Farm Carbon Cutting Toolkit

Carbon, Cows and Calculators

Digging deeper into the solutions

Becky Willson

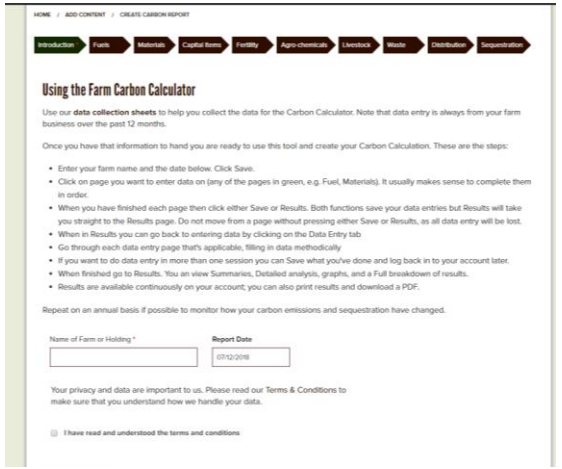
The Farm Carbon Cutting Toolkit

Farm Carbon Cutting Toolkit

Aim: to encourage and support farmers and growers to reduce their greenhouse gas emissions, increase their farm energy resilience and in doing so improve their farm business in the future

Key resources

Farm Carbon Cutting Toolkit



THE SOIL CARBON PROJECT

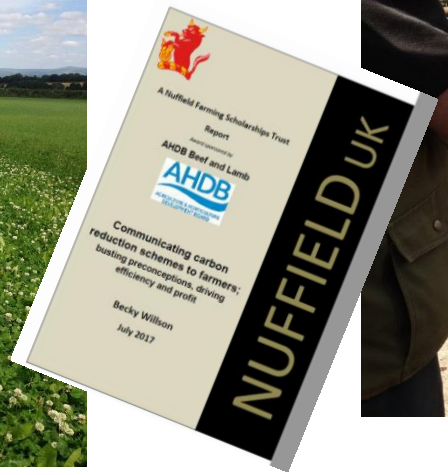
The day job…..

Farm Carbon Cutting Toolkit

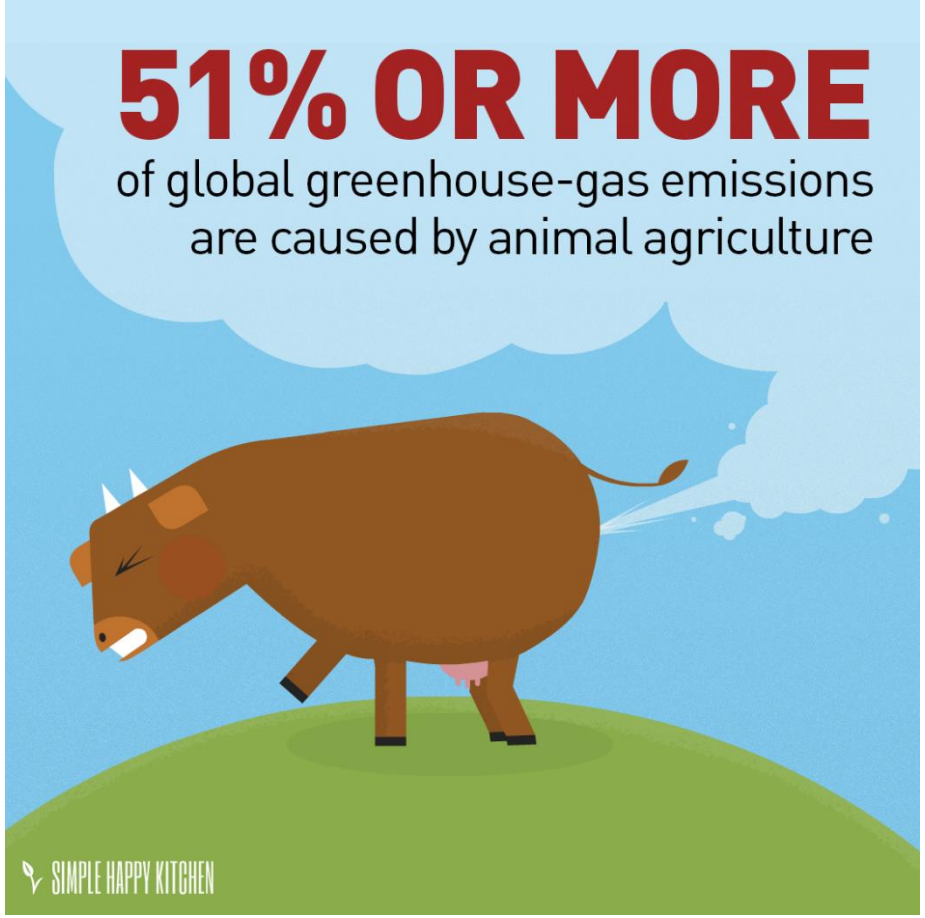
Duchy College
RURAL BUSINESS SCHOOL

THE SOIL CARBON PROJECT

THE FARM CRAP APP



GHGs from Agriculture

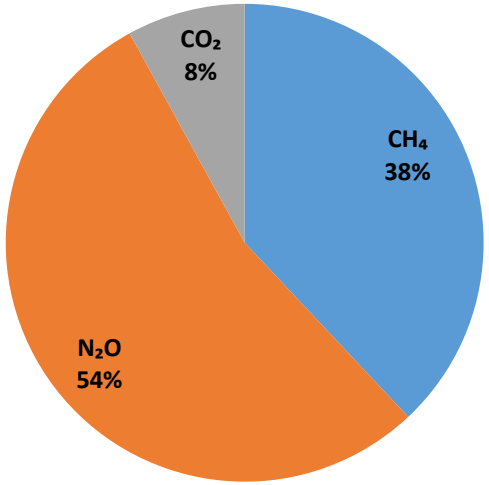


What is the real number?

- UK 10% of emissions
- Globally about 24-25% of emissions 5.1 – 6.1Gt CO2e/yr
- Can we appreciate what the numbers mean?

Greenhouse Gases from agriculture

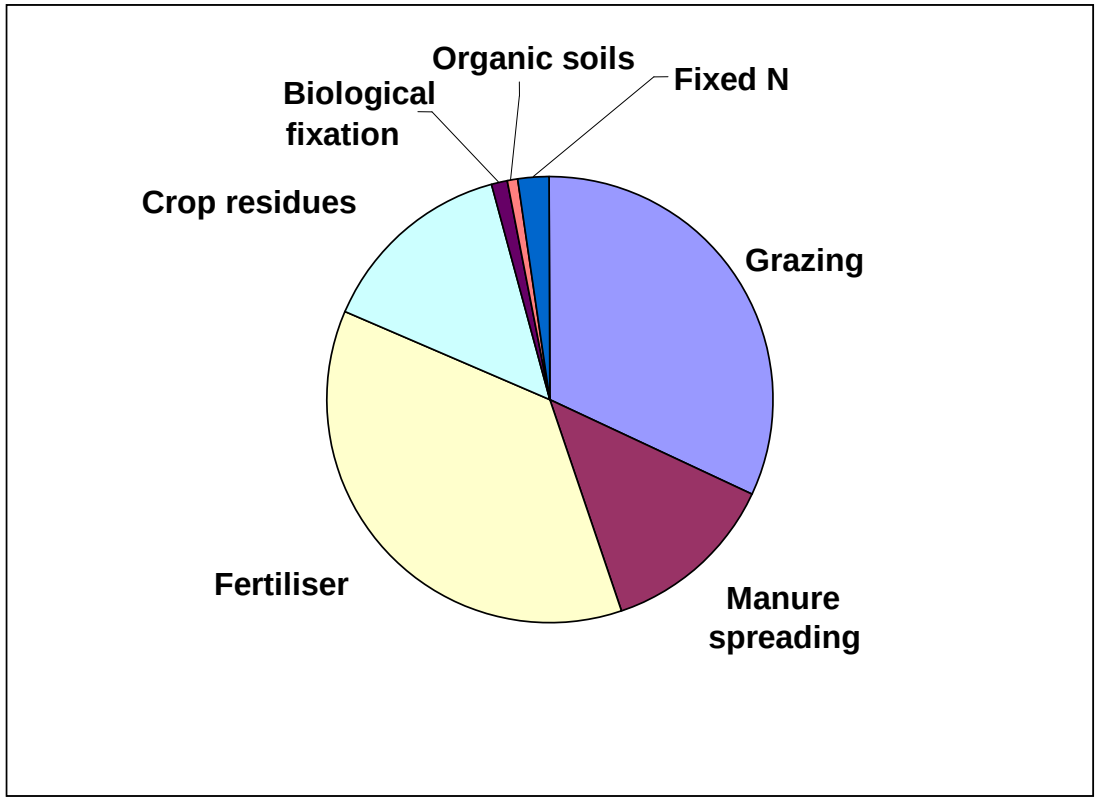
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Carbon Dioxide (CO_2)
- Ag: 10% of UK emissions



- Carbon management and business efficiency are closely linked
- No ‘one size fits all’ – a complicated industry!
- Linked to food production, difficult to measure and dependent on the weather

Land based Emissions of Nitrous Oxides

- 80% of UK nitrous oxide emissions are from agriculture
- Mainly from soils and fertiliser production
- Indirectly they also come from:
  - Nitrate leaching
  - Nitrogen deposition



