PRIFYSGOL BANGOR UNIVERSITY

Livestock production and climate change: friend or foe?

Prysor Williams
Prifysgol Bangor University

Background

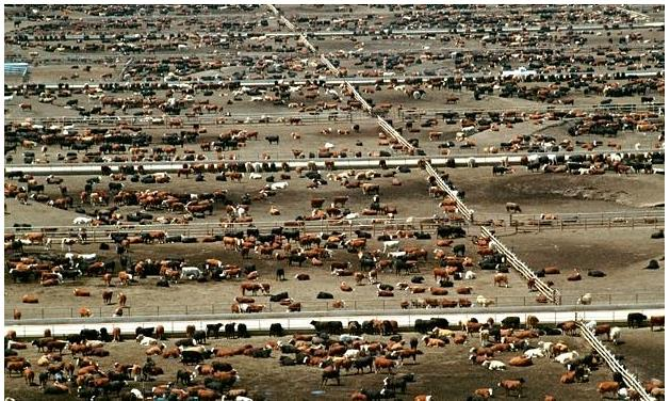
- Good news & bad news…

Background

- Livestock agriculture often reported as a significant source of environmental impact

Giving up beef will reduce carbon footprint more than cars, says expert

Study shows red meat dwarfs others for environmental impact, using 28 times more land and 11 times water for pork or chicken



Environment

Would eating less meat really combat climate change?

If every Briton went vegetarian, we could cut our greenhouse gas footprint by 25 per cent

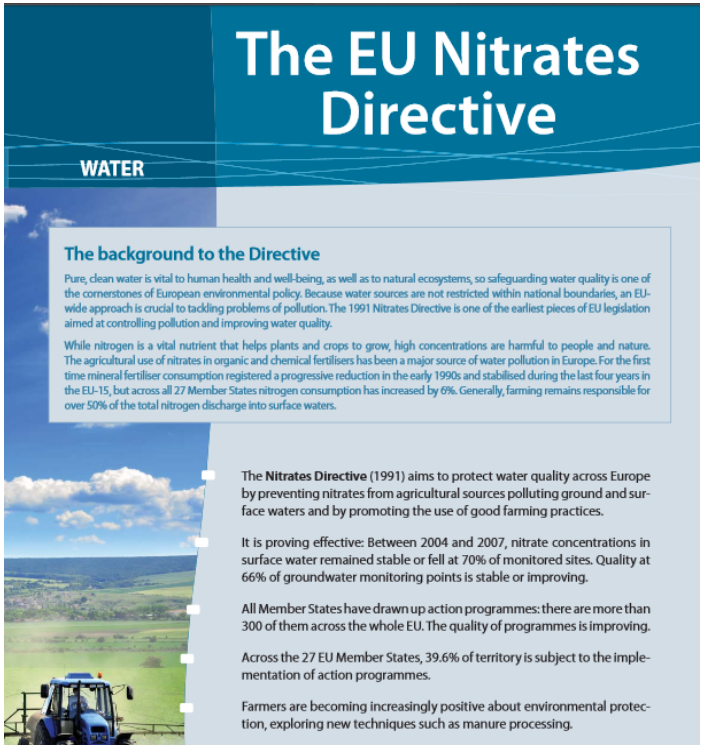
Mike Berners-Lee | Sunday 29 November 2015 | 17 comments

15K shares

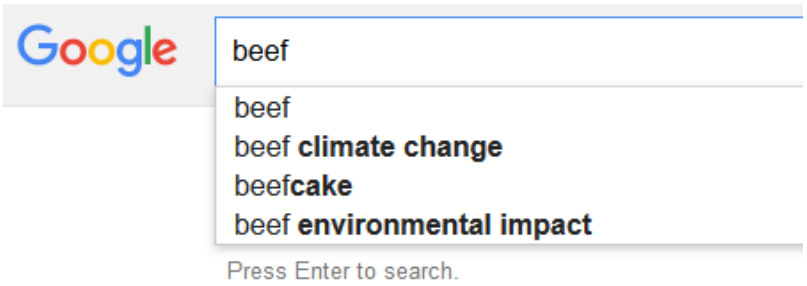
Cows graze on grass at the Stemple Creek Ranch in Tomales, California *Getty*

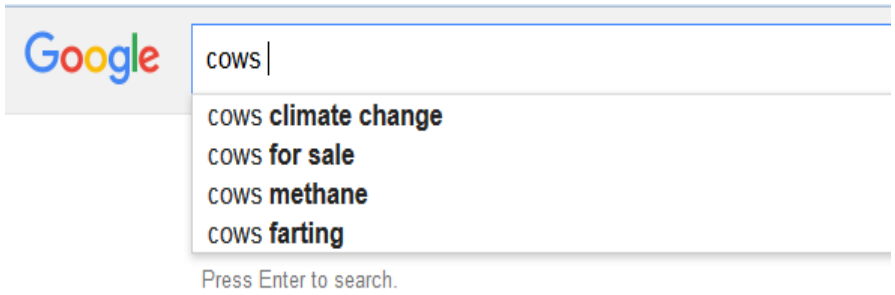
Background

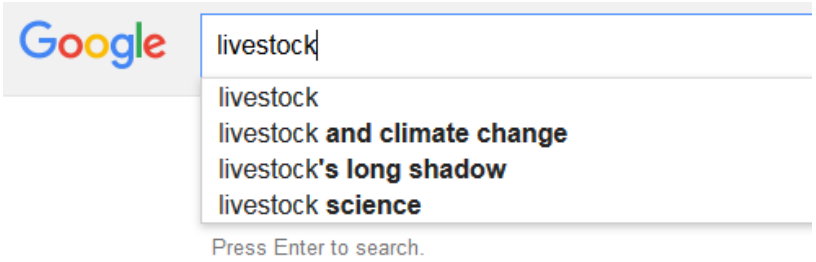
- Livestock agriculture often reported as a significant source of environmental impact

