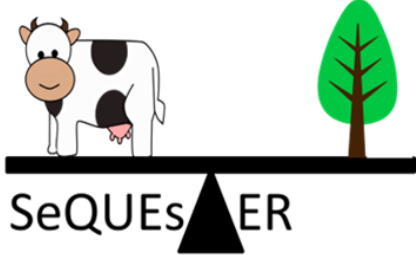


Implications of climate neutrality for Ireland's land sector

David Styles, Colm Duffy, Remi Prudhomme, Eilidh Forster, Mary Ryan, Cathal O'Donohue



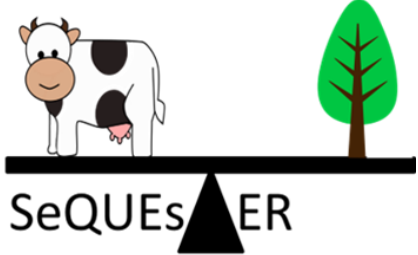


Presentation Outline



Objective: Deliver insight from recent research on land sector GHG mitigation & climate neutrality

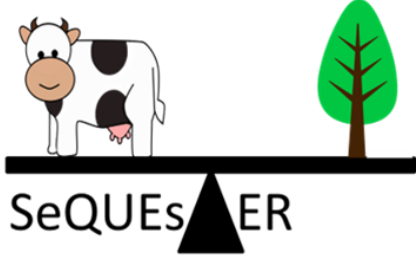
1. Conclusions
2. Context
3. Limitations of livestock abatement
4. Land use diversification
5. Discussion



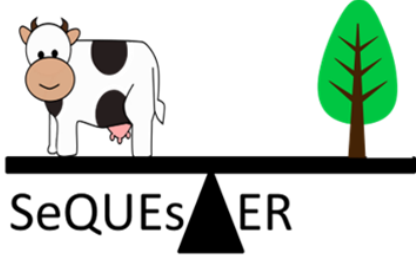
Conclusions



- The climate emergency will drive **transformative change** over next three decades
- **Climate neutrality** shifts focus from efficiency to **absolute national** targets
 - Zero sum game, requiring **all** CO₂ & N₂O emissions to be balanced by **removals (offsets)**
 - Estimated c.**1 Mha of diversification** required (minimum)
 - Scale of herd reduction also depends on efficiency of **future** abatement technologies
- Failure to plan beyond important medium-term targets risks **misallocation** of resources
 - **Disorderly contraction** of bovine production
 - **Stranded assets** (production infrastructure & abatement tech.)
 - Unpreparedness to exploit **emerging markets** (in carbon, bioproducts & bioenergy)
- Urgent need for (a) **future vision(s)** for the land use sector to maximise chances of a **just transition** for farmers

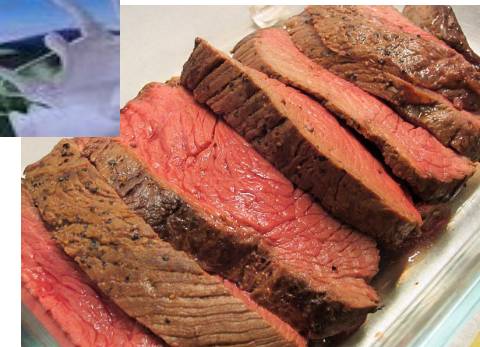


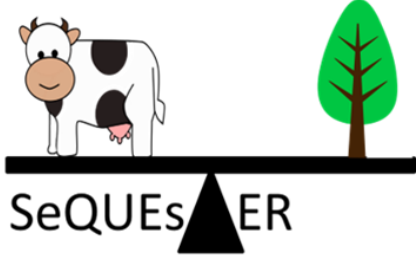
CONTEXT



Efficient bovine production

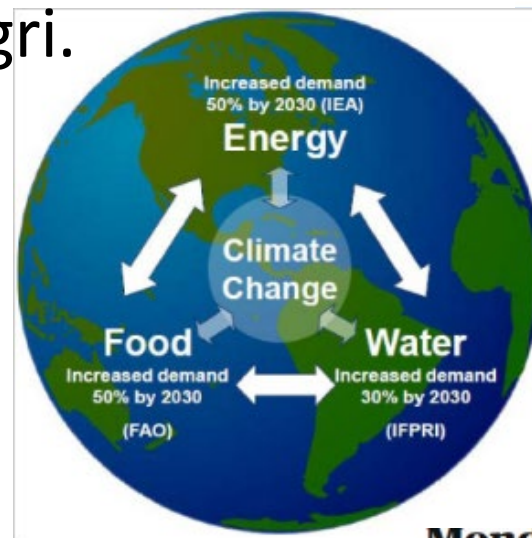
- ✓ Comparatively low carbon footprint milk & beef
- ✓ MACC has identified 10-15% further emission cuts
- ✓ Productive grass platform (large grassland C stores)
- ✓ Efficient value chain: spring calving to milk solids export
- ✓ Low-cost production of milk solids
- ✓ 7% IE GNI & employment, 10% exports
- ✓ Large multiplier effect, 1.8 - 2.5 x
- ✓ Excellent traceability



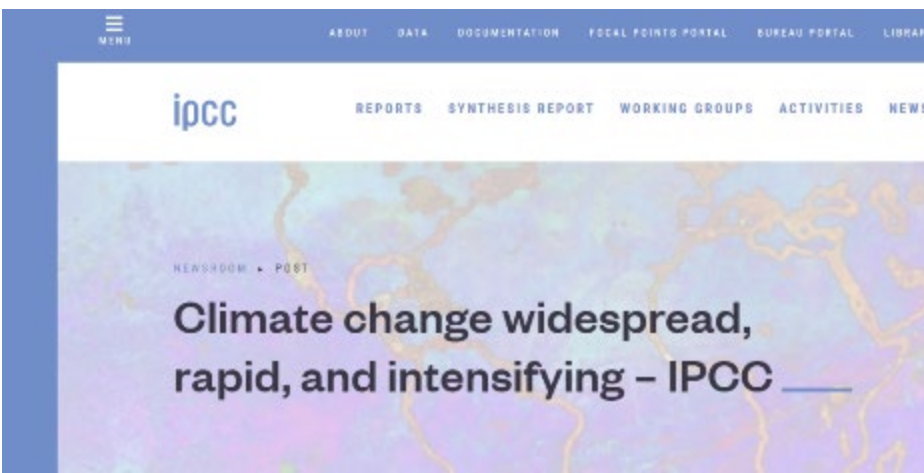


Climate & Biodiversity Emergencies

- IE >12 t CO₂e per capita, 35% from agri.
- Land use sector a net GHG emitter
- NH₃ and NO_x exceed EU 2016/2284
- Declining water quality
- Import €4.5 bn yr⁻¹ fossil energy



Monday 6 May 2019



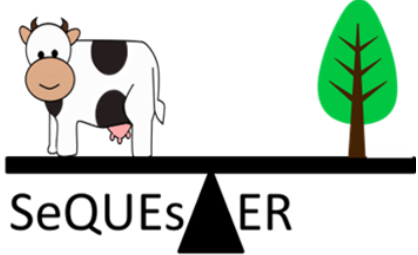
'We are in trouble' / Human society under urgent threat from loss of Earth's natural life

Biodiversity What the



Opinion Loss of

Na

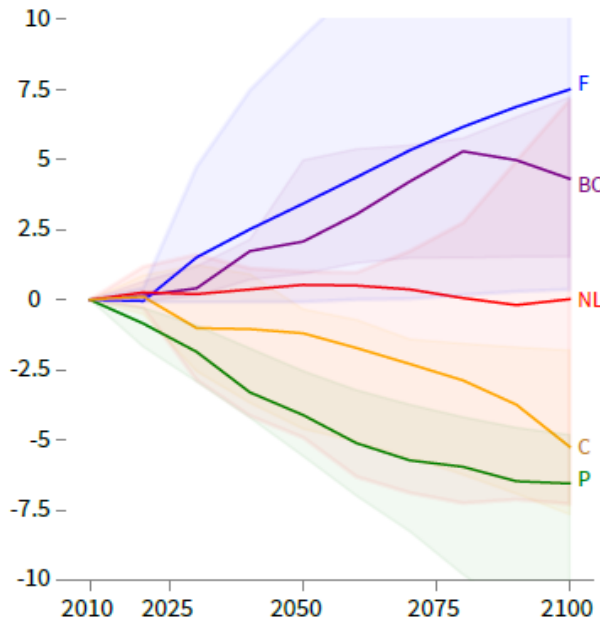


Global scenarios for climate stabilisation



■ CROPLAND
 ■ PASTURE
 ■ BIOENERGY CROPLAND
 ■ FOREST
 ■ NATURAL LAND

SSP1 Sustainability-focused
Change in Land from 2010 (Mkm²)



