Gaseous Emissions –a Marginal Abatement Cost Curve

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The Challenges

- Industry expanding to meet global food demand
- GHG and ammonia emissions increased since 2011
  - 32% greenhouse gas emissions
  - 98% ammonia emissions

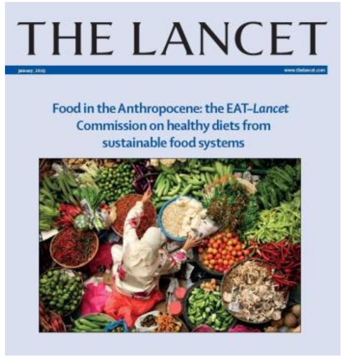
Agricultural GHG 2030 targets:

  - Reduce emissions ~10% (17.5 -19Mt CO_2e)
  - Deliver carbon sequestration ~ 10% (2.7 MT CO_2e)

Ammonia targets:

  - 1% reduction 2020-30
  - 5% from 2030 onwards

- Increasing **political pressure** on agriculture to reduce environmental impact
  - EU Green deal – farm to fork strategy
  - Increasing emphasis on plant based diets
  - Planning permissions refused due to ammonia
  - Dutch farm protests over suggested 50% herd decrease
- **Carbon neutrality** 2050



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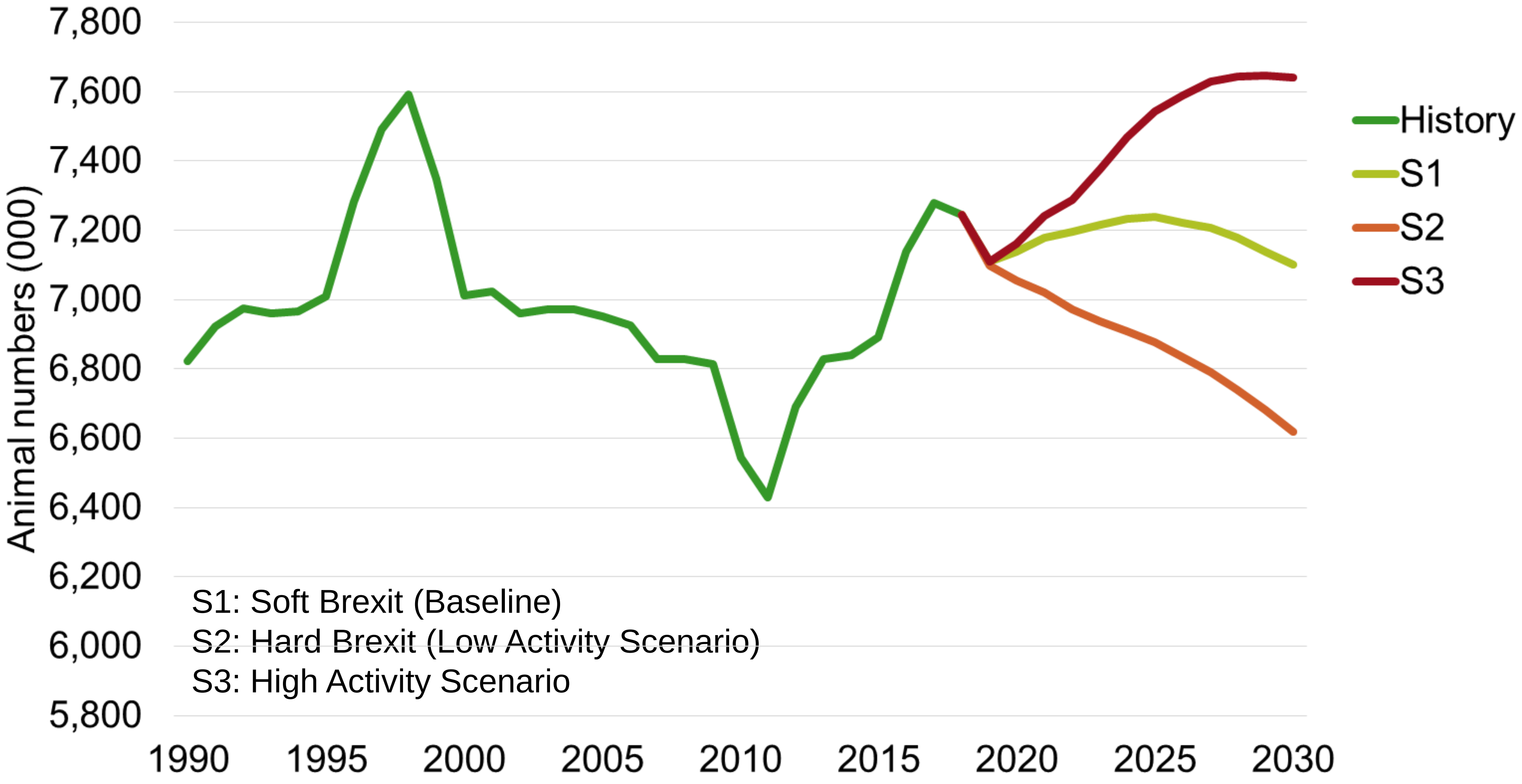
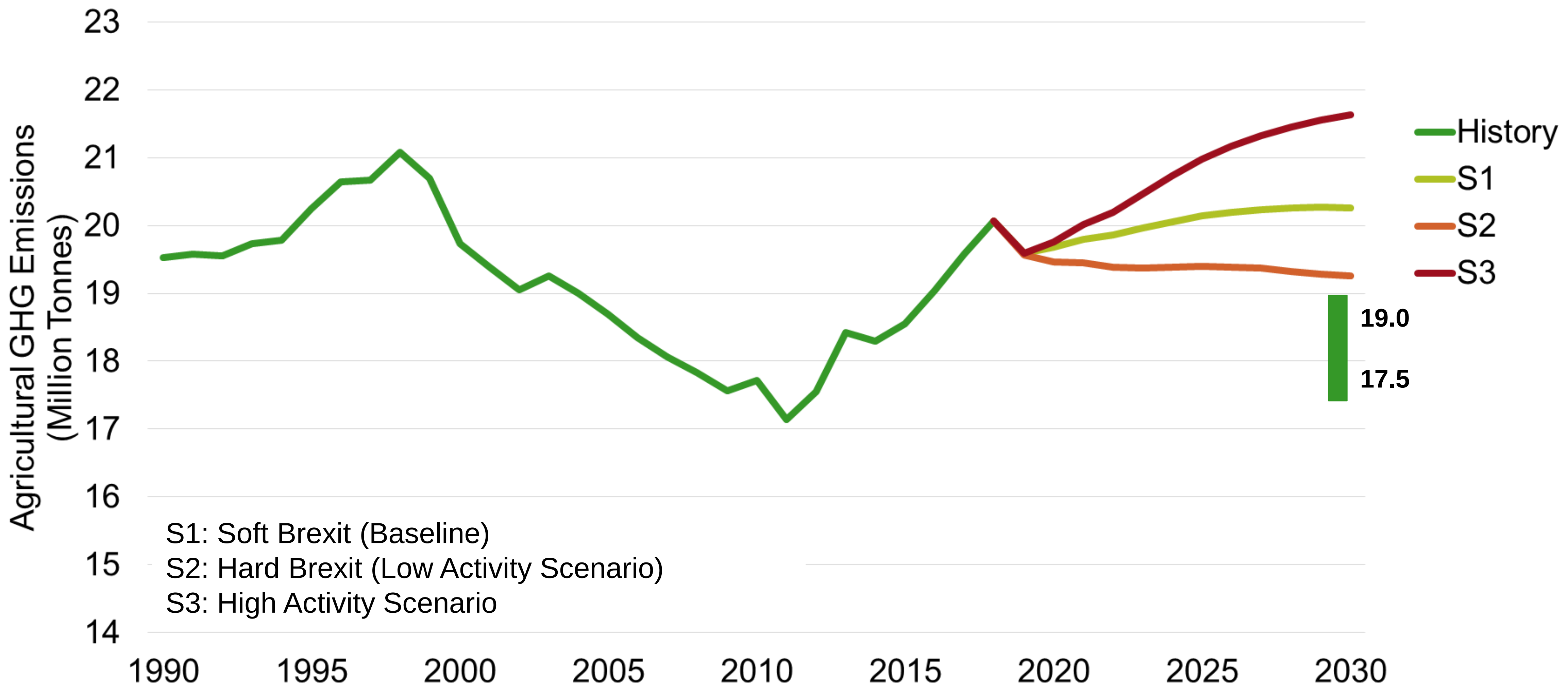
Actual and projected Total Cattle