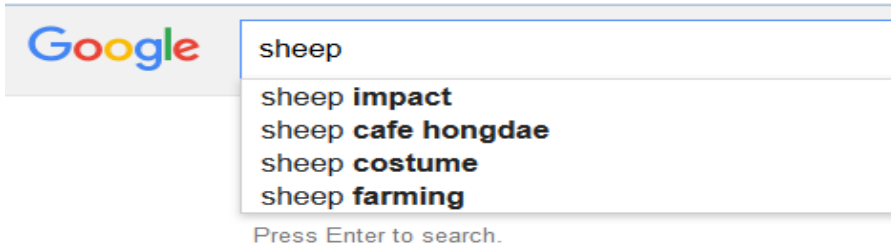


Some Google searches…

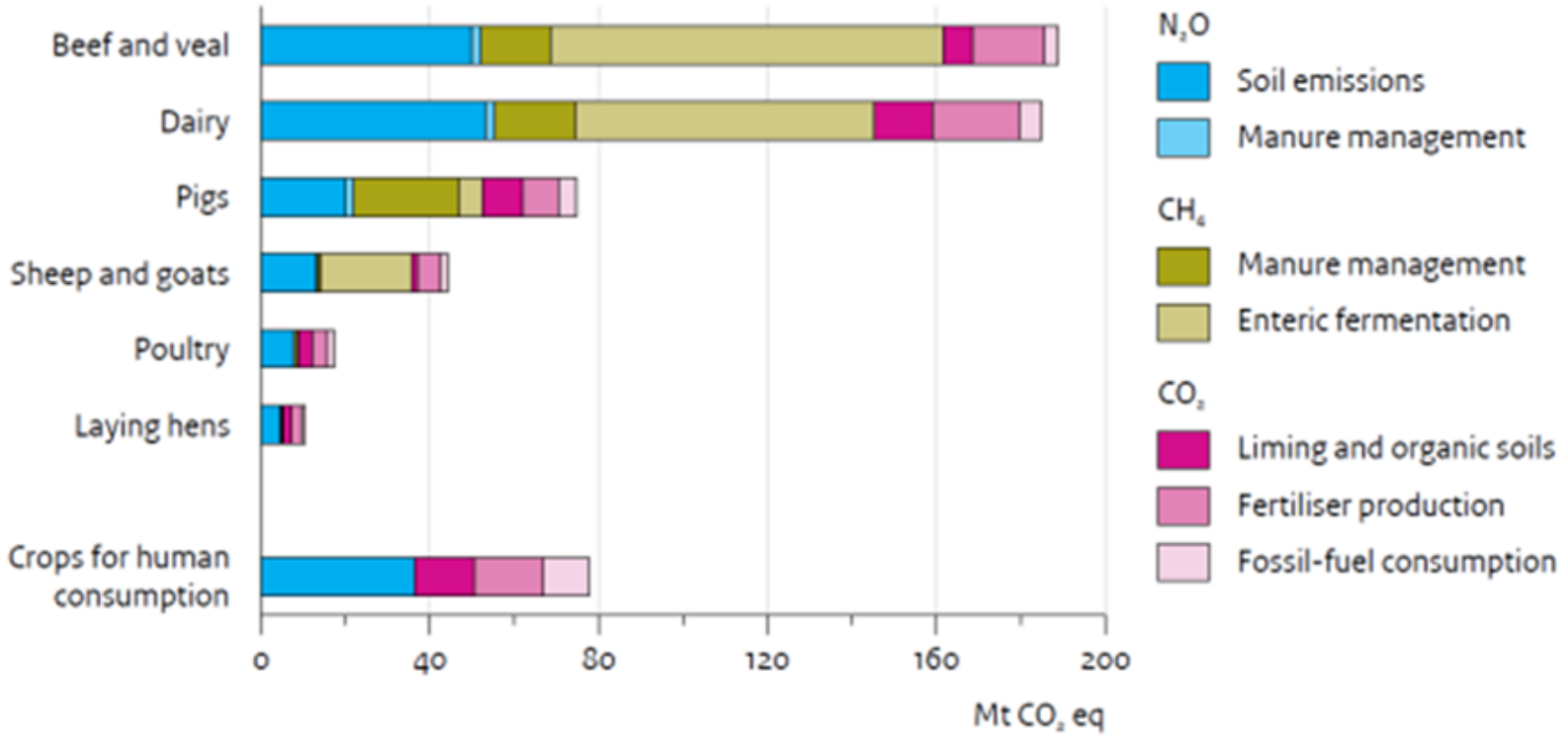








GHG emissions



Where do we go from here?

- UK Climate Change Act target to cut GHG emissions 80% by 2050
  - All sectors will be under the spotlight
  - Each has to play its part
- In short: agriculture will need to stand up to the challenge

The roadmap

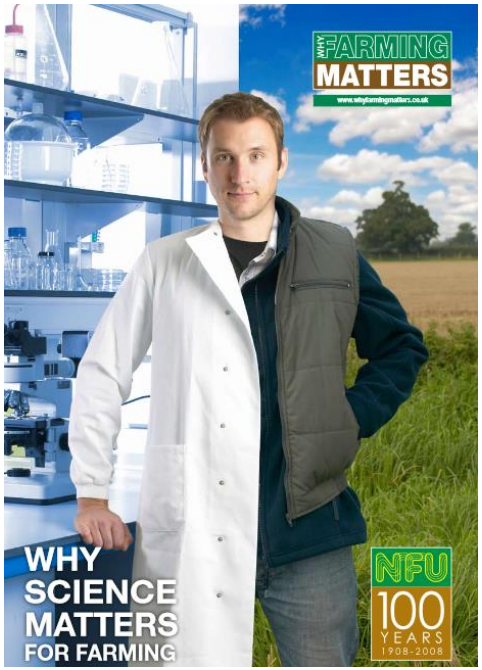

A Sustainable Future
The Welsh Red Meat Roadmap
www.hccmpw.org.uk
HYBU CIG CYMRU

Upping our game

- We can't pretend that there is no room for improvement
- Need to be more efficient across all areas
  - Inputs vs. outputs
- *But how do we get there?*

