Reducing Greenhouse Gas Emissions from Soils

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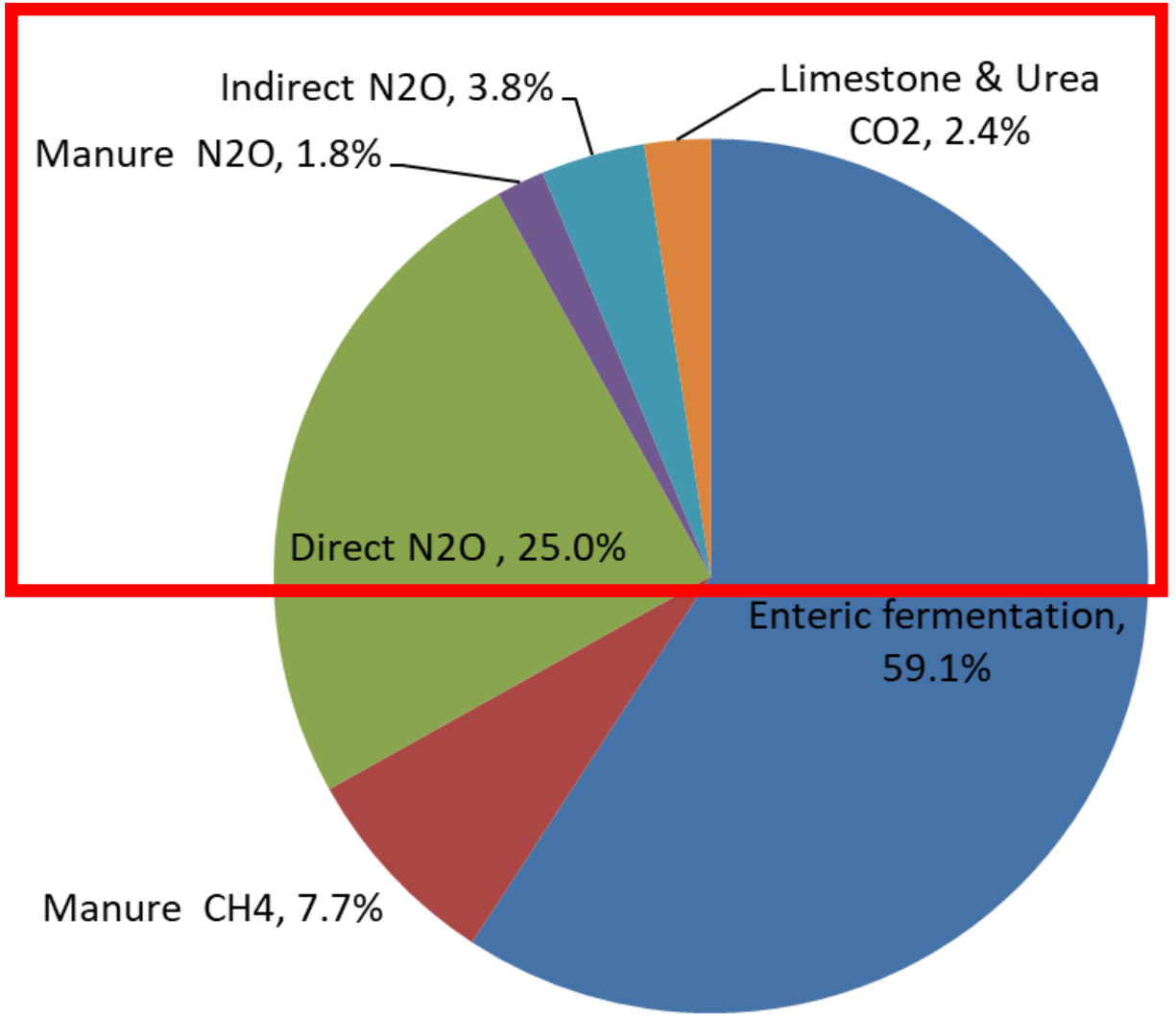
Introduction – Soil Emissions

- Soils important source of Nitrous Oxide (N_2O) emissions
- N_2O powerful greenhouse gas 265 times higher carbon dioxide (CO_2)
- Main Sources
  - Direct N_2O (fertiliser, dung/urine)
  - Indirect N_2O (ammonia & nitrate)
  - Lime
  - Manure