Source: Donnellan and Hanrahan 2019

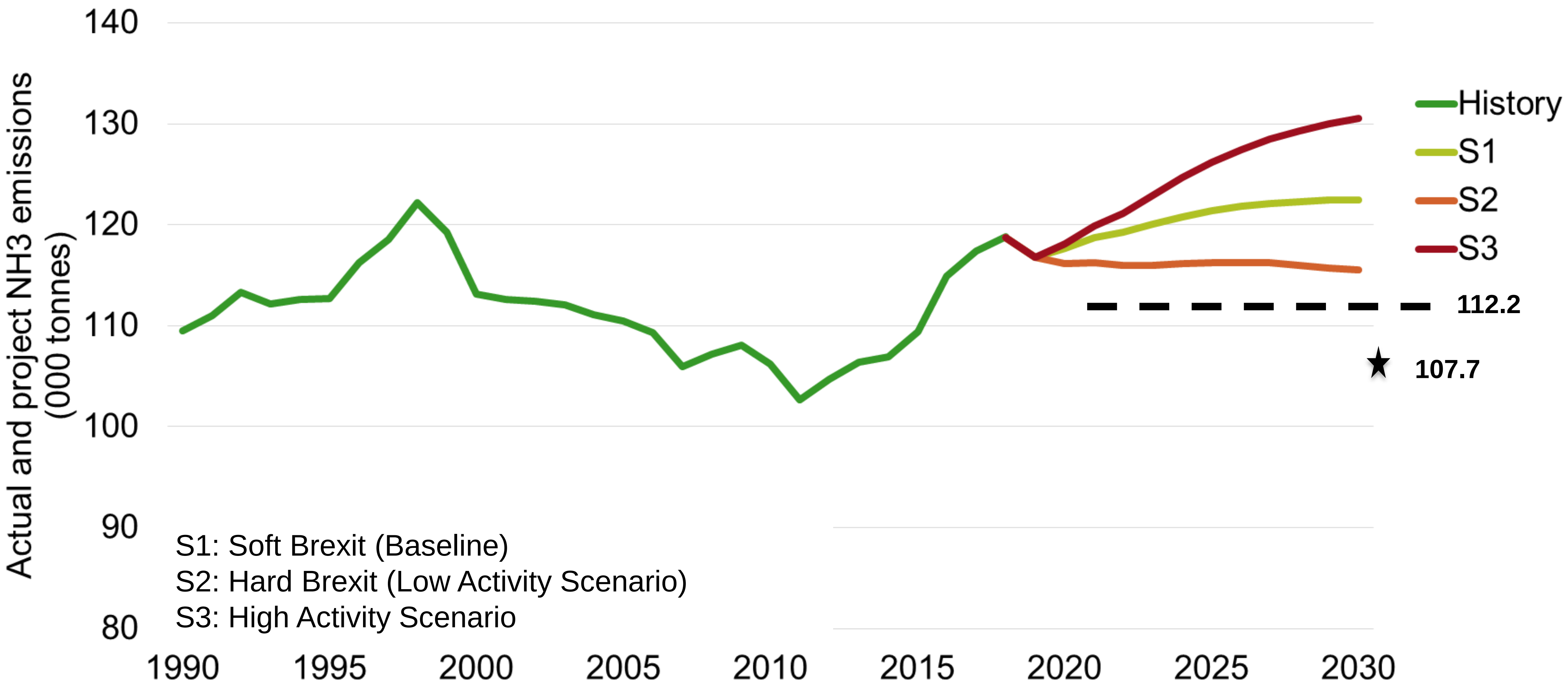
Actual and project agricultural GHG Emissions



Source: Donnellan and Hanrahan 2019

Note: Excludes Emissions from Fuel Combustion (circa 0.6mt per annum)

Actual and projected Ammonia Emissions



Source: Donnellan and Hanrahan 2019

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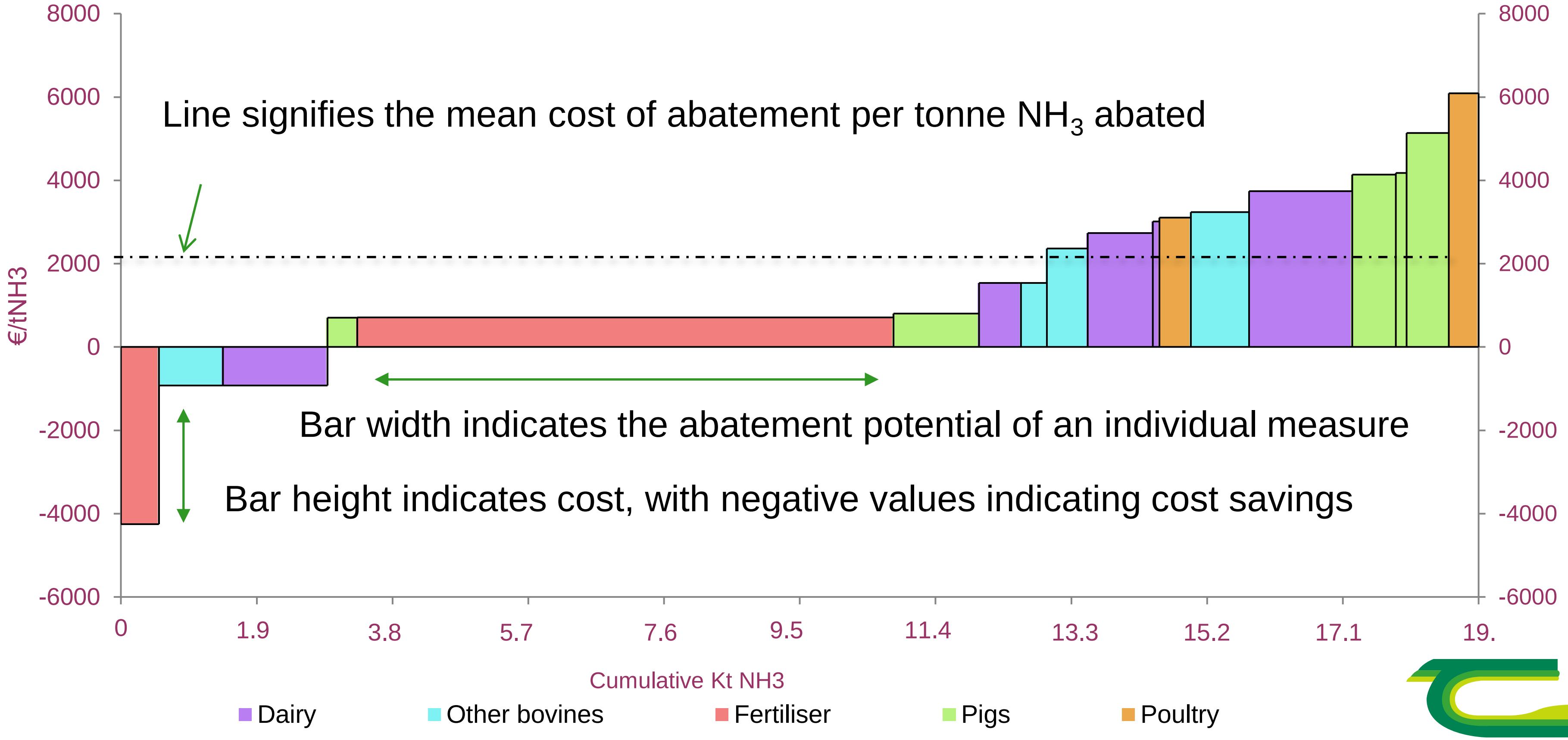
MACC Histogram

