The Signpost Series

'Pointing the way to a low emissions agriculture'

Carbon Sequestration in Temperate Grasslands

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Outline

- EU Green Deal and Climate Action
- Carbon Sequestration
- Land use & management
- Climate Neutral Livestock Farming

Europe's Green Deal

- A roadmap for sustainable growth
  - Circular Economy:
    - » "Give back more than it takes away" - President of the EU Commission
  - Restore habitats and biodiversity
  - Climate neutral continent
    - » Net zero greenhouse gas (GHG) emissions by 2050

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Agriculture and The Green Deal

- "Farm to fork" strategy
  - Fair return for producers
  - Affordable food
  - 25% of total farmland organic

- Carbon farming initiative
  - Curbing climate change
  - Payments for increasing C sequestration and GHG reduction
    - » CAP and/or carbon markets

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Ireland's Climate Action Plan

- Consistent with EU climate neutrality vision
- Aims to meet Irish GHG targets for EU effort sharing regulation – 2020 to 2030
  - Requires concerted action from all sectors
  - Does not compromise food production ambitions
- Carbon sequestration allowed reduce ~6% (2.7 Mt CO_2/yr) of Irish emissions

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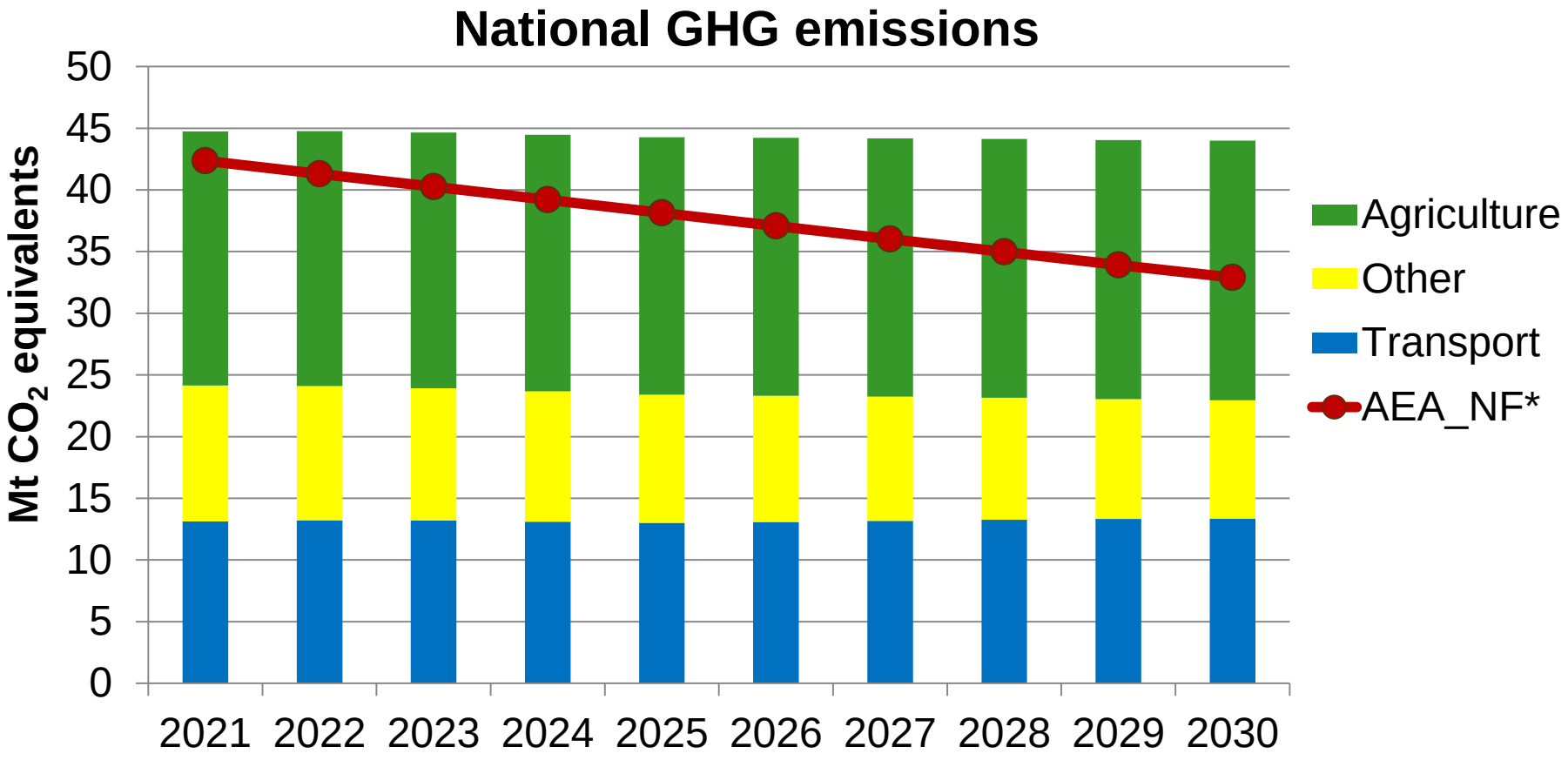
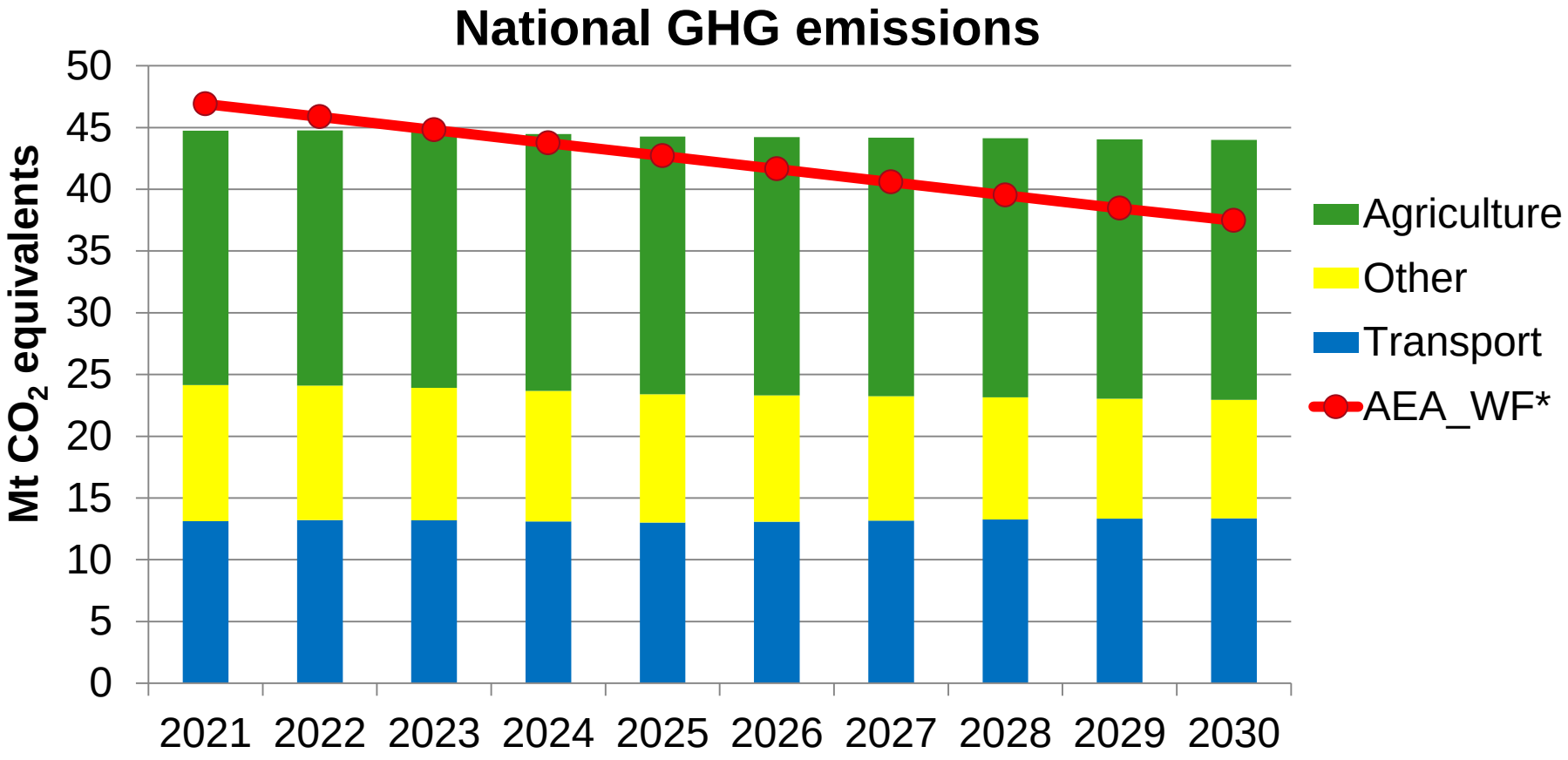
ESR* targets & GHG projections



