

The Journey to “Beyond” Net Zero

A Practitioner’s Perspective



Prof. John Gilliland OBE

Professor of Practice, Queens University Belfast; Chair, ARC Zero
Special Advisor, AHDB; Owner, Brook Hall Estate.

6th December 2023

Essential - Deliver Multiple Public Goods, Not Single Agendas



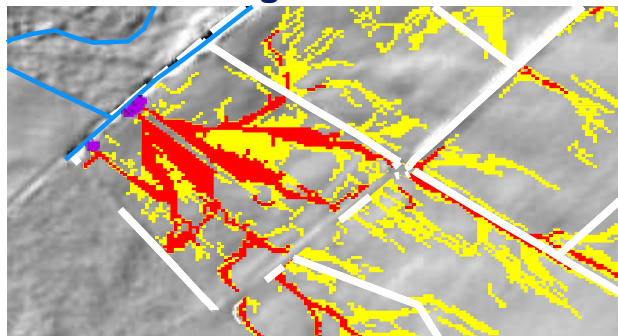
Producing Nutritious Food & Tackling Malnutrition



Delivering Soil Improvement Both Fertility & Health



Accelerating Carbon Sequestration, Both Above & Below Ground



Improving Water Quality by Reducing Over Land Flow



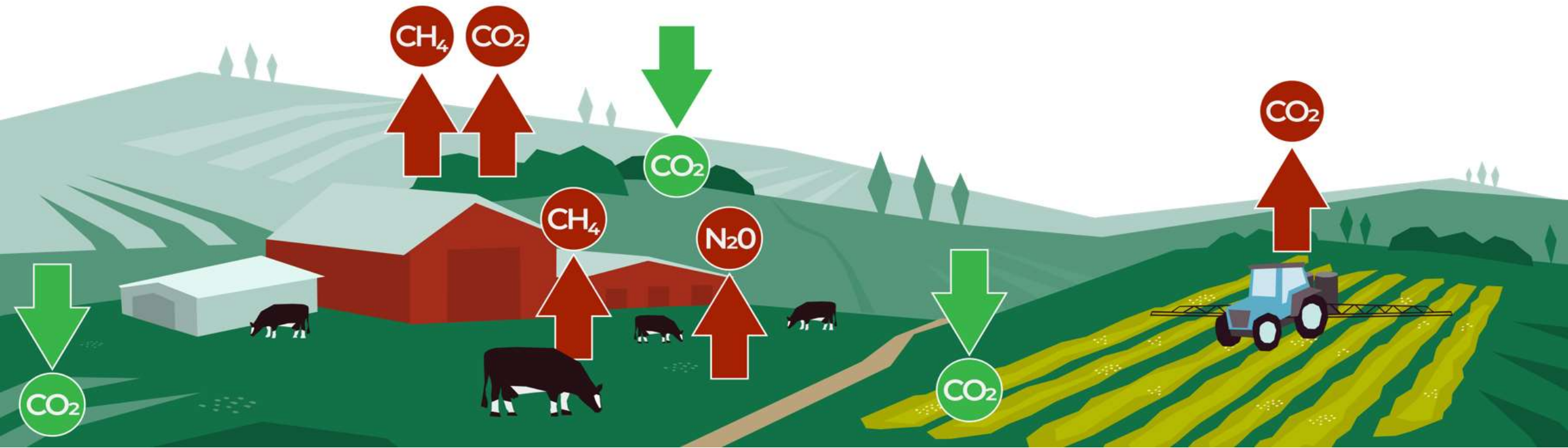
Optimising Biodiversity, Especially Below Ground



Generating Profits

Net Zero Definition: Sum of Emissions equals Sum of Sequestration

Adjusted for any fossil fuel CO₂ emissions displaced by Renewables
& for any methane emissions reduced by waste management



It is not about Zero Emissions.....

So how do Farms move towards Net Zero?

- Measure & Manage..... & use of Life Cycle Assessment Calculators (LCA)

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- LCA “Factors,” Emissions now to TIER 2 (A National Average)
Sequestration only at TIER 1 (An International Average)
- Ideally, we need both to be at TIER 3 (Actual on farm data)

But.....

So how do Farms move towards Net Zero?

- Measure & Manage..... Using Life Cycle Assessment Calculators (LCA)
- LCA “Factors,” Emissions now to TIER 2 (A National Average)
Sequestration only at TIER 1 (An International Average)
- Ideally, we need both to be at TIER 3 (Actual on farm data)

But..... The challenge of selecting an appropriate soil organic carbon simulation model: A comprehensive global review and validation assessment

Agata Garsia | Antoine Moinet | Carmen Vazquez  | Rachel E. Creamer |
Gabriel Y. K. Moinet 

WUR, June 2023



An EIP Operational Group - Accelerating Seven N. Irish Farms towards Net Zero



Roger & Hilary Bell *Sheep*

Simon Best *Arable & Beef*

Patrick Casement *Sheep & Sucklers*

John Egerton *Suckler Beef*

John Gilliland *Willow & Dry Stock*

Hugh Harbison *Dairy*

Ian McClelland *Dairy*



Piloting the Journey at the Farm Level





Where did we start..... We Learnt our Numbers.....

Baselined & Benchmarked.....



Where did we start..... We Learnt our Numbers.....

Baselined & Benchmarked.....

- GHG Emissions
- Carbon Sequestration
- Carbon Stocks in Soil
- Carbon Stocks in Trees
- Net Carbon Position
- Behavioural Change
- **Delivering other Public Goods Simultaneously.....**



Gross Emissions for the seven ARC Zero farms

Using  TIER 2 Emissions Module

<i>2021 Agrecalc Analysis</i>	Enterprises	Gross Emissions t CO ₂ -e/yr
Ian McClelland	Dairy	1,101
Hugh Harbinson	Dairy	2,009
John Egerton	Beef & Sheep	1,475
Roger & Hilary Bell	Sheep with Beef	754
Simon Best	Arable with Beef	1,799
Patrick Casement & Trevor Butler	Beef & Sheep	492
John Gilliland	Willows with Dry Cows	151



Gross Sequestration for the seven ARC Zero farms

Using  TIER 1 Sequestration Module

<i>2021 Agrecalc Analysis</i>	Enterprises	Gross Sequestration t CO ₂ -e/yr
Ian McClelland	Dairy	309
Hugh Harbinson	Dairy	549
John Egerton	Beef & Sheep	444
Roger & Hilary Bell	Sheep with Beef	456
Simon Best	Arable with Beef	738
Patrick Casement & Trevor Butler	Beef & Sheep	548
John Gilliland	Willows with Dry Cows	156



Net Carbon as a Percentage of Gross Emissions Using TIER 1 Sequestration Module

<i>2021 Agrecalc Analysis</i>	Enterprises	Gross Emissions t CO2-e/yr	Gross Sequestration t CO2-e/yr	Net Emissions t CO2-e/yr	% Reduction
Ian McClelland	Dairy	1,101	309	792	28%
Hugh Harbinson	Dairy	2,009	549	1,459	27%
John Egerton	Beef & Sheep	1,475	444	1,031	30%
Roger & Hilary Bell	Sheep with Beef	754	456	298	60%
Simon Best	Arable with Beef	1,799	738	1,061	41%
Patrick Casement & Trevor Butler	Beef & Sheep	492	548	-56	111%
John Gilliland	Willows with Dry Cows	151	156	-4	103%

No two farms are the same.....