Allow for ranking of measures based on cost-effectiveness



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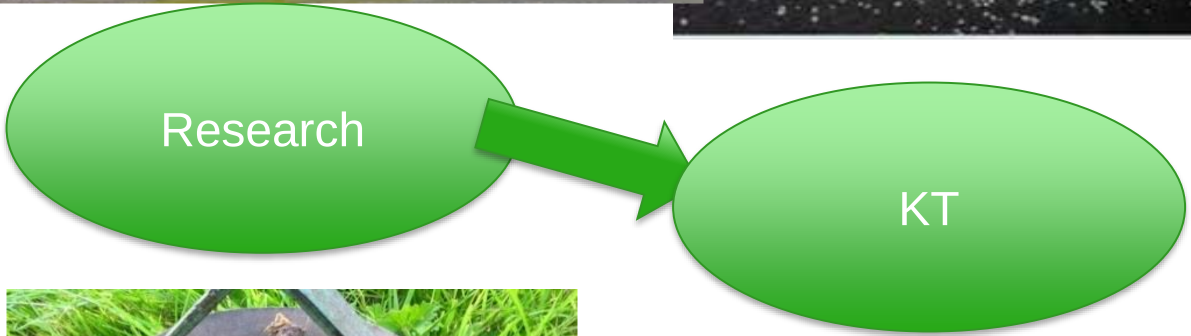
The Solutions

- Reduce methane
  - animal genetics
  - Finishing times, output per head
  - extended grazing, health and diet
- Fertilisers and nutrient use –
- Protected urea can reduce N_2O substantially
- Improving liming,
  - N & P-use fertiliser reduced
- Manure
  - Additives can reduce ammonia and methane by 70-80%
  - LESS reduces ammonia and min. fertiliser

But need effective knowledge transfer -



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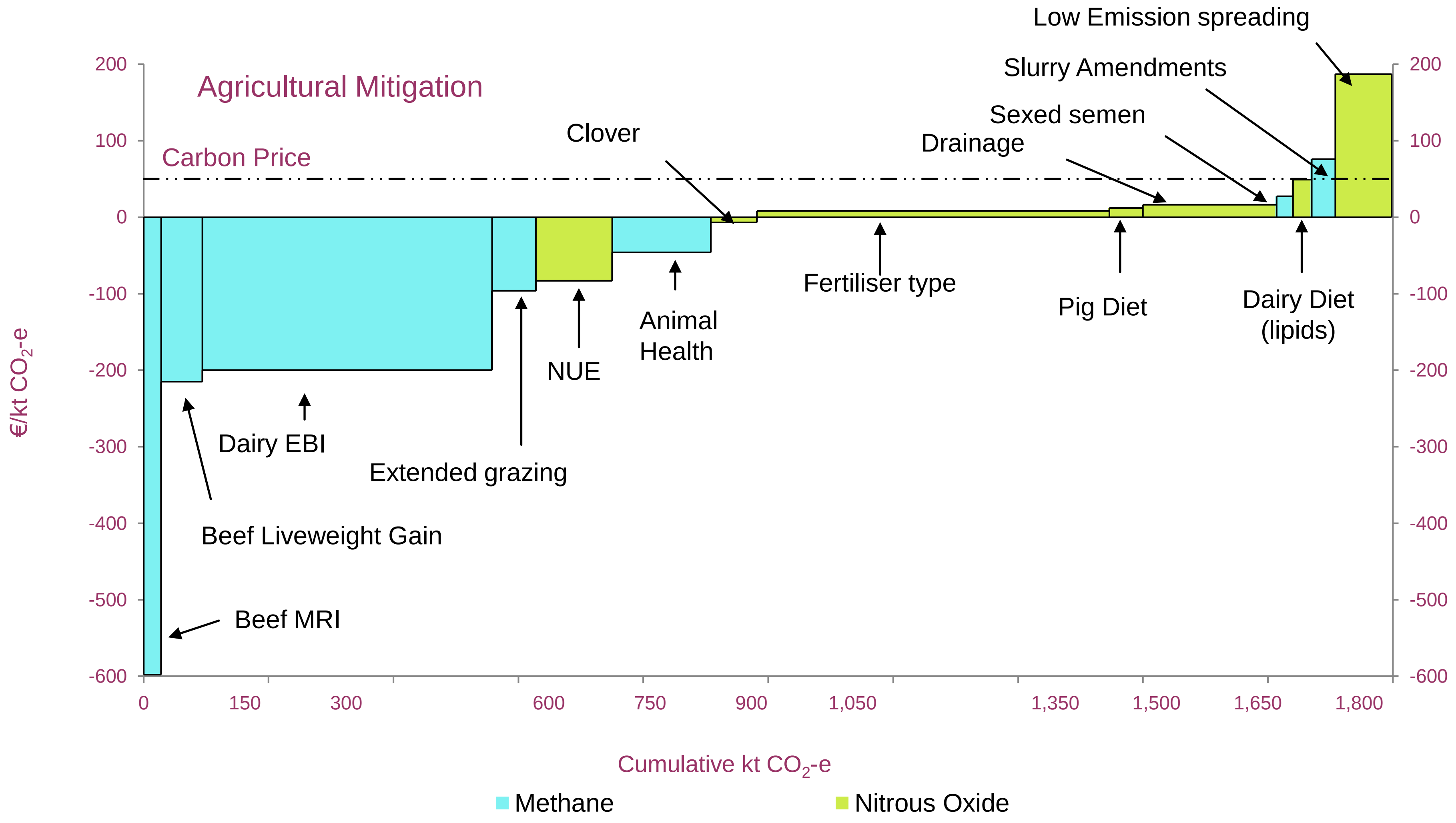
Agricultural Mitigation = 1.85 Mt CO_2e pa assuming linear uptake….by 2030 mitigation will reach 3.06 Mt CO_2e pa



