

# Rothamsted Repository Download

## A - Papers appearing in refereed journals

Zhang, Y. and Collins, A. L. 2025. Global Warming Potential of farming systems across England: possible mitigation and co-benefits for water quality and biodiversity. *Agronomy for Sustainable Development - ASD*. 45, p. 22. <https://doi.org/10.1007/s13593-025-01015-4>

The publisher's version can be accessed at:

- <https://doi.org/10.1007/s13593-025-01015-4>

The output can be accessed at: <https://repository.rothamsted.ac.uk/item/9932v/global-warming-potential-of-farming-systems-across-england-possible-mitigation-and-co-benefits-for-water-quality-and-biodiversity>.

© 2 April 2025, Please contact [library@rothamsted.ac.uk](mailto:library@rothamsted.ac.uk) for copyright queries.

**Global Warming Potential of different farming systems across England: magnitude of mitigation possible using best management and co-benefits for water quality and biodiversity**

*<sup>a</sup>Net Zero and Resilient Farming, Rothamsted Research, North Wyke, Okehampton, Devon, EX20 2SB, UK.*

Yusheng Zhang<sup>†</sup>, Adrian L. Collins

<sup>†</sup>Corresponding author email address: [yusheng.zhang@rothamsted.ac.uk](mailto:yusheng.zhang@rothamsted.ac.uk)

