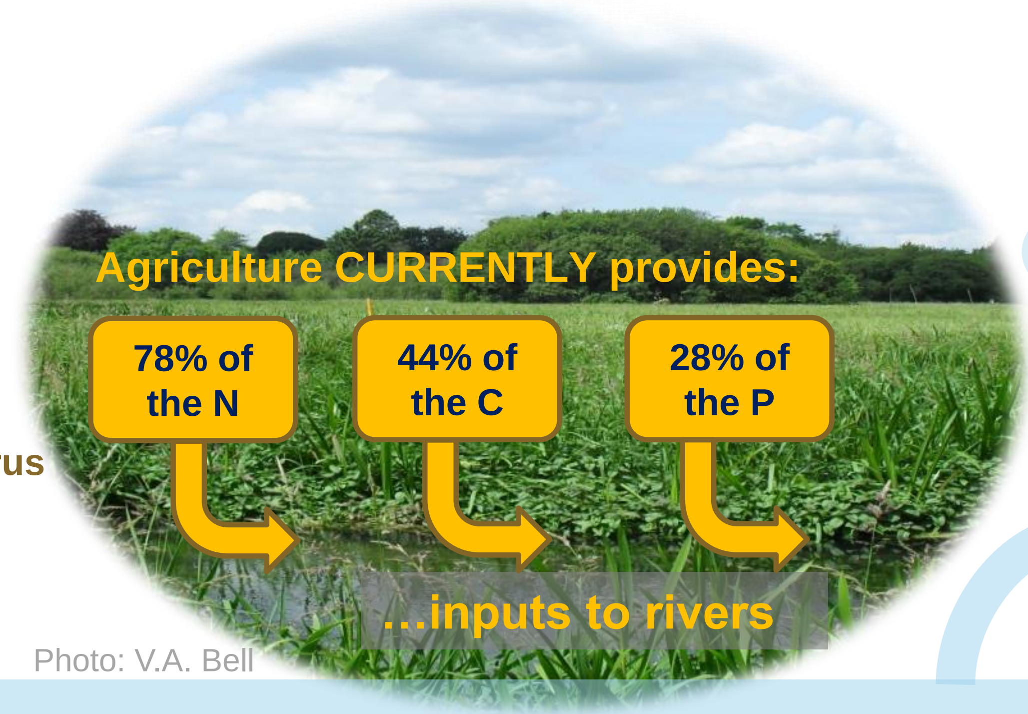


Photo: V.A. Bell

~**20% of dissolved C** and **10% of N** turns to gas

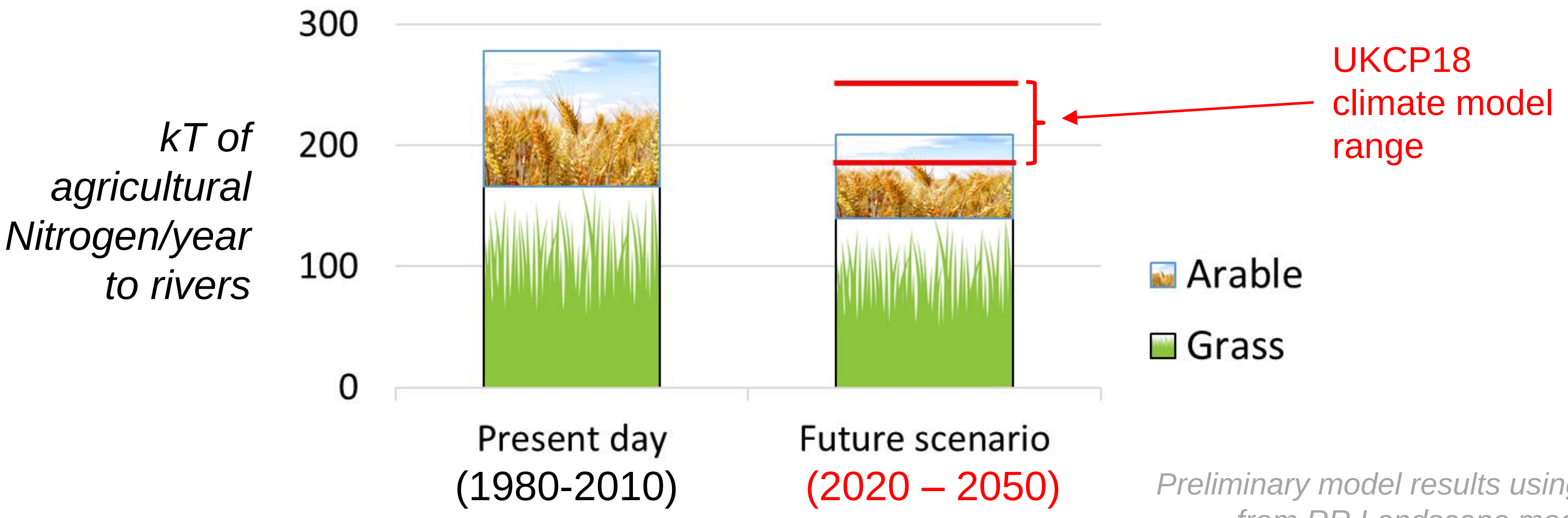
Since 1800, N & P fluxes in many rivers have more than doubled, and in some rivers are 10 times higher.