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Teagasc MACC Analysis

Agricultural Measures	Abatement $MTCO_2e$	Landuse-Landuse change Forestry	Abatement $MTCO_2e$	Bioenergy Measures	Abatement $MTCO_2e$	Ammonia measures	Abatement KT NH3
Protected urea	0.52	Forestry	2.1	Wood Biomass for energy	0.76	Protected urea	7.7
Dairy EBI	0.43	Water table mgt of organic soils	0.44	Biogas (anaerobic digestion)	0.22	trailing shoe	4.4
Draining wet mineral soils	0.2	Pasture management	0.26	Biomass (SRC) for electricity	0.19	altered timing manure	2.41
Low-emission slurry spreading	0.12	Tillage mgt - Cover crops	0.1	Biomass (SRC & Miscanthus) for heat	0.18	Crude protein pigs	1.3
Water table mgt of organic soils	0.1	Tillage mgt - Straw incorporation	0.06	Biomethane	0.15	Increase NUE	0.57
Improved animal health	0.1			Energy efficiency on farm	0.03	Slurry additives	0.57
Other	0.36						
Total	**1.83**	**Total**	**2.96**	**Total**	**1.53**	**Total**	**16.95**

Ammonia MACC draft being finalised and published in 2020

- Abatement potential – verifiable activity changes (fertiliser type, absolute fertiliser use)
- Efficiency measures (EBI) may not decrease absolute emissions (Footprint)
- Emission Factor and activity must be included in national inventory