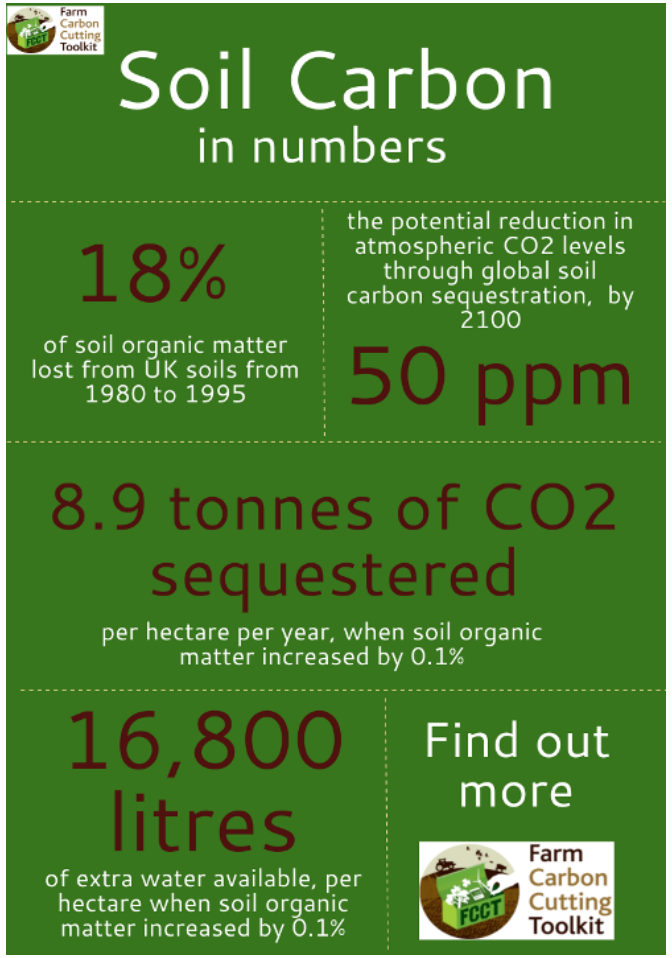
Emissions from methane

- Enteric fermentation
- Released from manure and slurry
- Can be reduced per unit of production through improved livestock health, modification of animal diets and breeding

Carbon dioxide

- CO_2 released from burning of fossil fuels (farm vehicles and machinery)
- Electricity production for on-farm use
- Production of agro chemicals
- Disturbance of soil – cultivation / land use change

Carbon sequestration (more on this later)



5 billion hectares of hope..

Managing carbon on –farm: Why should we bother?

- National targets to reduce C emissions from agriculture
- CC Act – ↓emissions by at least 80% of 1990 levels by 2050
- New Net zero legislation (June 2019)
- Also international targets
- Increasing attention on agriculture

Why manage carbon on-farm

- It makes business sense!
- It allows us to be more informed and make decisions
- It enables a positive narrative
- It creates more resilient businesses
- Future proofing

Carbon footprinting

You can’t manage what you don’t measure

Measuring carbon on-farm

Identifying the C footprint of a business is the first vital step in being able to quantify the contribution that the farm is making to climate change

Identifies quantity and source of CO_2, CH_4, and N_2O emitted from farm and highlight areas where improvements or changes can be made to reduce GHGs.

Allows you to become more aware and make informed decisions

Metrics need to be relevant, practical, consistent and **inform behavioural change**

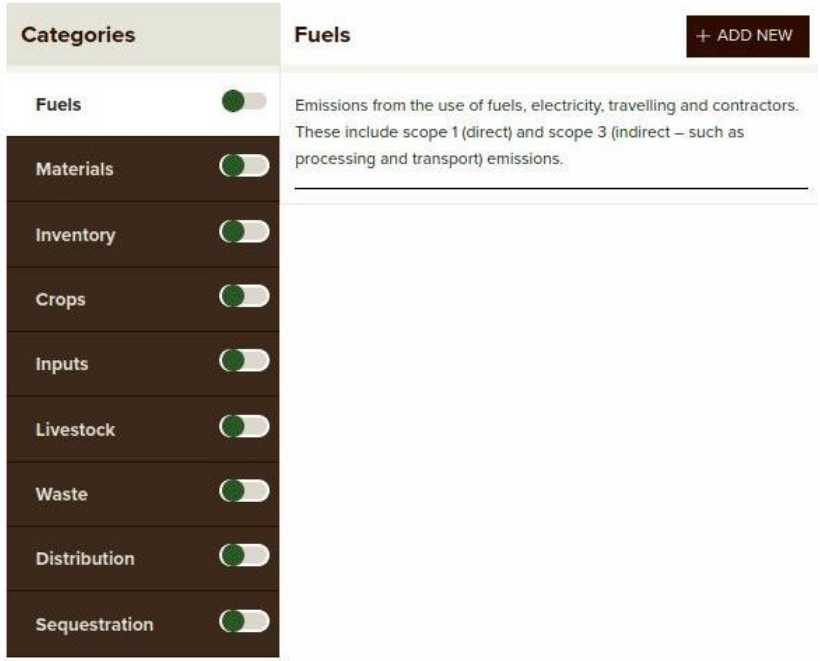
Farm Carbon Cutting Toolkit

The Carbon Calculator

- Developed for farmers by farmers
- Free to use
- Accounts for soil carbon sequestration
- Linked into soil carbon research project to populate models
- Allows monitoring of the farm's footprint annually
- Provides footprint as CO_2e but ability to see different GHGs
- Inclusion of new methane methodology
- New reporting format and user interface being developed currently and was launched at Oxford 2020.

How to calculate your carbon footprint

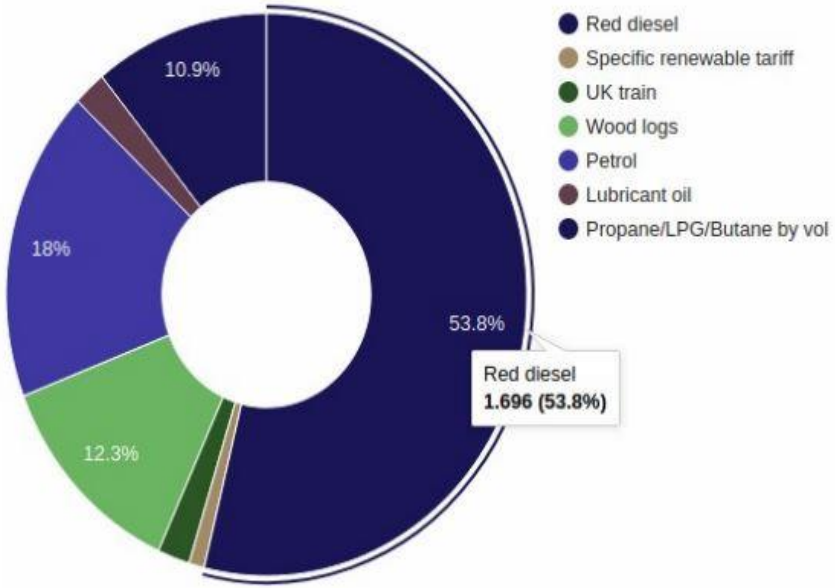
1. Login or register
2. Collate your data first
3. Create a report / enter your data

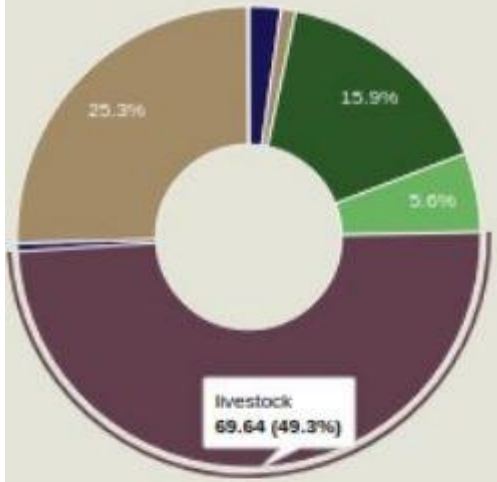


Calculating your carbon footprint

Live results

Fuel type	Quantity	Emissions (t CO_2e)	
Liquid fuels > Red diesel	500 litres	1.6955	EDIT DELETE
Electricity > Specific renewable tariff	1,200 kWh	0.0300	EDIT DELETE
Public transport > UK train	800 miles	0.0630	EDIT DELETE
Solid fuels > Wood logs	250 kg	0.3881	EDIT DELETE
Liquid fuels > Petrol	200 litres	0.5652	EDIT DELETE
Liquid fuels > Lubricant oil	20 litres	0.0641	EDIT DELETE
Gas fuels > Propane/LPG/Butane by vol	200 litres	0.3428	EDIT DELETE
Total for Fuels:		3.15	



