Building carbon footprints from the bottom up:

Farms, farmers, scale and uncertainty

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Structure

- Story of our experiences
- Uncertainty
- Variability
- Data
- Conclusions

Data capture

- Sample selection
  - Who are you interviewing and why?
  - No sample framework.
  - Are your respondents typical and/or representative?

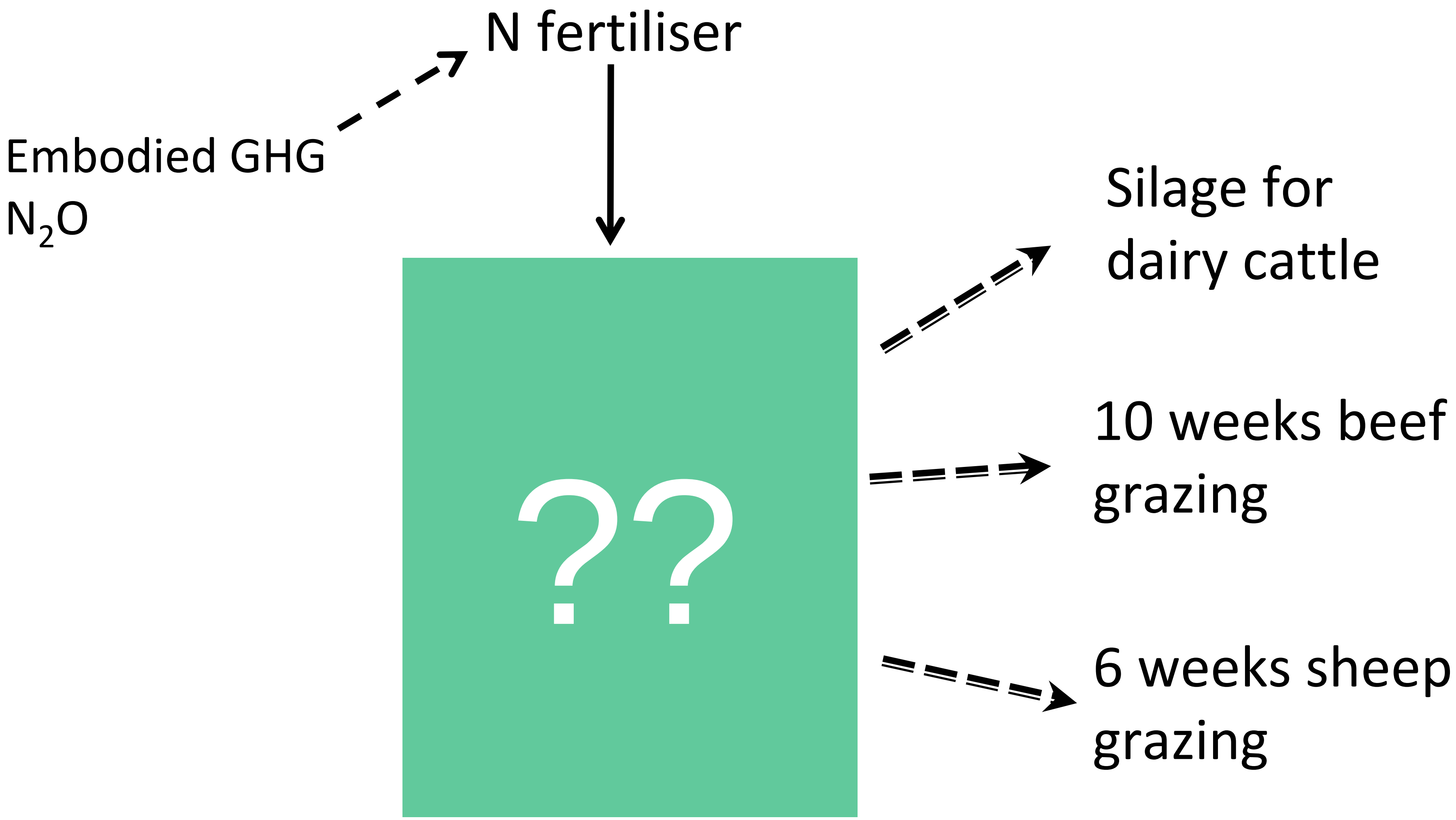
- Time consuming

- Do they have the data you want?

- Will they tell you the truth?

- Do you understand the ‘truth’?