Research and agriculture: where we're at

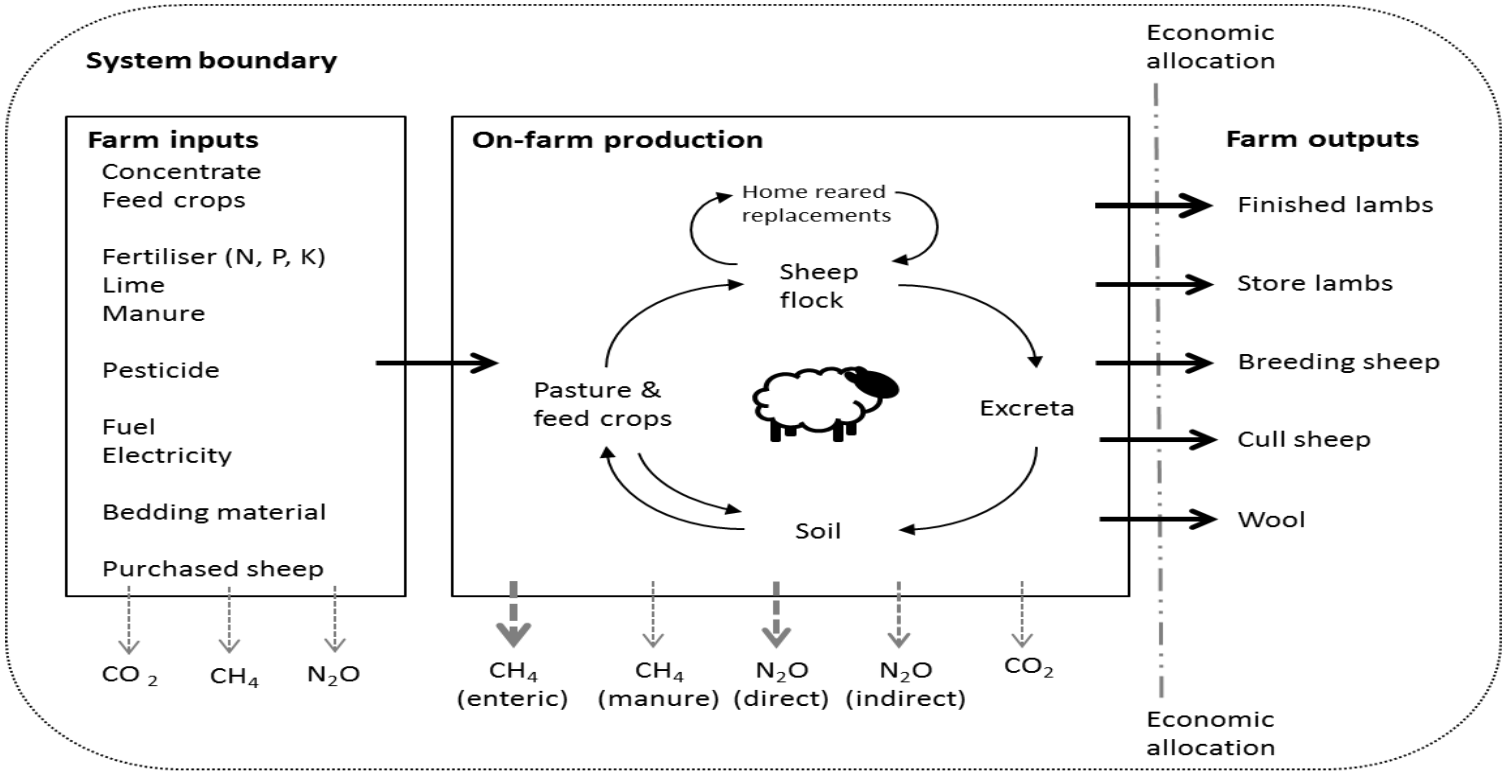
- Any progressive industry invests in research
- Agriculture should be no different
  - Farmers need to engage with researchers and vice versa
  - "bottom-up" and "top-down"
- HCC have sponsored a number of relevant projects at Bangor University



PhD studentships

- Anna Jones: *The mitigation of greenhouse gas emissions in sheep farming systems*
- John Hyland: *Reducing the environmental impact of the red meat sector in Wales*
- Rory Shaw: *Developing in-situ and real-time methods of soil nitrogen determination*

1. Starting point: carbon footprints



Carbon footprint method

- Face to face questionnaires on 60 sheep farms:
  - Inputs: feeds, fertilisers, pesticides, bedding, fuel
  - Stock numbers and movements throughout the year
  - Outputs: produce

- Emissions calculations:
  - Intergovernmental Panel on Climate Change equations
  - Emission factors from standard databases

Results

- Means (kg CO_2equivalents/kg lamb):

Emission source	Lowland	Upland	Hill
Inputs (direct and indirect emissions)	2.18	2.70	2.98
Enteric CH_4	4.62	5.59	8.61
Excreta CH_4	0.11	0.13	0.20
N_2O from soils (direct and indirect emissions)	3.79	4.21	5.91
N_2O from manure storage (direct and indirect emissions)	0.14	0.23	0.16
	10.85	12.85	17.86

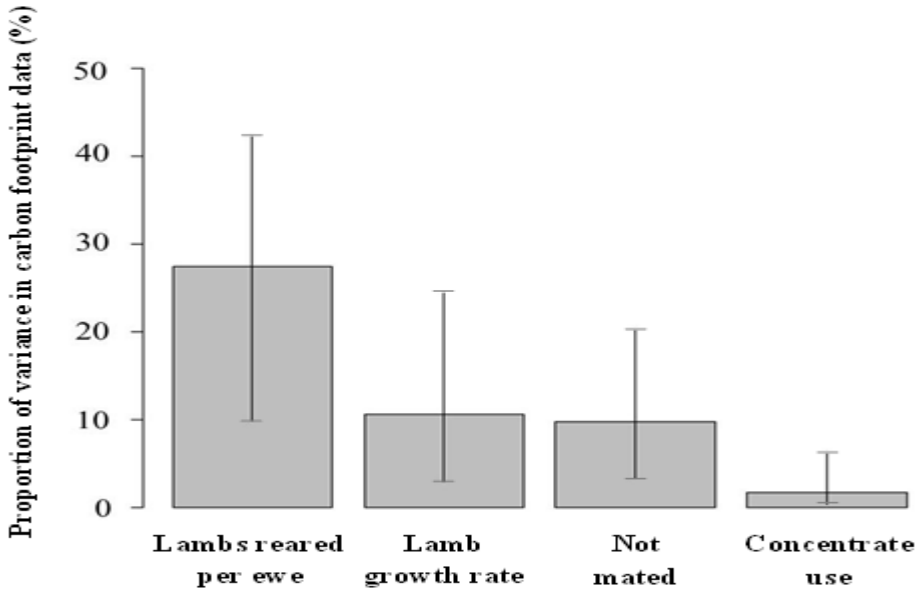
- Carbon footprints ranged from:
  - 5.4 to 21.5 kg CO_2e/kg lamb – lowland farms
  - 8.3 to 18.3 kg CO_2e/kg lamb – upland farms
  - 8.8 to 33.3 kg CO_2e/kg - hill farms

Impact of management variables

Significant variables from stepwise regression:

1) Concentrate use (kg/LSU)
2) Number of lambs reared per ewe (head/ewe)
3) Lamb growth rate (g/day)
4) Percentage of ewe and replacement ewe flock not mated (%)

Dominance analysis results:



Implications for farmers

- Importance of productivity and efficiency
  - Maximising output per unit input
- Number of lambs reared per ewe
  - Breeding for ewe productivity
  - Lamb survival
  - Nutritional management
- Closing the productivity gap

2. Doing something about it

- Mitigation measures need to be
  - Practical
  - Cost-effective
  - Effective

2. Doing something about it

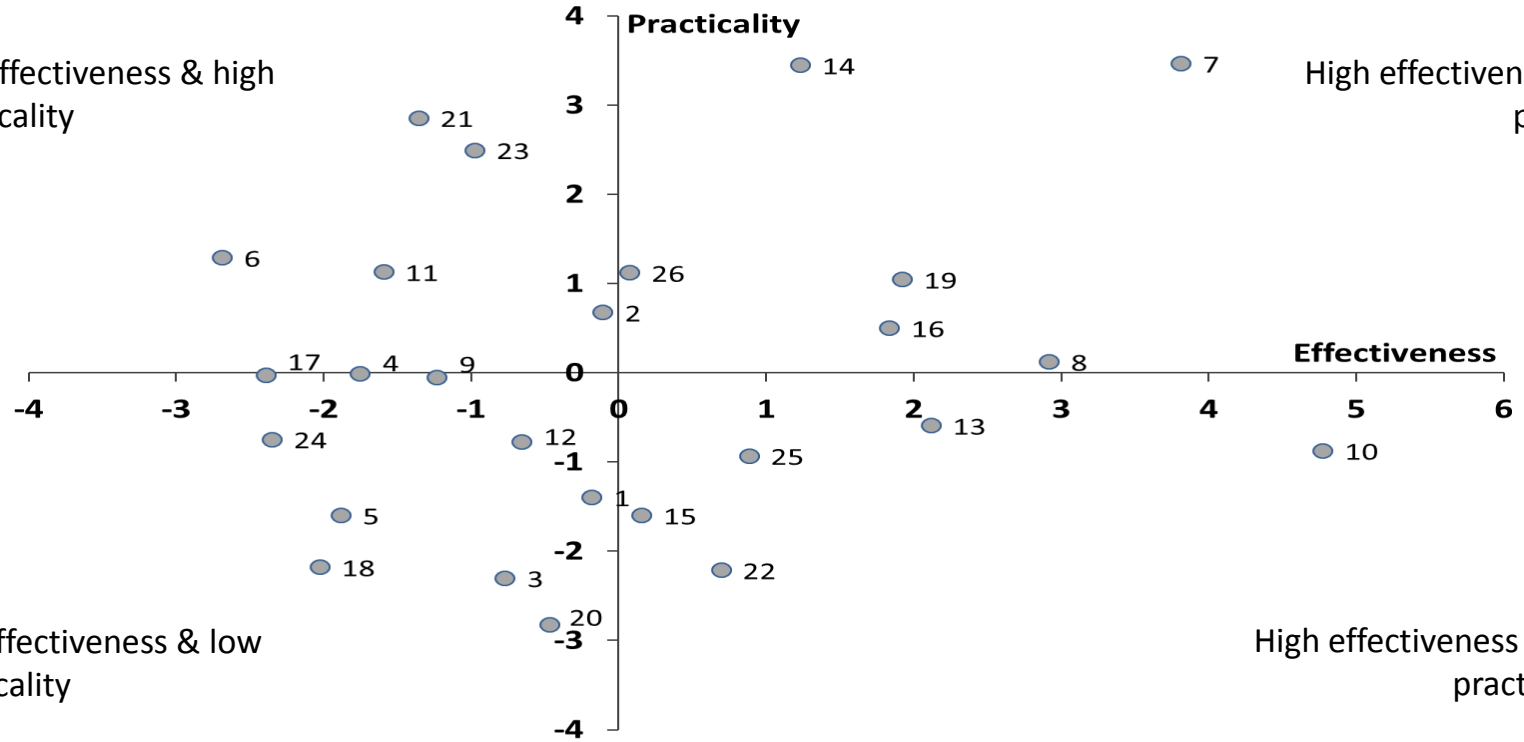
Number	Mitigation Measure
1	Use a fertiliser recommendation system
2	Improve timing of fertiliser applications
3	Improve precision of fertiliser applications in soil
4	Avoid feeding excess nitrogen to minimise nitrogen losses in excreta
5	Analyse manure prior to application
6	Calibrate & maintain spreader equipment
7	Include legumes in pasture reseed mix e.g. clover
8	Increase lamb growth rates for earlier finishing
9	Feed a diet balanced in energy & protein
10	Increase the number of lambs born per ewe
11	Increase pasture productivity to enhance carbon storage
12	Performance recording & selective breeding for improved feed conversion efficiency
13	Increase ewe longevity
14	Improve ewe nutrition in late gestation to increase lamb survival
15	Increase diet digestibility
16	Reduce mineral fertiliser use
17	Split fertiliser applications
18	Improve drainage (non-organic soils only)
19	Lamb as yearlings
20	Performance recording & selective breeding for reduced enteric CH_4/kg dry matter intake
21	Improve hygiene & supervision at lambing
22	Avoid conversion of peatlands
23	Select pasture plants bred for improved nitrogen conversion efficiency
24	Avoid fertiliser applications prior to pasture renovation
25	Avoid conversion of woodlands to pasture / crops
26	Select pasture plants bred to minimise dietary nitrogen losses e.g. high sugar grasses

Best-Worst Scaling method

- Best-Worst Scaling surveys to identify practical and effective mitigation measures