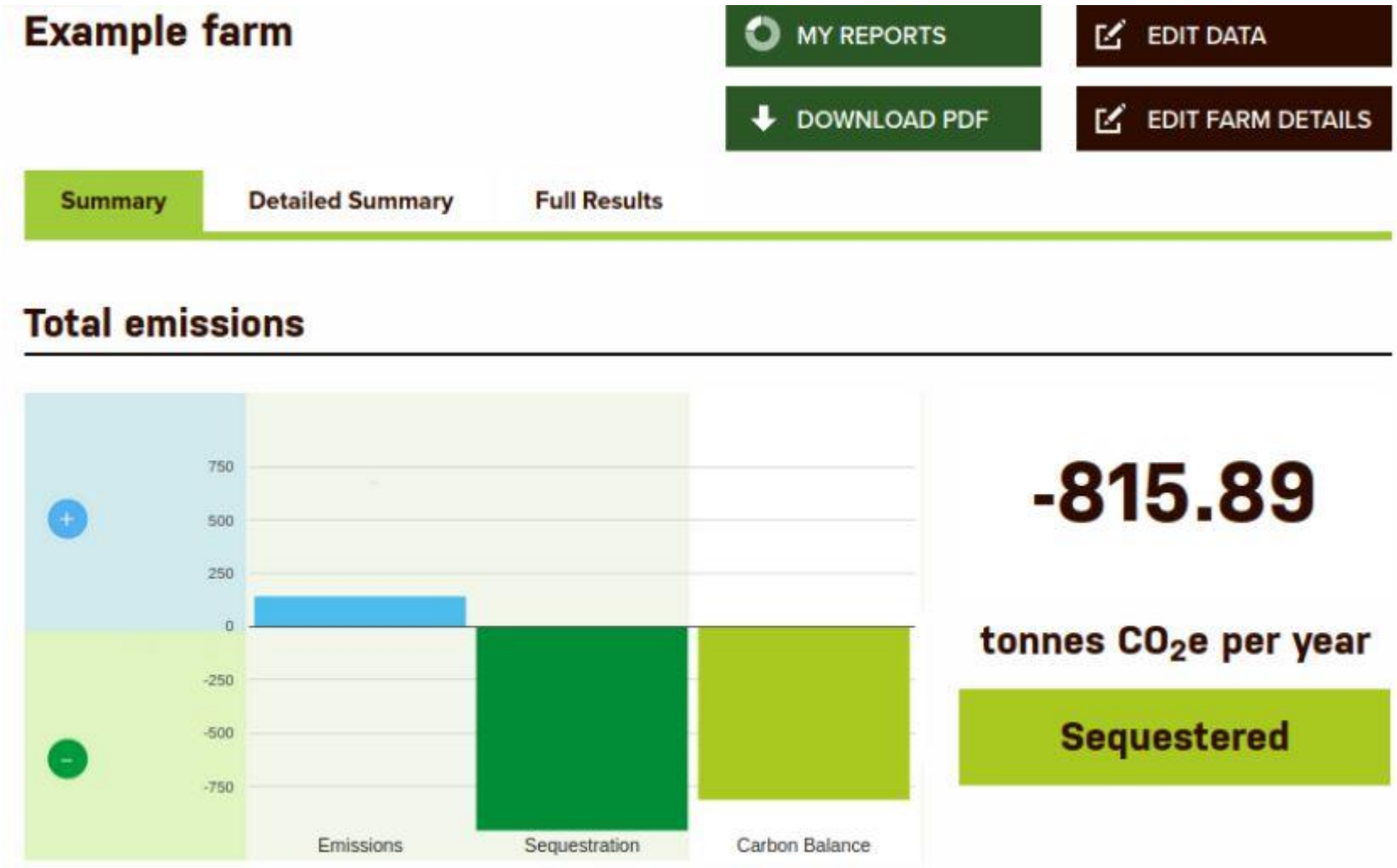


Emissions Totals

Type	t CO_2e/year
Fuels	3.15
Materials	1.45
Inventory	22.39
Crops	7.85
Chemicals	0.15
Livestock	69.64
Waste	0.79
Distribution	35.79
Sequestration	0.00
Total:	**141.21**

Calculating your footprint

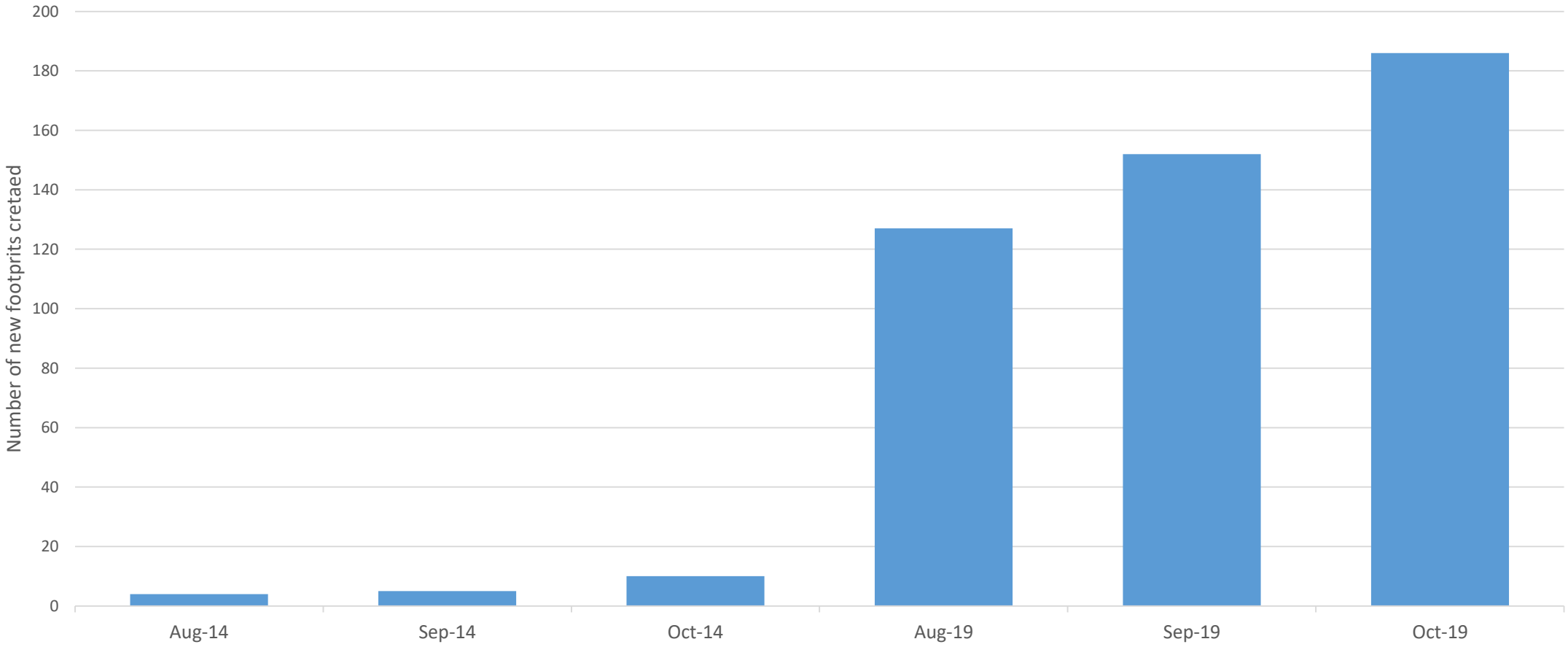
Your carbon balance



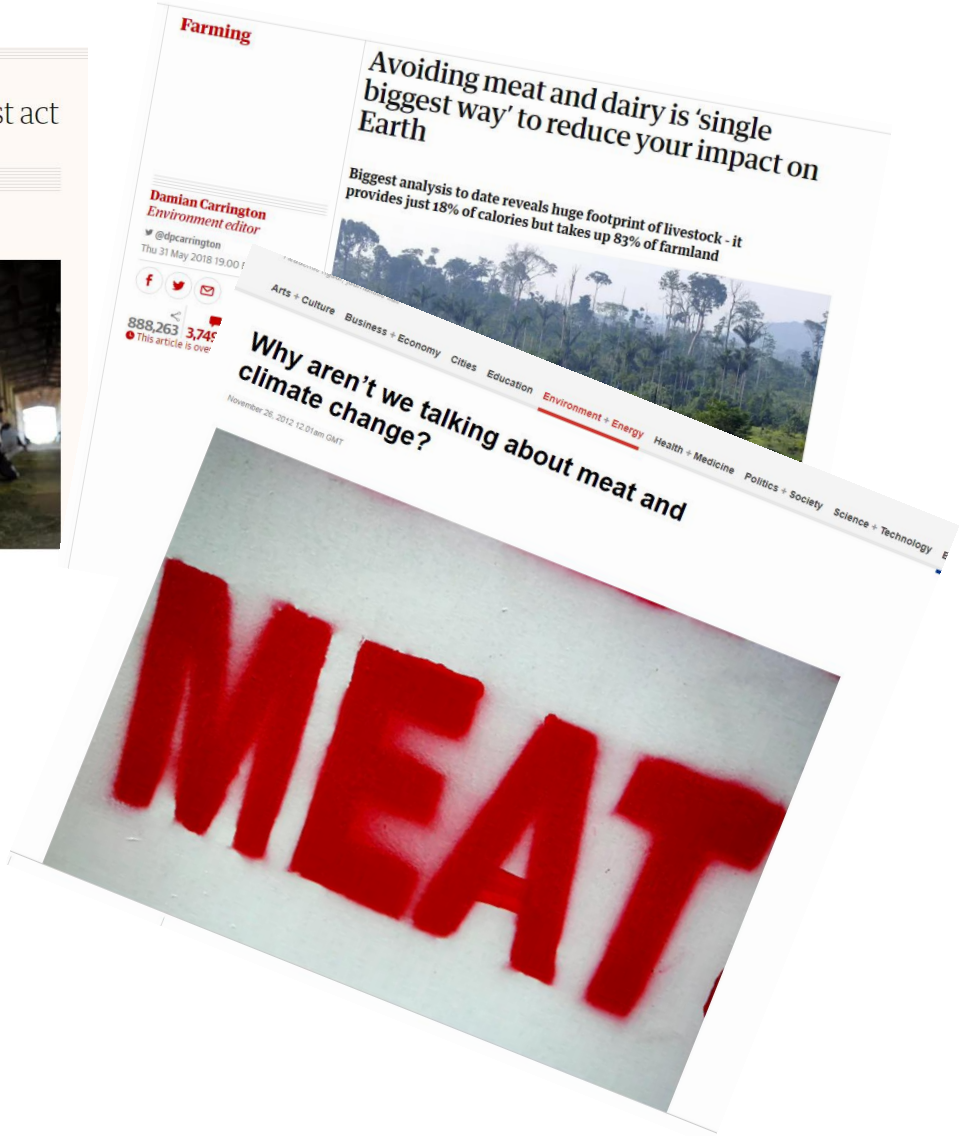
Interpreting results

- A key part of the process
- Can be used to evaluate current position and plan the farm's strategy for reducing emissions and improving sequestration in the future
- Gives you a baseline
- Allows you to be more informed
- Provides evidence to change management

The rise in interest!



What is driving this interest?