Some farms will find the journey easier than others.....



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Some farms will find the journey easier than others.....

Some farms are beyond Net Zero already.....



Accuracy of Carbon Sequestration – New Measuring Technologies When repeated every 5 yrs. measures actual change, essential for TIER 3



Aerial LiDAR Survey
at 40 scans per metre

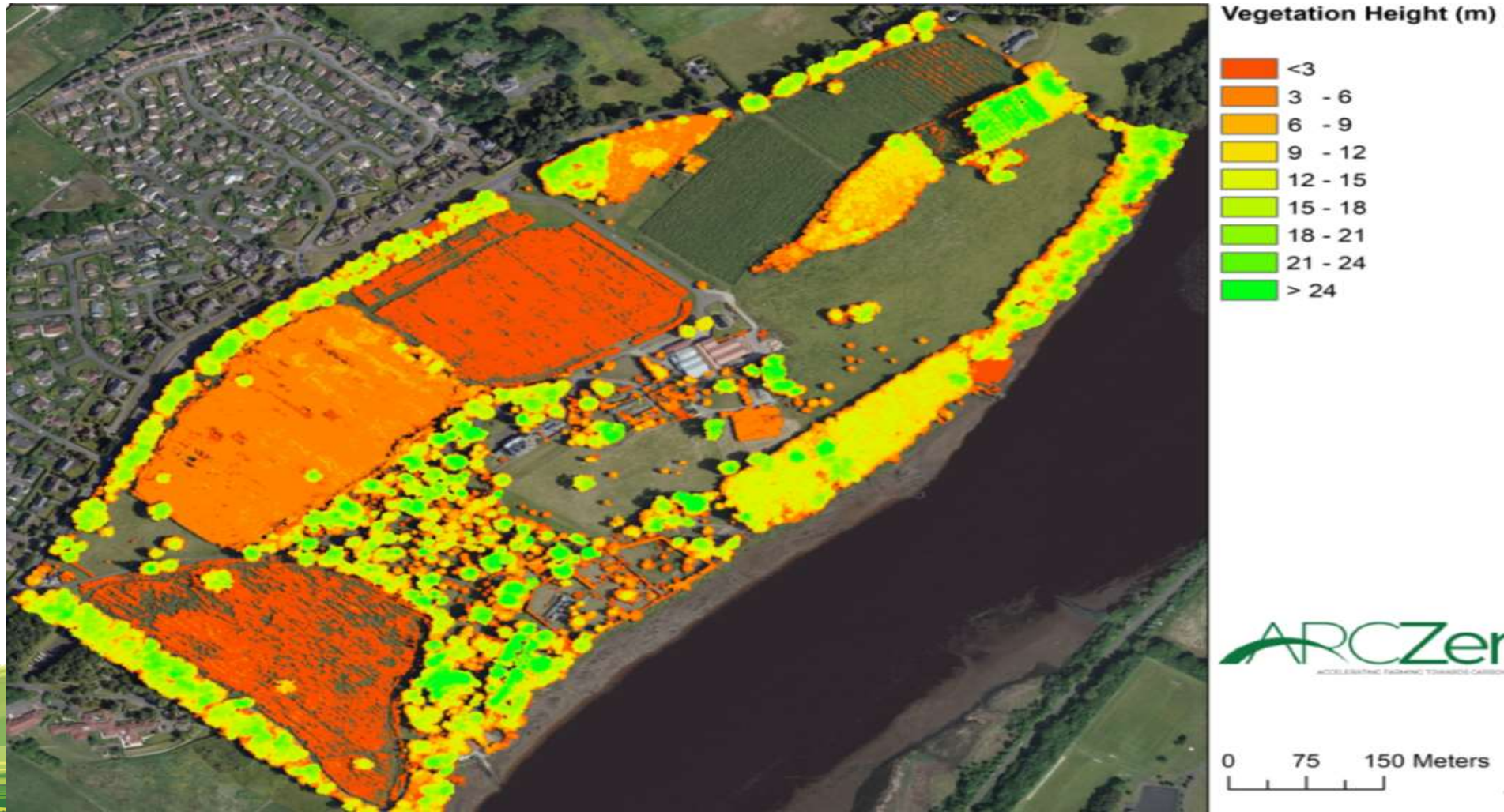


Soil Sampling to one
metre deep



Measuring Carbon in Trees & Hedges Using Aerial LiDAR at Brook Hall

A. Higgins 2021 **afbi** AGRI-FOOD & BIOSCIENCES INSTITUTE



Measuring Carbon in Trees & Hedges Using Aerial LiDAR at Brook Hall

A. Higgins 2021 

Vegetation type	Brook Hall Estate Totals					
	Hedge Length (km)	AGB (t)	C (t)	BGB* (t)	C (t)	Total C (t)
Hedge 0-4m	0.78	14.92	7.1	2.86	1.3	8.5
Hedge 4-7m	0.35	6.36	3.0	1.22	0.6	3.6
Hedge 7-10m	0.25	10.32	4.9	1.98	0.9	5.9
Hedge >10m	1.00	156.17	74.5	29.99	14.1	88.6
Total Hedges	2.38	187.77	89.5	36.05	16.94	106.49
	Canopy Area (ha)					
Single Trees	1.87	494.78	236.0	95.00	44.6	280.6
Deciduous Woodland	17	1352.74	645.1	259.73	122.1	767.2
Coniferous Woodland	0.09	6.17	2.9	1.27	0.6	3.5
Biomass	28.96	337.61	161.0	64.82	30.5	191.5
Total	47.92	2,379.07	1,134.6	456.8	214.7	1,349.3

AGB
Above Ground
Biomass

BGB
Below Ground
Biomass



Measuring Carbon in the Soil Stratified for different Land Uses & Land Managements at Brook Hall

Land Category	Total ha	Soil pH	Av. LOI/SOM	No. of Soil Cores	No. of Samples	Av. C. 0-10cm	Av. C. 0-30cm	Av. C/ha	Av. C/Category
<10% Soil Org. Matter, Short Rotation Willow Coppice	34.2ha	pH 6.2	7.60%	55	11	4.20%	3.20%	87.1t	2,978.8t
<10% Soil Org. Matter, Permanent Grass, no slurry/FYM, only grazed	1.4ha	pH 6.3	9.30%	15	3	4.90%	3.10%	87.3t	122.2t
<10% Soil Org. Matter, Deciduous Woodland	0.5ha	pH 5.3	9.10%	15	3	5.80%	4.10%	114.7t	57.4t
10-20% Soil Org. Matter, Permanent Grass, no slurry/FYM, only grazed	12.9ha	pH 6.1	13.70%	30	6	5.50%	3.40%	93.7t	1,208.7t
10-20% Soil Org. Matter, Silvopasture, no slurry/FYM	4ha	pH 4.8	14.80%	25	5	5%	2.80%	81.6t	326.4t
10-20% Soil Org. Matter, Deciduous Woodland	4.6ha	pH 5.3	13%	25	5	6.90%	4.90%	136t	625.6t
Totals	57.6ha			165 Soil Cores	33 C. Samples			92.3t/ha	5,319.1t of C.