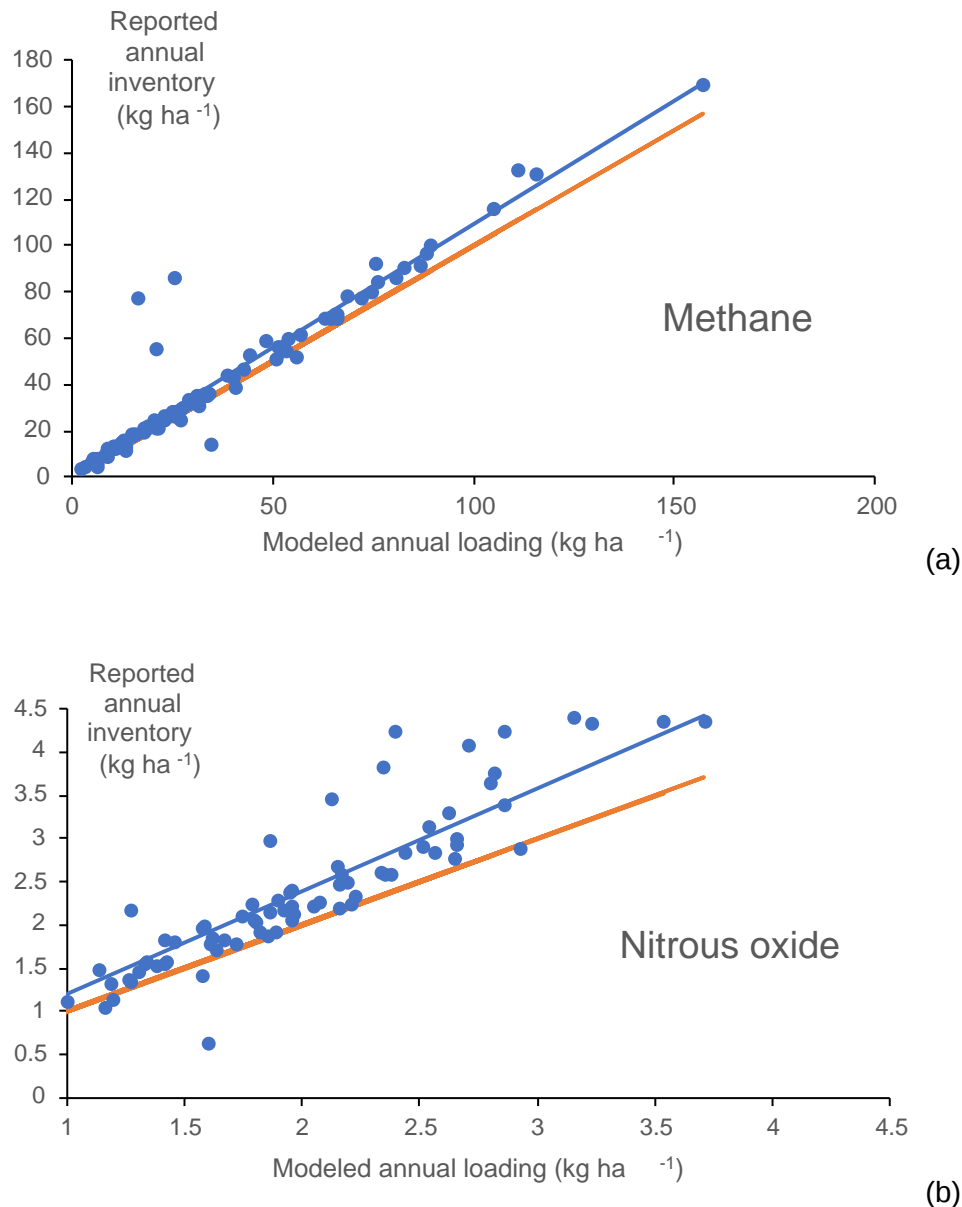


Fig. S1. Comparison of modeled GHG emissions against reported national inventories at WMC scale (straight line in red is the 1:1 line). Regression line equations are  $y = 1.0688x + 2.1786$  with  $r^2 = 0.91$  for methane and  $y = 1.1896x + 0.0209$  with  $r^2 = 0.78$  for nitrous oxide.