The age of misinformation

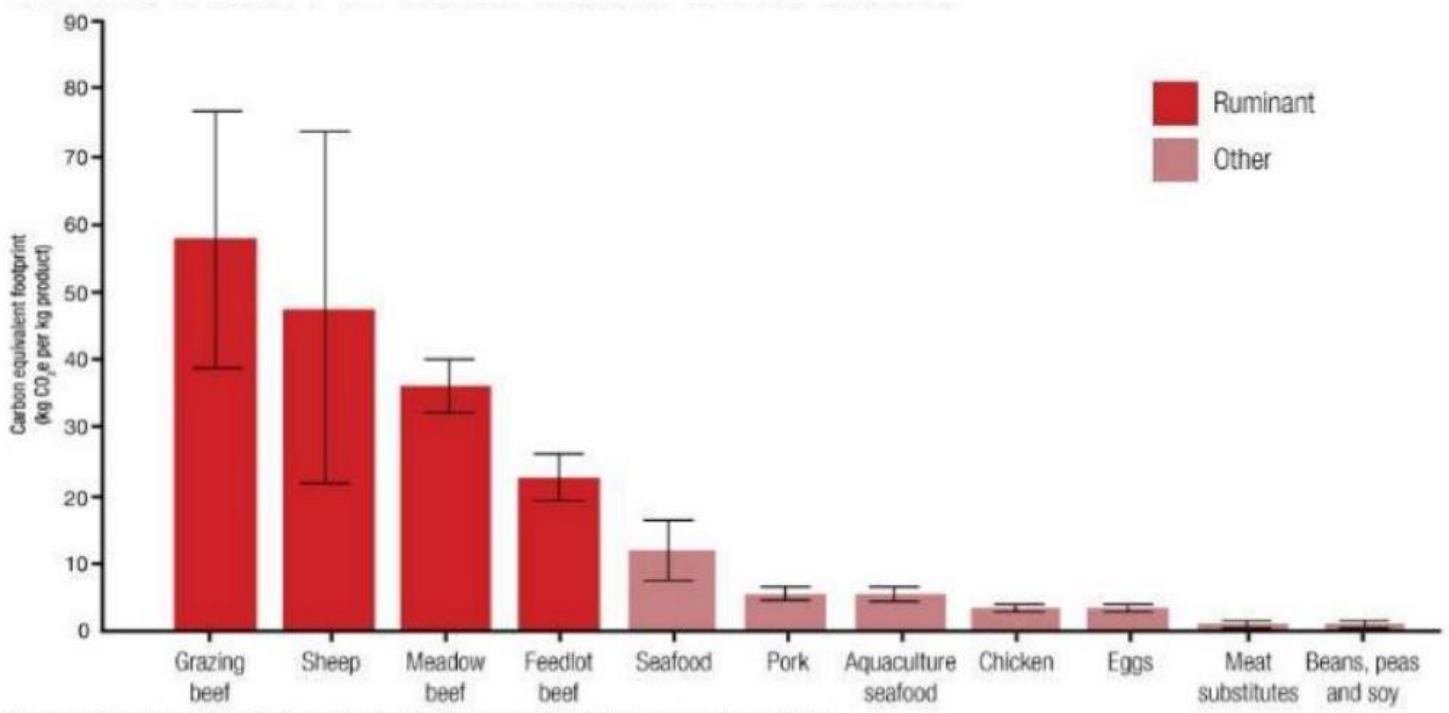
Being driven by:

- A lack of **understanding** and a desire to **simplify** messages
- No **consistent** way of measuring the footprint of a farm – lack of clarity from government
- National and international accounting methods **silo emissions and sequestration**
- A **lack of confidence** from farmers to respond to claims due to **lack of data**
- A lack of clarity and research on the potential of **soil carbon sequestration**

Ruminant Livestock – enemy number 1

Why does it look so bad?

Global Warming potential – mass based assessment (CO2eq/kg product)



Reproduced from Nature Climate Change: Ruminants, climate change and climate policy; January 2014

New Research: change what you measure

ROTHAMSTED RESEARCH

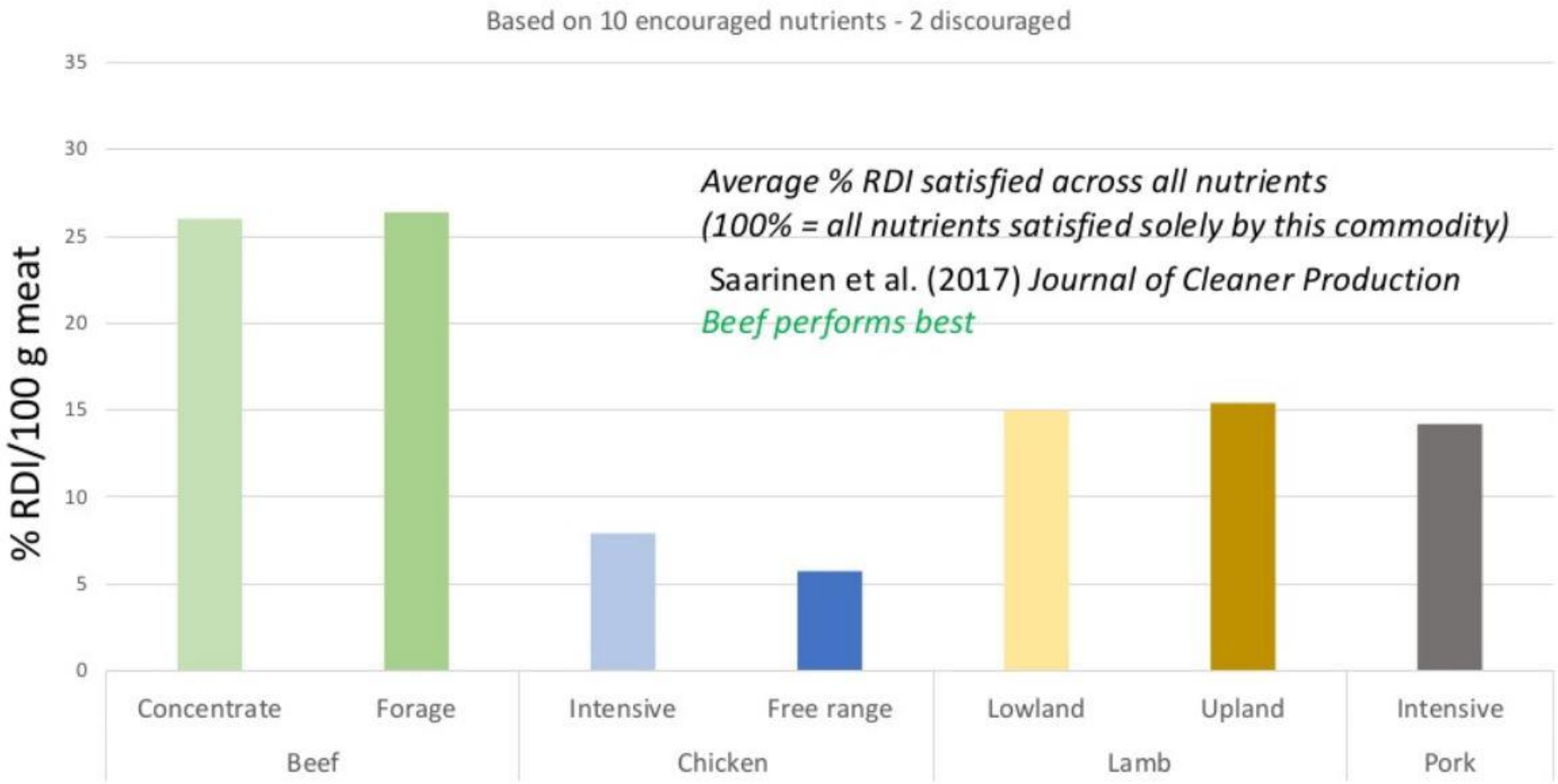
Accounting for nutritional quality: nutrient index (NI)

(contents per 100 g meat)