Soil Carbon at Brook Hall = 5,319 t of C, or 19,468 of CO₂e



Total Carbon Stocks across ARC Zero farms.....

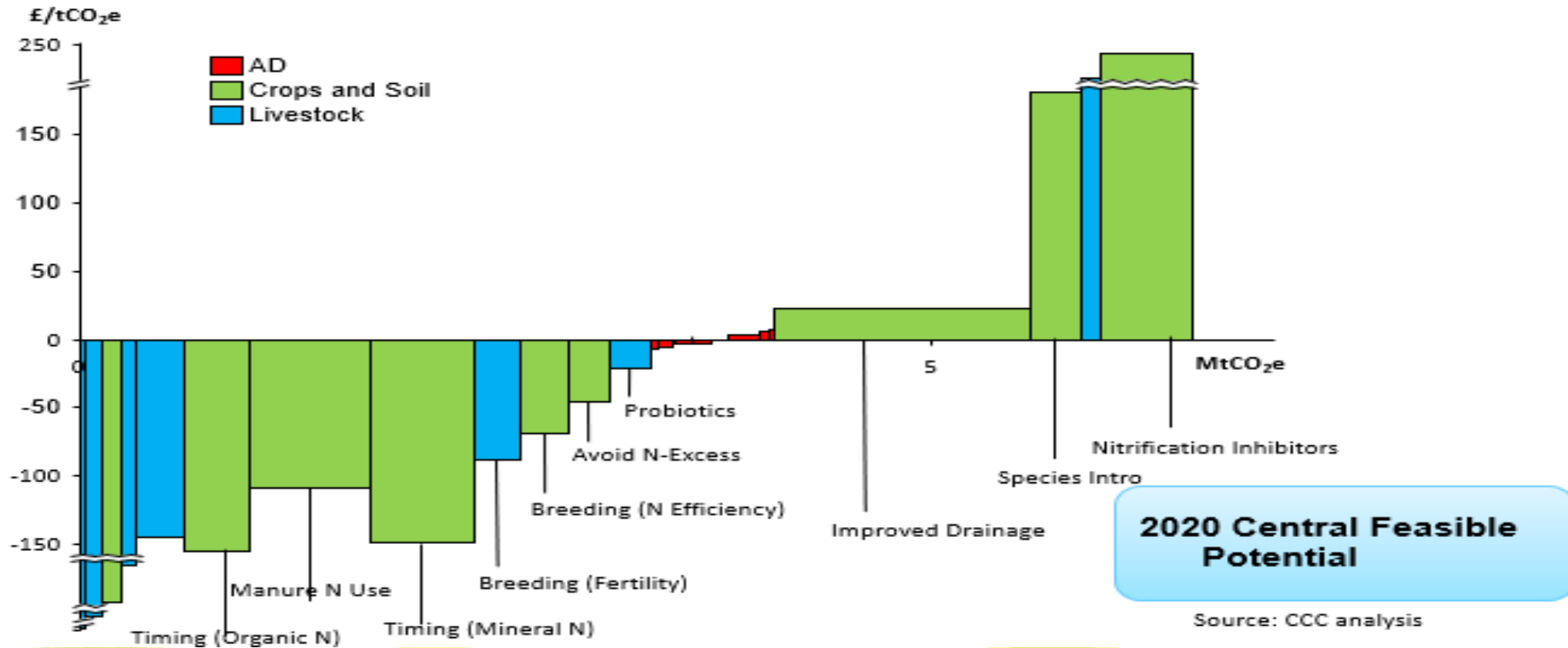
<i>Total ARC Zero CO₂e Stocks</i>	Soil Carbon	Tree Carbon	Total Carbon	% C in Soil
Ian McClelland	31,813t	1,310t	33,123t	96%
Hugh Harbison	68,054t	1,969t	70,023t	97%
John Egerton	31,813t	1,310t	33,123t	96%
Roger & Hilary Bell	50,819t	688t	51,507t	98%
Simon Best	237,915t	6,493t	244,407t	97%
Patrick Casement & Trevor Butler	54,556t	4,022t	58,578t	93%
John Gilliland	19,468t	4,937t	24,405t	80%
		Total	515,166t	

ARC Zero farms manage 515,166t of CO₂e, 97% is within the Soil
 2027 target 540,000t? Will Scope 3, or GHG Inventory recognise Improvement



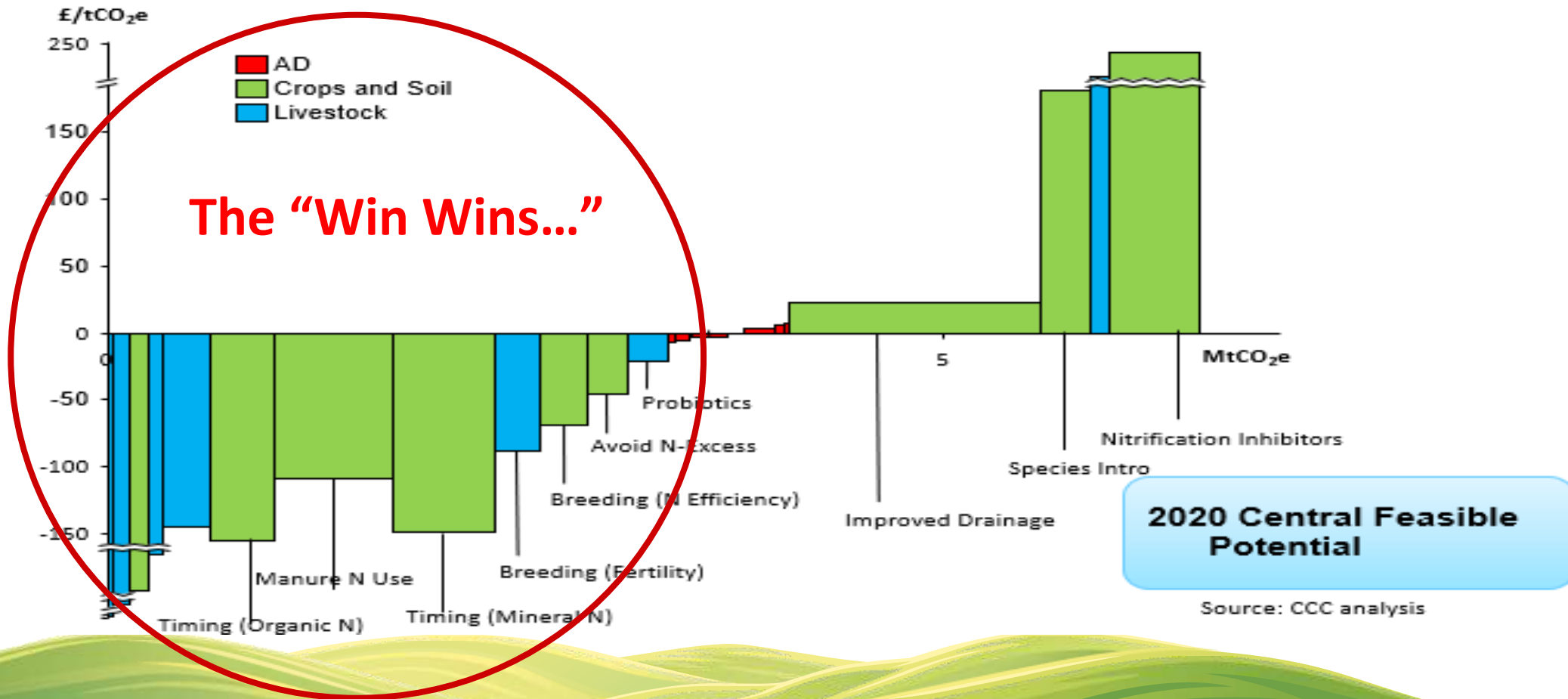
Accelerating towards Net Zero..... How do we do it?

