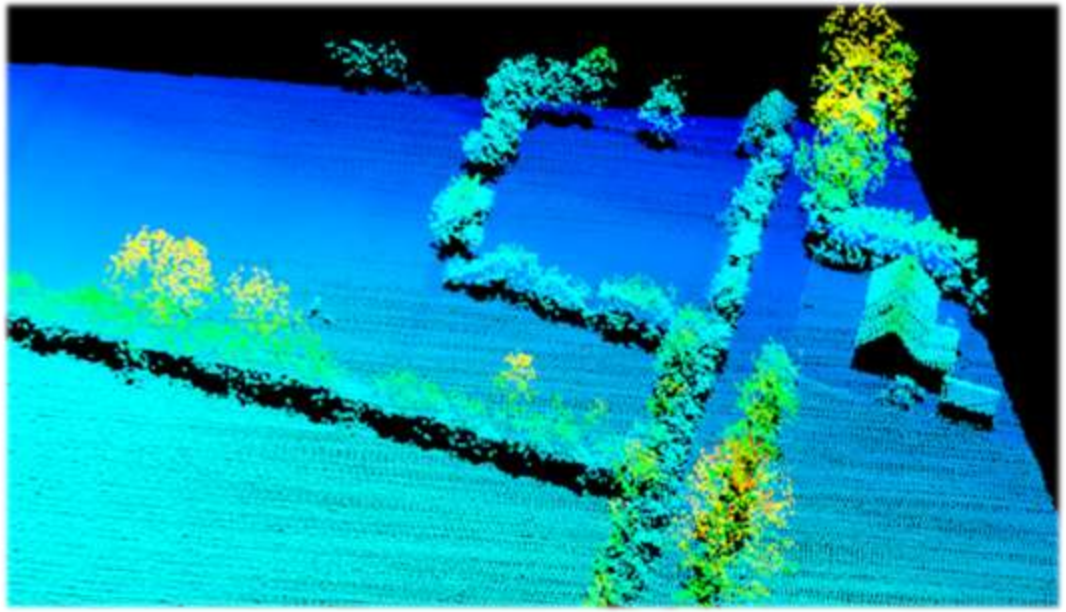
Achieving Net Zero – The Role of Increasing Carbon Stocks on Farm



Prof. John Gilliland OBE
Director of Agriculture & Sustainability, Devenish
Chair, ARC Zero; & Professor of Practice, Queens University Belfast
September 2022

Sustainable Meat and Livestock Production

ARCZero — ACCELERATING FARMING TOWARDS CARBON NEUTRALITY

75 UNECE

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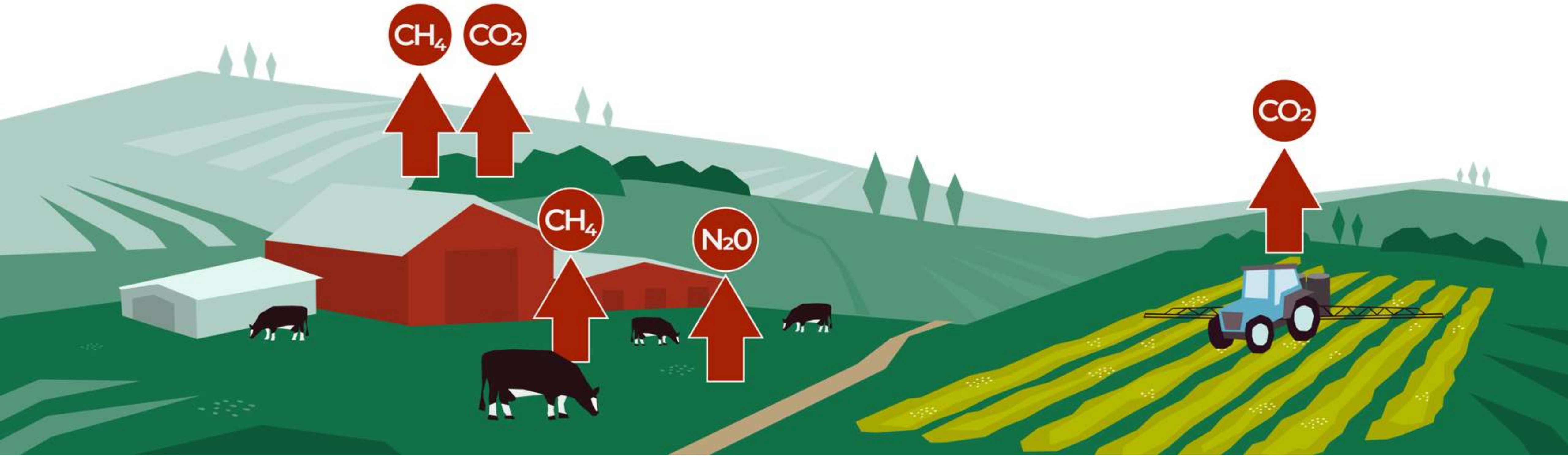
Net Zero, A definition in Three Steps, for a Farm Business….