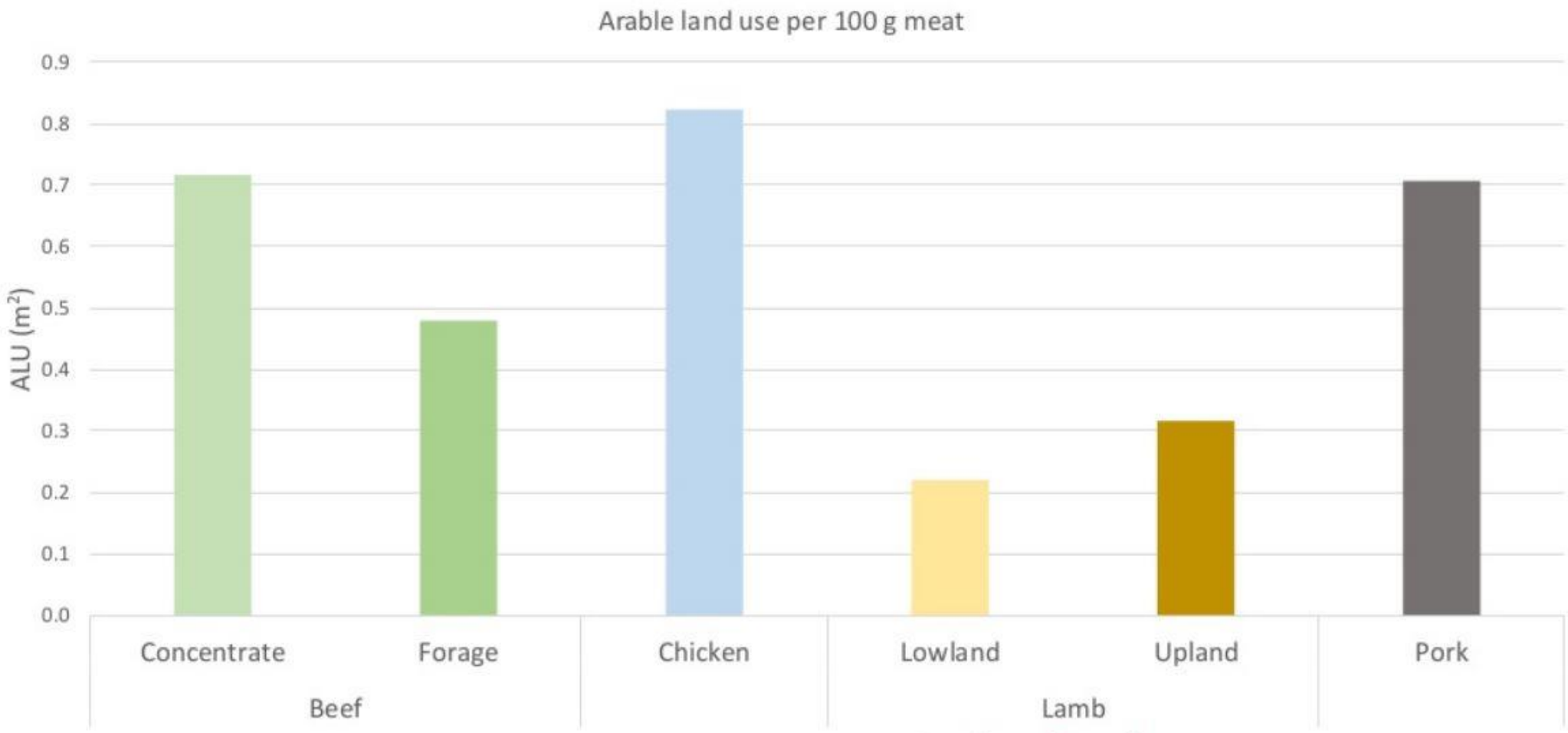
			Beef		Chicken		Lamb		Pork
Nutrient	Unit	RDI	Concentrate	Forage	Intensive	Free range	Lowland	Upland	Intensive
Protein	g	50.25	23.5	23.5	26.3	26.3	20	20	18.6
MUFA	g	37.5	1.13	1.63	3.70	5.44	1.30	1.07	0.85
EPA+DHA	mg	250	3.4	27.4	17.6	14.7	26.4	31.7	14.8
Ca	mg	700	5	5	11	11	12	12	10
Fe	mg	11.75	1.6	1.6	0.7	0.7	1.4	1.4	0.4
Riboflavin	mg	1.2	0.26	0.26	0.15	0.15	0.2	0.2	0.18
Folic acid	µg	200	16	16	9	9	6	6	1
Vitamin B12	µg	1.5	2	2	0	0	1	1	1
Se	µg	67.5	8	8	15	15	3	3	11
Zn	mg	8.25	4	4	1.5	1.5	2	2	1.3
Na	g	6	0.07	0.07	0.08	0.08	0.07	0.07	0.05
SFA	g	25	1.14	1.50	2.43	3.69	1.34	1.21	0. 90

Using nutrient indices

Accounting for nutritional quality: nutrient index (NI)



Accounting for other metrics: arable land use (ALU)



Lamb performs best

Wilkinson and Lee (2018) *animal*

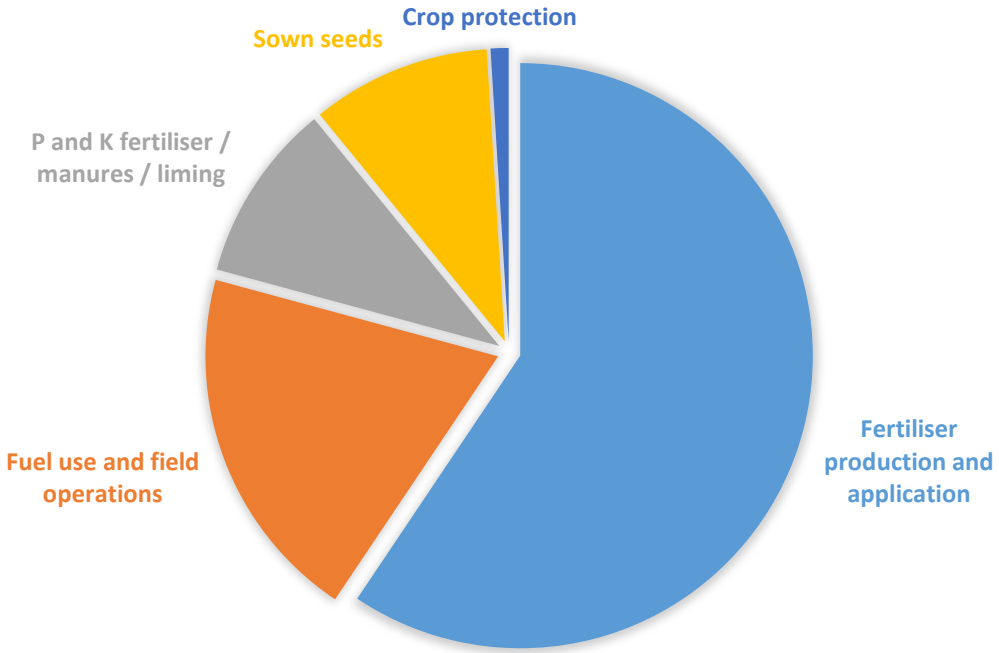
Other new research into methane

- The difference between long lived climate pollutants (CO2) and short lived climate pollutants (namely methane).
- Shows that methane doesn’t behave in the same way as carbon dioxide and the conventional accounting methods aren’t working.
- Important in terms of modelling and developing strategies for achieving net zero

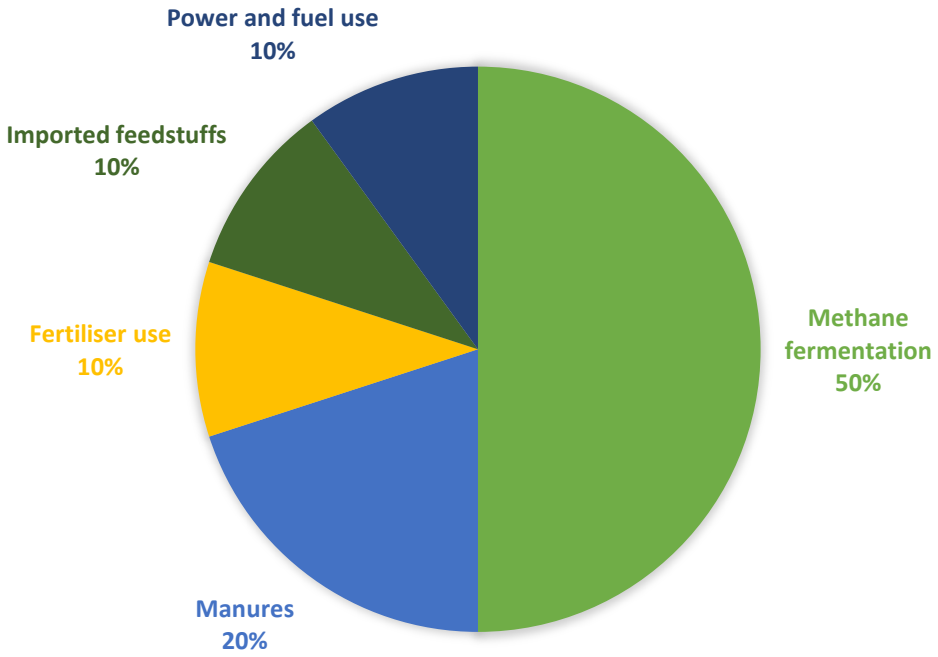
What can we do about it?

Where do the emissions come from?

Arable farms



Ruminant livestock farms



5 key actions to focus on

- Optimising livestock performance
- Soils, fertilisers and manures
- Energy and fuel use
- Developing renewable energy
- Locking in carbon

What about sequestration?

Carbon sequestration

- The deal with trees

Table 4.1 Forest carbon stock

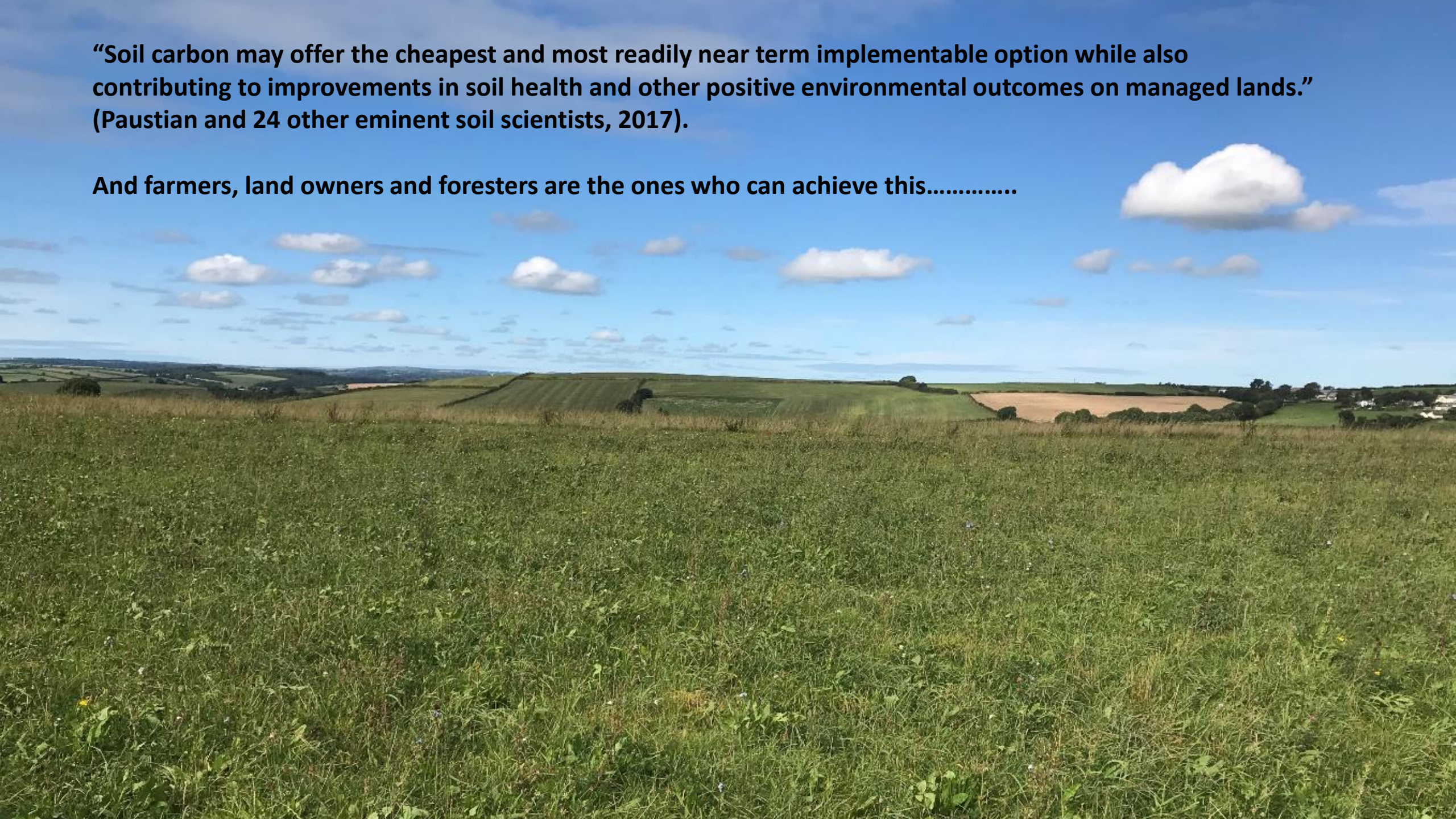
	1990	2000	2005	2010	2015
		million tonnes of carbon dioxide equivalent			
Carbon in above-ground biomass	360	471	527	583	639
Carbon in below-ground biomass	129	170	190	210	230
Carbon in dead wood	9	10	10	10	10
Carbon in litter	165	175	179	182	187
Soil carbon [1, 3]	2 366	2 533	2 594	2 629	2 715
Total forest carbon	**3 029**	**3 359**	**3 500**	**3 614**	**3 781**