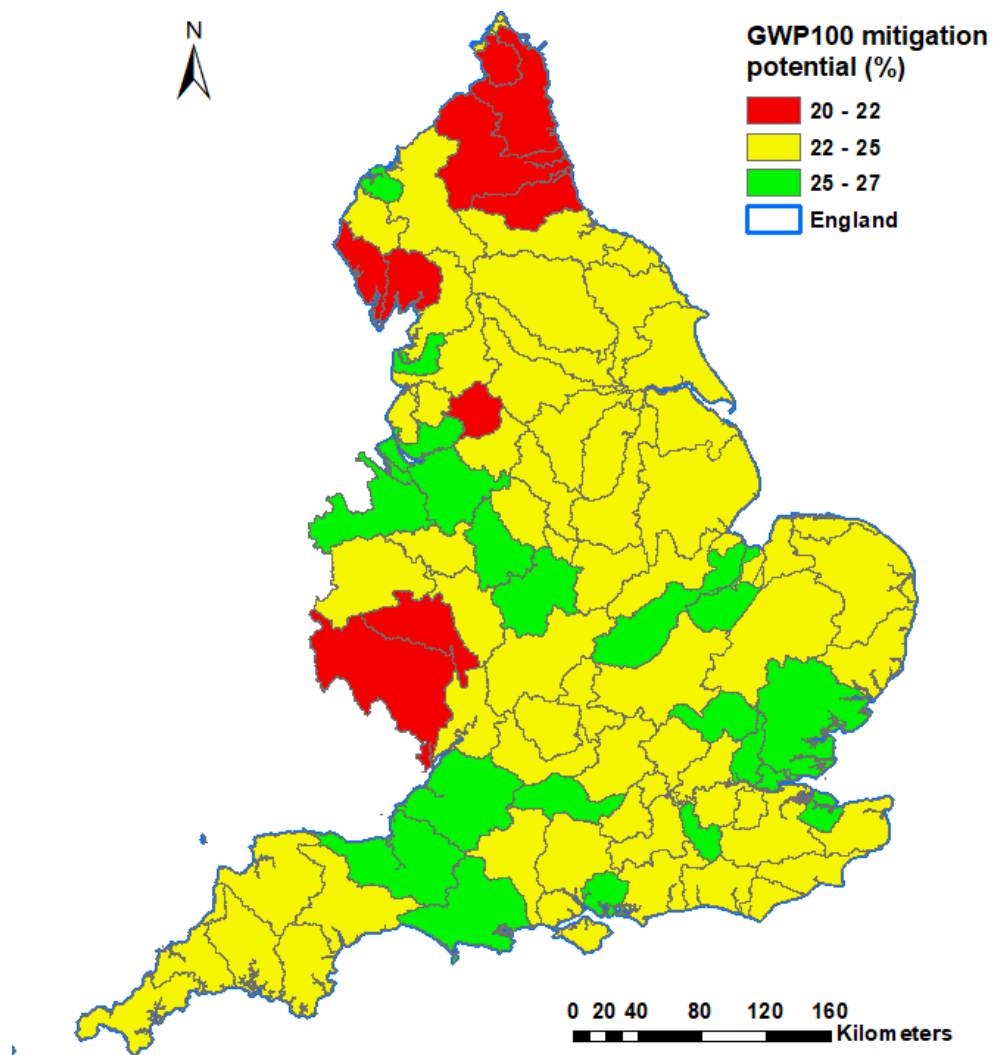


Fig. S2. Mapped maximum technical feasibility for the mitigation of GWP100 at WMC scale.

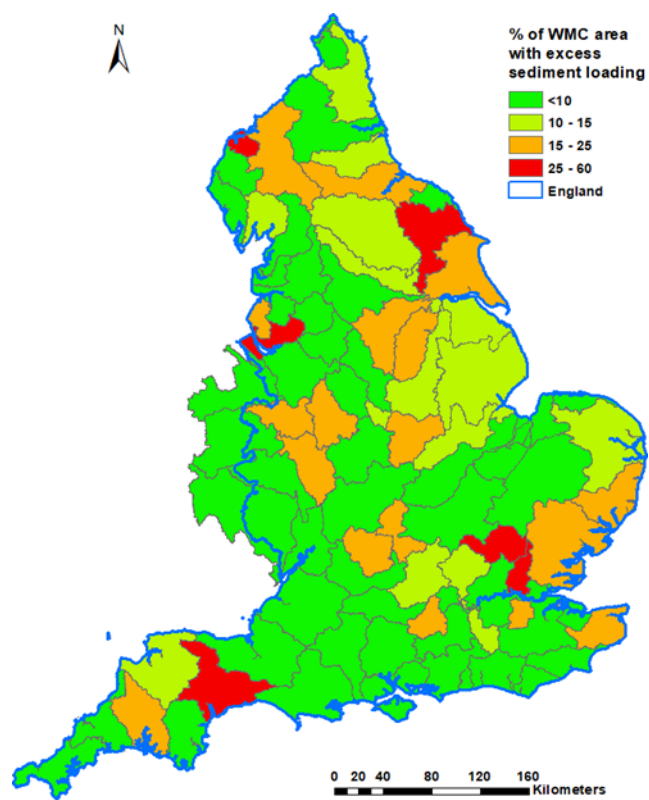


Fig. S3. Spatial distribution of excess sediment loadings at WMC scale.