Problem 1 - allocation



Solution to problem 1

Details on all grazing animals sold:

- Liveweight
- Age
- Price
- Understanding of the grazing system

Problem 2 – away wintering

Who is responsible for the emissions of sheep sent away to graze for the winter?

- A) when the sheep farmer pays a Cheshire farmer to take them?
- B) when his brother in Shropshire takes them for free?
- C) when he shifts then between 3 separate farms – all of which he owns but are run as different businesses?

Solution 2

Get an understanding of

- The ‘system’
- the business structure
- legal structures
- informal barters

Problem 3 – diesel use

- How much diesel do contractors use for each task?
- You need to know this in order to do allocation correctly.
- Farmers have no idea how much their contractors use?

Problem 3 - solution

- Talk to contractors about diesel use
- Standard power equations for each operation

Problem 4 - clover

Solution 4

??????

- More science?
- Details on percentage of clover in the sward?

??????

Uncertainty

Uncertainty exists as:

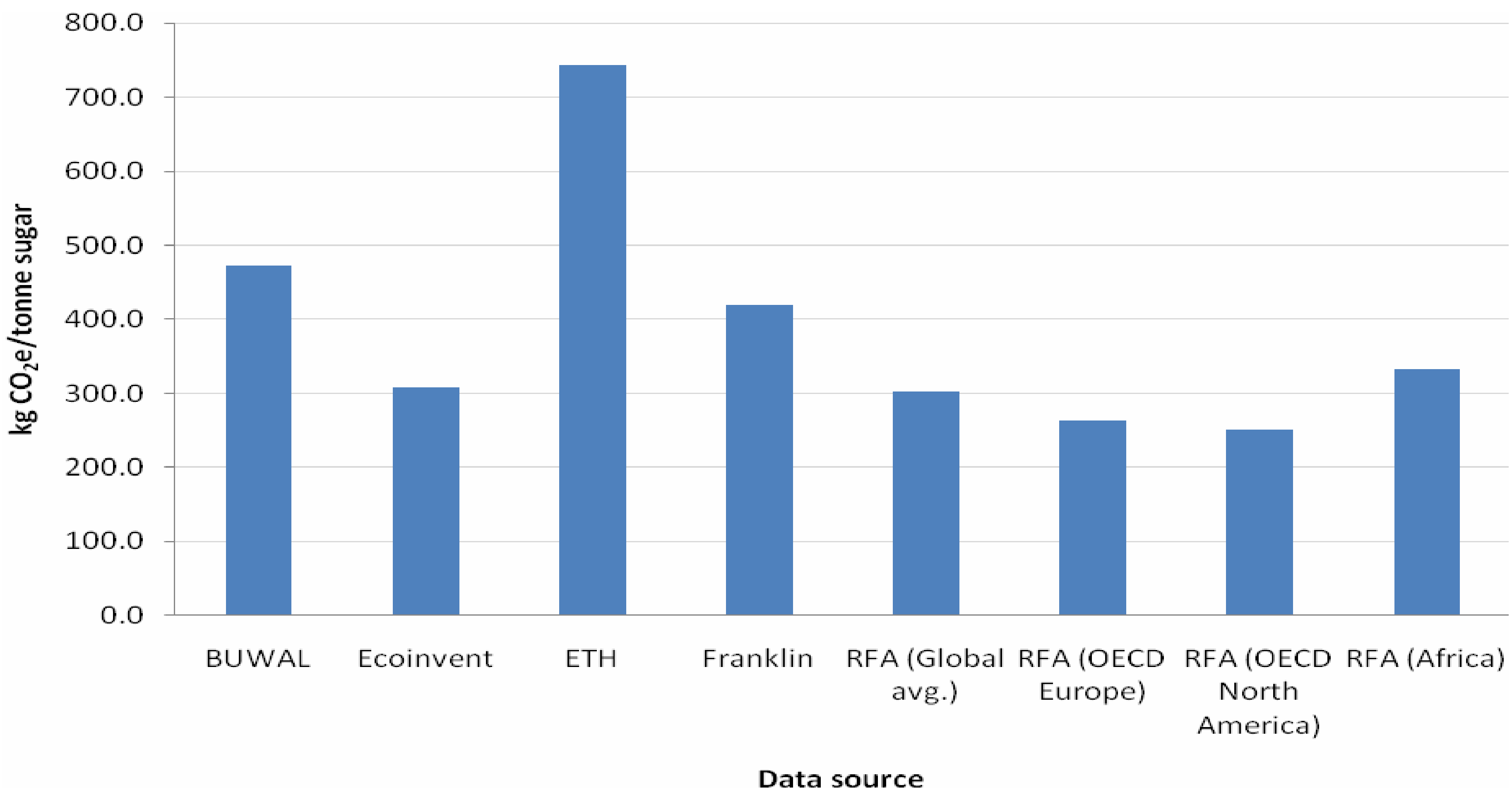
- Uncertainty over emission factors
- Uncertainty over data quality
- Uncertainty over understanding and representation