EPA National Inventory Report 2022

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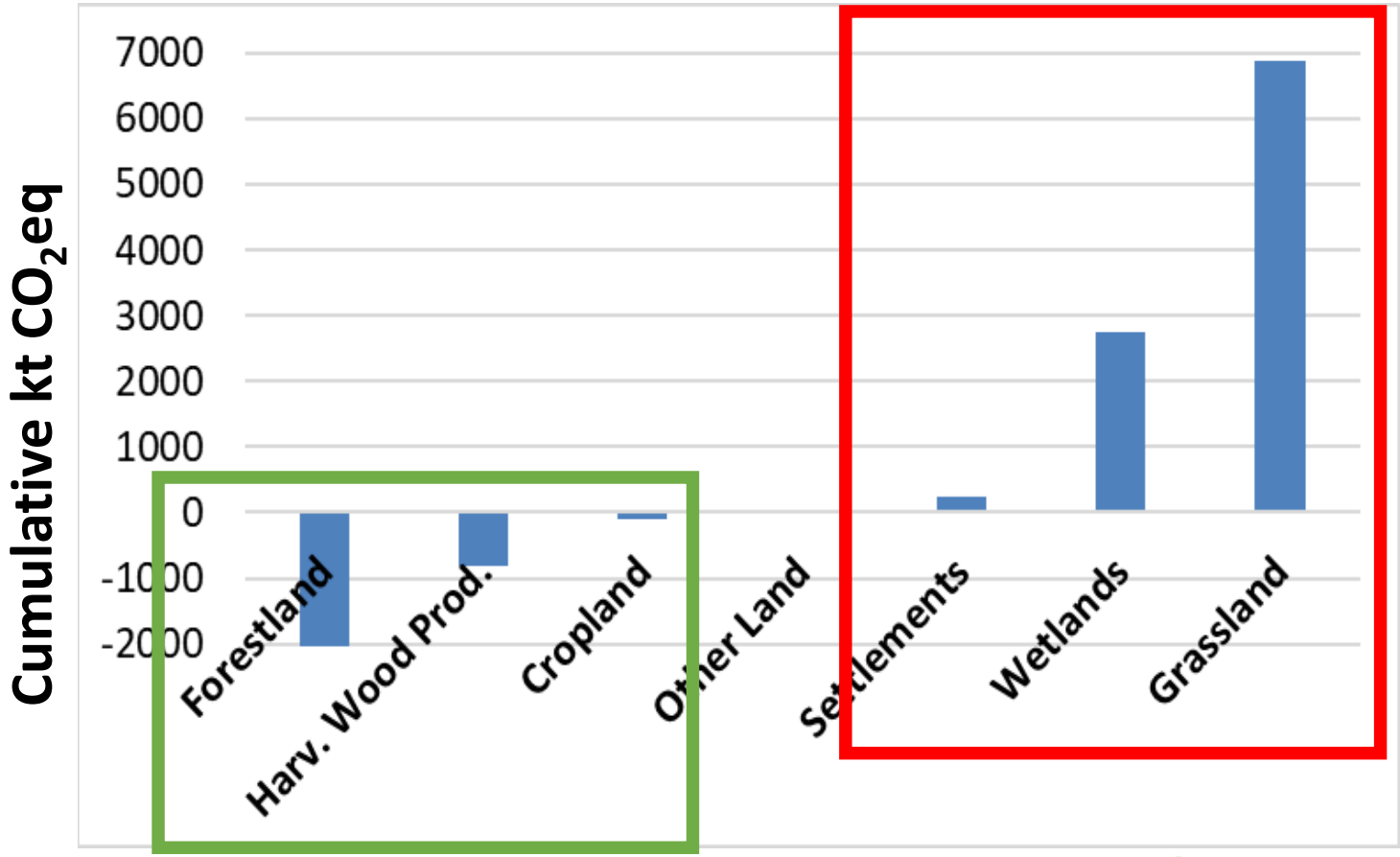
Introduction – Soil Emissions

- Soils main store of carbon
- Soil C x3 times > atmosphere
- Ireland main carbon sinks
  - Forestland
  - Harvested wood products
  - Cropland
- Ireland soils important carbon dioxide (CO_2) emissions source
  - Grassland
  - Wetlands
  - Settlements



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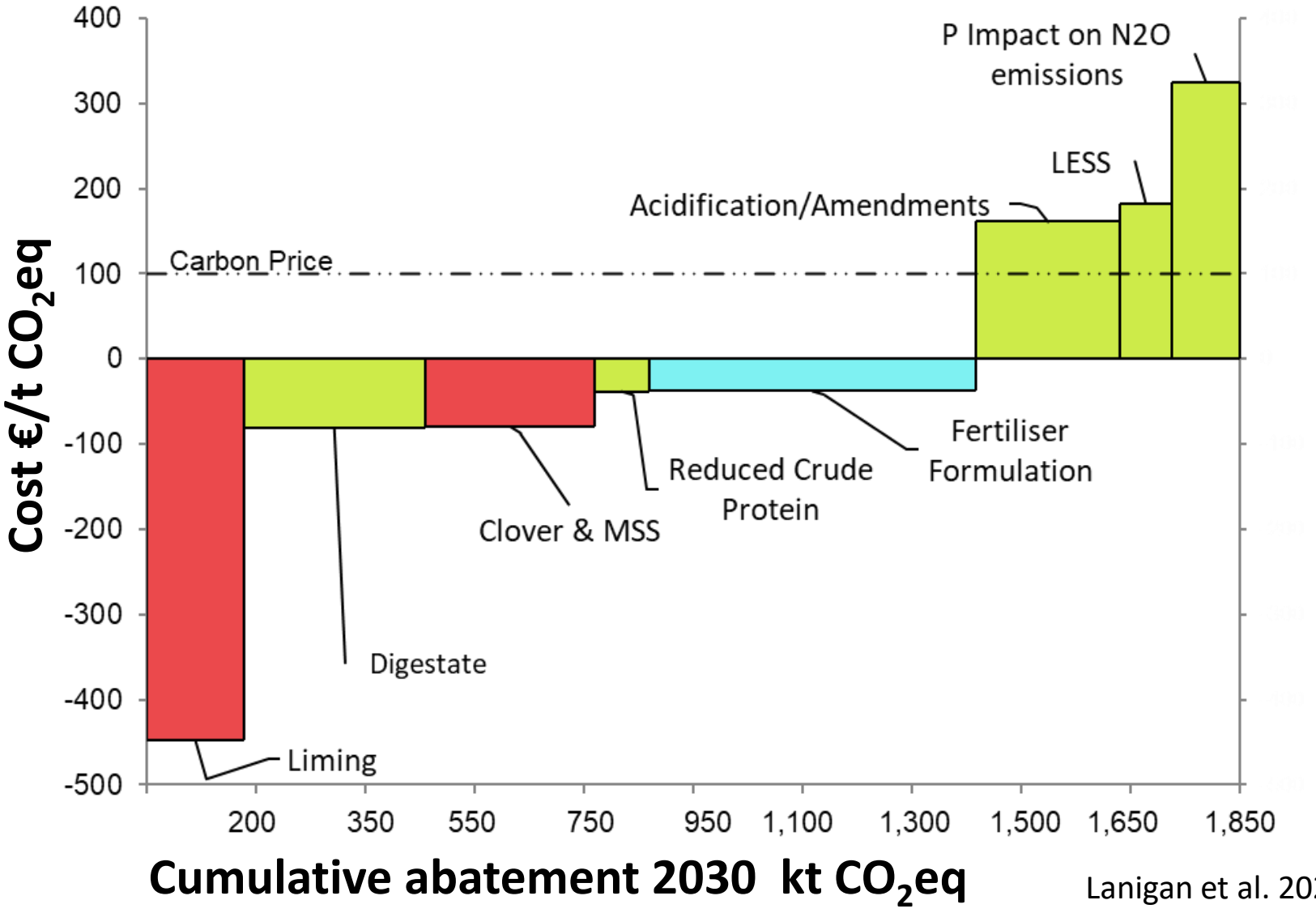
Reducing Soil Emissions from Agriculture