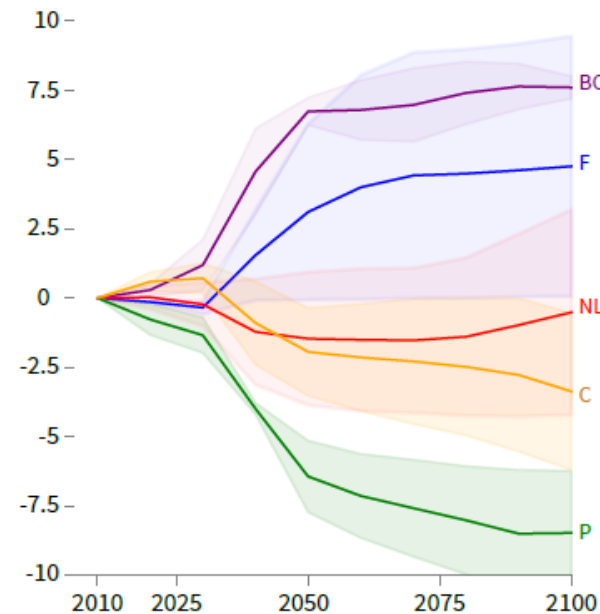
Progressive scenario
(rapid & steady
mitigation)



Sustainable
intensification

Energy & food demand
moderation

SSP5 Resource intensive
Change in Land from 2010 (Mkm²)



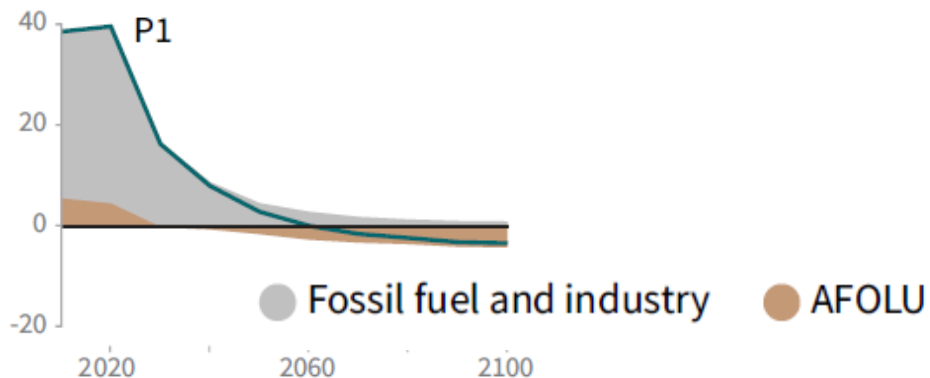
Laggard scenario
(delayed & disruptive
mitigation)



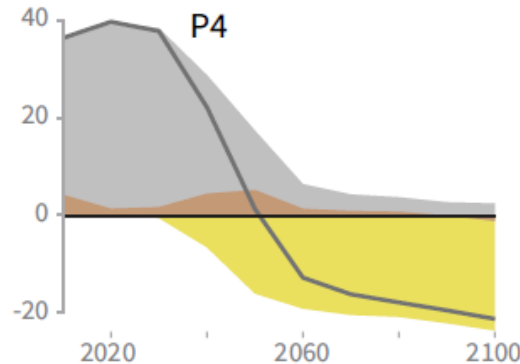
More rapid (late) change

Heavy reliance on
bioenergy & BECCS

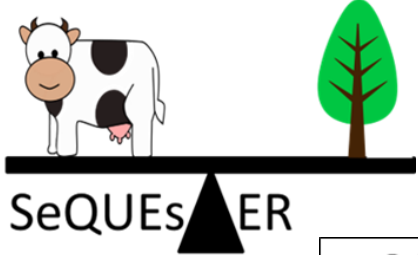
Billion tonnes CO₂ per year (GtCO₂/yr)



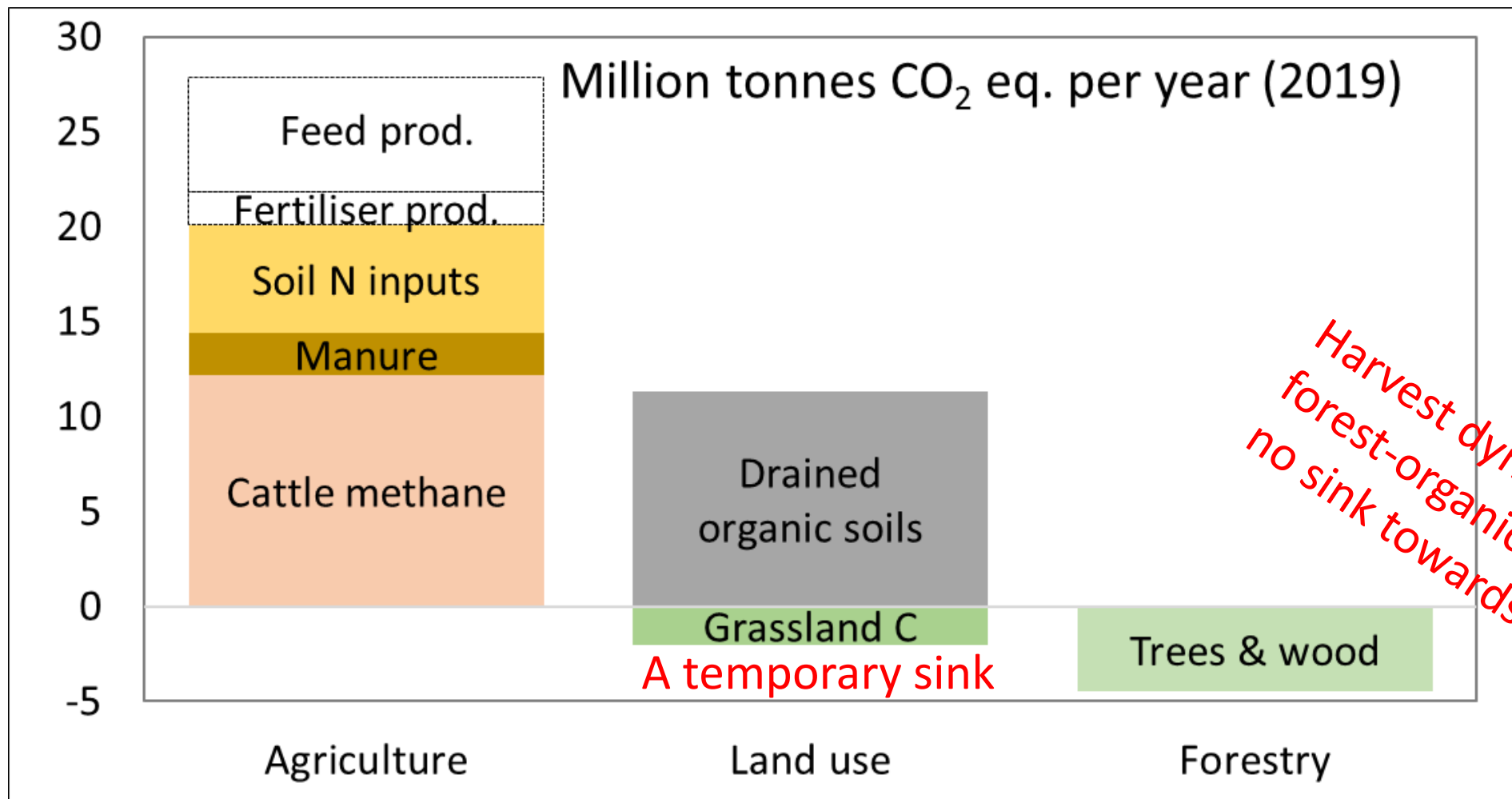
Billion tonnes CO₂ per year (GtCO₂/yr)



Sources: IPCC (2014) AR5; IPCC (2019):
Climate change & Land special report

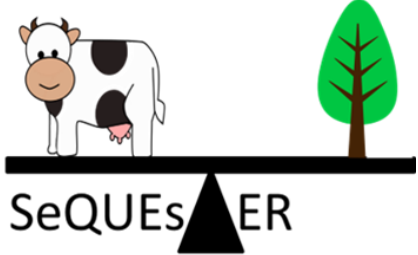


Ireland's land sector GHG balance

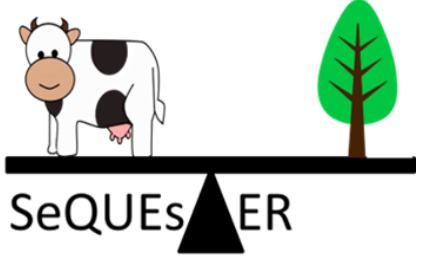


Harvest dynamics & new forest-organic soil EFs = no sink towards 2030!