Bell V.A. et al. (2021) "Long term simulations of macronutrients (C, N and P) in UK freshwaters". Science of The Total Environment. https://doi.org/10.1016/j.scitotenv.2021.145813

Unpublished results

How might agricultural Nitrogen (N) fluxes to Britain's rivers change in the FUTURE?

- By the 2050s UKCP18 climate models indicate **warmer air temperatures**, **wetter winters** and **drier summers**.
- Our models suggest that if farm management stays the same as present day, projected climate change alone could lead to **reduced** farmland nitrogen runoff to rivers.



Preliminary model results using information from RR Landscape model and LTLS

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Acknowledgements

Thanks to:

- *Helen Davies and Richard Broughton for producing the spatial datasets, and*
- *Giuseppe Formetta, Ed Rowe and Sajeev Mohankumar, Ed Tipping and Pam Naden for their work on model development*
- *The NERC Macronutrient Cycles programme for funding the LTLS macronutrients model*

References:

- *Bell V.A., Naden P.S., Tipping E., Davies H.N. et al. (2021) "Long term simulations of macronutrients (C, N and P) in UK freshwaters". Science of The Total Environment, 776, 145813. https://doi.org/10.1016/j.scitotenv.2021.145813*
- *Coleman, K., Muhammed, S. E., Milne, A. E., Todman, L. C., Dailey, A. G., Glendining, M. J., and Whitmore, A. P. (2017). The landscape model: A model for exploring trade-offs between agricultural production and the environment. Sci. Total Environ. 609:1483-1499 https://doi.org/10.1016/j.scitotenv.2017.07.193*

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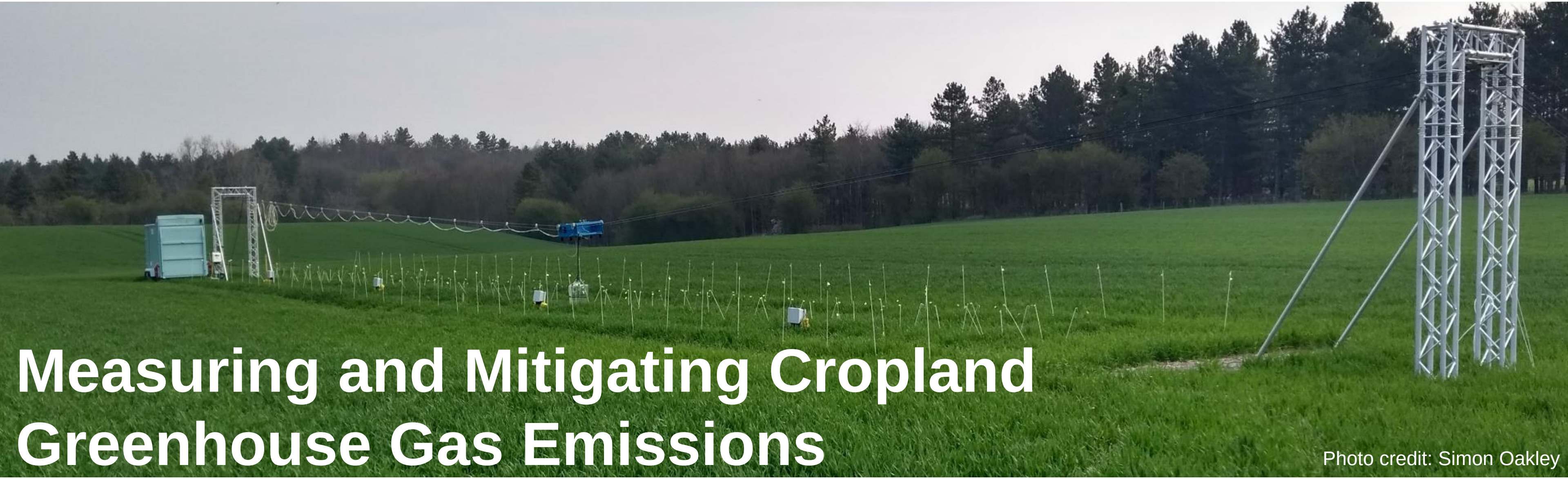