Understand the costs of the different Mitigation Options.... MACC Curve



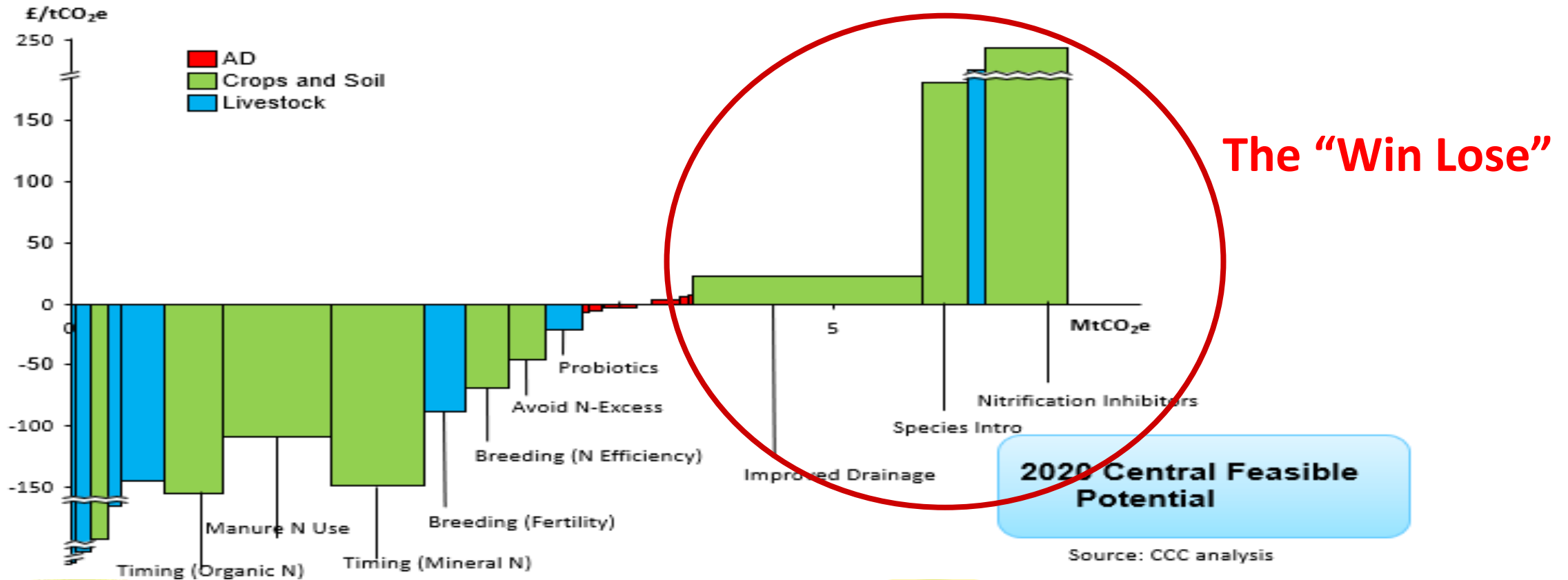
Accelerating towards Net Zero..... How do we do it?

Prioritising the “Win Win” Mitigation Options first....



Accelerating towards Net Zero..... How do we do it?

Exploring who will pay for the “Win Loose” Mitigation Options....??



Empowered, ARC Zero Farmers made the following Changes For both Mitigation & Building Carbon Stocks...

- Improving efficiency – genetics, age of slaughter, cow size, animal health
- Improving Soil pH – improving nutrient uptake & growth of clover
- Increasing the use of Legumes & Multi Species Pastures
- Reducing the use of Nitrogen fertiliser
- Planting trees & Hedgerow Management
- Grazing Willows
- Installing Renewables.....



The Resultant Improvements Observed over two years.....



Comparison between 2021 & 2023, gross emission/unit of output

<i>GHG Reduction 2021 to 2023</i>	Enterprises	2021	2023	% Reduction in GHGs
Ian McClelland	Dairy	1.3kg CO ₂ e/kg FPC Milk	1.1kg CO ₂ e/kg FPC Milk	13%
Hugh Harbison	Dairy	1.25kg CO ₂ e/kg FPC Milk	1.2kg CO ₂ e/kg FPC Milk	4%
John Egerton	Beef & Sheep	32.8kg CO ₂ e/kg dwt	25.6kg CO ₂ e/kg dwt	22%
Roger & Hilary Bell	Lamb	22kg CO ₂ e/kg dwt	15.7kg CO ₂ e/kg dwt	28%
Simon Best	Wheat	0.99kg CO ₂ e/kg grain	0.47kg CO ₂ e/kg grain	53%

Determining Factors – Price of Fertiliser

- Timing of sowing Legumes
- Livestock Health



Reporting Methane using GWP*, as well as GWP100 Methodology

IOP Publishing

Environ. Res. Lett. 18 (2023) 084014

<https://doi.org/10.1088/1748-9326/ace204>

ENVIRONMENTAL RESEARCH LETTERS



LETTER

OPEN ACCESS

Are single global warming potential impact assessments adequate for carbon footprints of agri-food systems?