Source: Forestry Commission

Also include on-farm hedges

Soil Carbon

The often overlooked opportunity.



“Soil carbon may offer the cheapest and most readily near term implementable option while also contributing to improvements in soil health and other positive environmental outcomes on managed lands.” (Paustian and 24 other eminent soil scientists, 2017).

And farmers, land owners and foresters are the ones who can achieve this……..

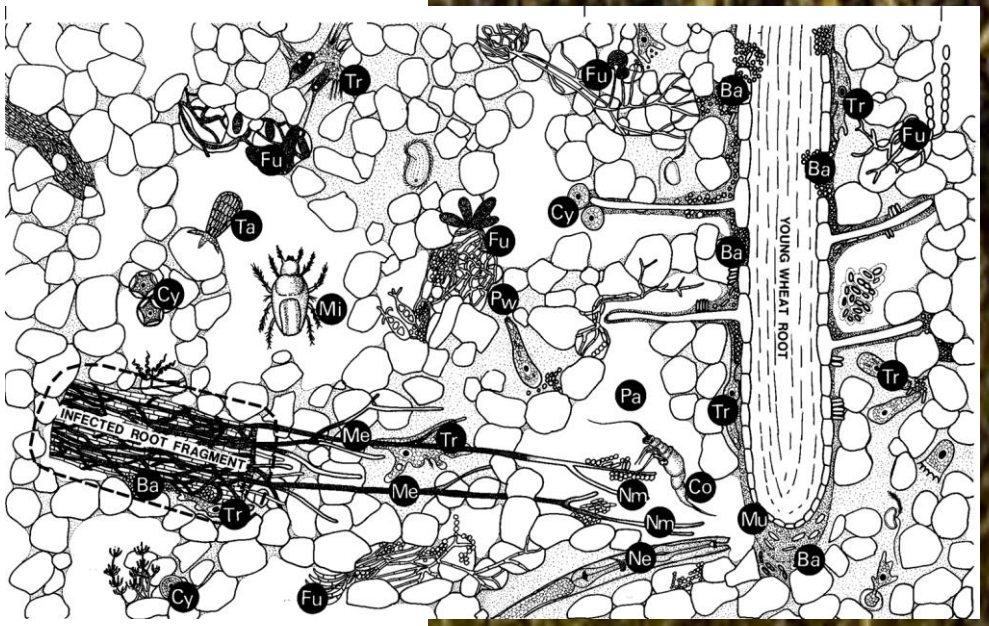
What is soil organic carbon?

Decomposing plants

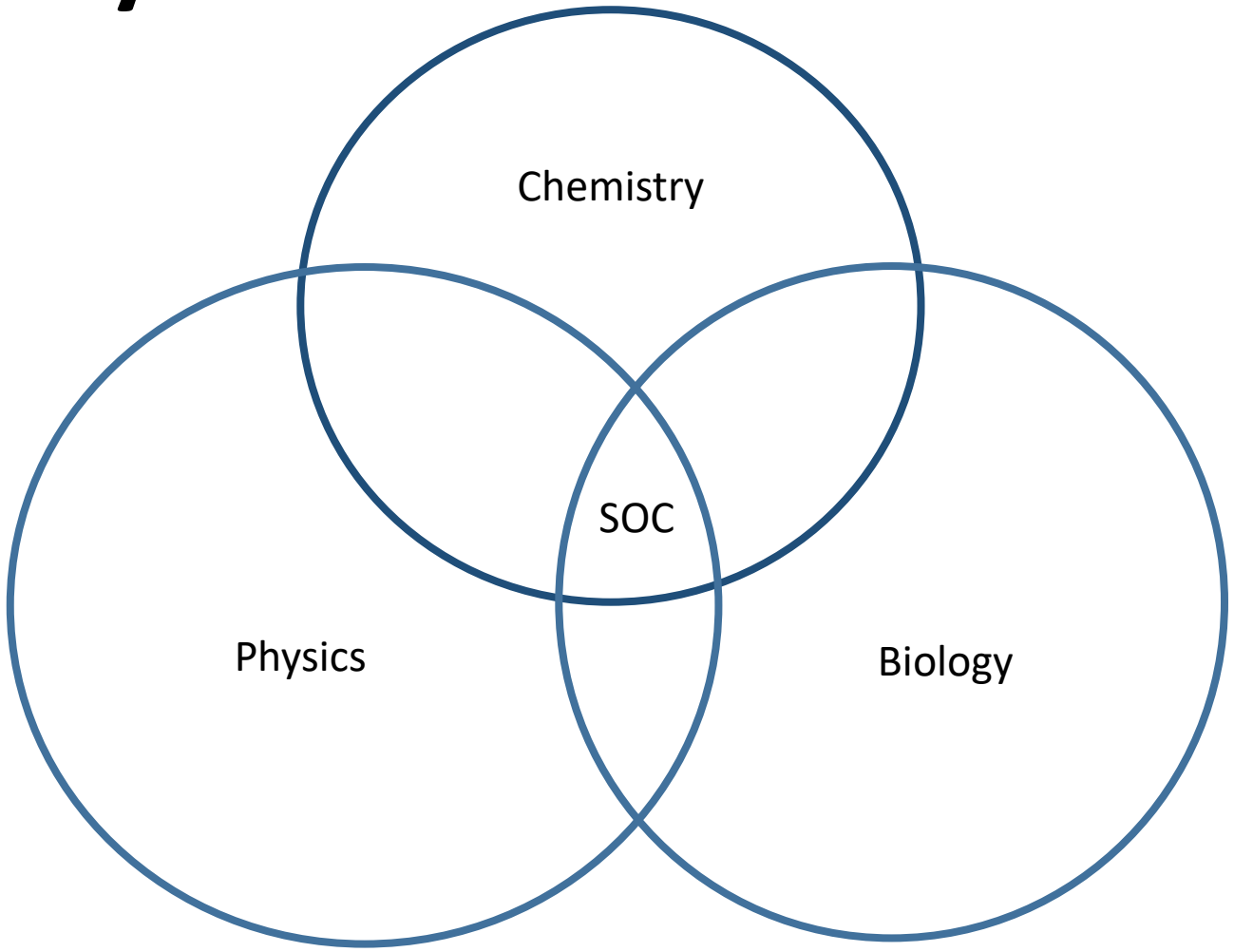
‘the energy of the sun flowing through your soil’