- Net emission c.25-32 Mt CO₂e annually



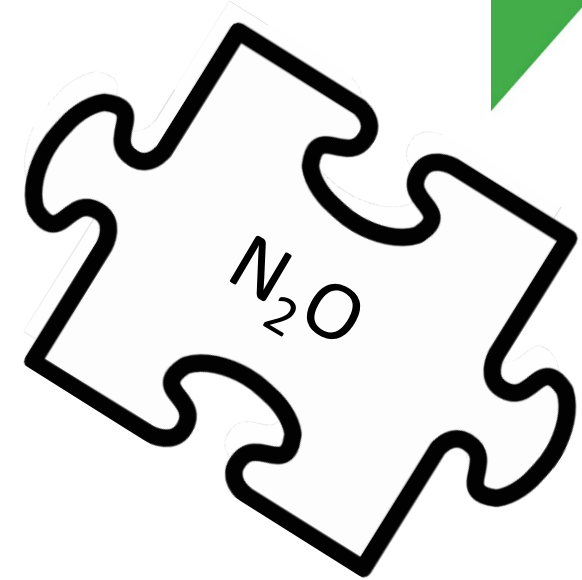
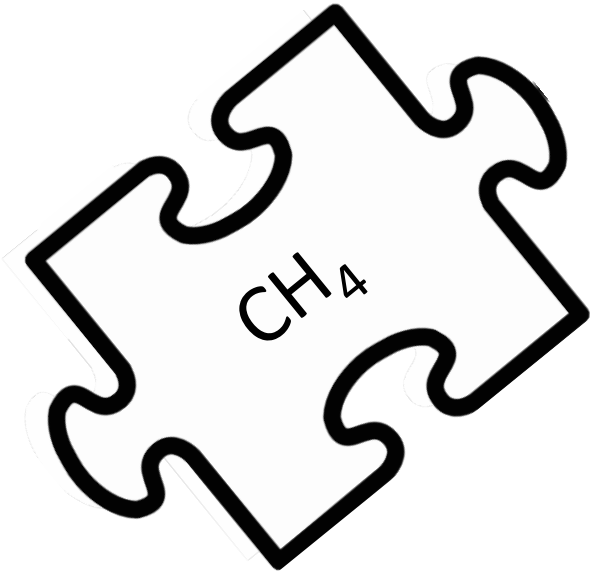
DEFINING CLIMATE NEUTRALITY



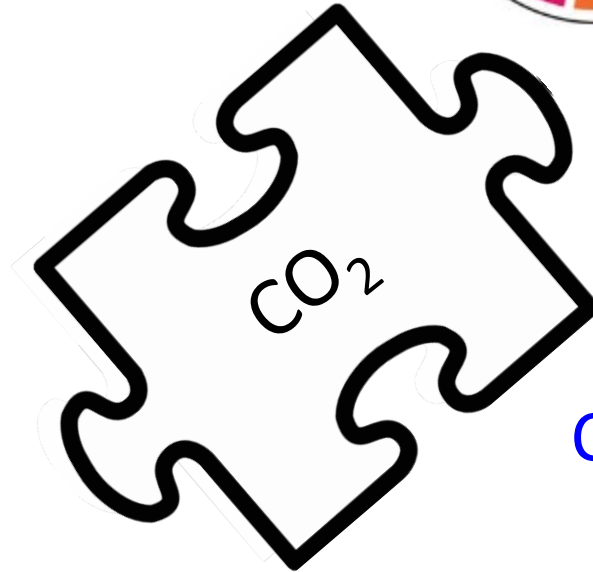
Defining climate neutrality



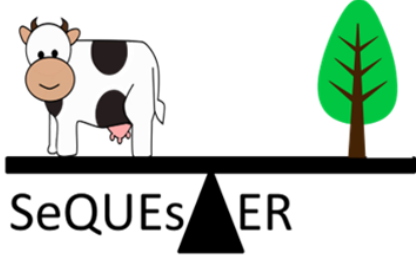
GHG aggregation metrics?



Time frame?



Cumulative budget vs target yr balance?



(non-zero) Methane targets

The problem with aggregation metrics...

GWP₁₀₀

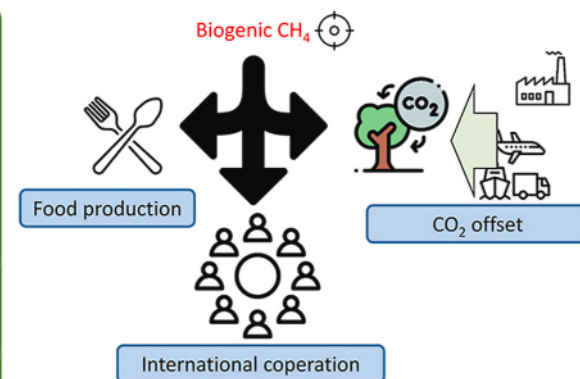
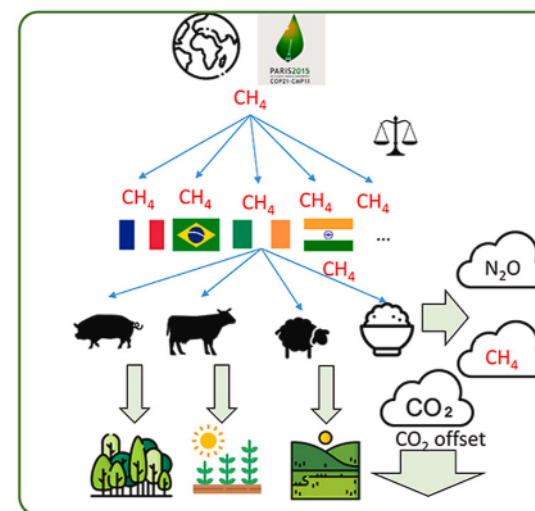
- Average warming of each kg of CH₄ emitted, over 100 yrs
- Useful for attribution (scalable: inventories & footprints);
- Poor representation of net CH₄ warming effect towards climate neutrality

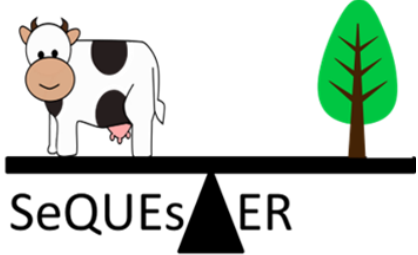
GWP*

- Marginal change in warming from emission trajectories vs a reference level
- Not useful for attribution (meaning when downscaled from global level?)
- Good representation of net CH₄ warming effect towards climate neutrality (forward looking);