***ESR** = EU Effort sharing regulation

***AEA_NF** = Annual emission allowance no flexibilities

ESR* targets & GHG projections



***ESR** = EU Effort sharing regulation

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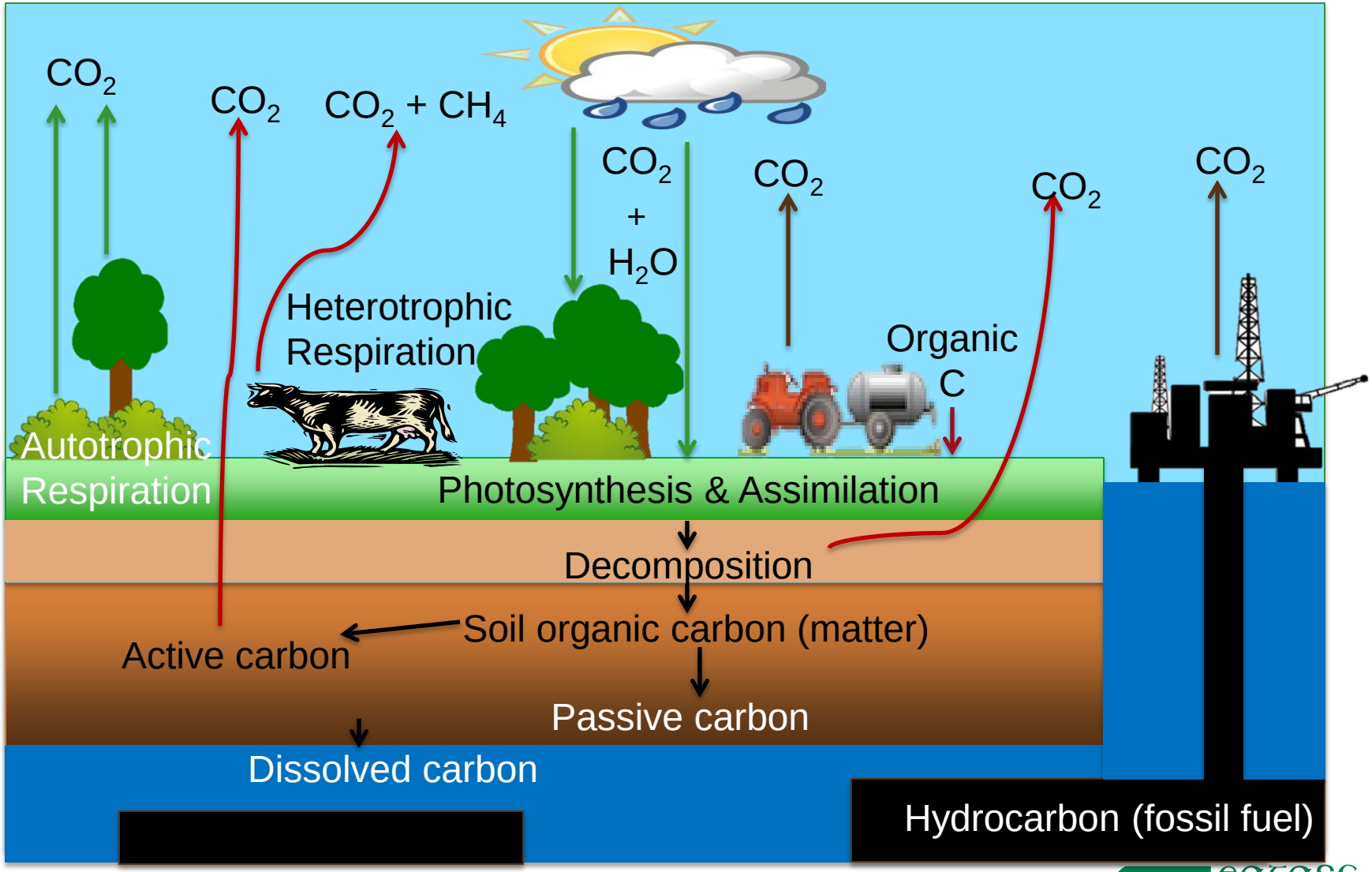
Teagasc – GHG mitigation strategy

1. Reduce agricultural greenhouse gas emissions

2. Displace fossil fuel and improve energy efficiency

3. Enhance carbon sequestration

The Carbon Cycle



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What is Carbon Sequestration?

- Carbon sequestration is a biological process part of the carbon cycle

Gross C Sequestration ≈ Photosynthesis less Respiration

of the process are:

hotosynthesis

2. Absorb
carbon
3. Organic carbon (C) is respired or
to soil or wood for storage

Factors that regulate C sequestration

- Climate
- Type of soil
- Land use
- Land management








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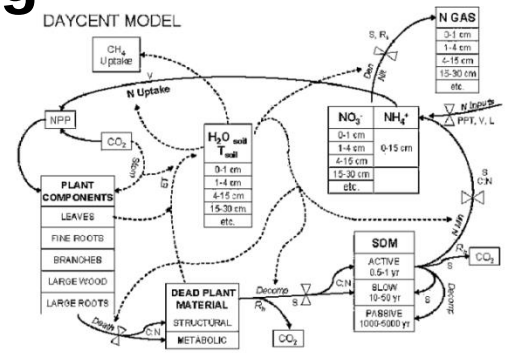
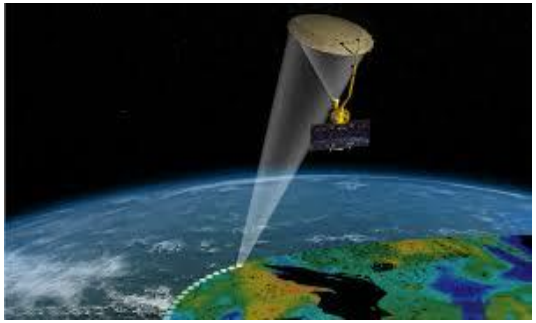
Quantifying C Sequestration is Complicated!