Reducing Soil N_2O Emissions

- Options to reduce emissions
- Soil N_2O mitigation can reduce by 1.85MT 2030
- Cost of measures varied fro -450 to +300 €/TCO_2 mitigated



Lanigan et al. 2023

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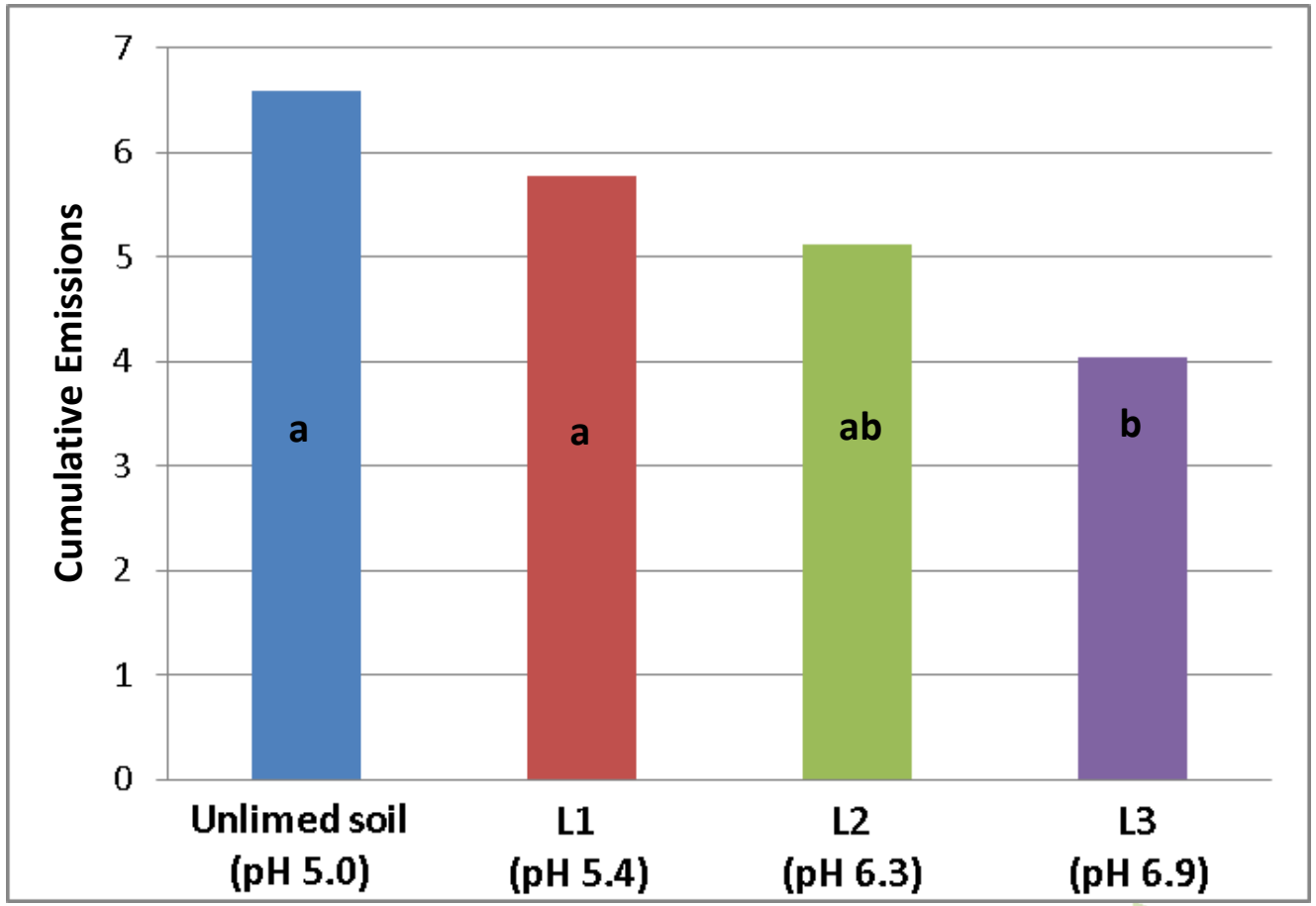
Liming