Gross Emissions, the sum of all CO_2, CH_4 & N_2O emissions



Currently what farm businesses are reported on today……..

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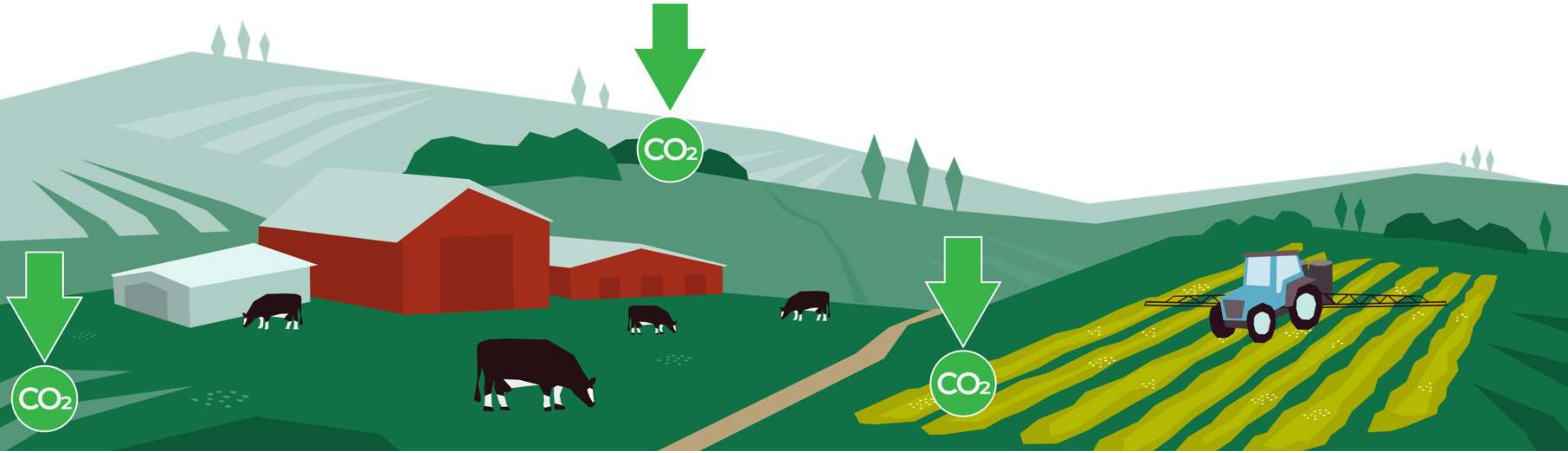
Gross Sequestration, the sum of All new Carbon locked up in Soil & Trees



Currently not measured, or reported on, as deemed too hard to measure…..

Yet it is Recognised by IPCC as essential to achieve, Net Zero, by 2050

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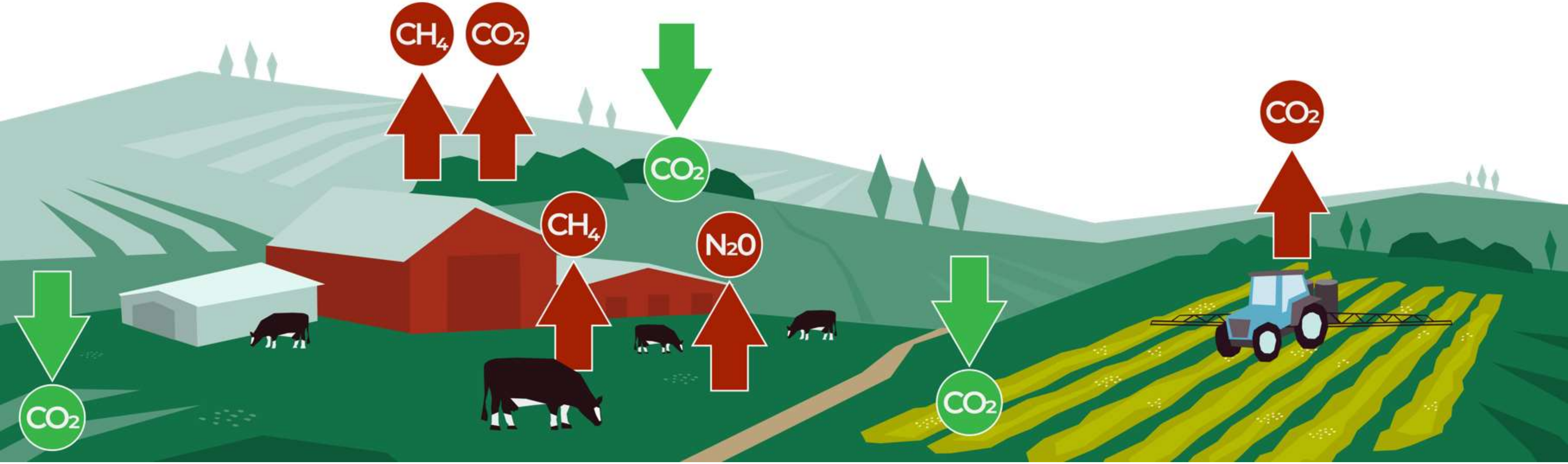
Net Zero Carbon : Where the Sum of Emissions equals Sum of Sequestration