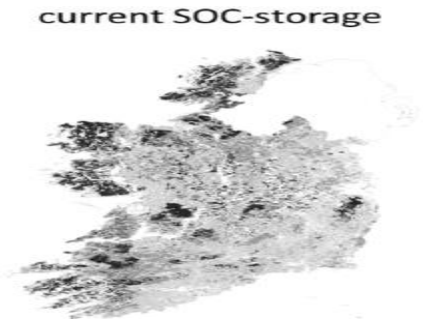
Measurement

Modelling



Mapping





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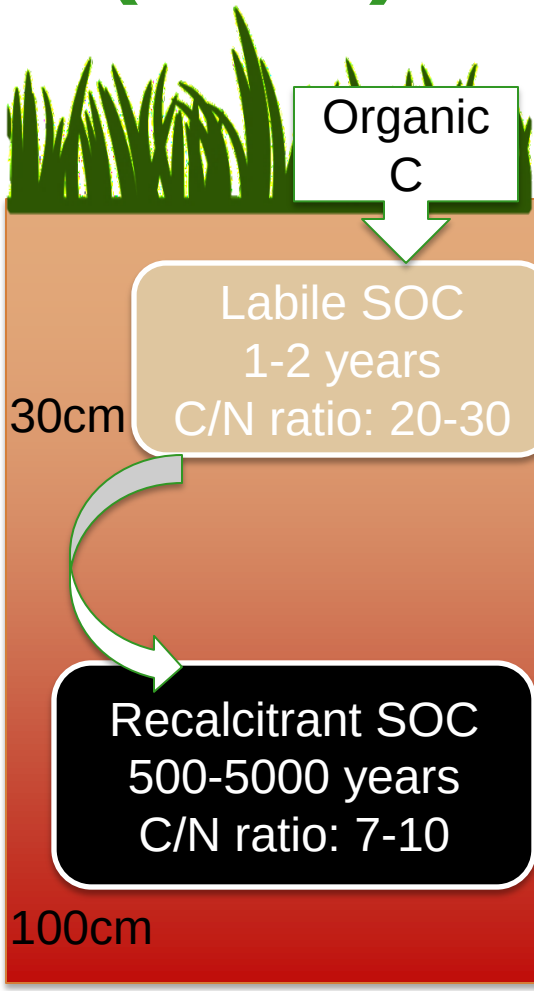
Measuring Soil Organic C (SOC)

- Most organic C is in top soil (30cm)
  - Labile – easy to breakdown
- C content of subsoil is low & stable
  - Less turnover & exposure to atmosphere
- Deeper soil sampling required for C
  - 50cm to 1 metre
- C Sequestration verified by long-term sampling



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Measuring C Fluxes

- Flux tower quantify net C exchange in agro-ecosystems: Daily & Annually

- Measure continuously (every sec)
  - Wind speed and CO_2 mixing ratio

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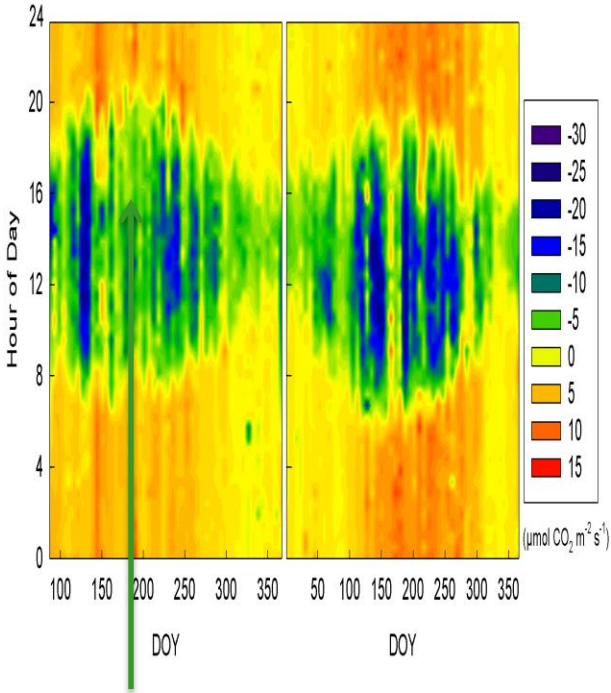
- Measure continuously (every sec)
  - Wind speed and CO_2 mixing ratio

- Sensitive to effect of weather and management on C
  - Indirectly estimates herbage growth



Dry summer

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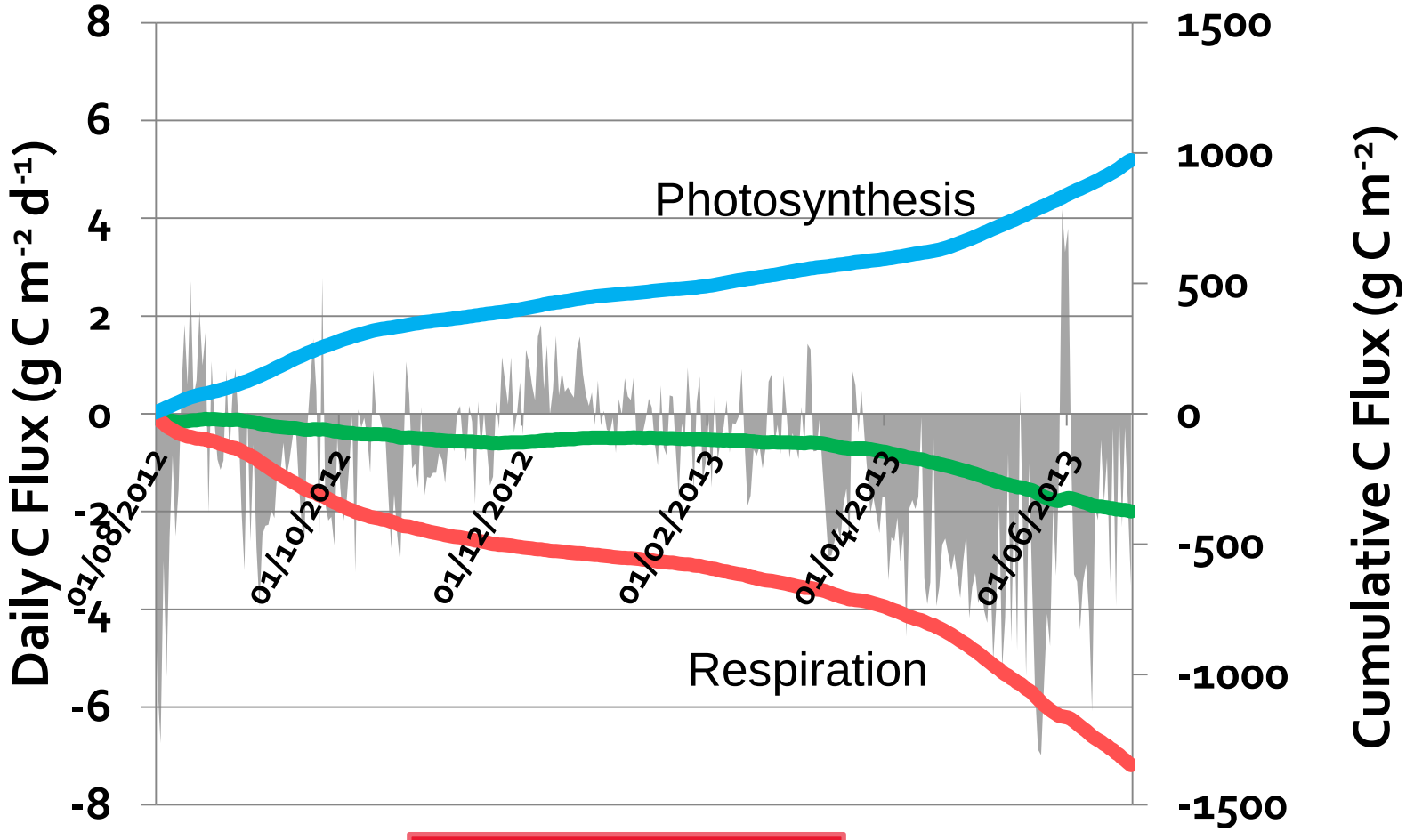
Net CO_2 exchange in agro-ecosystem