Ranges of greenhouse gas emissions from the production of different fertilisers, pesticides, concentrate feed and silage film reported in the literature.

Input	Min	Max	Mid
Fertiliser – N (kg CO_2 e kg^{-1} N)	2.99	9.56	6.28
Fertiliser – K (kg CO_2 e kg^{-1} K)	0.3	0.72	0.51
Pesticides (kg CO_2 e kg^{-1} active ingredient)	3.42	34.2	18.8
Concentrate feed (kg CO_2 e t^{-1} product)	108	1156	541.2
Silage film (kg CO_2 equ kg^{-1} plastic)	1.3	1.94	1.64

Variation between different datasets in GHG emissions produced from transporting 1 tonne of sugar 2000km by road, in a 16t truck. (kg CO_2e for 1 tonne-km).

Data taken from four different LCA databases (BUWAL, Ecoinvent, ETH and Franklin) and UK Renewable Fuels Agency (RFA) values.



Why the difference?

- BUWAL value is based on the production and burning of fuel, and assumes that a truck carries on average 50% load
- Ecoinvent include the production, maintainance, operation and disposal of the truck, as well as a proportion of emissions from the construction, maintainance and disposal of roads
- ETH include the production, maintainance, operation and disposal of the truck as well as emissions from road construction and assume 40% vehicle efficiency
- Franklin include truck and fuel production and use only.

QUESTION.

Does the Defra emission factor for diesel include all life cycle stages?

IPCC present a range of emission factors

Example: land use change

	tropical moist deciduous forest			tropical dry forest			
	default	min	max	default	min	max	
Above-ground biomass	260	160	430	120	120	130	tonnes d.m. ha^{-1}
Litter C stocks	2.1	1.0	3.0	2.1	1.0	3.0	tonnes C ha^{-1}
Soil organic C stocks	65	65	65	38	38	38	tonnes C ha^{-1}

Variability

Variability occurs in:

- Inter - annual conditions – physical and financial
- Soil type
- Production efficiency related to location
- Production efficiency related to system
- Production efficiency related to management skill
- Methodology

Importance of organic and mineral soils

We compared footprints of 2 farms in Wales (Edwards-Jones et al 2009).