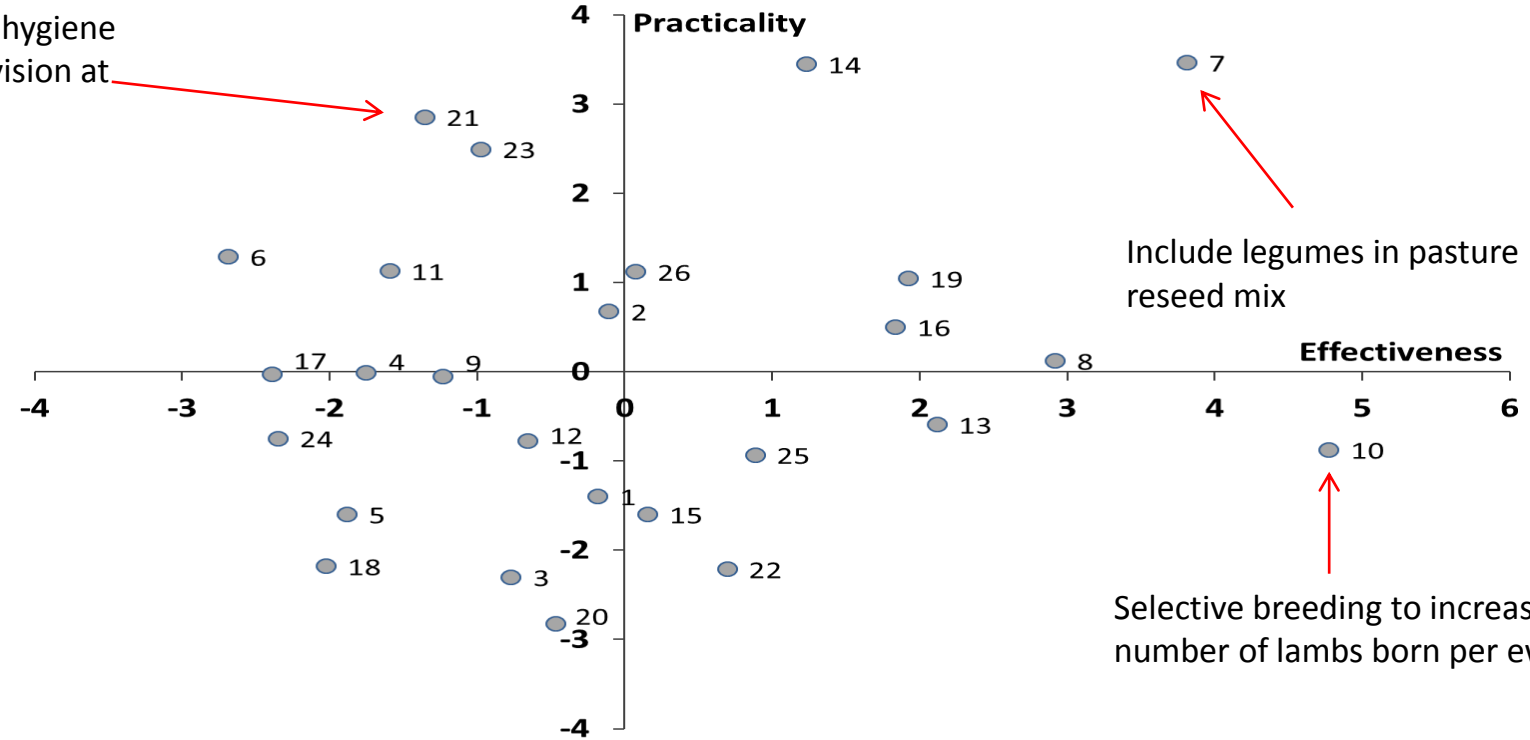
Most Practical		Least Practical
◯	Use a fertiliser recommendation system	◯
◯	Selective breeding to increase ewe longevity	◯
✓	Improve hygiene & supervision at lambing	◯
◯	Lamb as yearlings	✓
◯	Include legumes in pasture reseed mix	◯

Expert and farmer opinion results



Expert and farmer opinion results

Improve hygiene & supervision at lambing



Include legumes in pasture reseed mix

Selective breeding to increase number of lambs born per ewe

These were then costed and their effectiveness modelled

Clover: A practical mitigation measure

- Determine N_2O emissions from Ryegrass-Clover systems vs. Ryegrass-fertiliser
  - High/low N input
  - Dry matter yield

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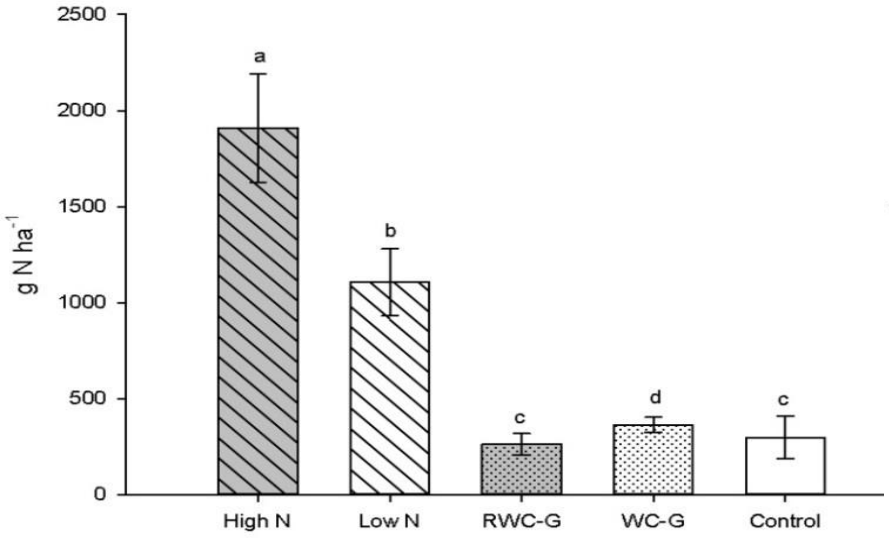
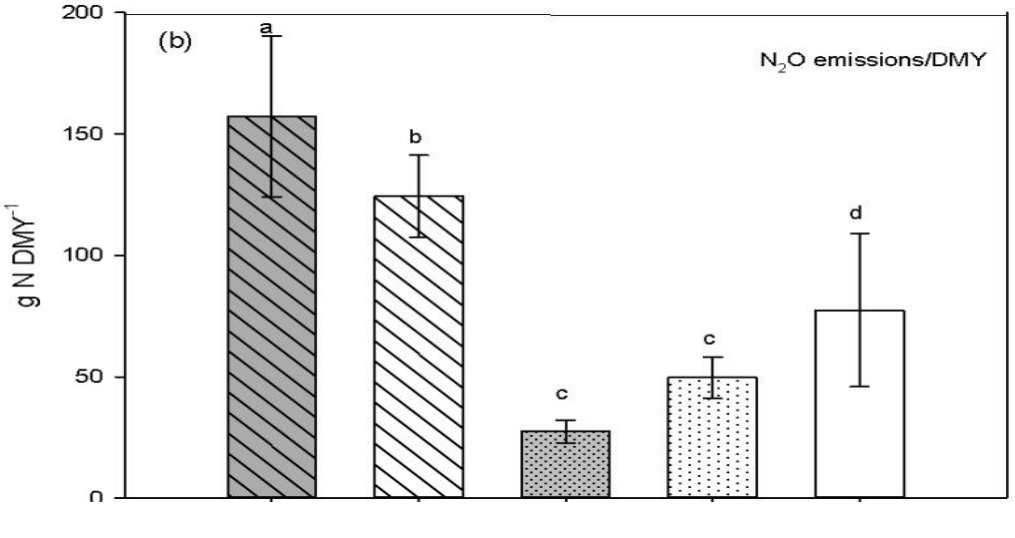