Lanigan et al. 2014

ΣNEE = -374 g C m^{-2}

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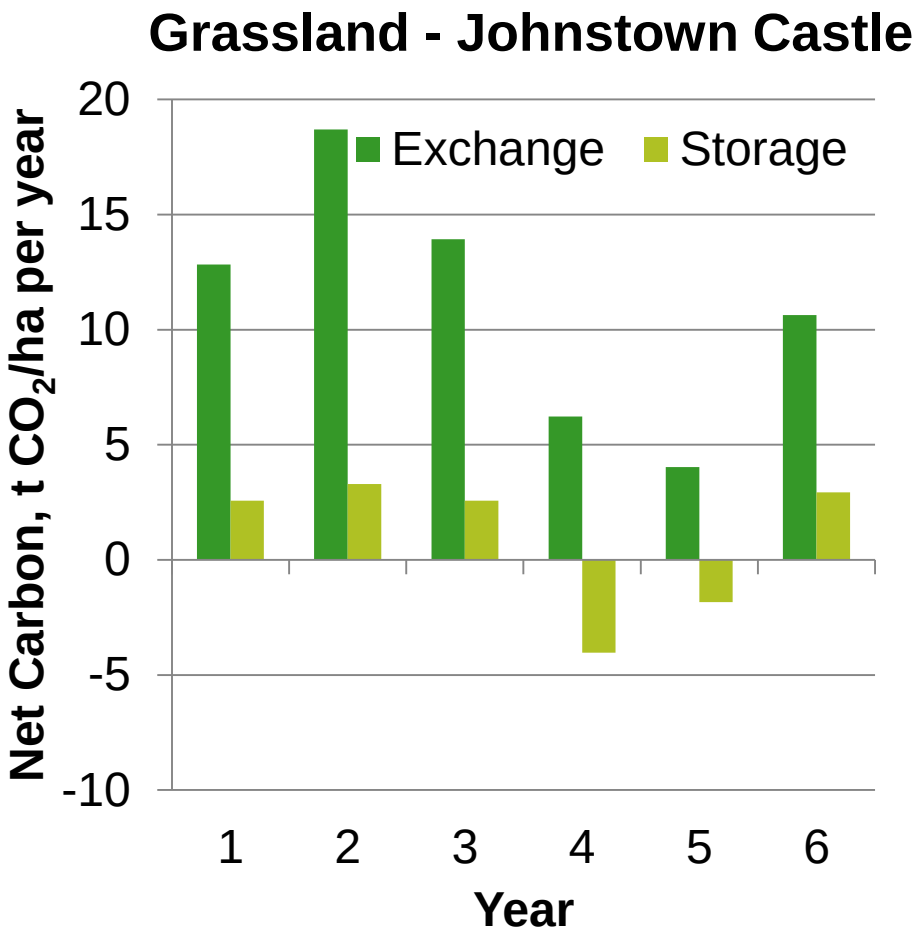
Net C Exchange & Net C Storage

- Positive net exchange = CO_2 uptake
- Net C storage includes:
  - C inputs
    - » Organic fertilizer
  - C removals
    - » Cutting and grazing
  - C losses
    - » Erosion, wildfire etc..



Lanigan et al. 2014

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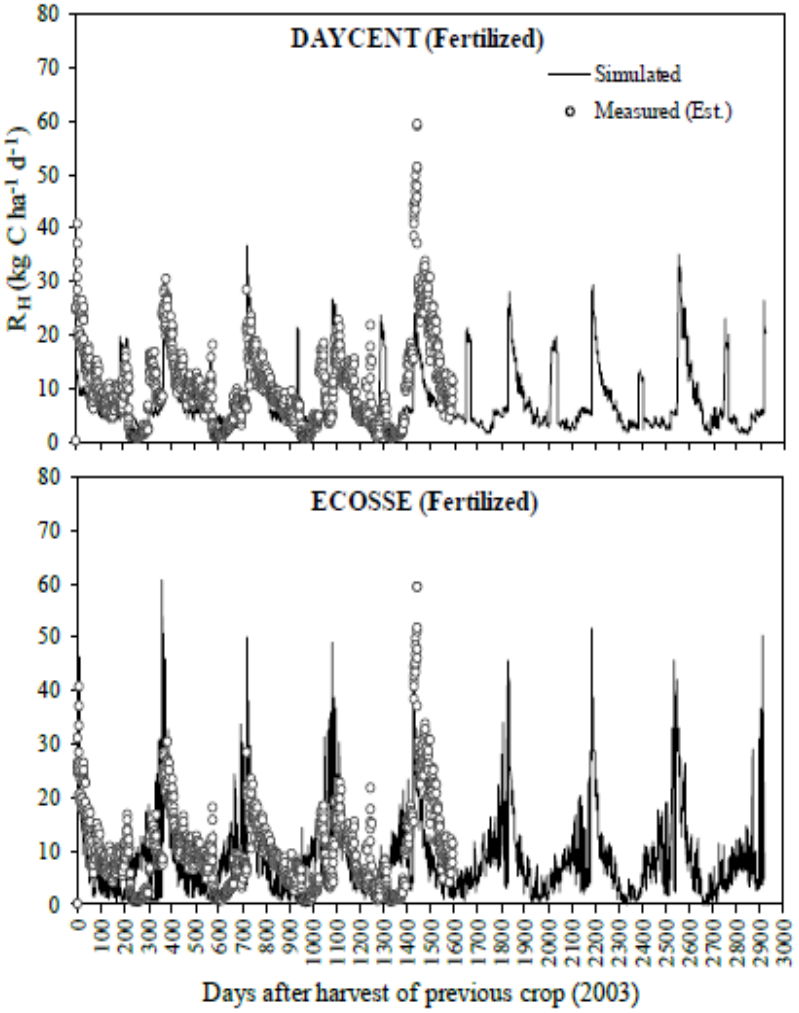
Modelling C Sequestration

- Soil C levels modelled for unmeasured sites
- Models developed from climate, soil C and flux records
- Ecosse, DayCent, PaSIM & RothC valid soil C models
  - Relatively accurate
  - Struggle to predict grass growth



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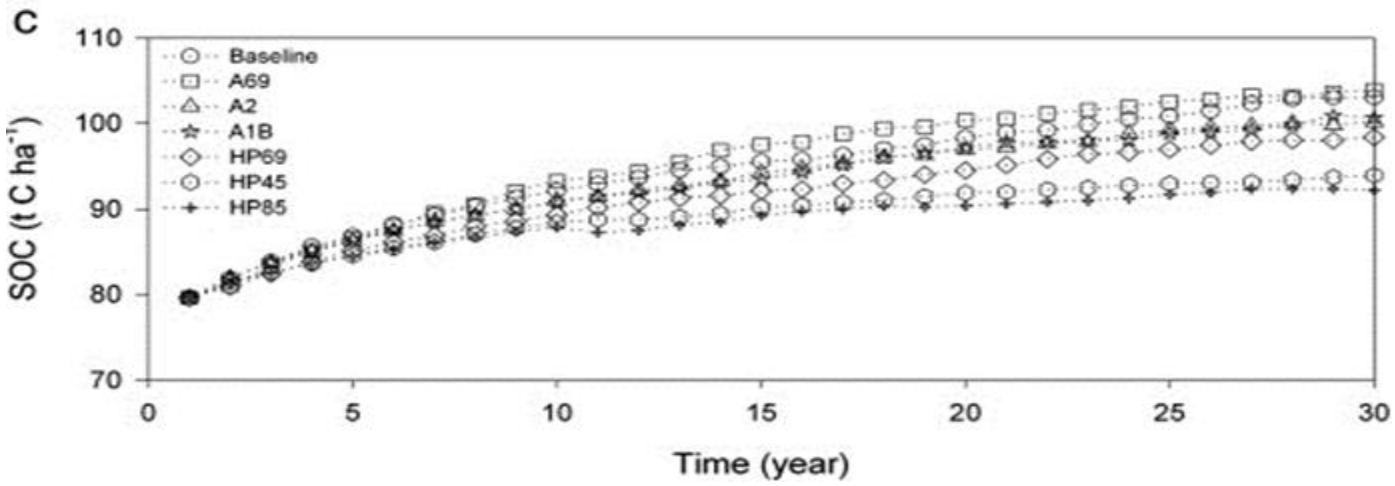
Model applications