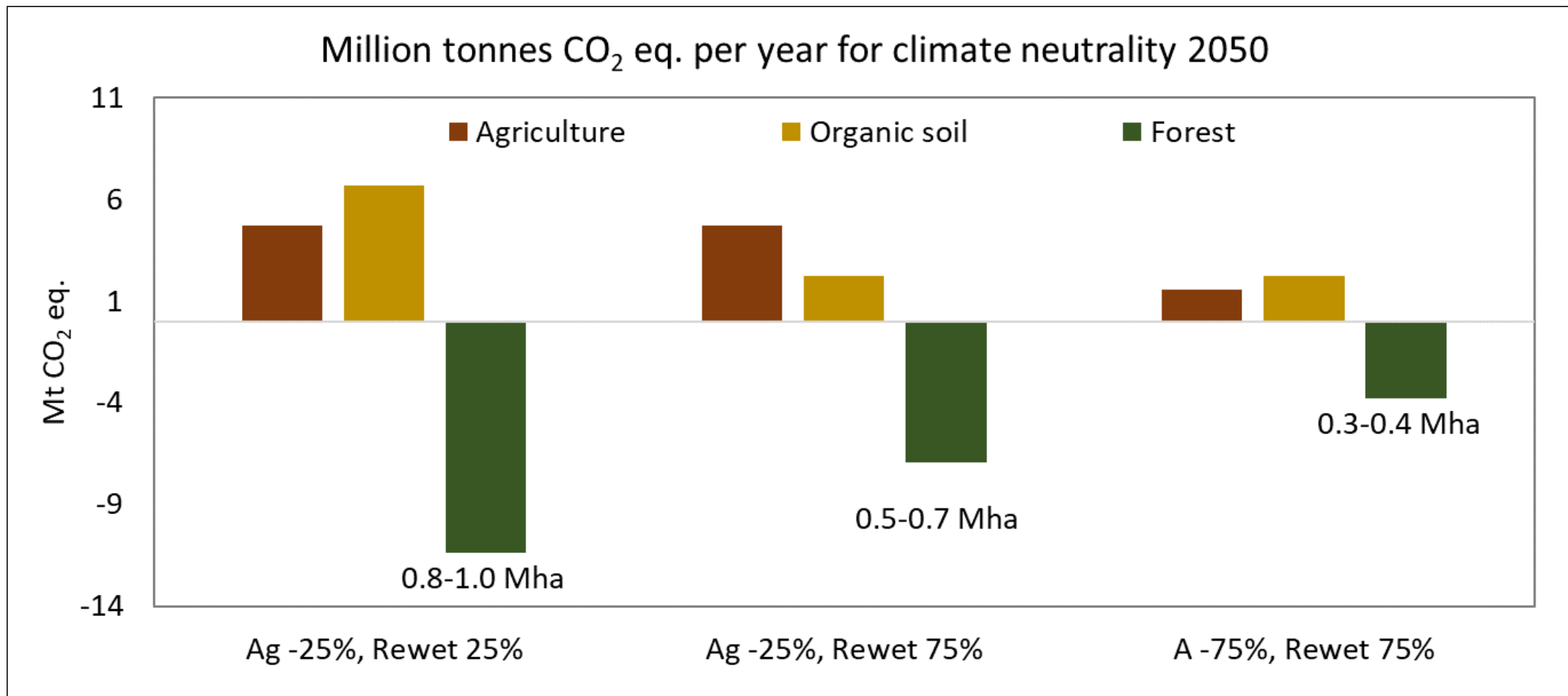
- Climate stabilisation: 24–47% reduction in global biogenic methane emissions by 2050
- Ireland's "fair share": 30-79% reduction vs 2010 emissions

How define a national biogenic methane target?

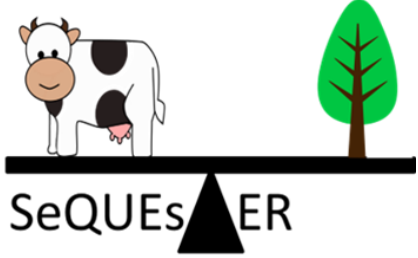




CO₂ & N₂O balance (2050)



- A simple but necessarily ambitious zero-sum game
- Less ambition for one pillar = more ambition elsewhere

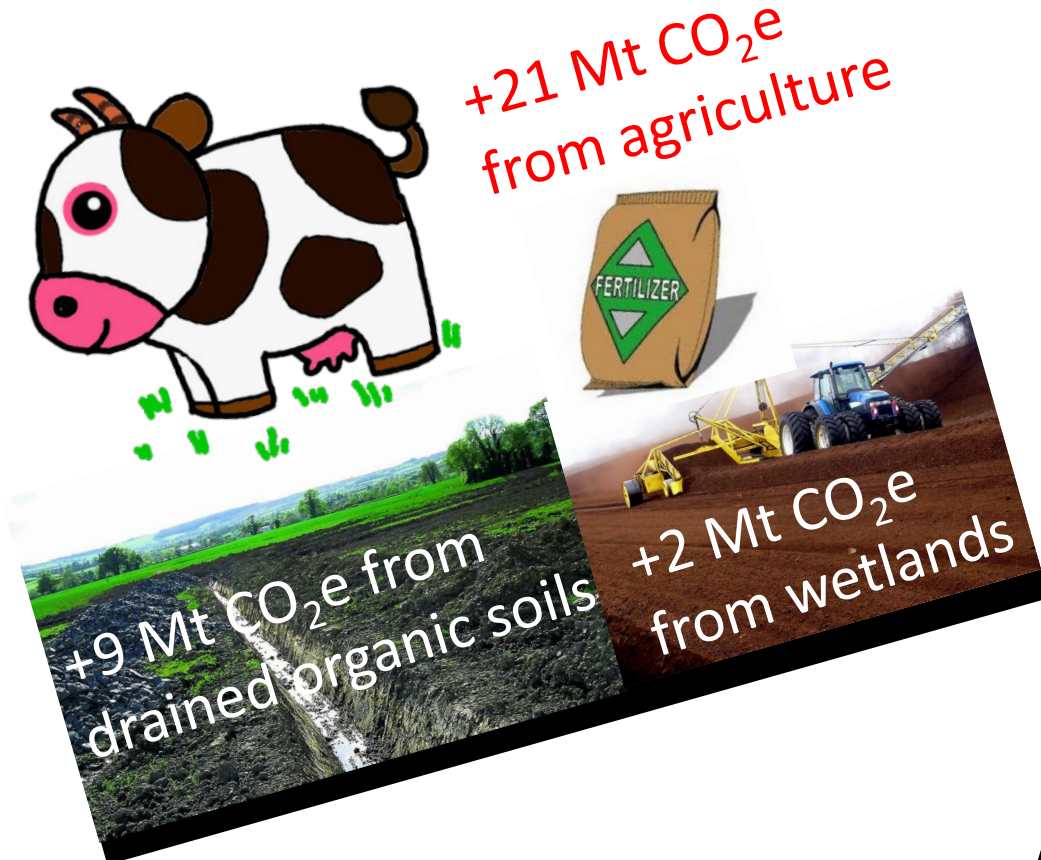


The need to dream...