Adjusted for any fossil fuel CO2 emissions displaced by Renewables



It is not about Zero Emissions……

What is the Role & Opportunity to credibly increase Carbon Stocks???

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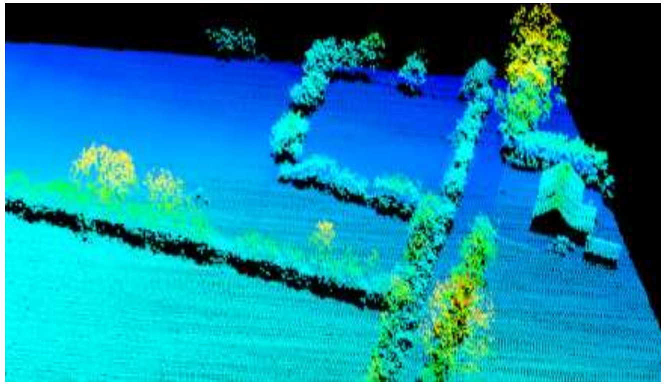
GLOBAL NETWORK OF
LIGHTHOUSE FARMS

The Lands at Dowth

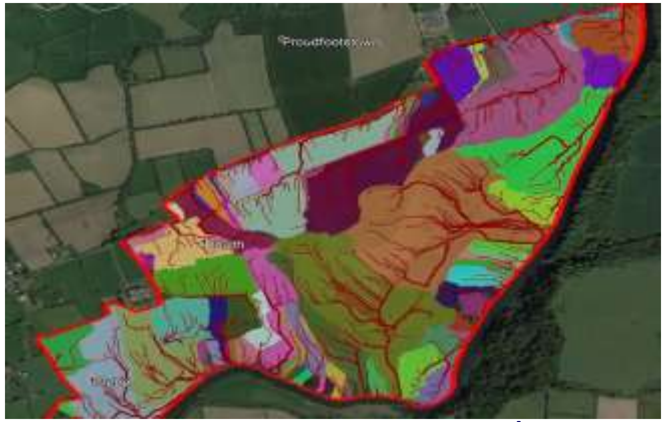
Delivering Multiple Public Goods, Simultaneously, from farming livestock

Purchased in 2013, 185ha
Grasslands & Woods

Delivering Soil Improvement
Fertility & Health



Measuring Carbon Sequestration,
Above & Below Ground



Improving Water Quality
Reducing Over Land Flow

Optimising Biodiversity,
Understanding Trade Offs

Managing our Landscape UNESCO
World Heritage Site

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If you can't Measure….. You will Never be able to Manage….