- Monitor C storage at small & large scale
  - From sites to farms, regions, nation
- Simulate C sequestration by good farming practices
  - Correct soil pH, P and K (0.8 t CO_2/ha per year)
  - Spread slurry on tillage land (1.1 t CO_2/ha per year)
- Project impact of climate change on soil C

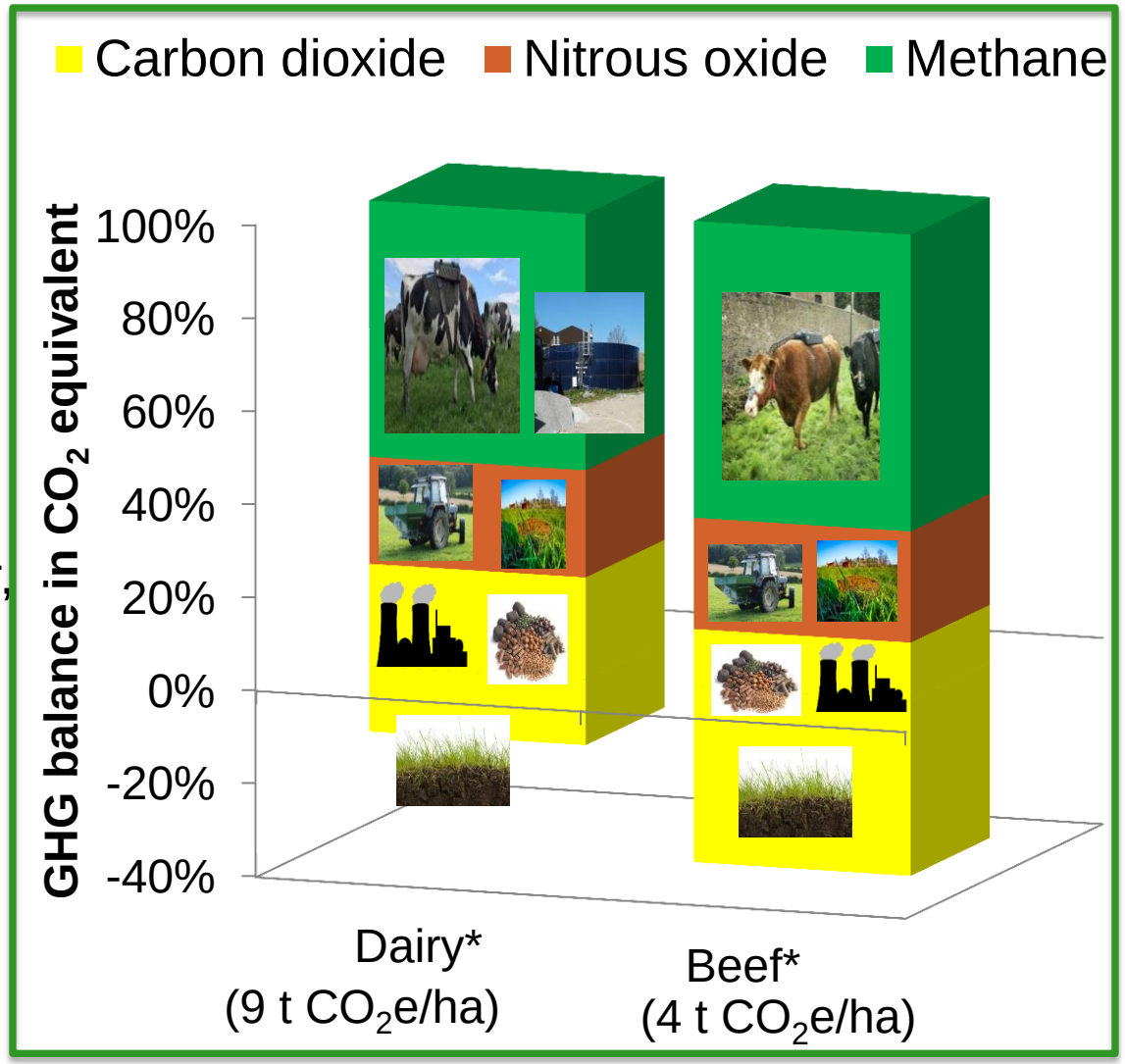


Balancing Irish agricultural GHG's

- Bovine herd - Principal driver of agricultural GHG emissions
- Irish cattle producers amongst the most GHG efficient in the world
  - EU Commission
- Further gains in efficiency challenging
  - Enhance C sequestration to balance GHG's
    - » Climate neutral

Balancing Irish agricultural GHG's

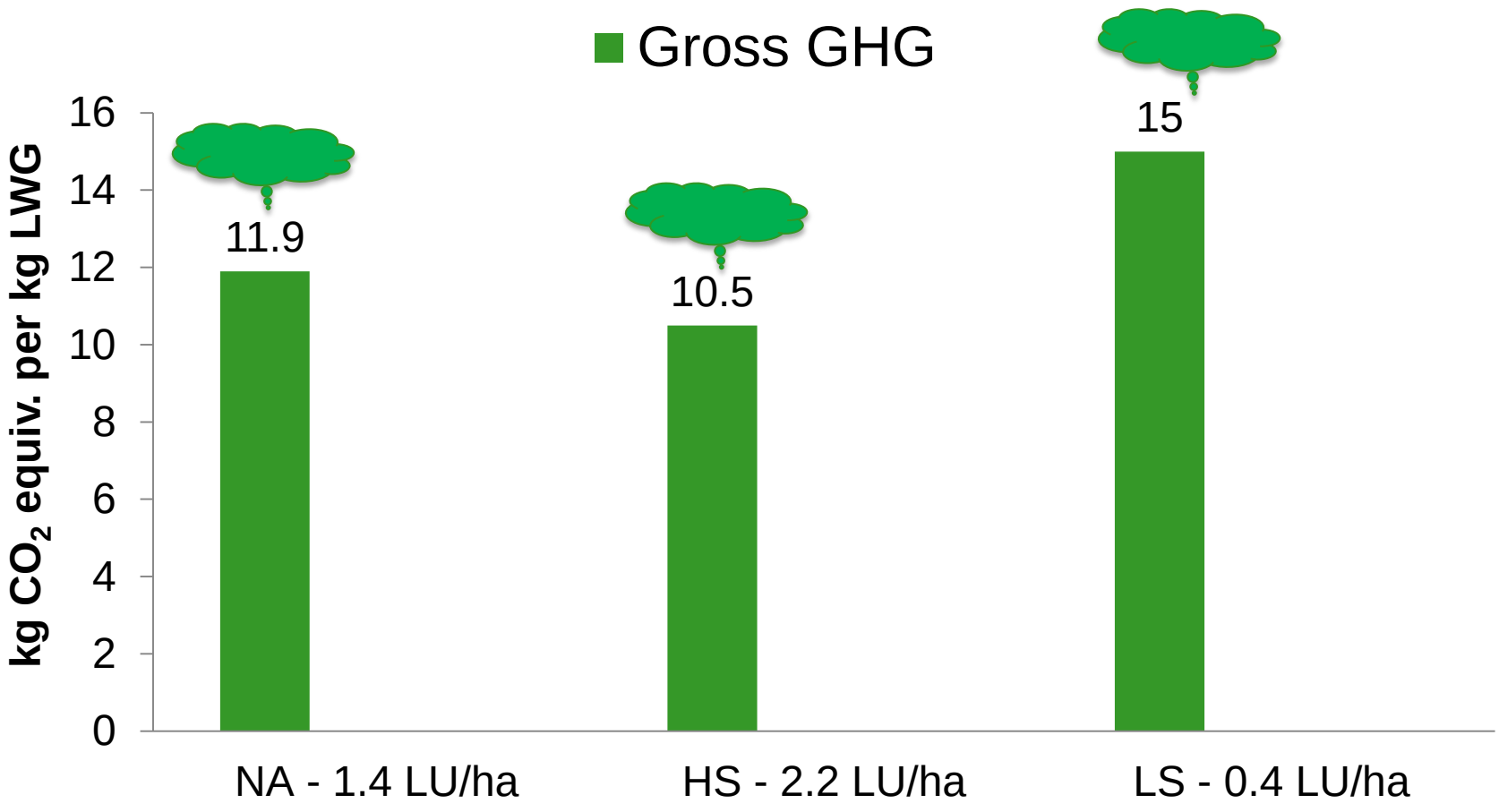
- Annual GHG's from cattle farms simulated with life cycle assessment
  - On-farm sources
    - » Cattle, manure, fertilizer, fuel, soils…
  - Off-farm sources
    - » Electricity, concentrate, fertilizer, fuel….