Measuring and Mitigating Cropland Greenhouse Gas Emissions

Photo credit: Simon Oakley

UK Centre for Ecology & Hydrology

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BGS British Geological Survey

Niall McNamara, Dafydd Elias, Simon Oakley, Ross Morrison, Alex Cumming, Sarah Brown, Morag McCracken, Sarah Hulmes, Lucy Hulmes, Julian Gold, Marek Nowakowski, Richard Pywell

funded by

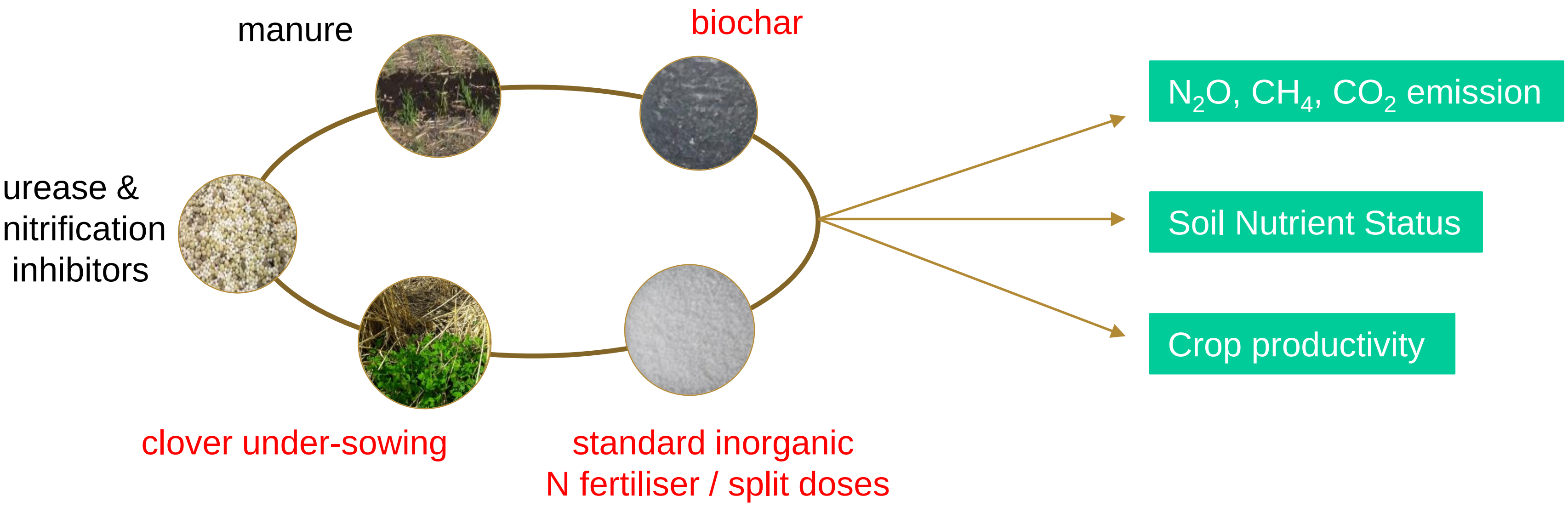
UKRI Natural Environment Research Council