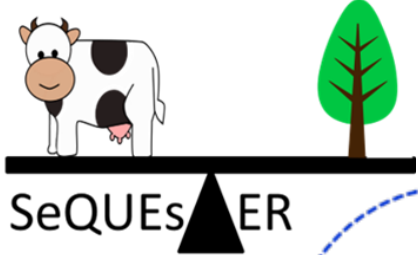


60% grassland

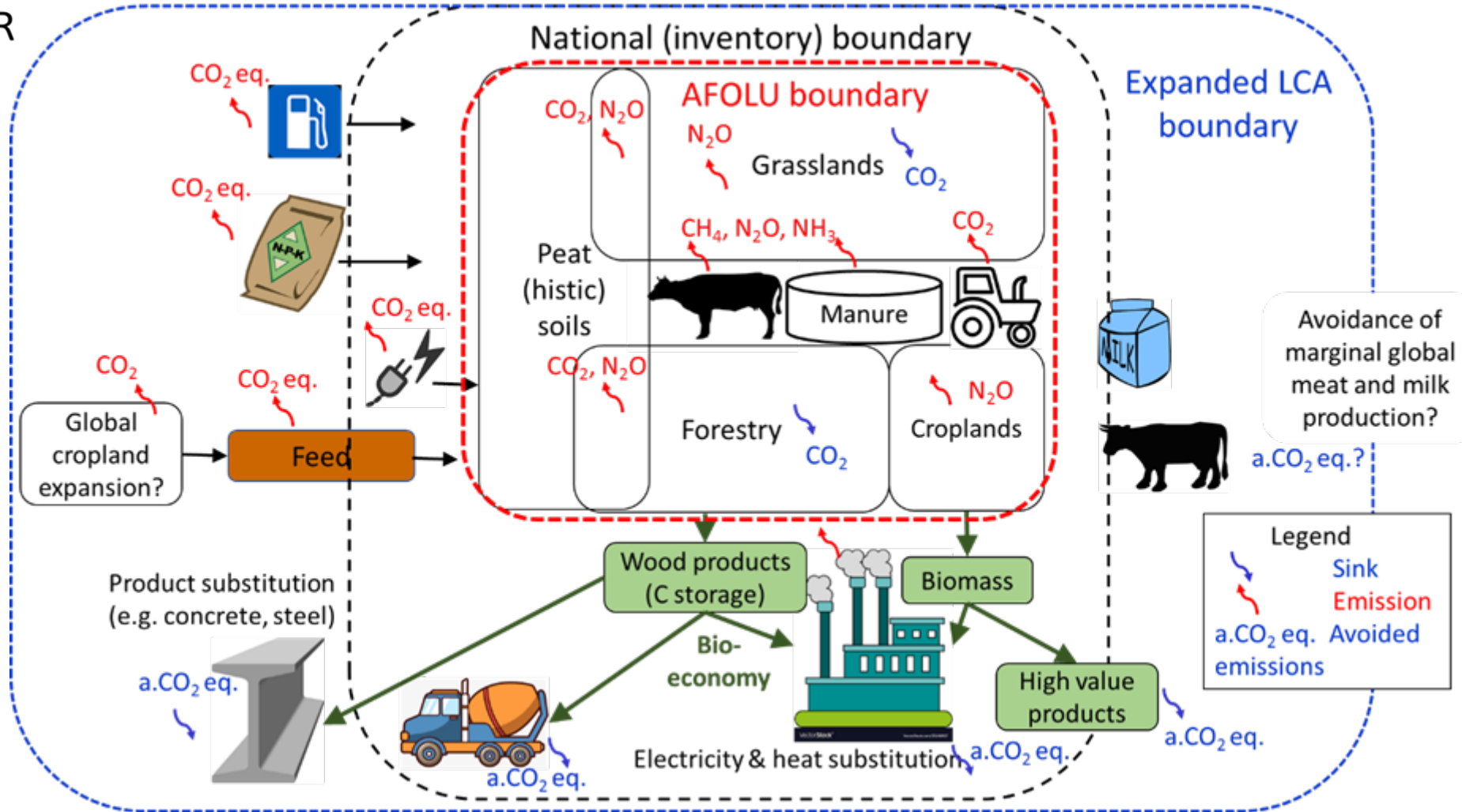
11% forest



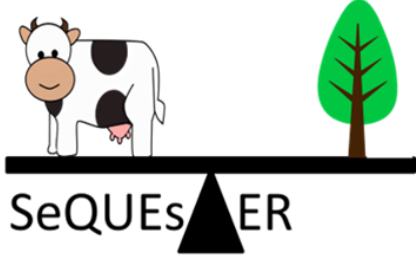
- "I wouldn't start from here!"
- We won't get there by extrapolation.
- Need to reimagine the future...



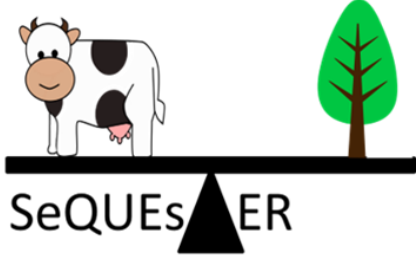
SeQUEsTER's GOBLIN



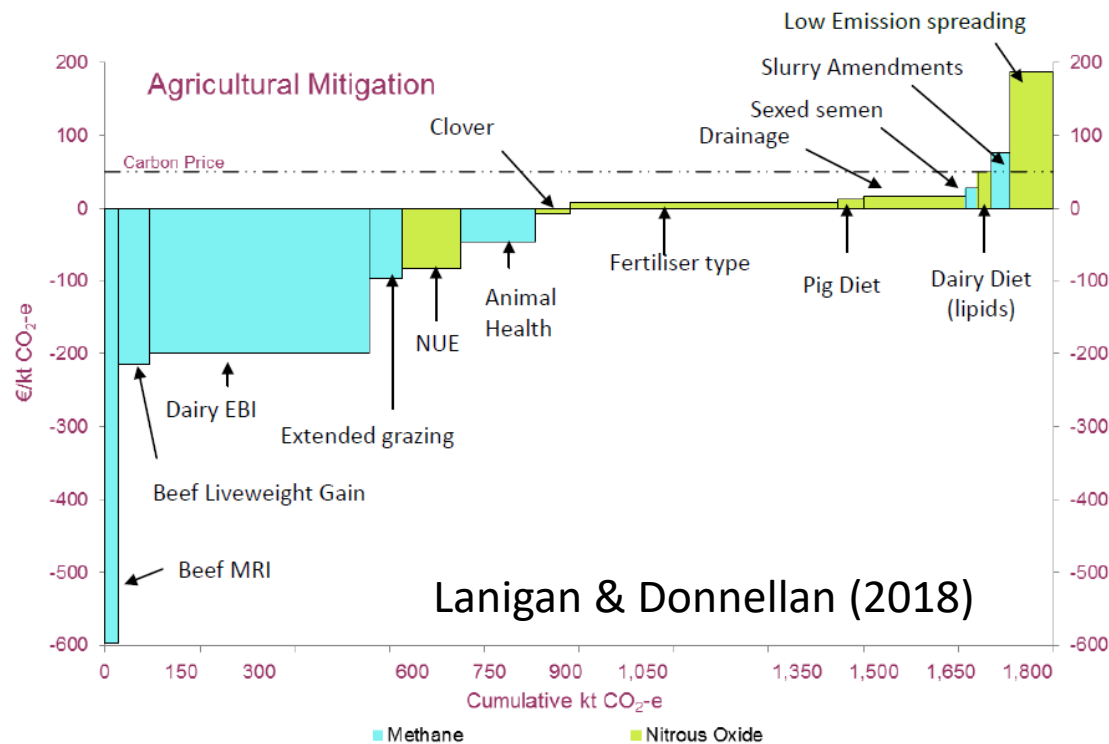
- Land sector area & emissions (Tier 2) balance (validated against NIR)
- *Randomised back-casting approach*
- Foundation for links to other sectors (bioeconomy LCA)



LIMITS OF LIVESTOCK ABATEMENT



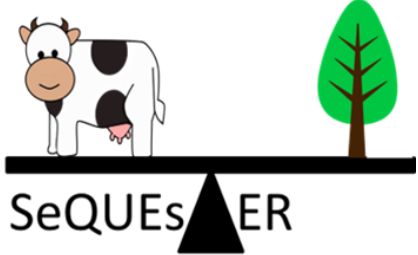
Abatement potential?



Solohead zero SNF blueprint

- MACC: 10-15% (3 Mt CO₂e) of decoupling by 2030
 - A long way from neutrality requirements
- Future: 3-nop (30% lower enteric CH₄?), zero SNF systems & inhibited urea (40% lower N₂O)?
 - Closer to neutrality requirements - feasible & affordable?