Mean cumulative emissions per treatment



Mean N_2O emissions per harvested DMY (t)

3. Making it happen

- Need to understand how farmers' beliefs and concerns about climate change influence their behaviours

Methodology

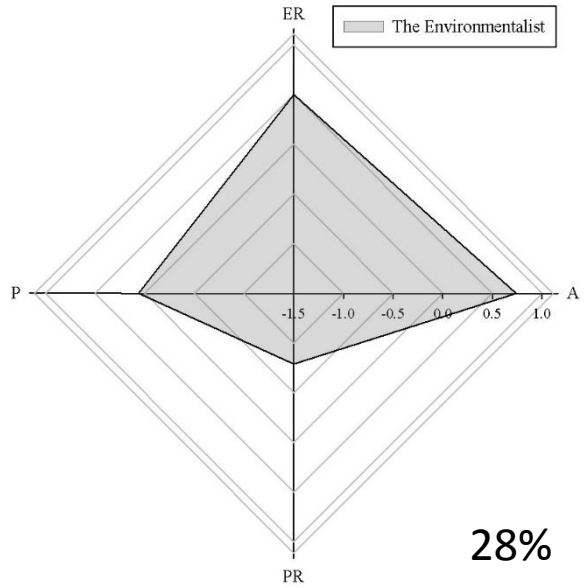
- 286 Welsh beef and sheep farmers answered questionnaire
  - Knowledge
  - Attitudes
  - Capacity and likelihood to change
- Statistical analyses to group respondents

Results: PCA

	A	ER	P	PR
Livestock farming contributes to climate change	.701			
Climate change will affect Welsh farming in the next 10 years	.669			
I accept that man-made climate change is happening	.633			
Livestock farmers should share responsibility towards the industry's impact on climate change	.612			
Climate change is an important global issue	.612			
It is possible to reduce GHG emissions from my farm without lowering production levels	.461			
Environmental regulations are important for the future of farming	.451			
Others in my family think that I should farm as environmentally friendly as possible		.686		
I want to farm as environmentally friendly as possible		.665		
Switching to a more environmentally friendly farming methods would not require much change from my current operation		.592		
As a farmer I have an obligation to maintain or improve the environment for future generations		.553		
I am interested in trying different technologies and/or systems to reduce my farms' GHG emissions		.534		
The way farming colleagues think about my farm is important to me		.449		
The government should encourage food production in the UK to reduce reliance on imports			.722	
The government should financially support farmers in adapting to climate change			.640	
Other industries pollute more than livestock farmers and should therefore be penalised more			.510	
Any climate change reduction strategies must make economic sense to the individual farmer			.475	
Being seem as primarily as a food producer is important to me			.426	
The best climate change mitigation strategies are too costly to adopt				.639
Climate change poses more of a threat to farming in the next 10 years than that of a general recession				.607
Climate change will lead to lower productivity on my farm due to disease and pests				.579
Uncertainty due to variable weather patterns caused by climate change will negatively influence my ability to farm in the future				.381
Beef or lamb produced with low emissions should be sold at a higher price				.351
Cronbach's alpha	*.774*	*.700*	*.533*	*.512*

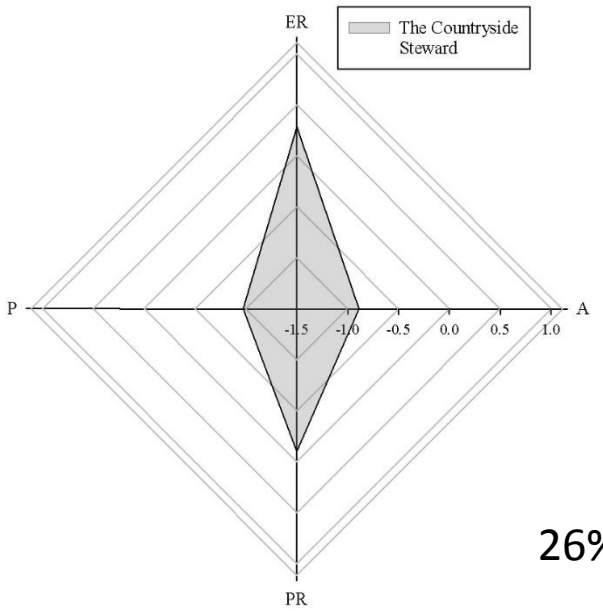
*** Factor codes: A = Awareness, ER = Environmental Responsibility, P = Productivism, PR = Perceived risk**

Results: Farmer types



28%

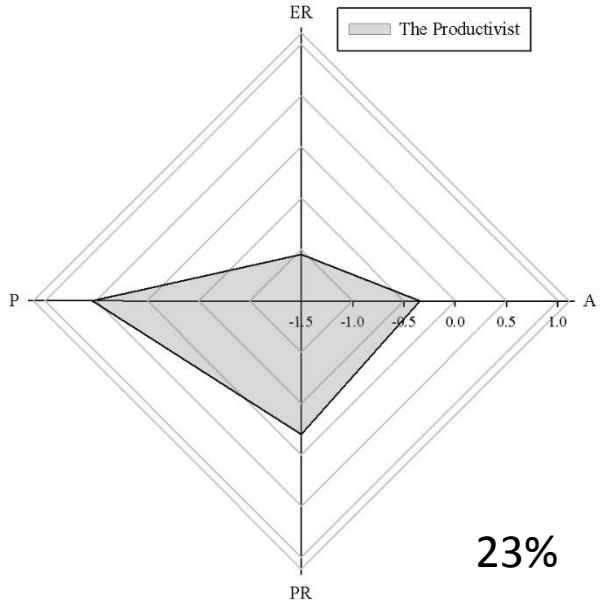
Environmental responsibility – high
Awareness – high
Perceived risk – low
Productism – low