Creating a Robust, Scientific Base Line to aid Future Management Decisions

Surveys carried out in 2014

Aerial LiDAR; Geophysics by Romano Germanic Commission; GPS Soil Analysis

In partnership with Dr Steve Davis, UCD School of Archaeology, for Devenish

UCD DUBLIN

DEUTSCHES ARCHÄOLOGISCHES INSTITUT
RÖMISCH-GERMANISCHE KOMMISSION

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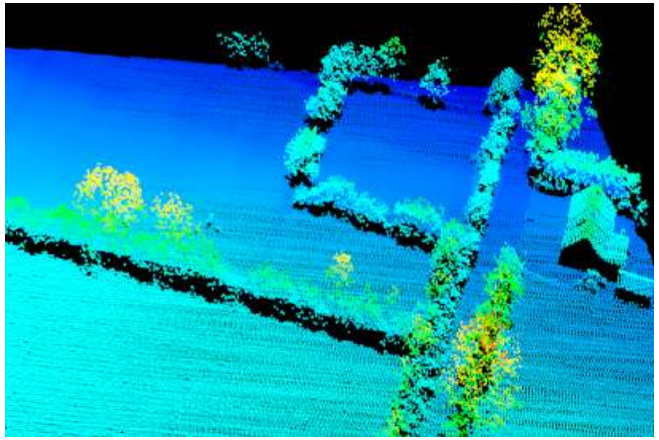
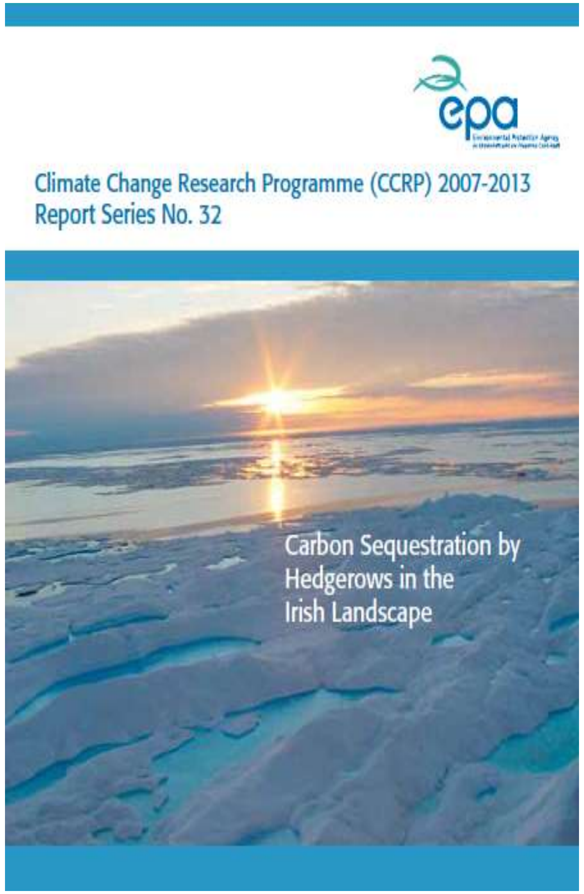
Creating the Baseline of Carbon Stocks

Aerial LiDAR Survey measured Total Above Ground Biomass @ 40 scans per metre (2014)





	Woods	Hedges	Total
Biomass Density (t C/ha)	83	127	86
Total Biomass in Dowth (t C)	3495	385	3880
Sequestration Potential for Dowth (t C/Yr)	50	1.2	51

S. Green, Teagasc, 2014

Teagasc
Agriculture and Food Development Authority

LiDAR Survey repeated in 2021 to measure scale of change since 2014

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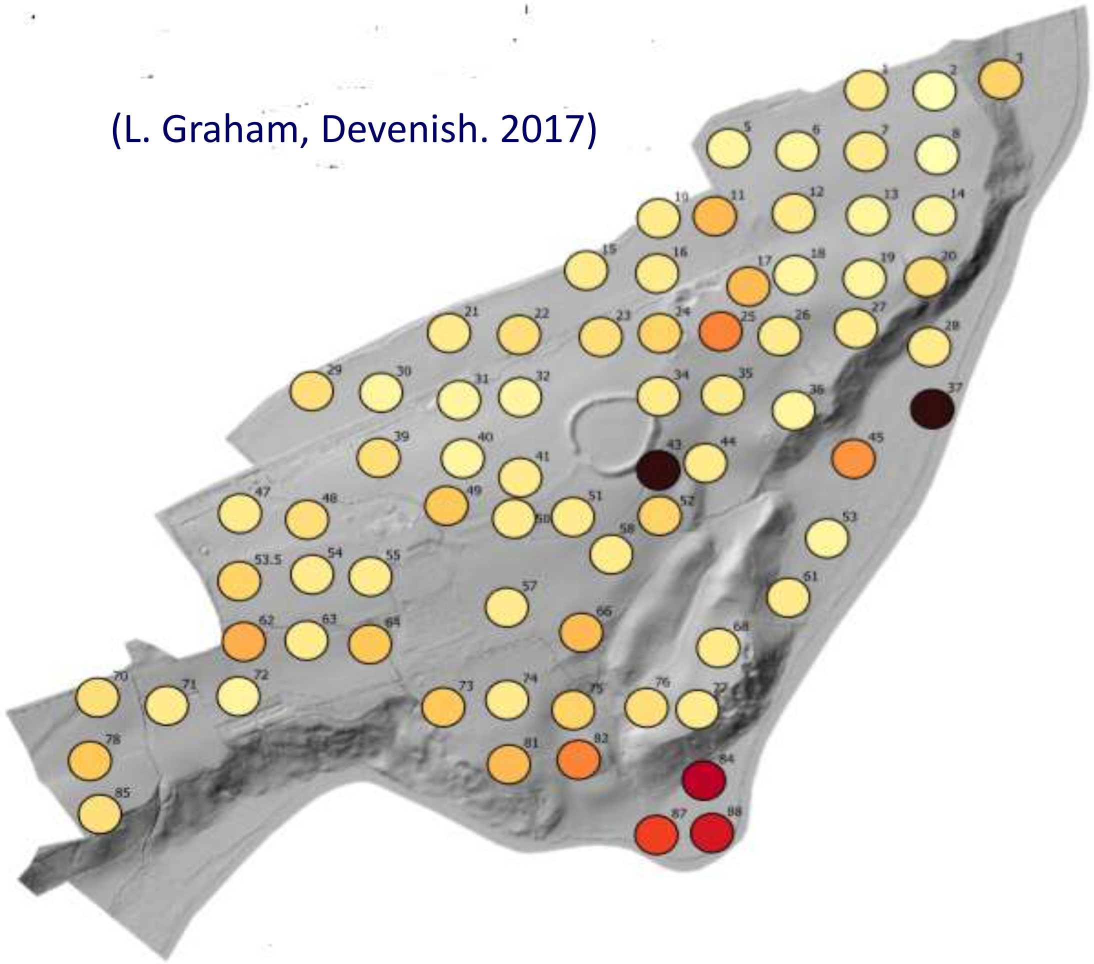
Creating the Baseline of Carbon Stocks