**Table S1 Full list of mitigation measures included for the maximum technically feasible mitigation scenario modeling**

---

Establish cover crops in the autumn
Early harvesting and establishment of crops in the autumn
Cultivate land for crops in spring rather than autumn, retaining over-winter stubbles
Adopt reduced cultivation systems
Cultivate compacted tillage soils
Cultivate and drill across the slope
Leave autumn seedbeds rough
Manage over-winter tramlines
Establish in-field grass buffer strips
Establish riparian buffer strips
Loosen compacted soil layers in grassland fields
Allow grassland field drainage systems to deteriorate
Ditch management on arable land
Ditch management on grassland
Improved livestock through breeding
Use plants with improved nitrogen use efficiency
Fertiliser spreader calibration
Use a fertiliser recommendation system
Integrate fertiliser and manure nutrient supply
Do not apply manufactured fertiliser to high-risk areas
Avoid spreading manufactured fertiliser to fields at high-risk times
Use manufactured fertiliser placement technologies
Use nitrification inhibitors
Replace urea fertiliser to grassland with another form
Replace urea fertiliser to arable land with another form
Incorporate a urease inhibitor into urea fertilisers for grassland
Incorporate a urease inhibitor into urea fertilisers for arable land
Use clover in place of fertiliser nitrogen
Do not apply P fertilisers to high P index soils
Reduce dietary N and P intakes: Dairy
Reduce dietary N and P intakes: Pigs
Reduce dietary N and P intakes: Poultry
Adopt phase feeding of livestock: Dairy
Adopt phase feeding of livestock: Pigs
Reduce the length of the grazing day/grazing season
Extend the grazing season for cattle
Reduce field stocking rates when soils are wet
Move feeders at regular intervals
Construct troughs with concrete base
Increase scraping frequency in dairy cow cubicle housing
Additional targeted bedding for straw-bedded cattle housing
Washing down of dairy cow collecting yards
Frequent removal of slurry from beneath-slat storage in pig housing
Install air-scrubbers: mechanically ventilated pig housing
Install air-scrubbers: mechanically ventilated poultry housing

More frequent manure removal from laying hen housing with manure belt systems  
In-house poultry manure drying  
Increase the capacity of farm slurry stores to improve timing of slurry applications  
Adopt batch storage of slurry  
Install covers to slurry stores  
Allow cattle slurry stores to develop a natural crust  
Anaerobic digestion of livestock manures  
Minimise the volume of dirty water produced (sent to dirty water store)  
Minimise the volume of dirty water produced (sent to slurry store)  
Compost solid manure  
Site solid manure heaps away from watercourses/field drains  
Store solid manure heaps on an impermeable base and collect effluent  
Cover solid manure stores with sheeting  
Use liquid/solid manure separation techniques  
Use poultry litter additives  
Manure Spreader Calibration  
Do not apply manure to high-risk areas  
Do not spread slurry or poultry manure at high-risk times  
Use slurry band spreading application techniques  
Use slurry injection application techniques  
Do not spread FYM to fields at high-risk times  
Incorporate manure into the soil  
Fence off rivers and streams from livestock  
Construct bridges for livestock crossing rivers/streams  
Re-site gateways away from high-risk areas  
Farm track management  
Establish new hedges  
Establish and maintain artificial wetlands - steading runoff  
Irrigate crops to achieve maximum yield  
Establish tree shelter belts around livestock housing  
Calibration of sprayer  
Fill/Mix/Clean sprayer in field  
Avoid PPP application at high risk timings  
Drift reduction methods  
PPP substitution  
Construct bunded impermeable PPP filling/mixing/cleaning area  
Treatment of PPP washings through disposal, activated carbon or biobeds  
Protection of in-field trees  
Management of woodland edges  
Management of in-field ponds  
Management of arable field corners  
Plant areas of farm with wild bird seed / nectar flower mixtures  
Beetle banks  
Uncropped cultivated margins  
Skylark plots  
Uncropped cultivated areas  
Unfertilised cereal headlands  
Unharvested cereal headlands

Undersown spring cereals  
Management of grassland field corners  
Leave residual levels of non-aggressive weeds in crops  
Use correctly-inflated low ground pressure tyres on machinery  
Locate out-wintered stock away from watercourses  
Use dry-cleaning techniques to remove solid waste from yards prior to cleaning  
Capture of dirty water in a dirty water store  
Irrigation/water supply equipment is maintained and leaks repaired  
Avoid irrigating at high risk times  
Use efficient irrigation techniques (boom trickle, self closing nozzles)  
Use high sugar grasses  
Monitor and amend soil pH status for grassland  
Increased use of maize silage  
Improve livestock through genetic modification  
Slurry acidification during storage  
Slurry acidification at spreading  
Install covers to slurry stores and burn off methane  
Use feed additives to reduce enteric methane emissions

---