60% of soil organic matter

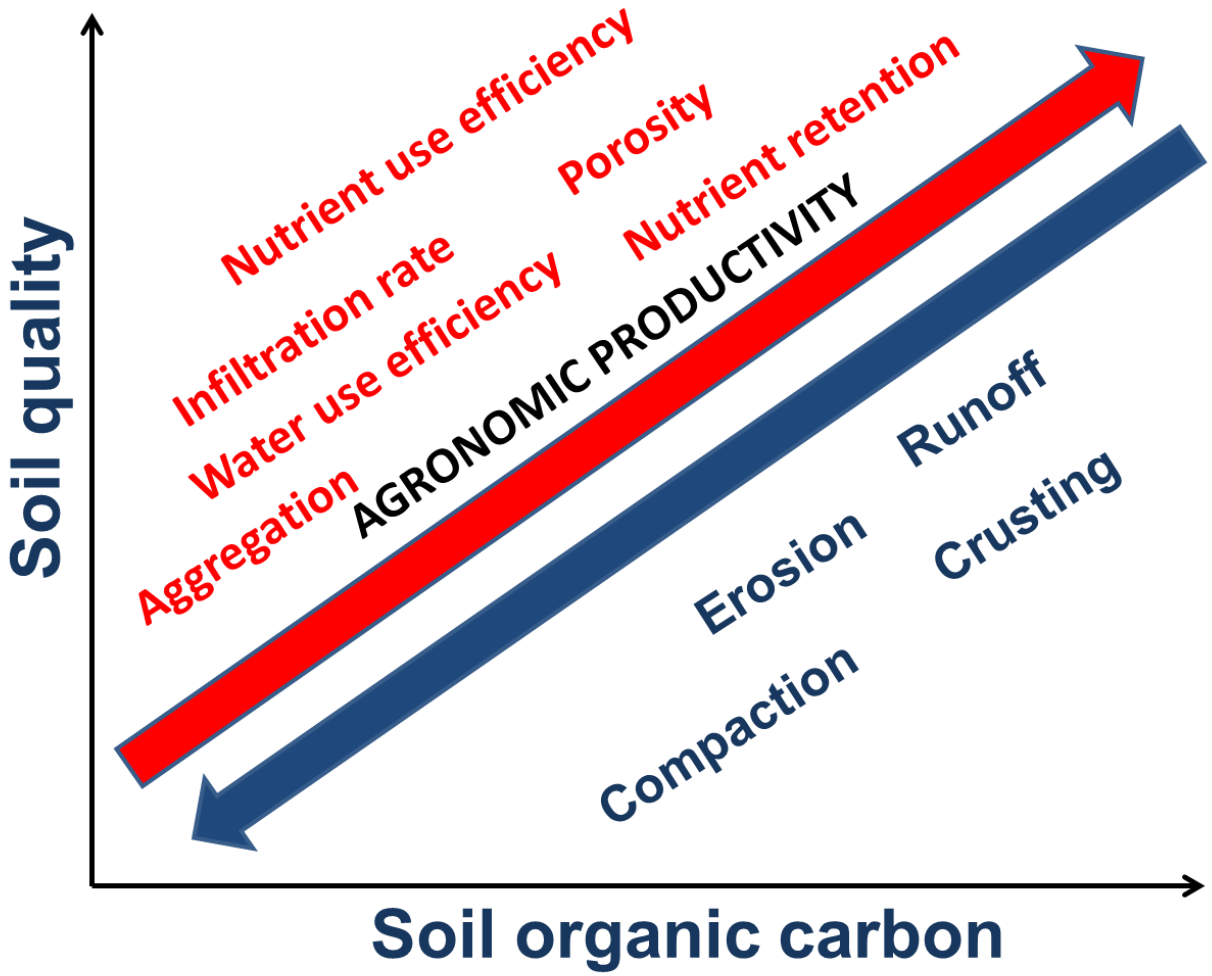
- 5% of soil organic matter is alive (soil biology)
- Underground industry supporting the sustainability of your farm



What drives a healthy soil?



How soil organic carbon increases yields



Acknowledgements: Prof Rattan Lal, The Ohio State University

Soil HealthExpert

How to increase soil organic carbon?

- Land use change
- Reduce erosion
- Organic amendments (manure and biosolids)
- Reduced tillage (green mulches and crop residues)
- Deep roots in deep soil horizons

Project aims

To understand in more detail how farmers can build soil health & business resilience and its links to soil organic matter & soil carbon content.

By:

- Assessing how to test for soil carbon
- Understanding the impact of testing depth
- Evaluating the link between soil organic matter and proxy measures
- Investigating the impact of soil carbon on whole farm carbon footprint
- Assessing the impact of management practices

Proxy tests

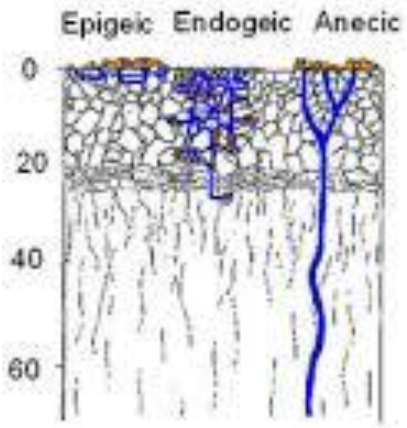


Figure 1. Assessment of appearance of air-dry peds in artificial effluent (SAR 5; EC 1 dS/m).

Farm Soil Survey

- Range of soils & farms
- ~15 samples per field, (0-10, 10-30, 30-50cm)
- Proxy measures:
  - soil structure,
  - infiltration,
  - worm numbers
  - aggregate stability
- Management, crop history

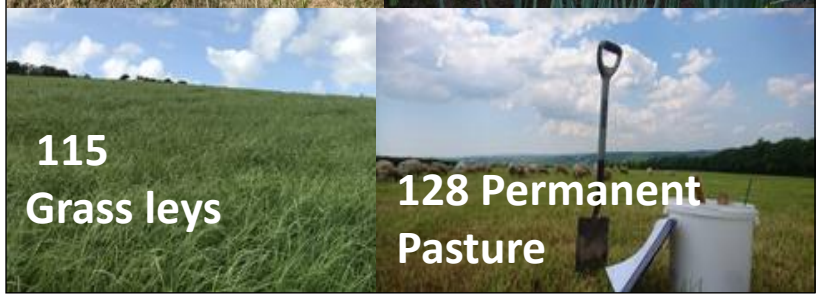
So far:

88 Farms

472 fields

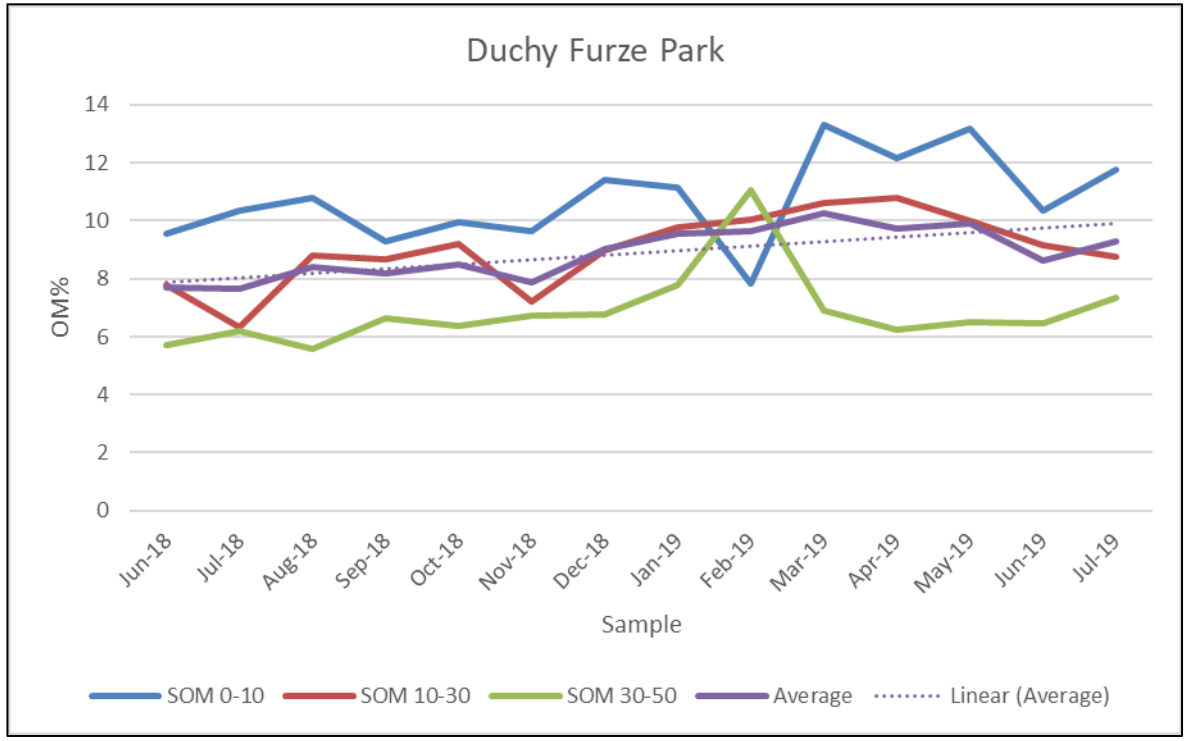
(368 fields twice)

2,705 Ha



Project findings: Seasonal variation

	SOM 0-10	SOM 10-30	SOM 30-50	**Average**
Jun-18	9.54	7.79	5.71	**7.68**
Jul-18	10.36	6.35	6.19	**7.63**
Aug-18	10.8	8.8	5.59	**8.40**
Sep-18	9.31	8.67	6.62	**8.20**
Oct-18	9.95	9.21	6.37	**8.51**
Nov-18	9.66	7.21	6.74	**7.87**
Dec-18	11.39	8.96	6.76	**9.04**
Jan-19	11.15	9.79	7.77	**9.57**
Feb-19	7.84	10.04	11.07	**9.65**
Mar-19	13.29	10.6	6.91	**10.27**
Apr-19	12.14	10.8	6.22	**9.72**
May-19	13.2	9.98	6.5	**9.89**
Jun-19	10.34	9.15	6.44	**8.64**
Jul-19	11.78	8.77	7.35	**9.30**



The impact of grazing

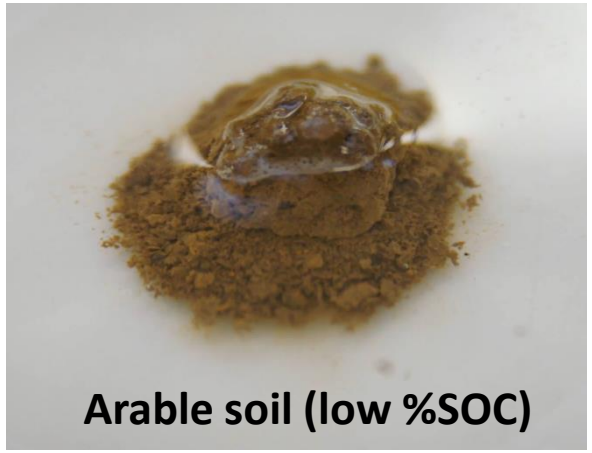
- Moving from set stocking to rotational (and / or mob grazing) seems to improve soil carbon levels (from 0.1 – 0.6% /ha/yr). Cautiously optimistic.
- Including deep rooting species (where possible) can supercharge this process
- Diversity of species increases diversity of rooting depths – good for soil health!
- Including legumes and reducing fertiliser is a good help both for soil carbon and reducing emissions!