UKRI Biotechnology and Biological Sciences Research Council

ASSIST Greenhouse Gas (GHG) plot trials

Objective: Evaluate five **cropland nutrient management strategies** that minimise soil GHG emissions whilst maintaining productivity

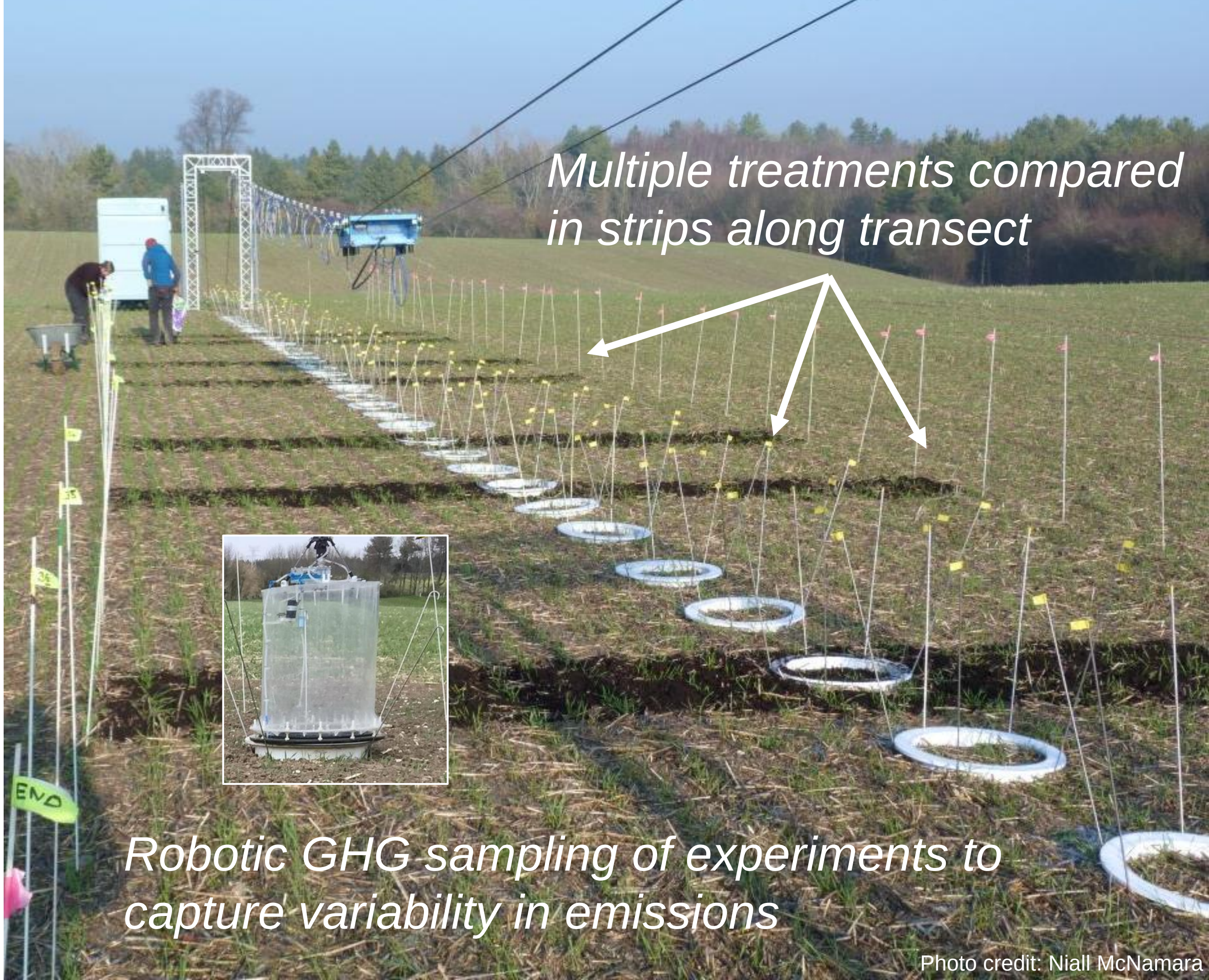
Primary focus is on the potent GHG nitrous oxide (N_2O); 2/3 of UK N_2O emissions from agriculture