*Average producer in 2017

1 kg Methane = 25 kg CO_2; 1 kg Nitrous oxide = 298 kg CO_2

Suckler beef farms – GHG balance



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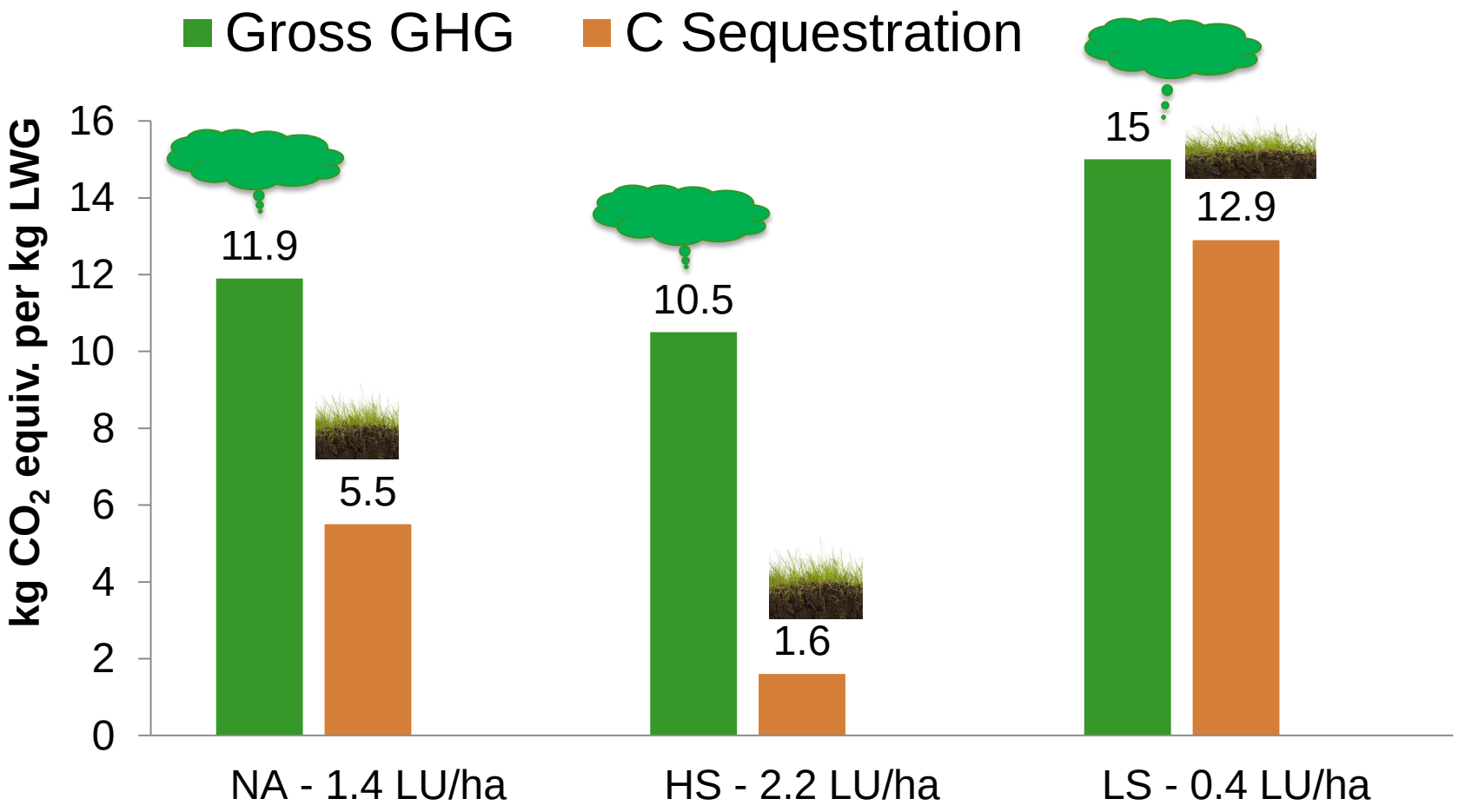