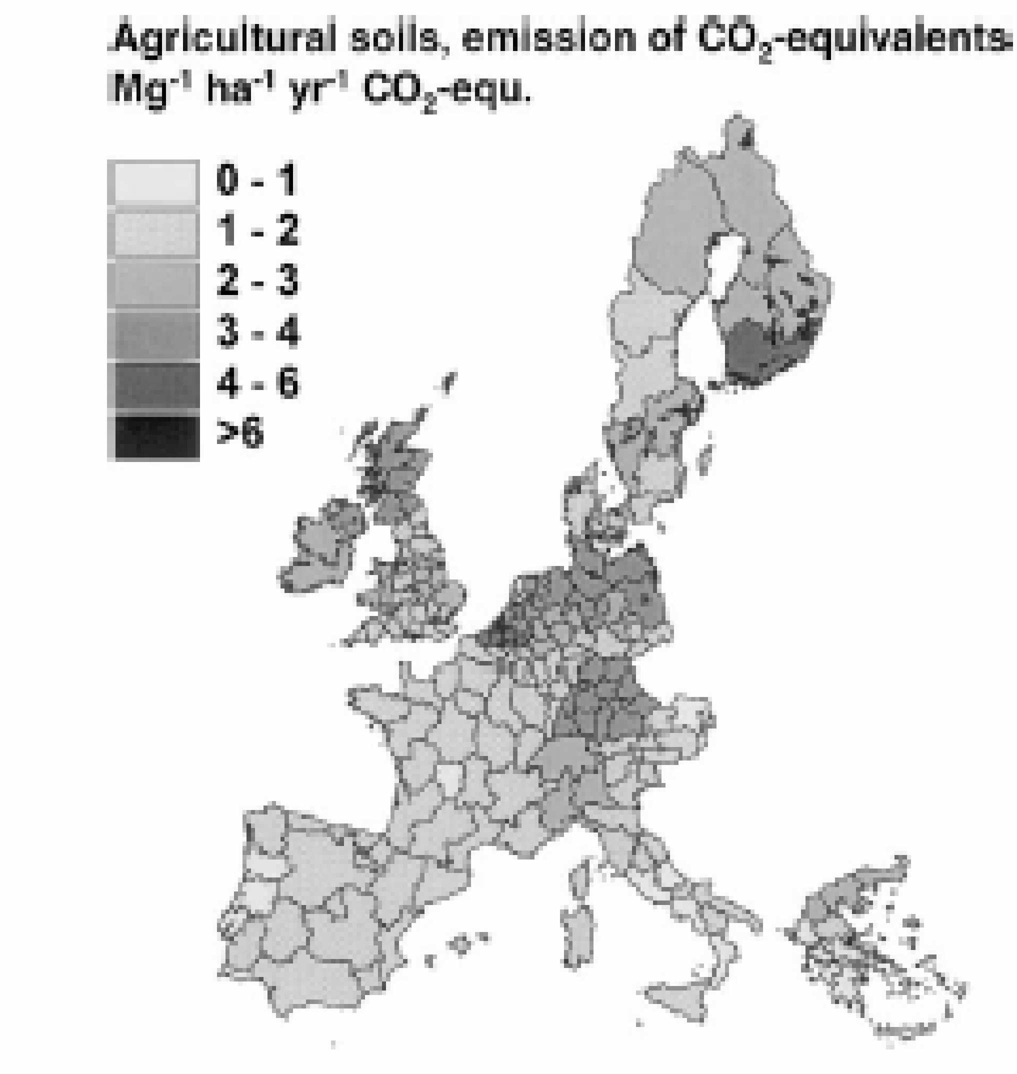
Emissions per kg of live weight were

Farm 1 = 8.1–31.7 kg CO_2e/kg live weight

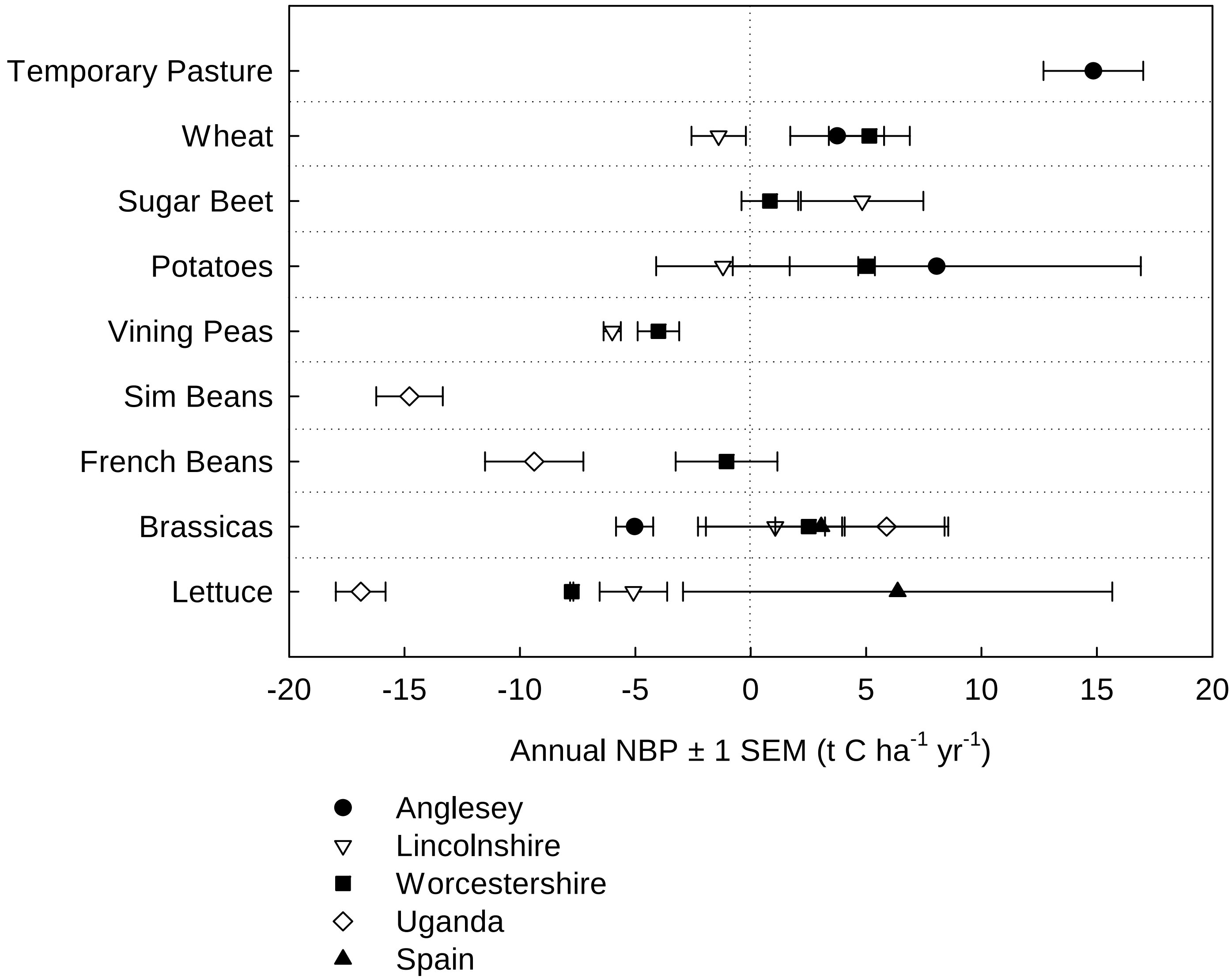
Farm 2 = 20.3–143.5 kg CO_2e/kg live weight