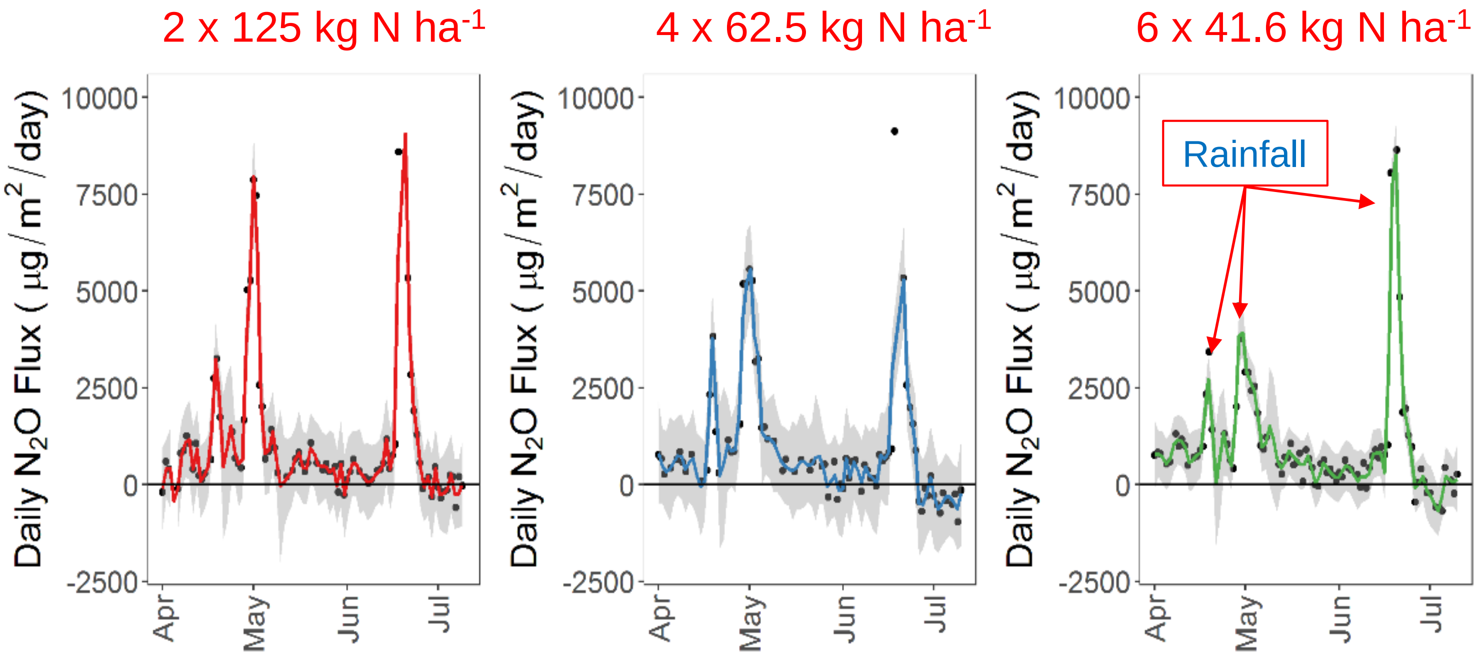
High frequency **24 hr data for CO_2, CH_4 & N_2O** from up to 36 plots

Traditional manual GHG measurements

Photo credit: Energy Technologies Institute



Split fertiliser application to match crop nutrient demand, reduce surplus soil nitrogen and limit N_2O emission



Result: Split N application cycles had **no effect on cumulative N_2O emission or crop yield**