Sampled Soil Carbon to 30cm (2017)

(L. Graham, Devenish. 2017)



Representative Sampling of Soils under Grass

88 soil pits, GPS positioned, for repeat sampling

No ploughing for 40 Years

Some land never ploughed

Soil Type – Brown Earth

Average Soil Carbon - 2.1%

Expected Soil Carbon – 4 to 5%

Why the disparity in Soil Carbon Levels?

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Total Carbon Stocks at Dowth, managed Annually

Carbon in Soils	Area (ha)	Av. t/ha of C	Total C (t)	Total CO2e (t)	% of Acreage
Grazing Ground	92	58	5,336	19,530	
Woods	42	71	2,982	10,914	
Flood Plains	10	277	2,770	10,138	
Hedges	8	71	568	2,079	
Total Carbon in Soils				42,661	72%
Above Ground Carbon					
Hedges	8	127	1,016	3,719	
Woods	42	83	3,486	12,759	
Total Above Ground Carbon				16,478	28%
Total CO2e Stocks at Dowth				59,139	

Farmers are Custodians of much of the Nation’s Carbon……

Estimated Annual Carbon Sequestration at Dowth

Using Carbon Baselines & Sequestration Factors from Peer Review Publications

	Area Ha	Carbon Seq. in Soils t of C/ha/ yr	Total soil Seq. t/ yr	Carbon Seq. in Trees t of C/ha/ yr	Total tree Seq. t/ yr
Grazing ground	91.91	0.5	46		
Woods	42	1.6	67.2	1.2	50
Floodplains	10.2				
Hedgerows	7.89	1.6	12.62	0.4	3
Total land area	156.48				
		Total soil seq./ yr	128	Total trees seq./ yr	54
	Total Dowth carbon sequestration, t of C/ yr.				181.6
	Total Dowth CO2e sequestration, t of CO2 e/ yr				665

D. Fornara & J. McAdam 2018, S. Green 2014, L. Graham 2017, D. Hagan 2018

Teagasc Agriculture and Food Development Authority

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

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Leveraging the Lands at Dowth's Knowledge by
Accelerating Seven farms towards Net Zero

ARCZero
ACCELERATING FARMING TOWARDS CARBON NEUTRALITY

Delivering Positive Change by Empowering Farmers with

Gross Emissions, Gross Sequestration & Net Carbon Position; Soil fertility; Soil, Nutrient and Pesticide Run Off Risk Maps.

Partners

AFBI – Carbon in trees, hedges & soil P risk maps
AgriSearch – Communications
Devenish – Net farm Carbon Calculation
QUB – Soil Carbon
SRUC – AgReCalc calculator for Gross Emissions