- Liming important for optimal crop/grass growth
- Replaces N fertiliser by 70 kg N/ha
- Helps establish clover grass & multispecies swards
- Improves nutrient use efficiency
- Can reduce soil N_2O emissions
- Increased soil C sequestration



Žurovec et al. 2021. Agriculture, Ecosystems & Environment 311: 107319

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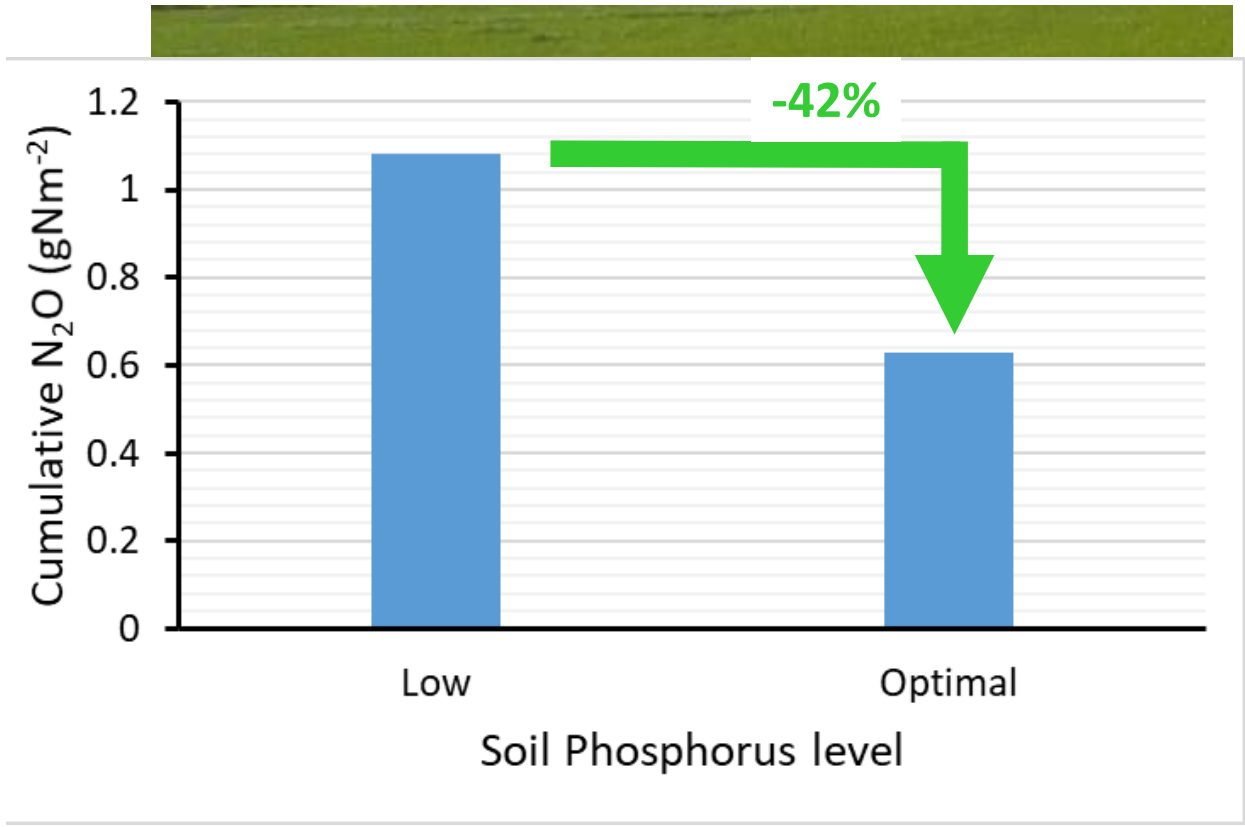
Optimising Soil Phosphorus

- Soil phosphorus (P) is important for crop/grass growth optimisation
- P experiment started 1995
- Optimising soil P reduced emissions by 38 to 42%
- P effects soil microbiome
- New ICONICA project assess the effect of soil P on soil emissions and C sequestration



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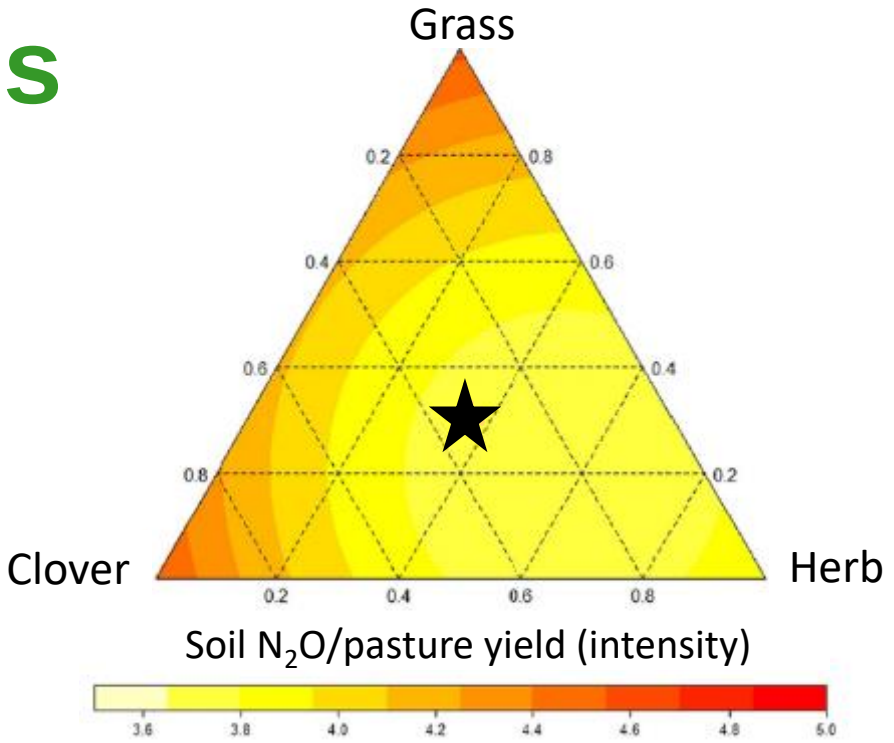
Clover and Multi Species Swards