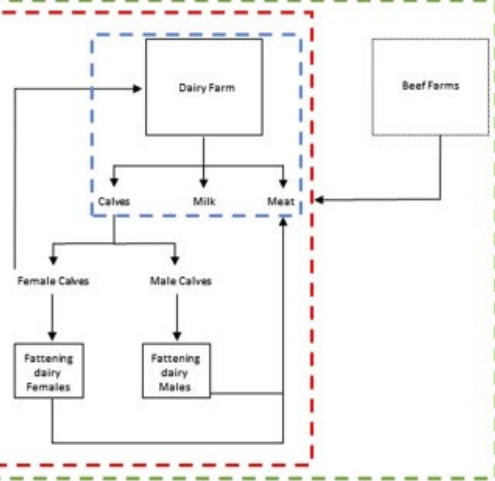




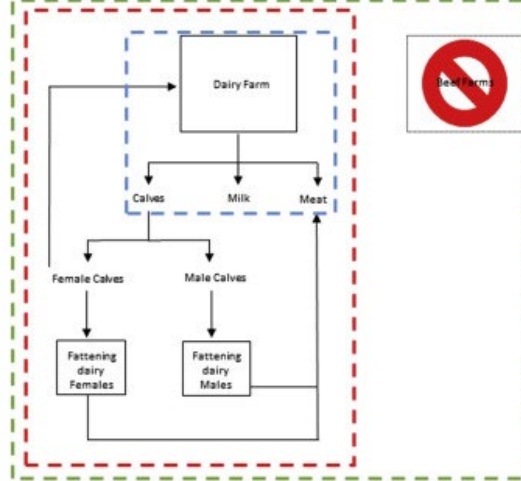
Dairy-suckler balance



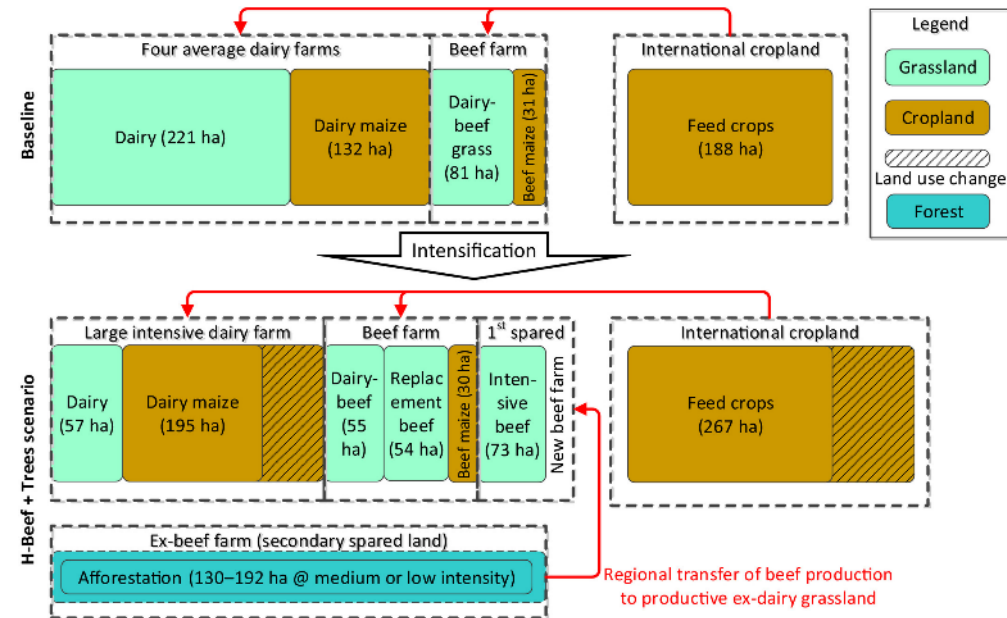
a) Beef:milk ratio < 0.10



b) Beef:milk ratio > 0.10



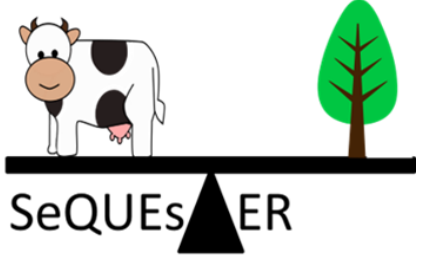
- - - Dairy System
 - - - Coupled Dairy-Fattening System
 - - - Cattle System



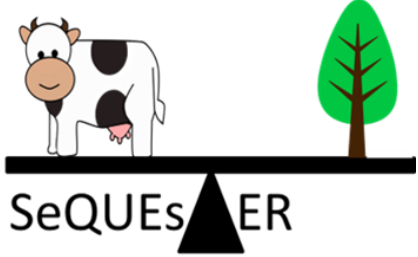
Styles et al. (2018). <https://doi.org/10.1111/gcb.13868>

Mazzetto et al. (2020). <https://doi.org/10.1016/j.jclepro.2020.124108>

- Most IE ag emissions from non-milking cows
- Specialise in profitable milk production?
- Important to maintain dairy-beef production (unless beef consumption massively reduced)
- Implications for land use patterns, biodiversity, water?



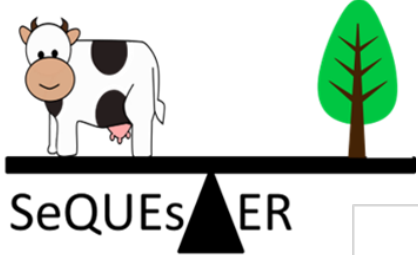
DIVERSIFICATION OF LAND USE



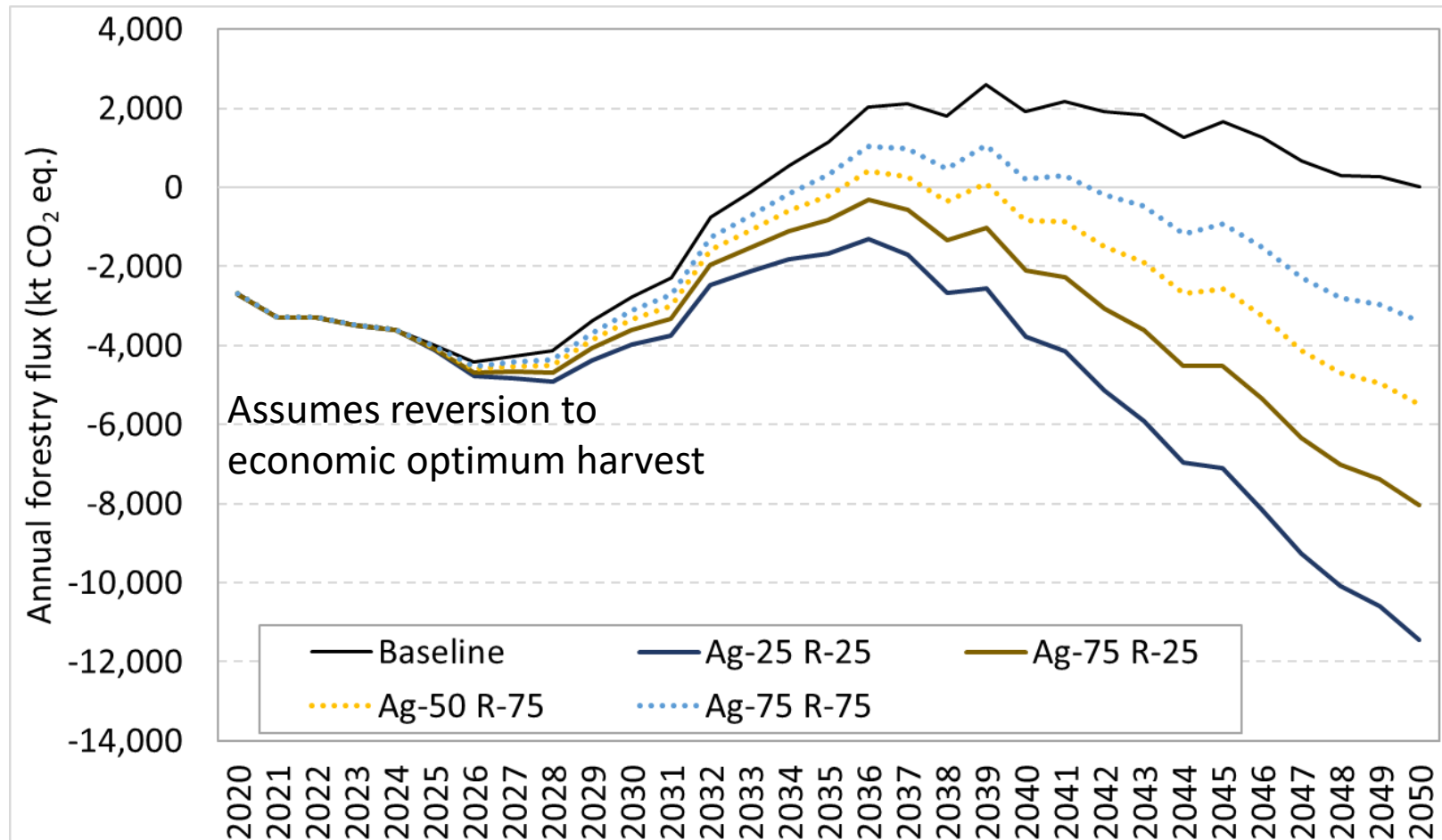
Land balance

Scenario	Organic soil rewetting			Commercial-mix afforestation				Conservation-mix afforestation			
	Annual (ha/yr)	Aggregate 2030 (ha)	Aggregate 2050 (ha)	Annual (ha/yr)	Aggregate 2030 (ha)	Aggregate 2050 (ha)	Forest cover 2050	Annual (ha/yr)	Aggregate 2030 (ha)	Aggregate 2050 (ha)	Forest cover 2050
Ag-25, R-25	2,888	23,103	83,750	32,000	160,000	800,000	22%	40,000	200,000	1,000,000	24%
Ag-75, R-25	2,888	23,103	83,750	24,000	120,000	600,000	19%	30,000	150,000	750,000	21%
Ag-25, R-50	5,776	46,207	167,500	27,000	135,000	675,000	20%	33,000	165,000	825,000	22%
Ag-75, R-50	5,776	46,207	167,500	19,000	95,000	475,000	17%	24,000	120,000	600,000	19%
Ag-25, R-75	8,664	69,310	251,250	21,000	105,000	525,000	18%	26,000	130,000	650,000	19%
Ag-50, R-75	8,664	69,310	251,250	18,000	90,000	450,000	17%	22,000	110,000	550,000	18%
Ag-75, R-75	8,664	69,310	251,250	13,000	65,000	325,000	15%	16,000	80,000	400,000	16%

- Min 0.7-0.8 Mha for rewetting & new forestry (planting rate 2-3 x AgClimatise)
- Additional offsets for wider economy...
- Additional 100s kha for biomaterials & bioenergy...
- Land a constraining factor!