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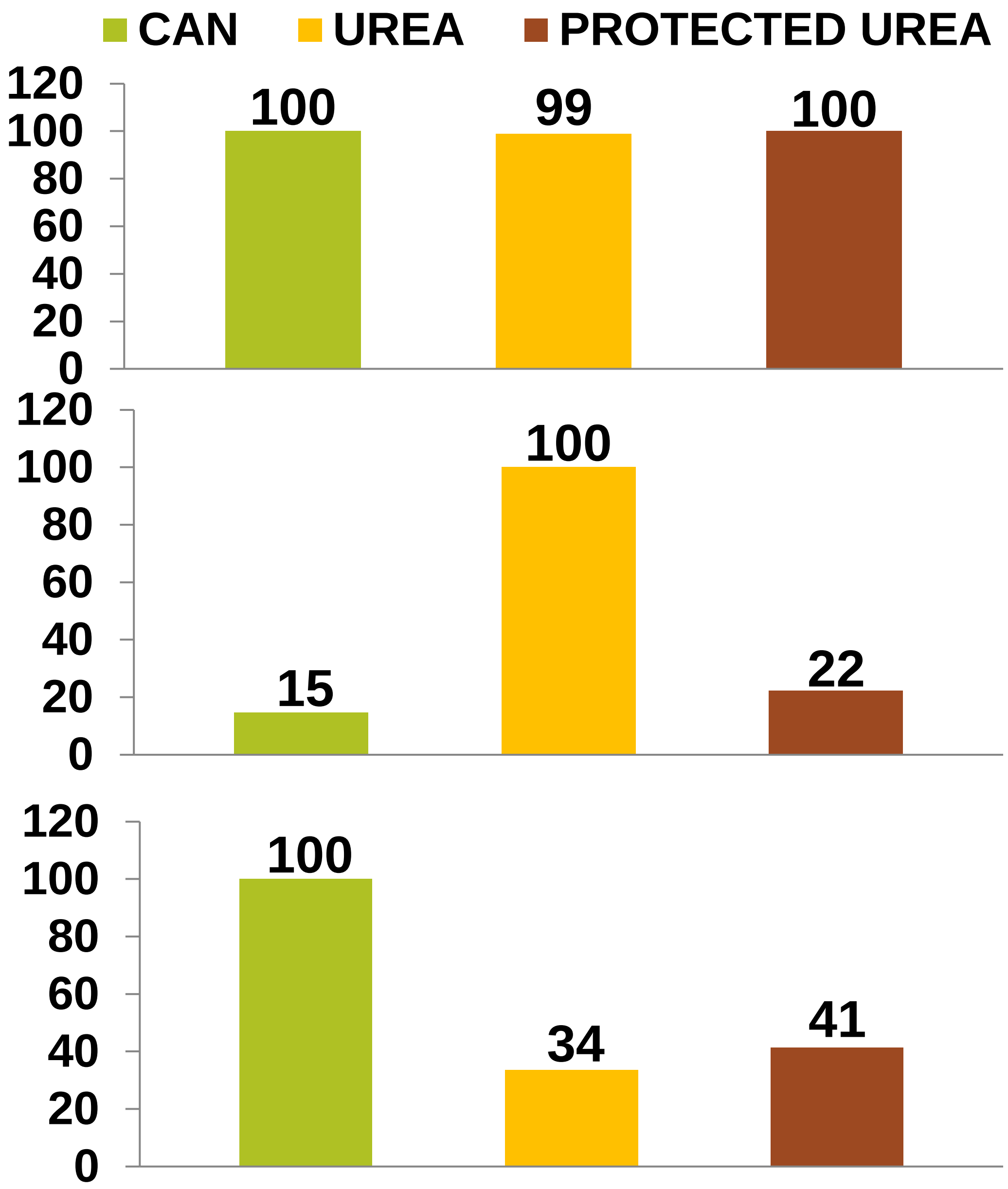
N use – key to reducing emissions



% Grass Yield Relative to CAN as best case

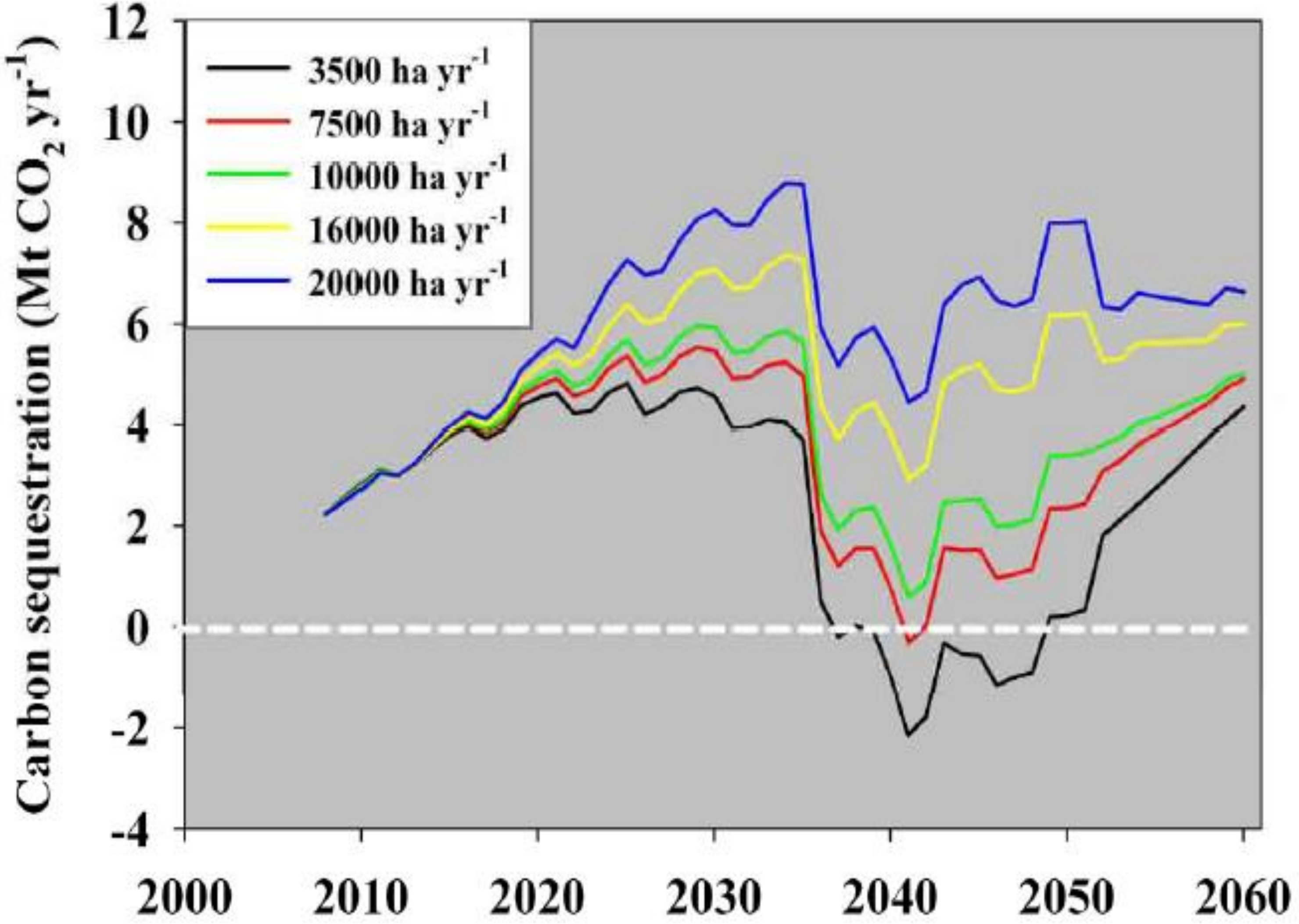
% Ammonia Loss Relative to Urea as worst case