- Clover can fix 100-150 kg N/ha
- Fixed N reduces fertiliser emissions
- Soil P & liming pH important for establishment
- Multispecies swards (MSS) have lower soil nitrate and emissions (plantain)
- Ongoing research
  - Soil C sequestration clover/MS swards
  - Biological nitrification inhibition
  - Soil health



Cummins et al. 2021 Sci. Tot. Env. 792: 148163.

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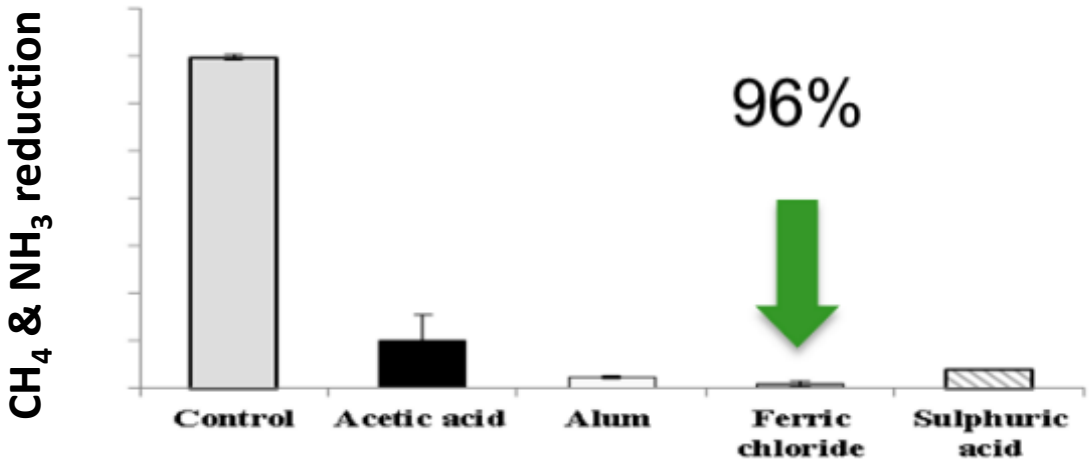
Emissions from Manure/Digestate

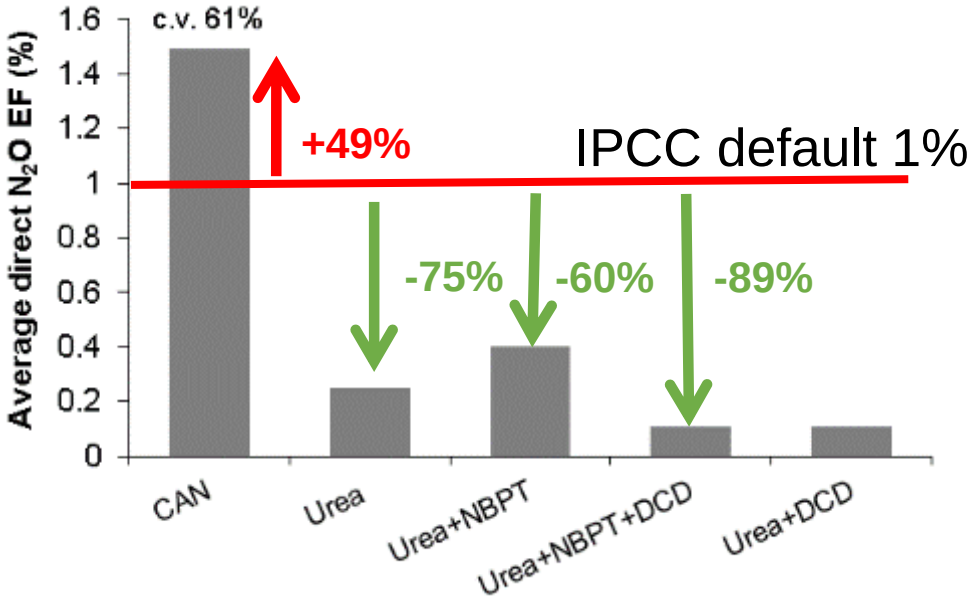
- Manure/digestate replaces N fertiliser
- Low emission slurry spreading – reduces emissions
- Amendments reduce emissions >90%
- Current research focusing new
  - Amendments
  - Dietary additives
  - Digestate from AD