RECEIVED

5 October 2022

REVISED



9 May 2023

ACCEPTED FOR PUBLICATION

27 June 2023

PUBLISHED

18 July 2023

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Methane emissions in livestock and rice systems

Sources, quantification, mitigation and metrics

UN's FAO Methane (CH₄) Report September 2023

- Methane is different, it is short lived
- Biogenic CH₄ is different to fossil fuel CH₄
GWP₁₀₀, 27 vis a vis 29.8, for fossil fuel CH₄
- Recognises GWP* as a metric
- “Recent guidance recommends considering multiple metric choices in Life Cycle Impact Assessments”



Reporting Methane using GWP*, as well as GWP100 Methodology

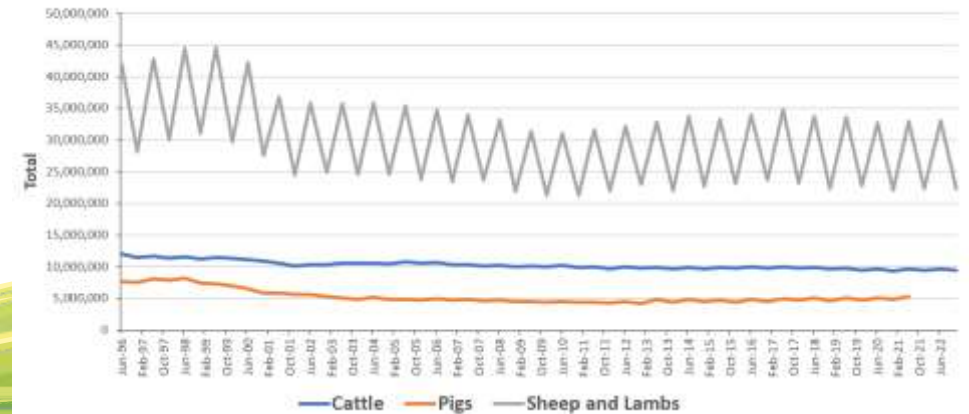
<i>2021 Agrecalc Analysis</i>	Enterprises	GWP100	GWP*
		% Reduction	% Reduction
Ian McClelland	Dairy	28%	47%
Hugh Harbinson	Dairy	27%	51%
John Egerton	Beef & Sheep	30%	63%
Roger & Hilary Bell	Sheep with Beef	60%	126%
Simon Best	Arable with Beef	41%	50%
Patrick Casement & Trevor Butler	Beef & Sheep	111%	325%
John Gilliland	Willows with Dry Cows	103%	251%

Assumptions:

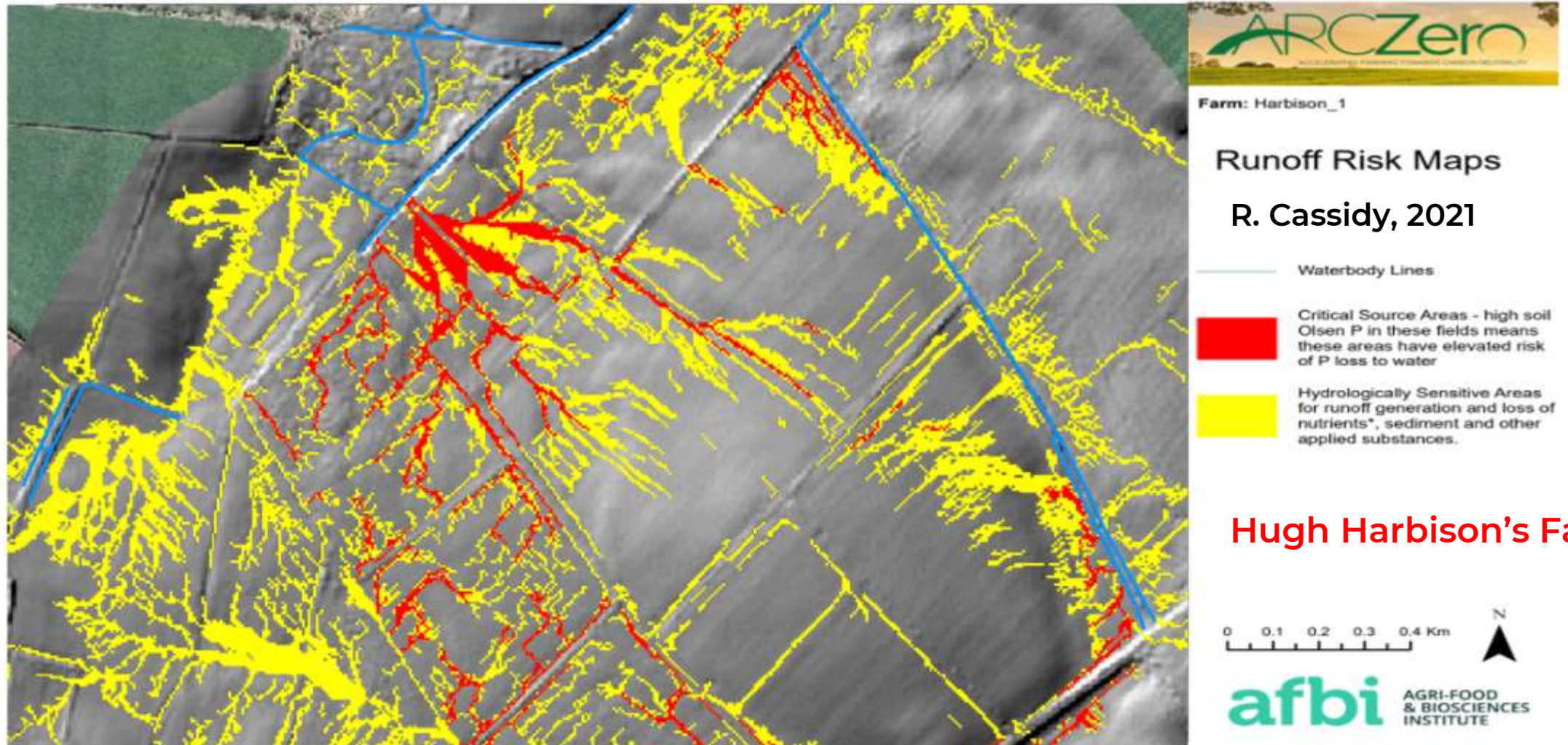
- Livestock Nos. Mirrored UK National Herd Trend over last 20 yrs
- IPCC AR4 CO₂e & GWP* conversion values
- GWP* calculation is equation 3, Lynch et al. 2020