% Nitrous Oxide Loss Relative to CAN as worst case

Forestry and Land-Use

- Under flexibilities 26.8 M tonnes CO_2 can be banked by enhancing C stocks / reducing ecosystem CO_2 loss
- Huge scope in Ireland to elect more sequestration- particularly in forests and ‘organic soils’ category but also in grassland and croplands

Forestry sink – it won't last unless we increase planting rate



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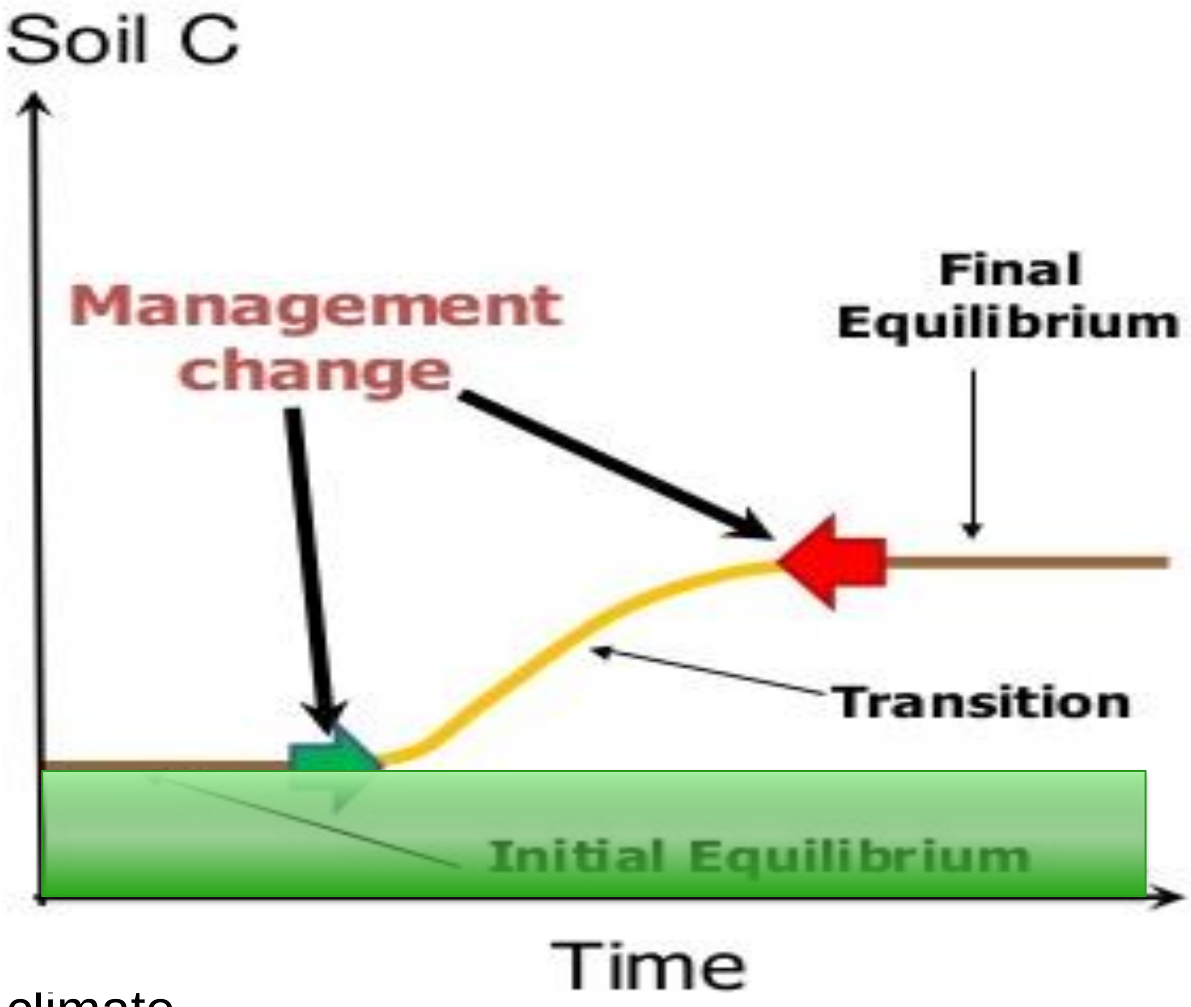
Carbon Sequestration