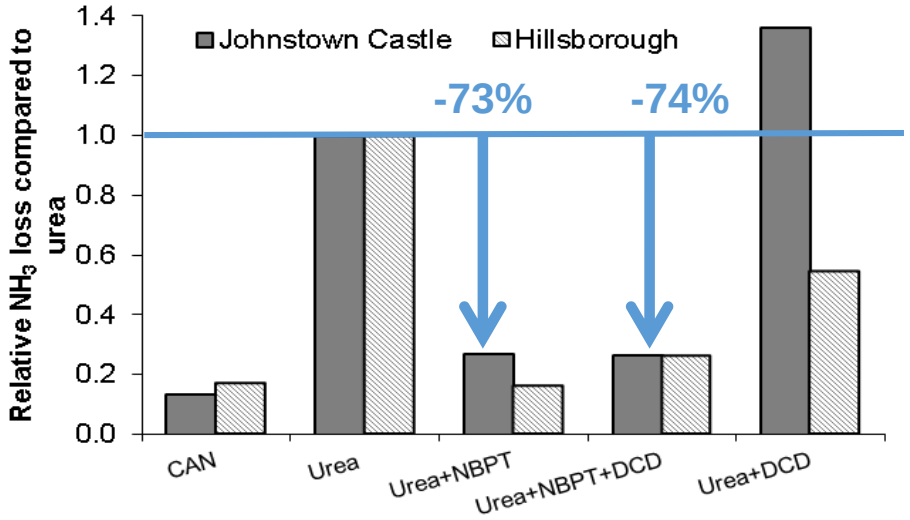


Kavanagh et al. 2019 J. Cleaner Production 237, 117822

Fertiliser Formulation

- Protected urea
  - Grassland reduced emissions by more than 70%
  - Protected urea didn't reduce yield
- Nitrification inhibitors
  - Reduced emissions by 89%
  - Potential to further reduce emissions
- Compound fertiliser may also reduce emissions ~40%





Harty et al. 2016. Sci. Total Env. 563: 576-586.
Forrestal et al. 2016. Soil use & Manag. 32: 92-100..

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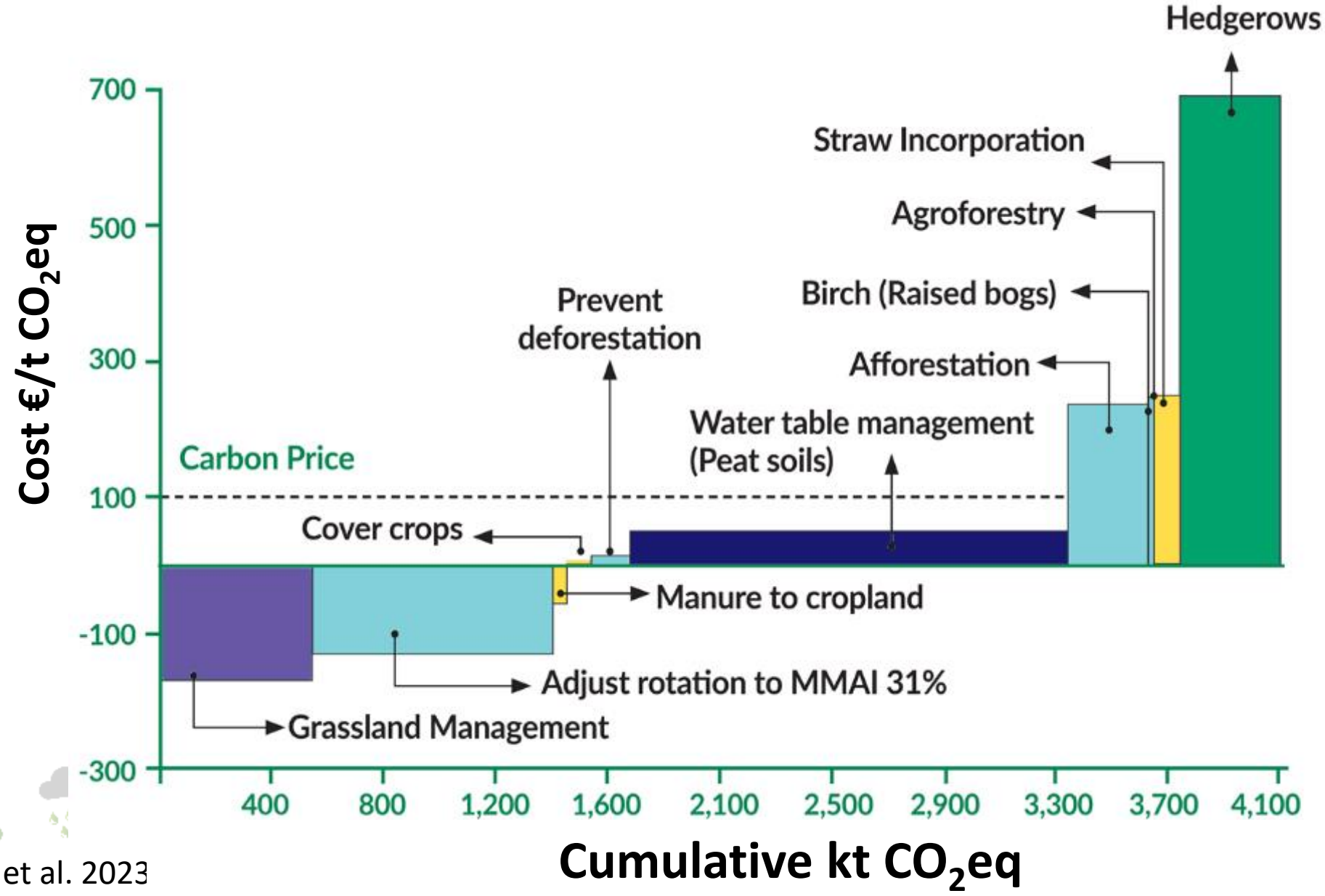
Reducing Soil Emissions From Land-use