Department of Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

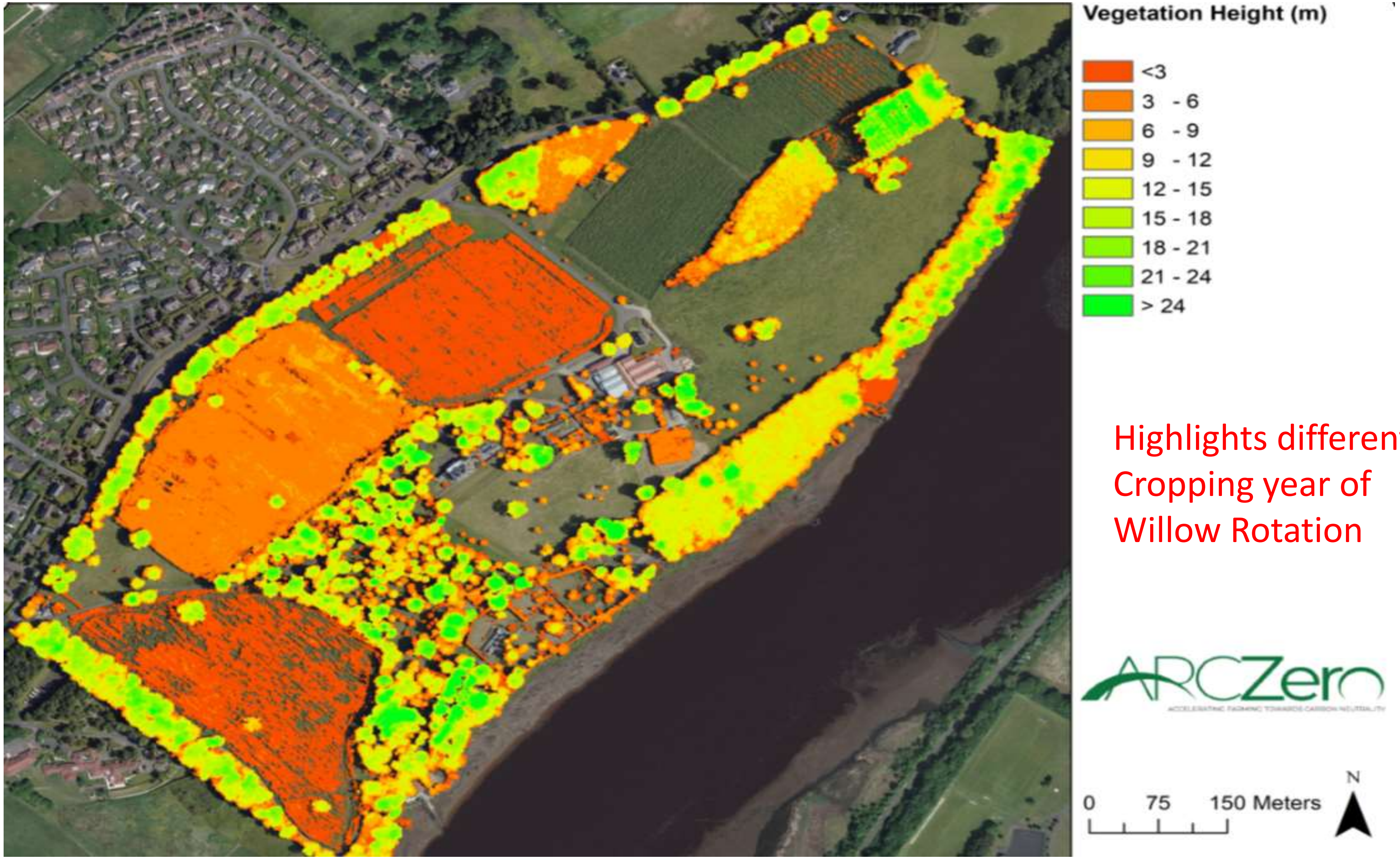
The European Agricultural Fund for Rural Development: Europe investing in rural areas

rural Development Programme

Created Baselines with Smarter LiDAR & Ortho Imaging Surveys, Brook Hall

Using LiDAR to Measure Carbon in Trees & Hedges, Brook Hall

(Alex Higgins, 2021)



Highlights different Cropping year of Willow Rotation

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BROOK HALL ESTATE

Using LiDAR to Measure Carbon in Trees & Hedges, Brook Hall

(Alex Higgins, 2021)

	Brook Hall Estate Totals					
Vegetation type	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 (roots)

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ARCZero ACCELERATING FARMING TOWARDS CARBON NEUTRALITY

Created Baselines with Smarter Soil Sampling Techniques

Originally, manually augured to 30cm, now automated to core to 100cm

IPCC Standard is to 30cm, but many soil amendments lay new carbon down deeper…

ARCZero

Brook Hall's Total Carbon Stocks

Soil Carbon in top 30cm & Above Ground Carbon

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, Decideous 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, Decideous 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.

Total Soil Carbon = 5,319t of C
Total Above Ground Carbon = 1,349t of C
Brook Hall's Total Carbon = 6,668t of C or 24,405t of CO_2e

BROOK HALL ESTATE

ARCZero ACCELERATING FARMING TOWARDS CARBON NEUTRALITY

Net Emissions Calculated across the ARC Zero farms

Giving farmers an understanding where they are on journey to Net Zero

agrecalc

Name	Enterprises	Gross Emissions	Gross Sequestration	Net Emissions	% Reduction
Ian McClelland	Dairy	1,125t/yr	309t/yr	816t/yr	27%
Hugh Harbison	Dairy	2,012t/yr	550t/yr	1,462t/yr	27%
John Egerton	Beef	1,404t/yr	442t/yr	962t/yr	31%
Roger Bell	Sheep with Beef	820t/yr	455t/yr	365t/yr	56%
Simon Best	Arable with Beef	1,799t/yr	738t/yr	1,061t/yr	59%
John Gilliland	Willow with dry cows	151t/yr	156t/yr	-5t/yr	103%

All farms are in a different place on their Journey to Net Zero
Some Farms will find the Journey a lot easier than others….