26%

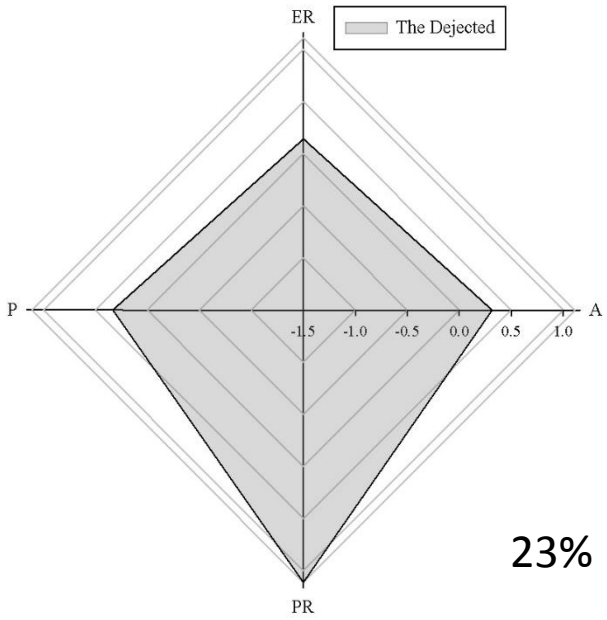
Environmental responsibility – high
Awareness – low
Perceived risk – low
Productism – low

Results: Farmer types



23%

Environmental responsibility – low
Awareness – low
Perceived risk – low
Productism – high



23%

Environmental responsibility – high
Awareness – high
Perceived risk – high
Productism – medium

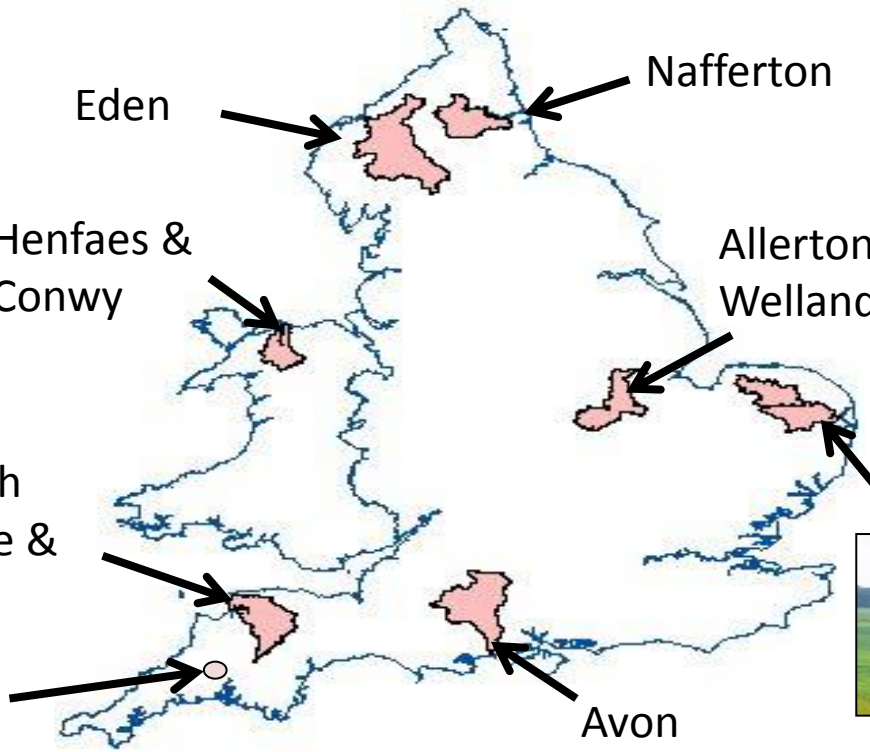
Monitoring of soil N levels

- Development of electrodes and probes
- Field-testing
- Generate fertiliser recommendations from real-time data
  - Targeted applications

Other activities

- “Sustainable intensification”
- Shorthand definition: 'producing more food with less negative impact‘
- Involves many disciplines and topics

SIP Study Farm and Area Locations



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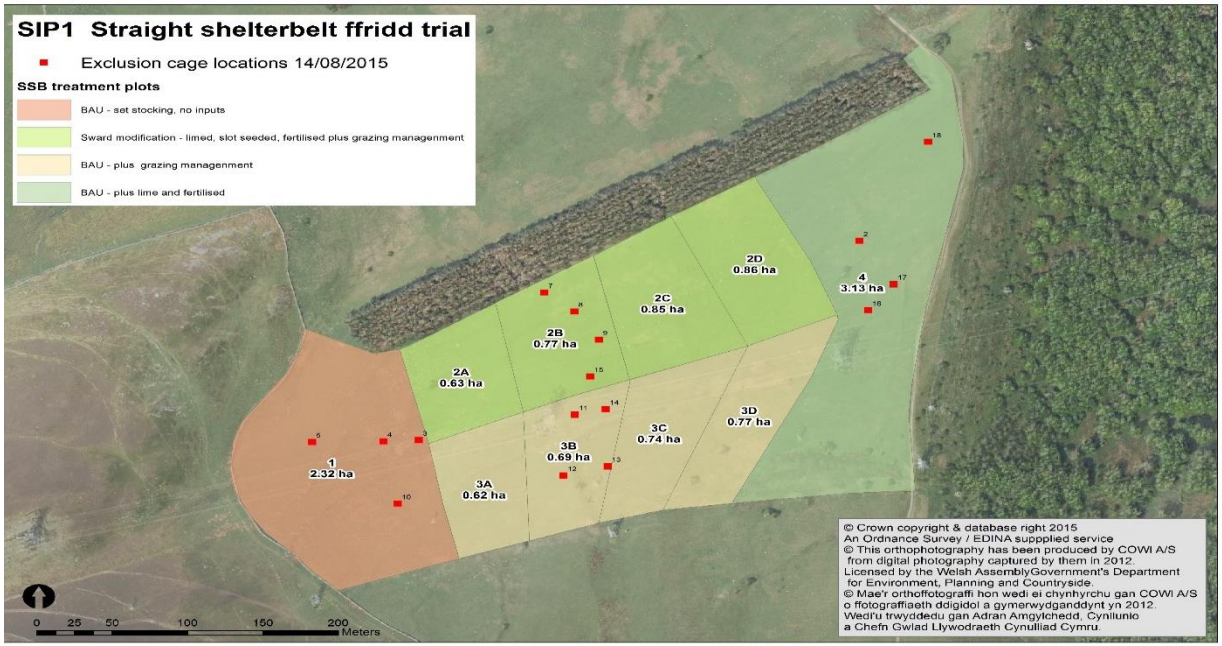
Henfaes: the Uplands Sustainable Intensification Platform