UK National Herd Statistics 1996 - 2022

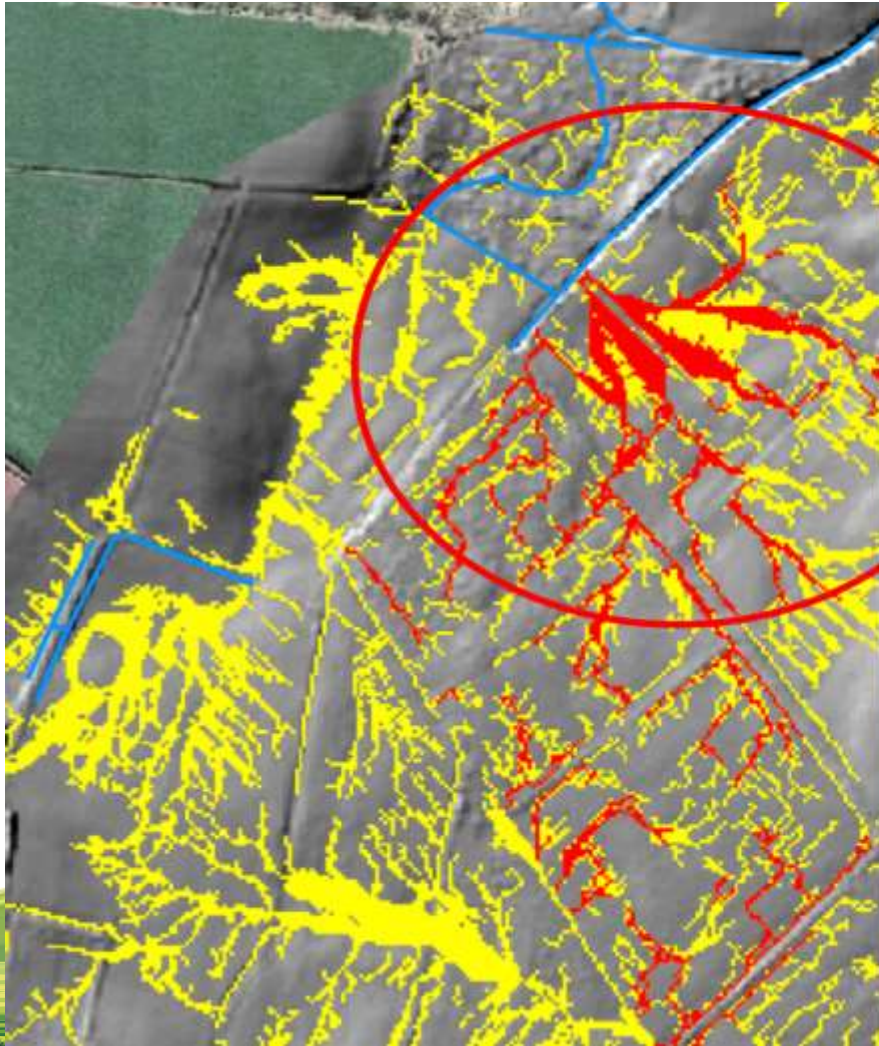


Delivering Multiple Public Goods Simultaneously Using LiDAR & Phosphate Soil Surveys to create “Run Off Risk” Maps



Delivering Multiple Public Goods Simultaneously

Multi Species Pastures – Water Infiltration, Biodiversity, Carbon Sequestration



Runoff Risk Maps

- Waterbody Lines
- Critical Source Areas - high soil Olsen P in these fields means these areas have elevated risk of P loss to water
- Hydrologically Sensitive Areas for runoff generation and loss of nutrients*, sediment and other applied substances.

Hugh Harbison's Farm



COMPARING DIFFERENT LAND USES



Willow SRC (28 Yrs. Old)



**Permanent Pastureland
(200 Yrs. Old)**

BROOK HALL
Estate & Gardens

R. Buffara, WUR, 2023



Silvopasture (120 Yrs. Old)

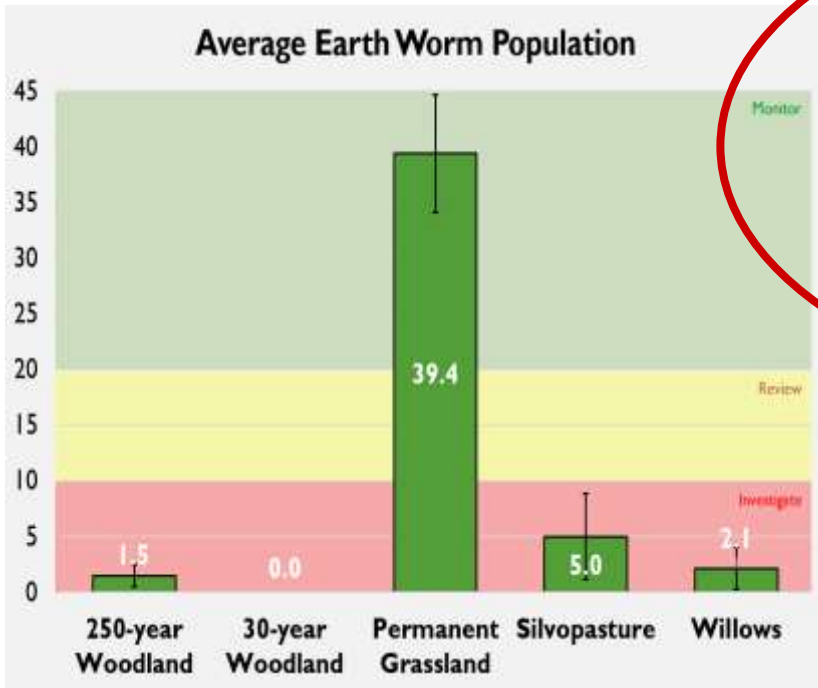


D. Woodland (30 Yrs. Old)



D. Woodland (250 Yrs. Old)

Delivering Multiple Public Goods – Learning from Historic Land Uses Increasing Biodiversity Under the Soil... Role of Livestock Faeces...