Soil aggregate stability is best test for soil organic carbon

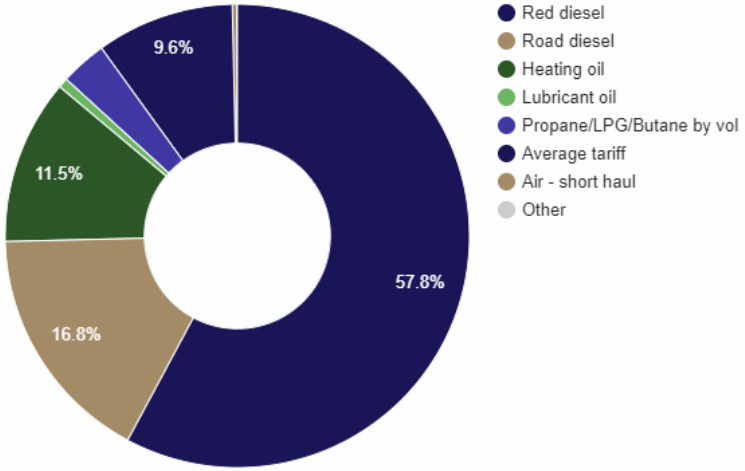
Soils with good physical structure are generally associated with larger soil organic carbon contents.

A constant supply of soil organic carbon is needed for aggregate formation and stability.

Stable aggregates indicate the level of soil organic carbon in farm soils



How does carbon measurement work in practice?



Farm example: Overall results

Footprint per hectare -0.54/ha/yr

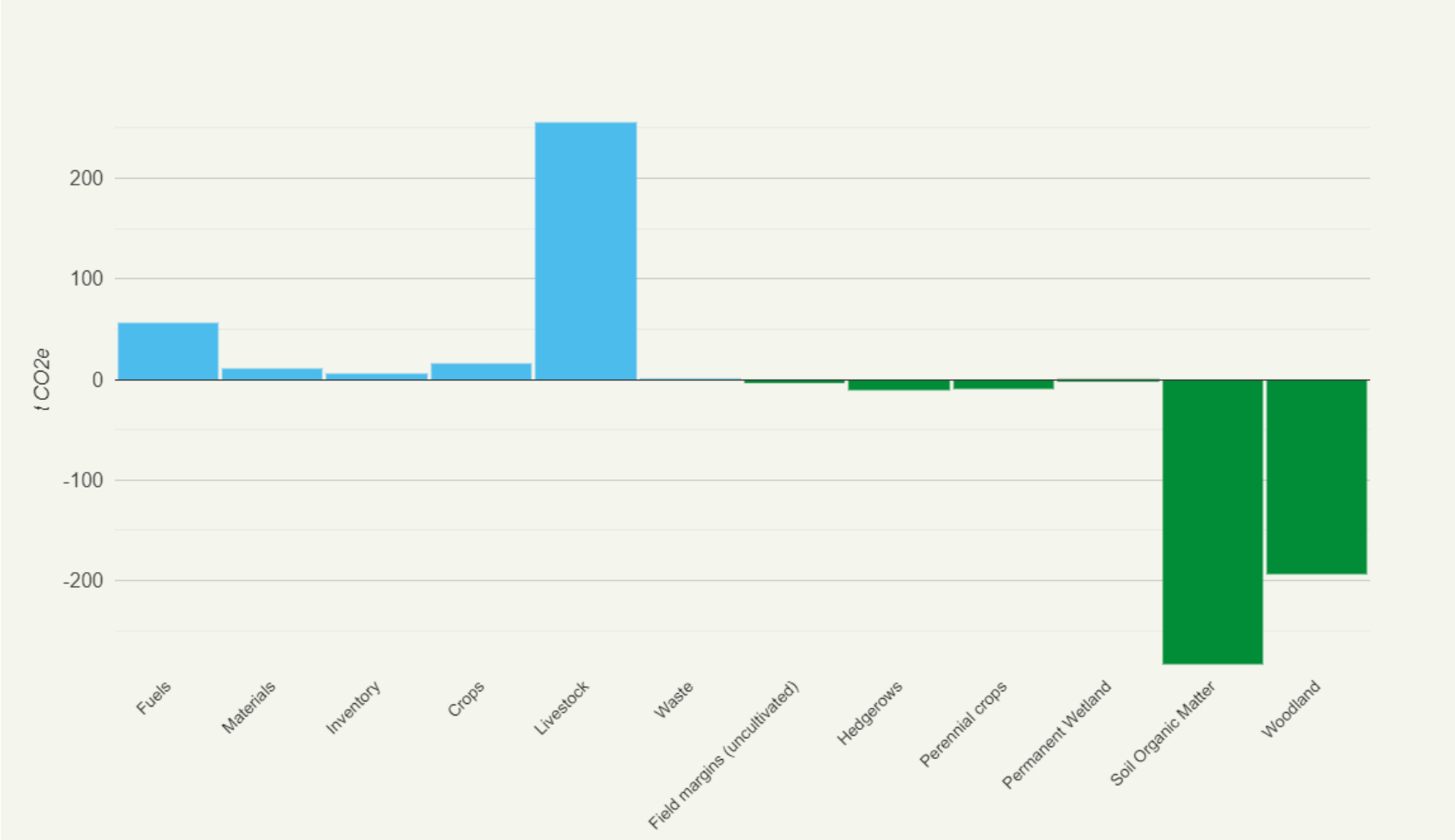
Total emissions

-158.65

tonnes CO_2e per year

Sequestered

Headline results per category



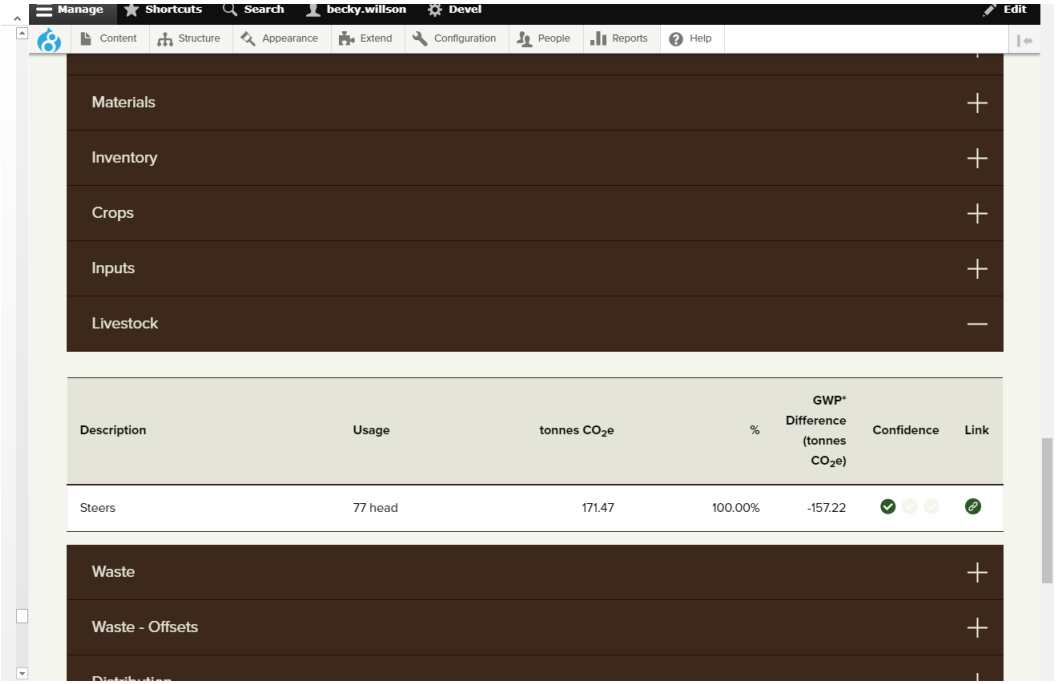
Percentage emissions from each category

Emissions	tonnes CO_2e	%
Fuels	55.92	16.33%
Materials	10.36	3.03%
Inventory	5.38	1.57%
Crops	15.97	4.66%
Livestock	254.70	74.39%
Waste	0.04	0.01%
Total	**342.38**	**100%**

Sequestration	tonnes CO_2e	%
Field Margins (Uncultivated)	-2.97	0.59%
Hedgerows	-10.48	2.09%
Perennial Crops	-9.90	1.98%
Permanent Wetland	-1.50	0.30%
Soil Organic Matter	-282.83	56.45%
Woodland	-193.35	38.59%
Total	**-501.03**	**100%**

What we've not included

- New methane methodology
- Transfers livestock emissions from GWP100 to GWP*



Impact on Carbon footprint

- CO2e footprint of 145 cattle – 254.7 t CO2e
- Carbon footprint of 145 cattle using the new methodology…….

A reduction in the carbon footprint of the livestock by 210.59 tonnes

New Livestock figure 44.11T CO2e

Accounting for nitrous oxide emissions from

Carbon balance per hectare

	Initial carbon balance (tCO2e)	Amended footprint (including methane GWP*) (tCO2e)
Example farm	-158.65t	-369.25t
Example farm / ha	-0.54t	-1.26t
Non organic grass fed farm	155.32t	98 t
Non organic grass fed farm	0.93t	0.6 t

Average carbon footprint per person in the UK 9.7t
America 19.8 t/person
Kenya – 0.3t/person

Take home messages

- The time to act is **now**
- The level of regulation, bureaucracy and legislation is only moving in one direction
- Monitoring business performance and driving efficiencies makes good business sense, saves money, safeguards resources and cuts carbon footprint
- Resource management, food security and environmental issues create business opportunities
- Need data driven decisions, skills development and pilot schemes.

Thank you!

becky.willson@farmcarbontoolkit.org.uk

@FarmC02Toolkit