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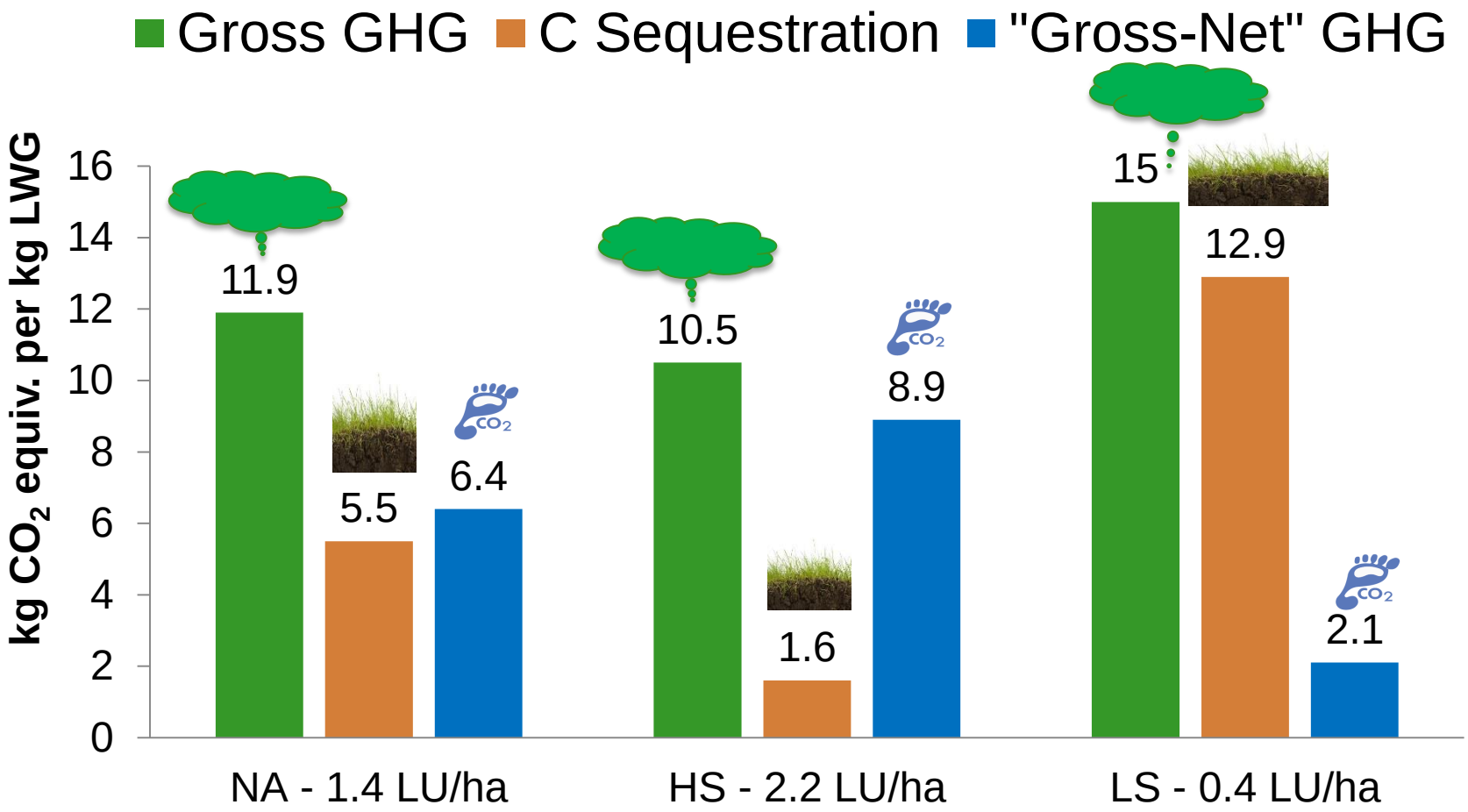

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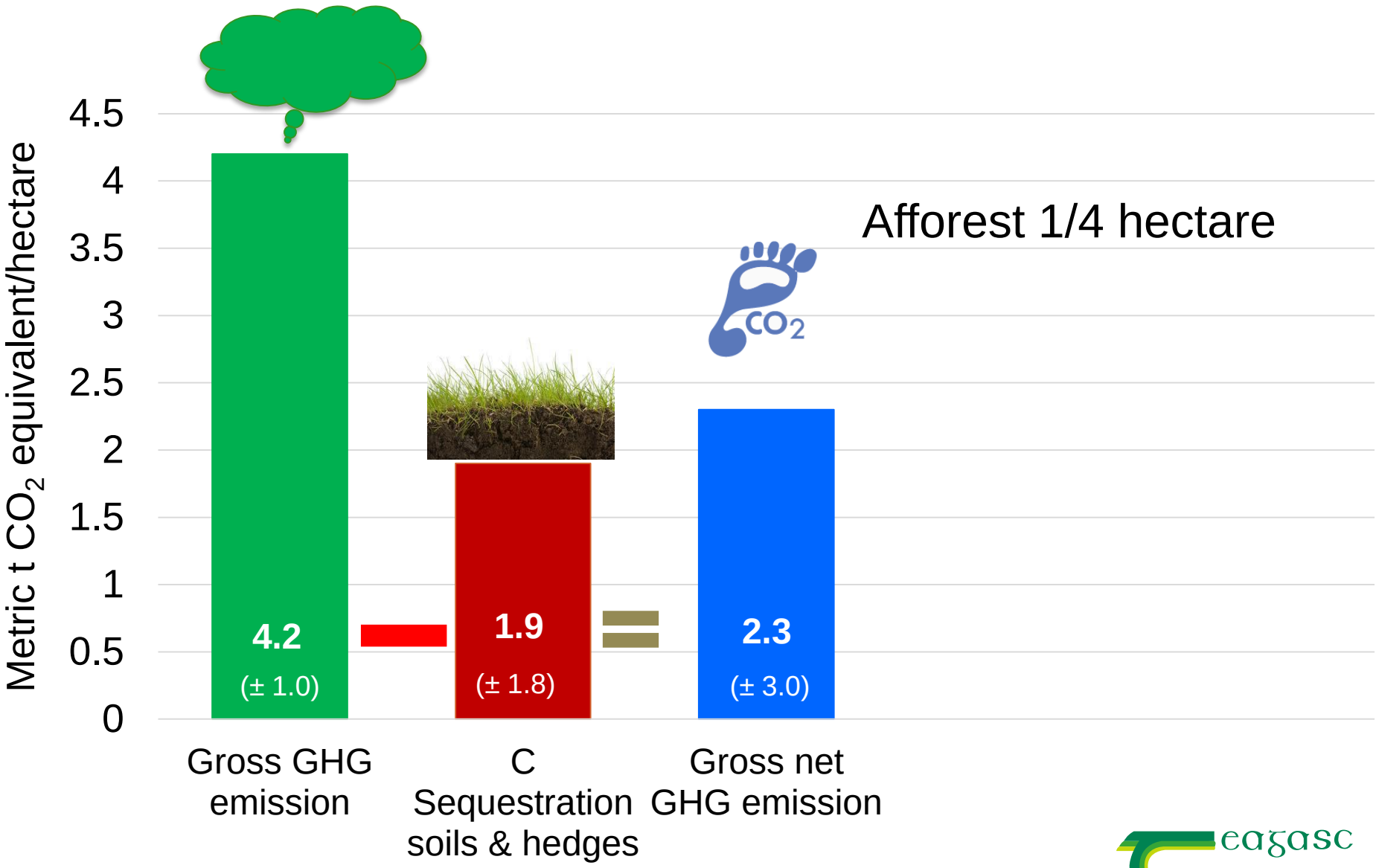
Low GHG Irish Beef Farm