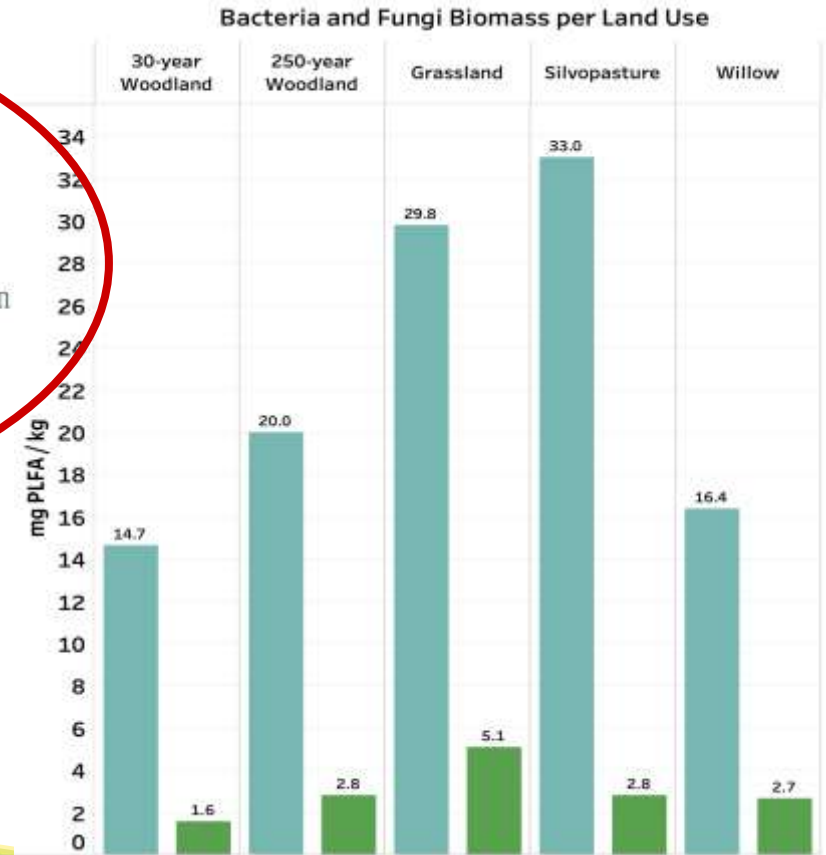


The age of extinction

More than half of Earth's species live in the soil, study finds

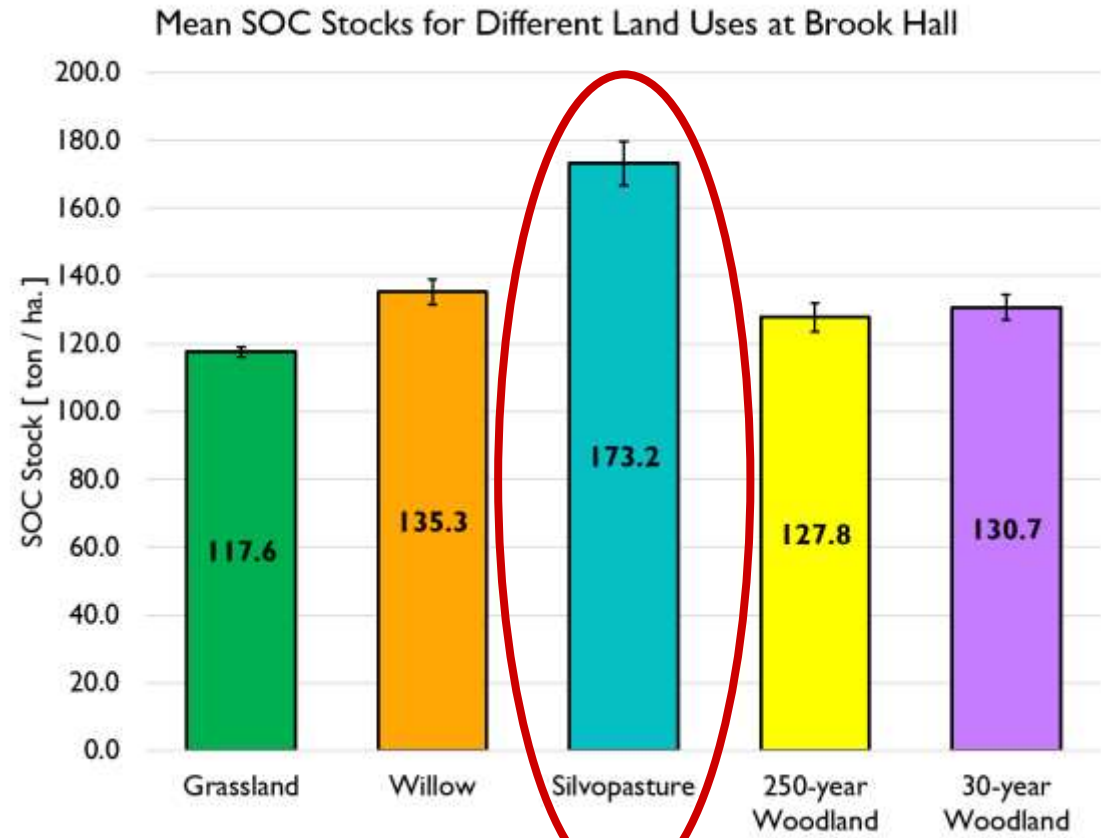
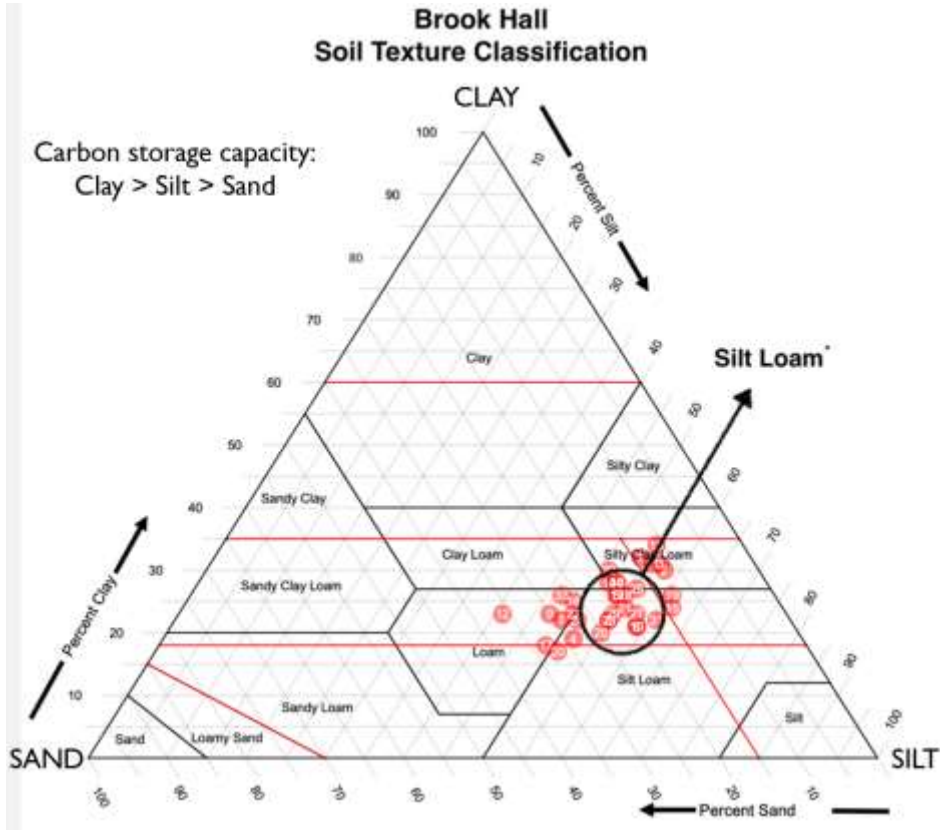
Soil estimated to be home to 90% of world's fungi, 85% of plants and more than 50% of bacteria, making it the world's most species-rich habitat