Lanigan et al. 2023

Reducing Soil CO_2 Emissions



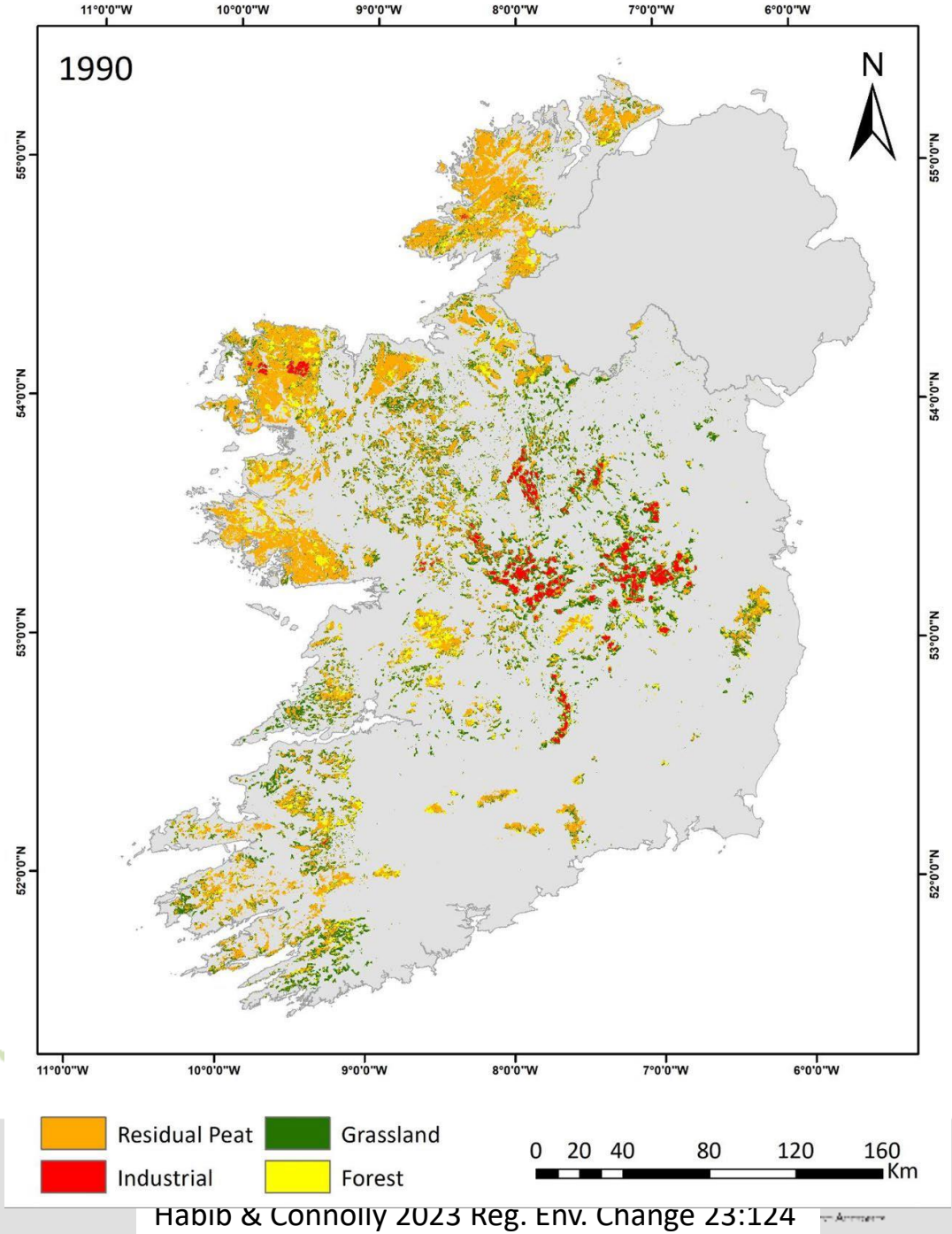
Lanigan et al. 2023

National Agricultural Soil Carbon Observatory

- Current inventory values are highly uncertain
- Need to produce national emission factors
- Monitor long-term changes in soil carbon stocks
- 28 carbon towers across Ireland to investigate management, land-use, soil type and climate impacts
- Use satellite data and biogeochemical models to extrapolate results
- Provide data to support science-based climate policy decisions

Agricultural Peat Soils

- Peat soils store 15-30% C globally
- Peat covers 21% Ireland
- Grassland peat soils emit ~9 $MTCO_2eq$
- Research underway to refine:
  - Area of peat soils
  - Drainage and nutrient status of peat soils
  - Emission factor peat types & mitigation
- Raising the water table reduces emissions