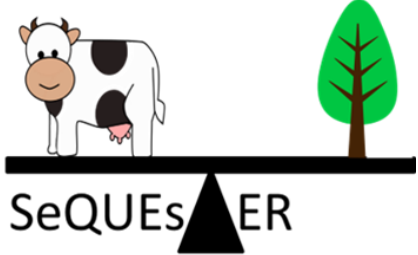


Forestry trajectories

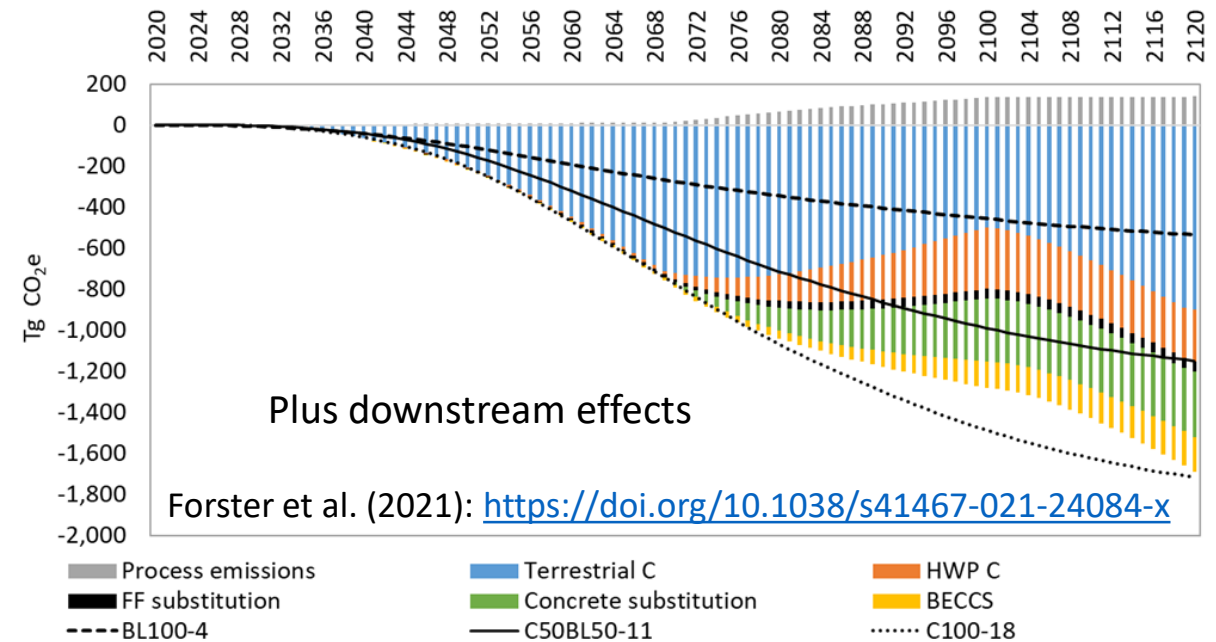
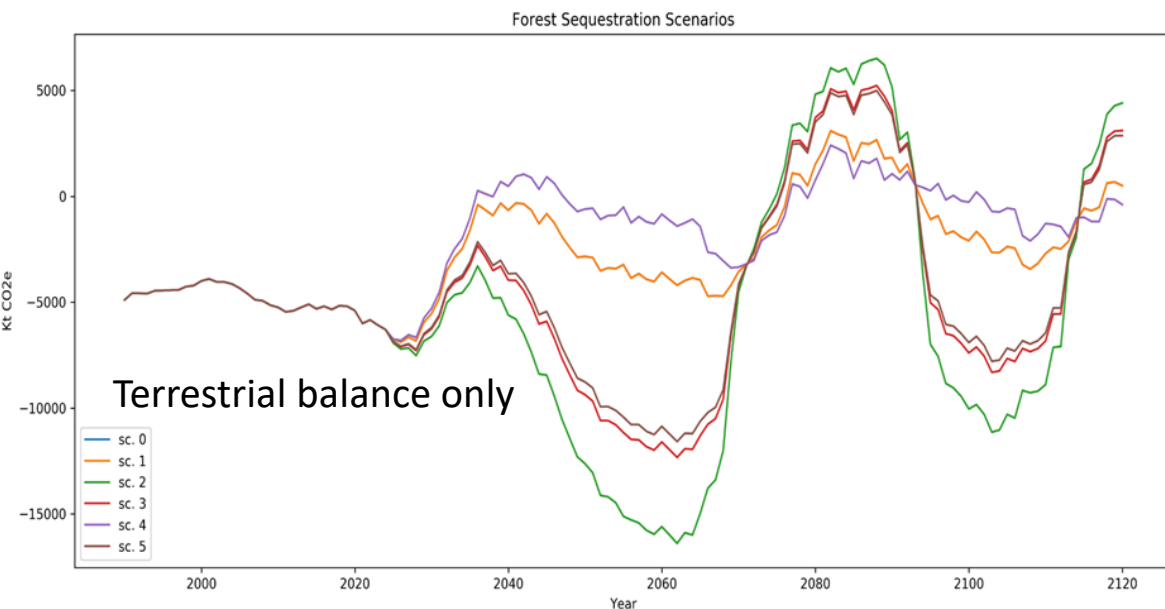
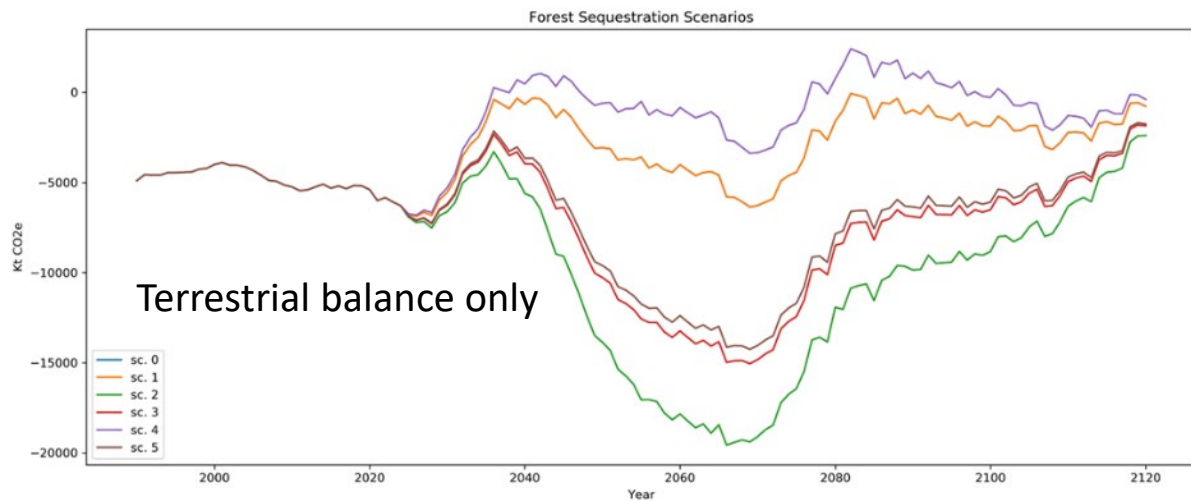


Conservative wrt WCC growth curves

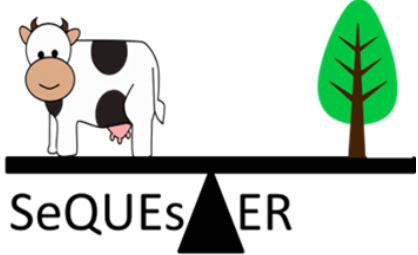
- Caveats re baseline & early accumulation
- Planting needs to start soon to deliver 2050 offsets!
- But won't deliver much for 2030 Carbon Budget (attribute future credits to early action?)