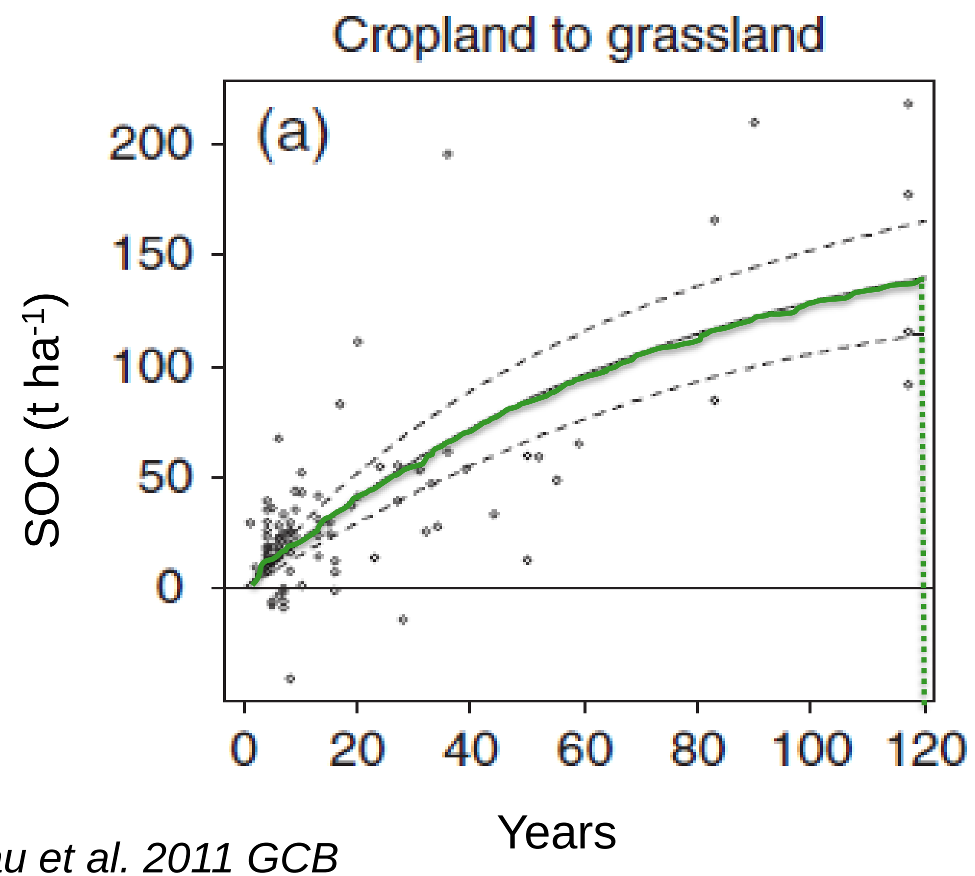
	Sandy soil	Clay soil	Peat soil
	High CO_2 uptake	High CO_2 uptake	Low CO_2 uptake
CO_2 Uptake			
	High CO_2 leaving system	SOC changes with LUC OTHERWISE CONSTANT	No loss so SOC builds up
CO_2 Loss			
Sequestration Potential			

Carbon Sequestration

- C Sequestration potential is finite
  - Land-use (peat, forest, grassland, crop)
  - Soil type
  - Climate
- C Sequestration is reversible
  - SOC lost quickly (20 yrs)
  - SOC increased slowly (120 yrs)
- To be included in inventory
  - Requires long term measurement
  - Multiple sites to differentiate land-use, soil, climate
  - Requires human and equipment resources



Soil Carbon Sequestration



Poeplau et al. 2011 GCB

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Re-wetting drained peatlands

- Drained peat soils emit between 16 and 30 t CO_2 per hectare per year
- Rewetting 40,000 ha would offset 440,000 t CO_2e per year

CC Advisory campaign

Knowledge transfer campaign for change

Training
Advisors
Consultants
Rural professionals
Business

All farmers

Signpost Demo farms

Students

Sustainability roadmap

Events

Discussion groups

Regulation	New CAP	Retail/consumers

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Summary

Challenges

- GHG targets 2030 & further lowering of target
- CAP increased environmental focus
- Increasing environ. regulation
- Farm income - price volatility
- Society's expectations for land management

- Significant mitigation potential exists
  - But these exist on paper only
  - Significant communication and action required
  - Particularly at farm level to realise these emissions reductions

  Behavioural change a significant challenge
- Diversification & Land-use optimisation
- Integrated sustainability measures (water quality & biodiversity)