Some farms will never reach Net Zero…..

ARCZero
ACCELERATING FARMING TOWARDS CARBON NEUTRALITY

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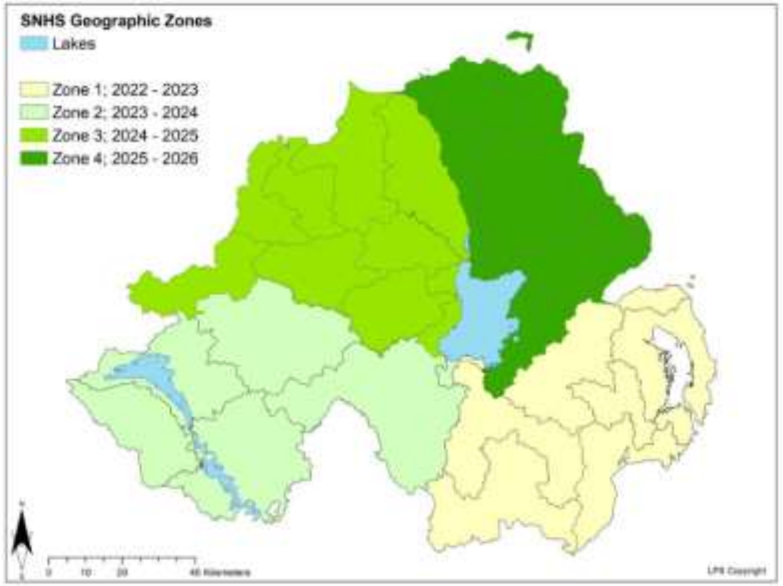
Beyond Nutrition

Scaling Up - N. Ireland Soil Nutrient & Health Scheme Opened

Baselining every field, tree/hedge in NI, including the use of Aerial LiDAR Survey



Department of
Agriculture, Environment and Rural Affairs

Sustainability at the heart of a living, working, active landscape valued by everyone

Agriculture Minister opens £45million Soil Nutrient Health Scheme investment over four years

Date published: 22 March 2022

When repeated every five years it will, at the Province level, measure credibly change on farm

And Could be the embryonic foundation for a Province wide, Credible MRV Vehicle

But…… There is a Catch…..

All Governments must report annually against agreed International GHG reduction targets

The GHG National Inventory is the vehicle used to do this.

IPCC SOURCE AND SINK CATEGORIES	CO_2	CH_4	N_2O
1. Energy	**M T1, T2, T3**	**M, T1, T2, T3**	**M, T1, T2, T3**
A. Fuel Combustion (Sectoral Approach)	M, T1, T2, T3	M, T1, T2, T3	M, T1, T2, T3
1. Energy Industries	T1, T3	T1, T2	T1, T2
2. Manufacturing Industries and Construction	T1, T2, T3	T1	T1
3. Transport	M, T2, T3	M, T1, T3	M, T1, T3
4. Other Sectors	T1, T2	T1	T1
5. Other			
B. Fugitive Emissions from Fuels	CS. T3	CS, T1, T3	CS, T3
1. Solid Fuels	NA	T1	NA
2. Oil and Natural Gas	CS, T3	CS, T1, T3	CS, T3
C. Carbon Dioxide Transport and Storage	NA		
3. Agriculture	**T1**	**CS, T1, T2**	**T1, T2**
A. Enteric Fermentation		CS, T1, T2	NA
B. Manure Management		T1, T2	T2
C. Rice Cultivation		NA	NA
D. Agricultural Soils		NA	T1
E. Prescribed Burning of Savannas		NA	NA
F. Field Burning of Agricultural Residues		NA	NA
G. Liming	T1		
H. Urea Application	T1		
I. Other	NA		

4. Land-Use, Land-Use Change and Forestry	**CS, D, T1, T2, T3**	**D, T1, T2**	**D, T1, T2**
A. Forest Land	CS, T1, T2, T3	D, T1	D, T1
B. Cropland	CS, D	D, T1	D, T1
C. Grassland	D, T1, T2, T3	D, T1	D, T1
D. Wetlands	D, T1, T2, T3	D, T2	D, T2
E. Settlements	D, T1, T3	NA	T1
F. Other Land	T1, T3	NA	T1
G. Harvested wood products	T2		
H. Other	NA	NA	NA
5. Waste	**T1**	**T1, T2**	**T1**
A. Solid Waste Disposal	NA	T2	NA
B. Biological treatment of solid waste	NA	T1	T1
C. Incineration and open burning of waste	T1	T1	T1
D. Wastewater treatment and discharge	NA	T1, T2	T1
E. Other	NA	NA	NA

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G. Liming	T1		
H. Urea Application	T1		
I. Other	NA		
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E. Other	NA	NA	NA

It is a collection of Individual Silos designed for easy Accounting & Reporting

But…… There is a Catch…..