Habib & Connolly 2023 Reg. Env. Change 23:124

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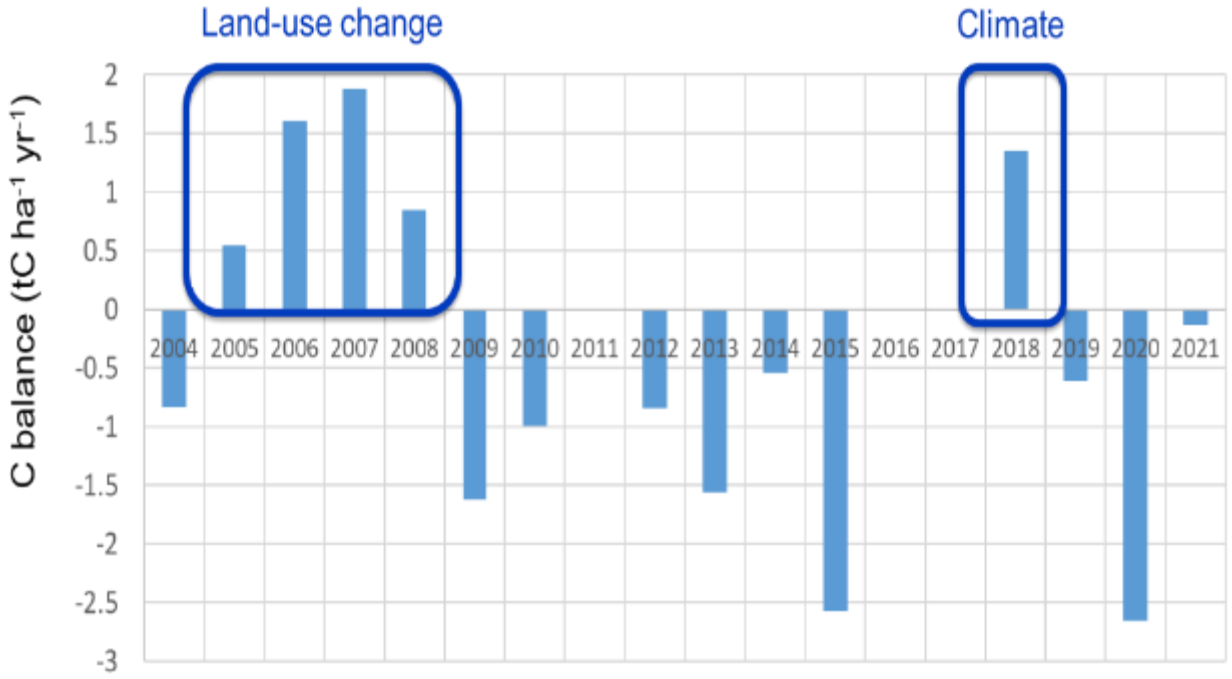
Mineral – Organo/Mineral soils

- Mineral soils sequester ~4 $MTCO_2eq$
- Refine emission factors for mineral and organo-mineral soils
- Need improved soil mapping
- How permanent is C sequestered
- Impact of mitigation practices
  - Multispecies swards/clover
  - Improved soil fertility
  - Land-Use change

Johnstown Castle C Balance 2004-2021



Murphy et al. In Prep.

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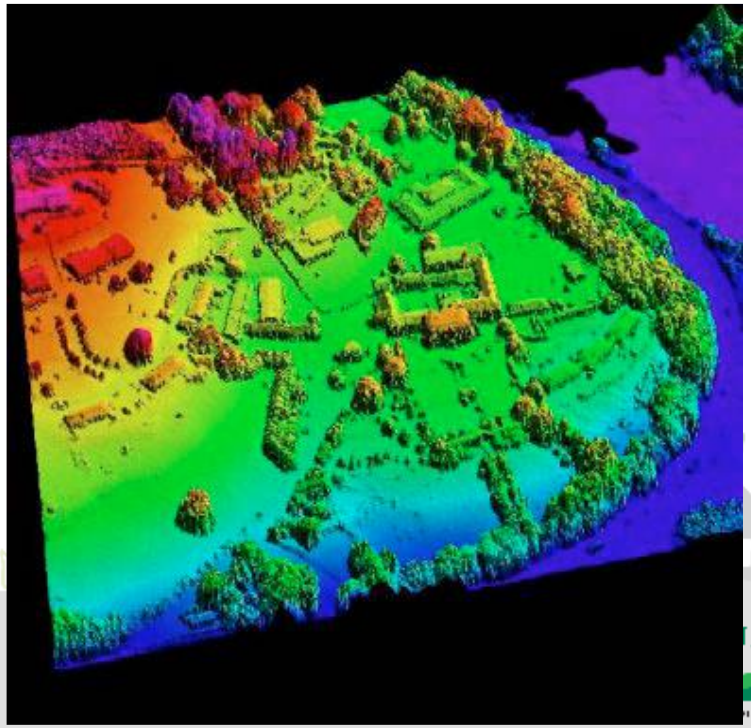
Forestry and hedgerows

- Challenge to reduce emissions due to forestry harvesting
- Delaying harvesting delays C loss
- Afforestation important for climate neutrality
- Enhanced hedgerow sequestration by reduced management
- On-going research
  - Map C stocks on Signpost farms
  - Climate adaptation
  - Management to reduce losses
  - Agro-forestry
  - Carbon farming



Signpost Farms & Advisory Programmes

- 125 Signpost demonstration farms across Ireland
  - Demonstration of mitigation practice
  - Farmers share experiences
  - Track progress
- Signpost Advisory programme
  - Free advise to farmers
  - 10,000 farmers per year
  - AgNav used to know farm C emissions & prepare a reduction plan

Key Take Home Messages

- Research has highlighted how agriculture can achieve the 25% reduction by 2030
- Soil N_2O mitigation options
  - Reduce N fertiliser use – soil fertility, clover/MSS, low emission slurry spreading
  - Use low emission fertilisers
  - Use manure additives
- Soil CO_2 mitigation options
  - Raise water table on peat soils
  - Extend forestry rotations
  - Plant more trees & improve hedgerows

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