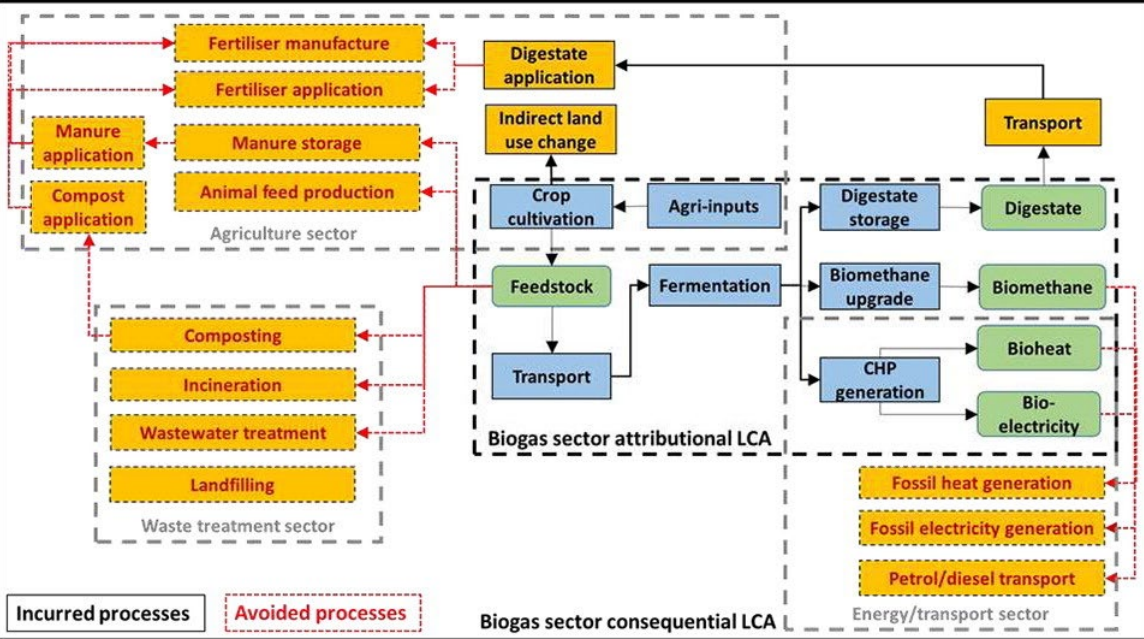
Post 2050 balance



- New commercial forest:
- Terrestrial C sequestration until 2060s-2090s
- Substitution 2060s-2090s (e.g. energy & cement sector decarbonisation)
- HWP C 2060s-2140s (e.g. 50 yr product life)
- 2nd (cascading) uses? 2110s-2140s+
- BECCS 2060s-2090s & 2110+++
- **Commercial forestry delivers long-term mitigation!**



Anaerobic digestion

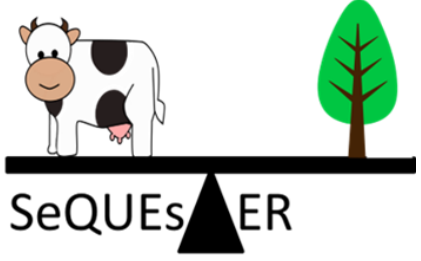


Renewable Energy Option	Primary energy replaced (MWh/ha/yr)	Net (life cycle) GHG mitigation (t CO ₂ e /ha/yr)	
		No ILUC	ILUC
Maize biogas CHP elec. only (13.5 t DM/ha/yr)	32	-1.3	11.4
Maize biogas elec. & heat use (13.5 t DM/ha/yr)	50	-6.2	6.5
Oil seed rape biodiesel (3.3 t seed/ha/yr)	8.3	-0.5	6.3
Miscanthus heating (12.6 t DM/ha/yr)	72	-21.5	-9
Wind (per net ha used)	3000	-396	-383
Solar PV (Wales)	1063	-141	-128

- ✓ Slurry
- ✓ Food waste
- ✓ Residues

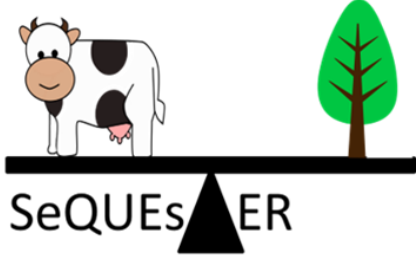
- ❖ Edible by-products
- ❖ Grass & maize

Limited grass biogas could leverage slurry-biogas & facilitate a bio-based transition

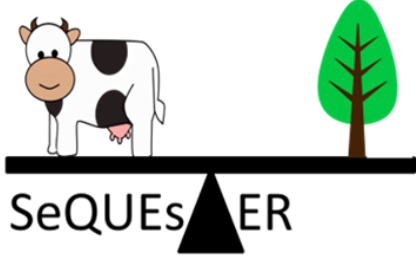


Disruptive technologies?

- Plant proteins
- Grass protein extraction
- Bioplastics, cellulose composites
- Controlled Environment Agriculture...



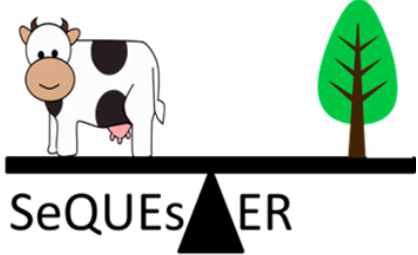
DISCUSSION



Challenges



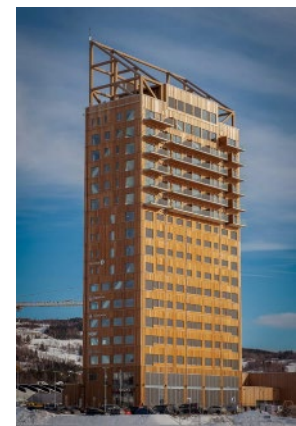
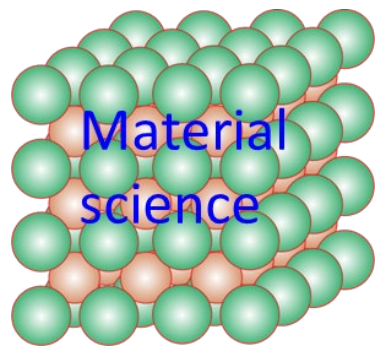
- Dairy farmers riding a market wave
- Beef farmers just getting by, but negative experiences with diversification
- Develop framework to support supply & demand (bio-industrial policy)
- Bureaucracy of forestry
- Monitoring, Reporting & Verification of C credits (including NIR refinements)
- Ownership of C credits?
- Can policy support bridge the temporal disconnect between costs & benefits?
- Control points & scale for achieving balance?

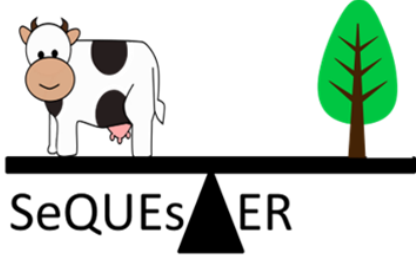


Need for a vision



- Change is happening
- Reactive approach carries many risks (€, reputational, quality of life)
- Pro-active approach can consolidate & develop IE advantages
- Integrated vision for the land sector
 - Efficiency, abatement, diversification, adaptation (resilience)
- Farmers are the agents of change, but need support & guidance
- Opportunity to re-evaluate what they do and how they are rewarded





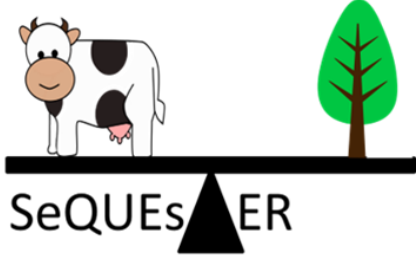
Key ingredients of neutrality

- + Ambitious livestock abatement
- + Significant herd reduction
- + 100s kha organic soil rewetting
- + Wetland regeneration
- + Many 100s kha afforestation (mix commercial & conservation)
- + Diversification of bioeconomy

Stakeholders need to determine the exact recipe...

(GOBLIN has just produced 850 randomised scenarios to help)





Thanks for your attention

David.Styles@ul.ie



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