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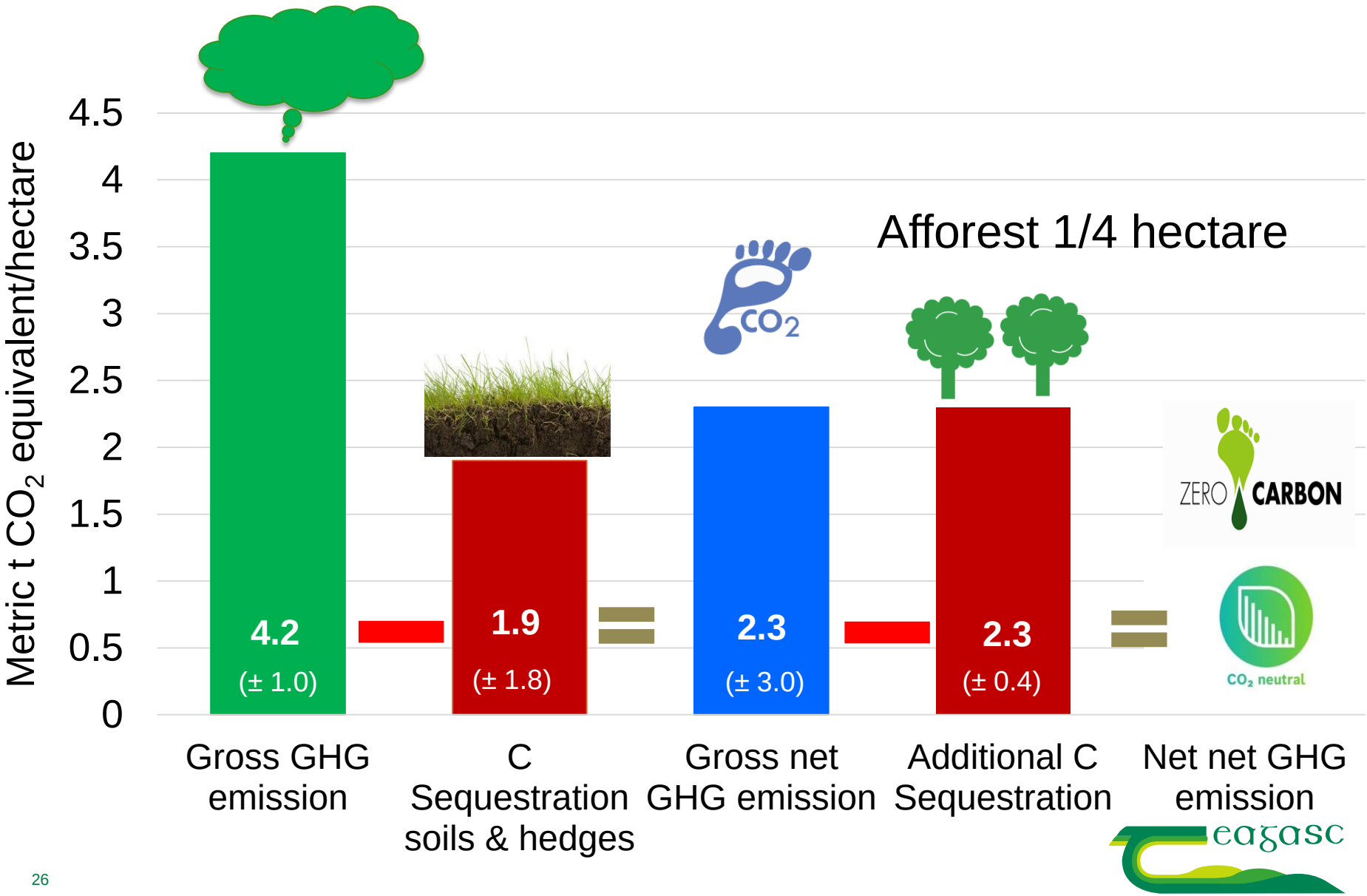
Climate Neutral Irish Beef Farm



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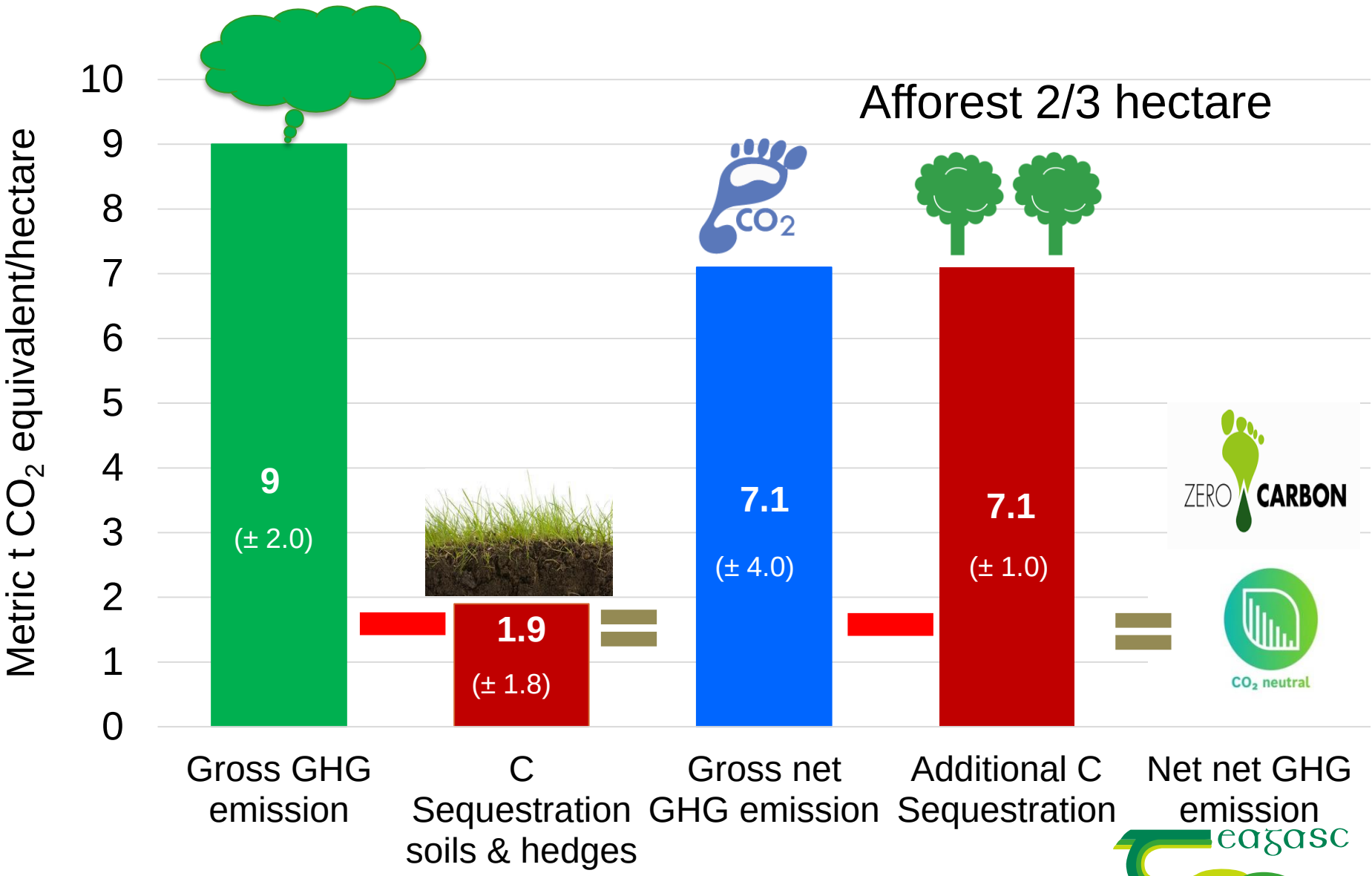
Climate Neutral Irish Dairy Farm



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Summary

- C sequestration supports the delivery of climate neutral livestock farming
  - Reduces GHG's in grass-based livestock farms

- Quantity of GHG's reduced by C sequestration in grassland variable & uncertain (-1.9 to 5.5 t CO_2/ha)
  - Aim to monitor larger number of grassland sites

- The distance to climate neutrality target is lower on extensive grass-based livestock farms

Summary

- Achieving climate neutrality is difficult on high output efficient grass-based livestock farm
- Demo events key to transferring C efficient farming practices
- Afforestation & low emission technologies likely to be needed to achieve long-term GHG targets

Helpful Links

- EU Farm to fork strategy: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal/actions-being-taken-eu/farm-fork_en
- Climate Action Plan 2019: https://www.dccae.gov.ie/en-ie/climate-action/publications/Pages/Climate-Action-Plan.aspx
- Teagasc Daily Online: https://www.teagasc.ie/publications/2020/enhancing-soil-carbon-sequestration-to-contribute-to-carbon-neutrality-on-irish-farms.php
- NEFERTITI: https://nefertiti-h2020.eu/
- CIRCASA: https://www.circasa-project.eu/
- Redmond, 2019. Grassland and carbon sequestration. Teagasc Moorepark 19' booklet: https://www.teagasc.ie/media/website/publications/2019/Grassland-and-carbon-sequestration.pdf

Thank you for listening

Questions?

Acknowledgements