FARM 2 IS LARGELY ON ORGANIC SOILS

Regional distribution of average emissions of CO_2-equivalents from soils, normalised by the area of agricultural land in the NUTS 2 regions (Freibauer 2003).



Net Biome Production from different crops in different locations (Koerber et al 2009)



Lamb comparative results

Methodological approach	Country	Result	Source
Real farm data	UK	12.9 kg CO_2e kg^{-1} LW (8.1-31.7)	Edwards-Jones et al (2009)
Real farm data	UK	51.6 kg CO_2e kg^{-1} LW (20.3-143.5)	Edwards-Jones et al (2009)
National average	Ireland	10.0 kg CO_2e kg^{-1} LW	Casey & Holden (2005)
Model	UK	17.5 kg CO_2e kg^{-1} DW	Williams *et al.* (2006)
Model - organic	UK	10.1 kg CO_2e kg^{-1} DW	Williams *et al.* (2006)
Real farm data? only CO_2	NZ	0.6 kg CO_2 kg^{-1} DW (excluding transport to the UK)	Saunders *et al.* (2006)
Farm management handbook data; only CO_2 emissions considered	UK	2.9 kg CO_2 kg^{-1} DW	Saunders *et al.* (2006)

Beef comparative results

Methodological approach	Country	Result	Source
Real farm data	UK	15.5 kg CO_2e kg^{-1} LW (9.7-38.1)	Edwards-Jones et al (2009)
Real farm data	UK	47.6 kg CO_2e kg^{-1} LW (18.8-132.6)	Edwards-Jones et al (2009)
Average suckler-beef system	Ireland	11.9 kg CO_2e kg^{-1} LW	Casey & Holden (2005)
Model - 100% suckler	UK	25.3 kg CO_2e kg^{-1} DW	Williams *et al.* (2006)
Model - organic	UK	18.2 kg CO_2e kg^{-1} DW	Williams *et al.* (2006)
Model – different systems	Germany	14.09-16.76e kg^{-1} DW	Hirschfeld *et al.* (2008)
Model – beef fattening system	Japan	32.3 kg CO_2e kg^{-1} DW	Ogino *et al.* (2004)
Intensive feed lot	USA	14.8 kg CO_2e kg^{-1} DW	Subak (1999))

CONCLUSIONS

- Livestock footprints are not straightforward – we are still learning

- Real farm data is:
  - Messy
  - Hard to get
  - Essential for understanding

- We need to explicitly recognise uncertainty and variability

- We need good understanding to help reduce emissions BUT..

.... **THE PLANET NEEDS REDUCTIONS NOT MORE NUMBERS.**