National Academy of Science, Aug 23

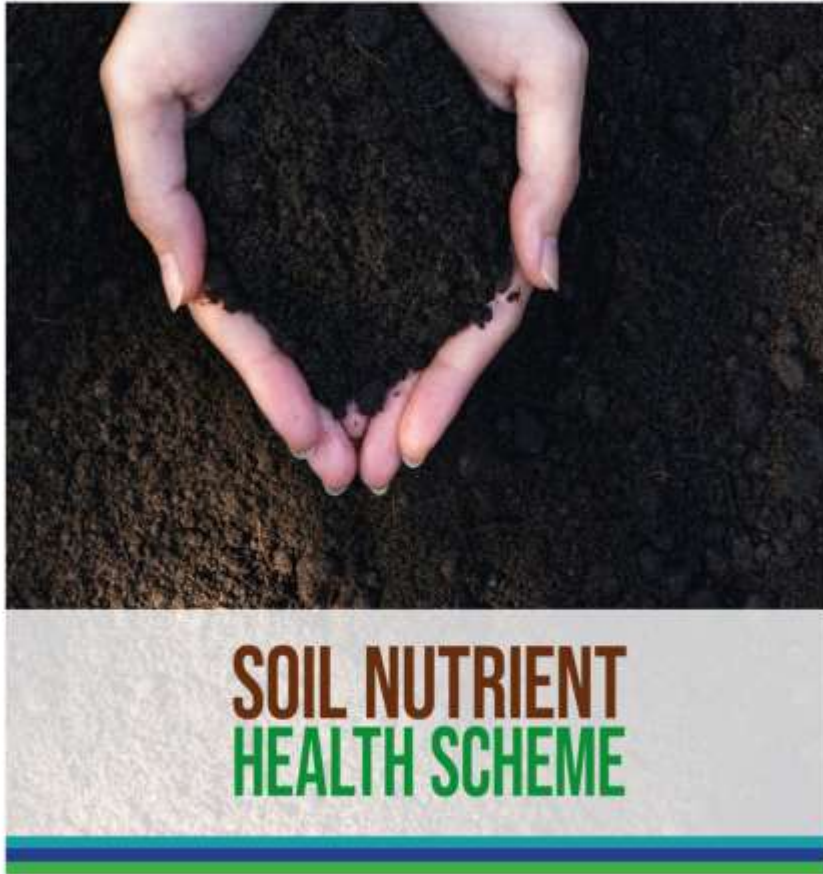


Role of different Land Uses in building Soil Organic Carbon

Diversity of root architecture is best... Monocultures are not the right answer...

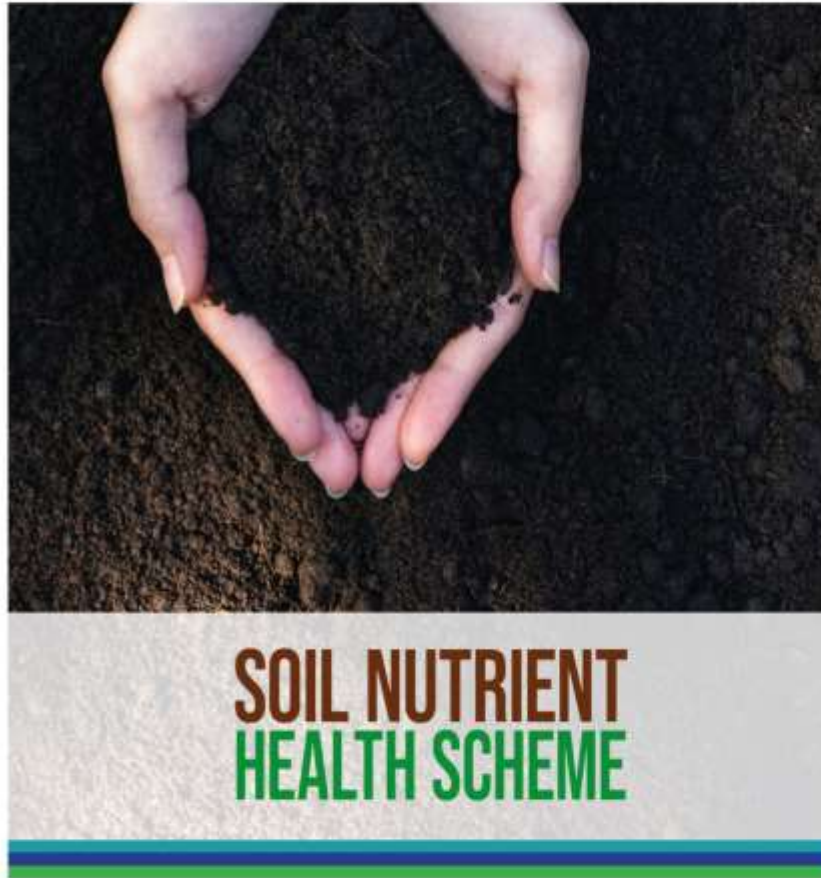


Is this Ambition Possible at a Regional Level.....



- £38m N. Ireland Scheme to base line every field, tree & hedge
- Carried out over four years, one Zone per year
- Online training, empowering farmers with their own Data
- Output - Soil Fertility, Carbon Stocks & Run off Risk Maps
- Opened May 2022, plan to repeat every five years
- **92% Farmer uptake in Zone One (25% of N. Ireland)**
- [Soil Nutrient Health Scheme | Agri-Food and Biosciences Institute \(afbini.gov.uk\)](https://www.afbini.gov.uk)

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Delivering at a National Scale.....

Australian Soil Carbon Credit Units (2014)



**1st farm in Australia
only approved in 2023**



**Premium
Australian
Carbon Credits**

DELIVERED BY REXTON, GOONDIWINDI QLD, AUSTRALIA

SOC measured to 1 metre, 7 years apart

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SOC measured to 1 metre, 7 years apart

**Sold at a Premium for AUS\$93/t
While Voluntary Market at AUS\$40/t**

Closer to home..... EU Parliament Adopts Certification Framework for Carbon Removals in the Land Based Sector



21/11/23

Statement

With the adoption today by the European Parliament of its final report on a proposal to establish the first EU-level certification framework for carbon removals, Europe is making great strides in the right direction. As the Council also adopted its negation mandates last week, trilogue negotiations will get underway in the coming weeks, and on the right track.

The EU voluntary carbon framework aims to facilitate and speed up the deployment of high-quality mitigation and adaptation actions in the EU, including those originating from carbon farming practices. The European Parliament acknowledges that carbon farming is not just sequestration of carbon but also emissions' reductions from soil, and enteric and manure fermentation. Copa and Cogeca welcome this step in the right direction, which will enable more farmers to see the benefits of this system.

In Summary – Key Issues for Journey towards & “beyond” Net Zero...

- The Definition of Net Zero & its Interpretation
- National Targets, vis a vis, where is “my” business on this Journey.... “the disconnect”
- Baseline my Carbon Stocks & not just my Emissions..... “knowing my numbers”
- The LCA Penalties of “Averaging,” the Desire for “Accuracy” at TIER 3
- Will my Positive Change be picked up by National Inventory, or by Scope 3 Declarations
- The necessity to “Inset” my carbon within my own legal business
- The Imperative to deliver other Public Goods, as well as Net Zero
 - Improving Water Quality, Biodiversity.....

The Journey to “Beyond” Net Zero

A Practitioner’s Perspective



Empowerment farmers by helping them “Know their Numbers”....
Key to Delivering Net Zero & Multiple Public Goods, Simultaneously

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