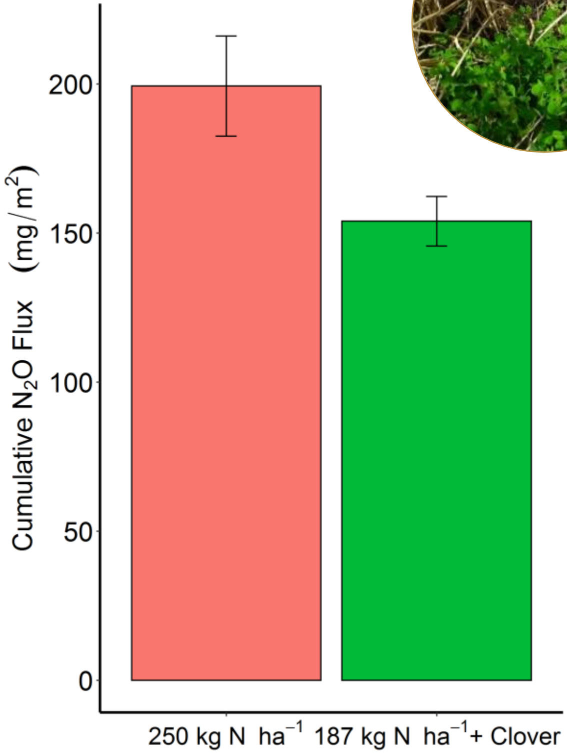
Dry conditions may have limited efficacy of this N management strategy

Clover under sowing with winter wheat for improved nitrogen use efficiency and reduced soil N_2O emissions

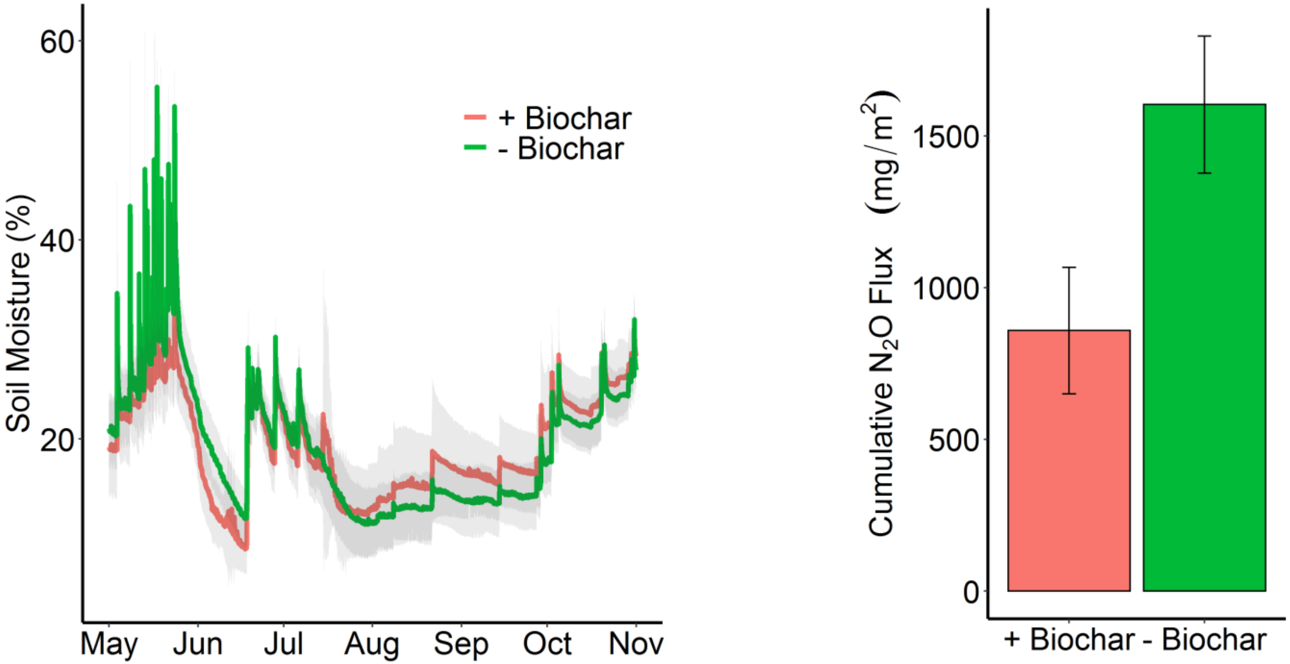
Result:

No loss of crop productivity with 25% reduction in N fertiliser when under-sown with white clover

20% reduction in soil N_2O emissions was observed due to lower soil inorganic N



Biochar addition to spring barley to limit N_2O emission during an unexpected period of high rainfall



Result: Biochar dampened the soil moisture spike, limited conditions favourable for N_2O emission whilst supporting crop productivity

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EARTHBOUND

Wildlife Farming Company
- Proven Wildlife Delivery -

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