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D. Wastewater treatment and discharge	NA	T1, T2	T1
E. Other	NA	NA	NA

Farm Businesses don't fit within the Inventory, as they are multifaceted, they are split between a possibility of four different Silos, which do not allow recognition of each other…..

Perverse Outcomes will happen when only using Inventory….

It encourages Sectoral/Silo Targets to be set, which totally ignores the interconnectivity of farm activities & farms' abilities to deliver the cheapest options, first…

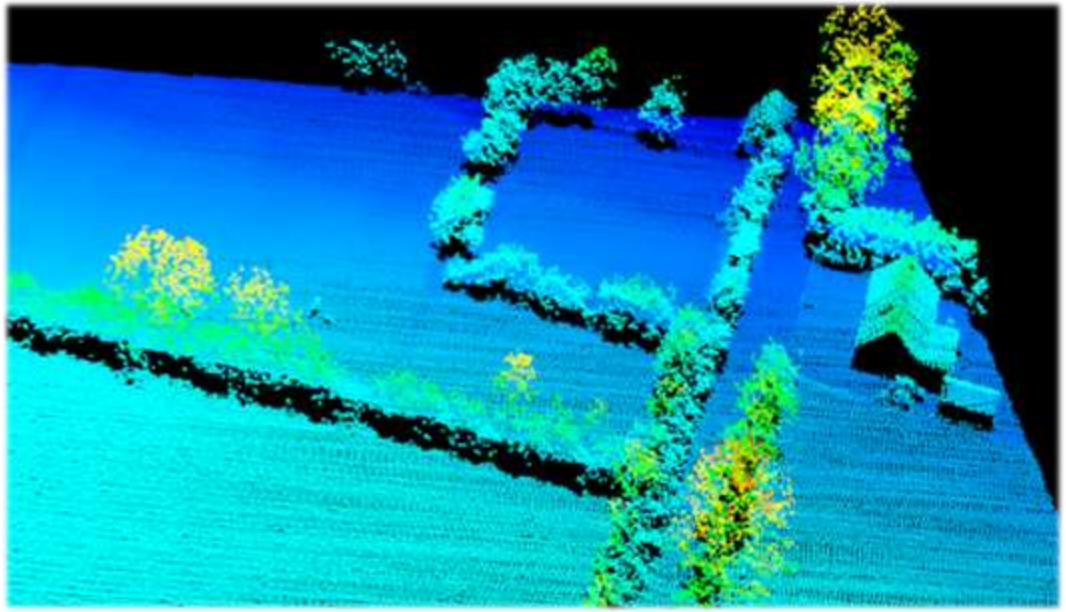
Table 1.3 Key Categories at IPCC Level 2 in 2019

IPCC Category code	IPCC Category (level 2)	GHG	2019 Estimate (kt CO_2 eq)	Level Assessment (%)	Cumulative Total of Level (%)
3.A	Enteric Fermentation	CH4	12,151.21	20.33	20.33
1.A.3	Transport	CO2	12,045.94	20.15	40.48
1.A.1.	Energy Industries	CO2	9,217.97	15.42	55.90
1.A.4	Other Sectors (Comm/Resid/Agric)	CO2	8,751.95	14.64	70.54
3.D.	Agricultural Soils	N2O	5,723.32	9.57	80.11
1.A.2.	Manufacturing Industries and Construction	CO2	4,567.77	7.64	87.76
2.A.1	Cement Production	CO2	1,892.60	3.17	90.92
3.B	Manure Management	CH4	1,572.27	2.63	93.55
5.A	Solid Waste Disposal	CH4	676.88	1.13	94.68
2.F.1	Product Uses as Substitutes for ODS -Refrigeration and air-con	HFC	671.60	1.12	95.81

Farm Businesses don't have the luxury to look at Carbon Neutrality, through single, silo lens

J. Gilliland's QUB Inaugural Lecture https://bit.ly/3MvNGUg

Achieving Net Zero – The Role of Increasing Carbon Stocks on Farm



Increasing Carbon Stocks is the poor relative to Reducing Emissions in Race to Net Zero

- Both are needed Simultaneously; Knowledge Gaps greatest in increasing Carbon Stocks
- Cost reduction, Smart MRV & Policy Recognition is Essential
- But Best tool to encourage positive farmer behavioural change…..

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