Henfaes: SI strategy

- Aim: *to increase grassland productivity through optimised soil, nutrient and grazing management*
- How to better utilise grass as the base of lamb production systems

Henfaes: approach

- Upland ‘ffridd’
  - ± lime/fert, ± re-seed, ± rotational grazing

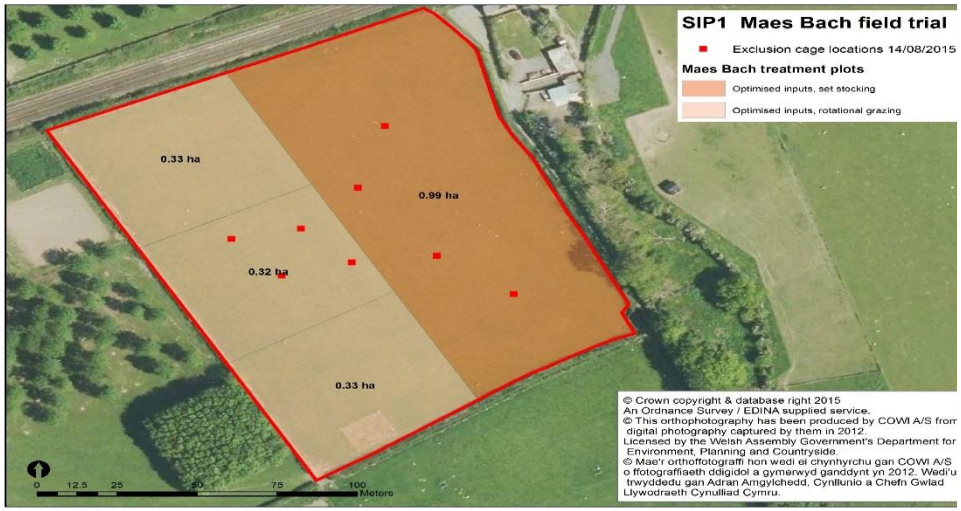


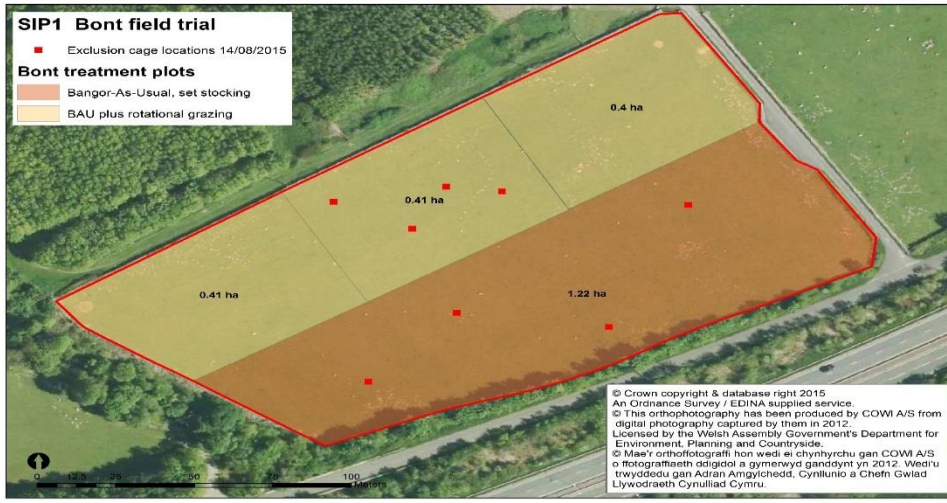
Henfaes: approach

- Upland ‘ffridd’
  - ± lime/fert, ± re-seed, ± rotational grazing

Henfaes: approach

- Lowland fields
  - ± lime/fert, ± re-seed, ± rotational grazing

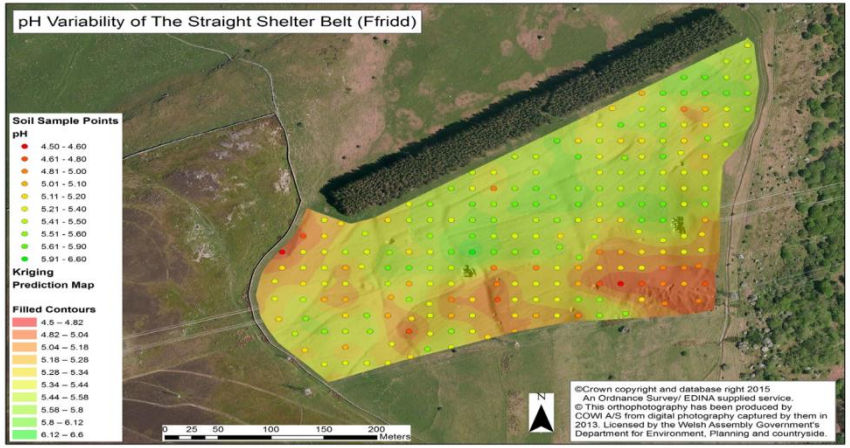


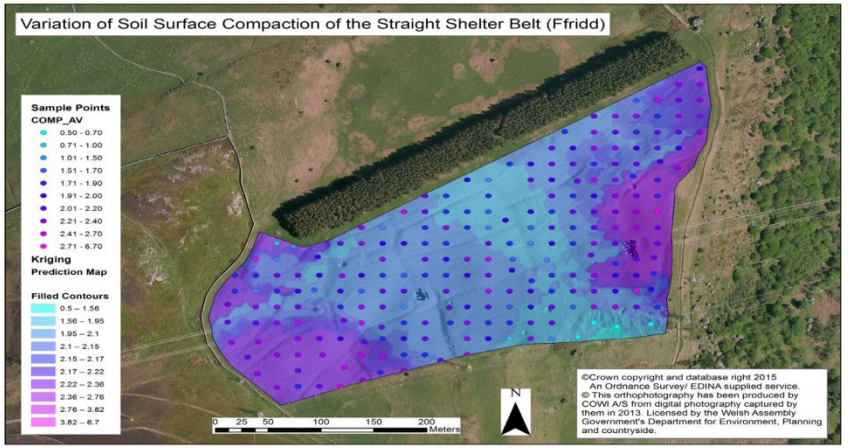


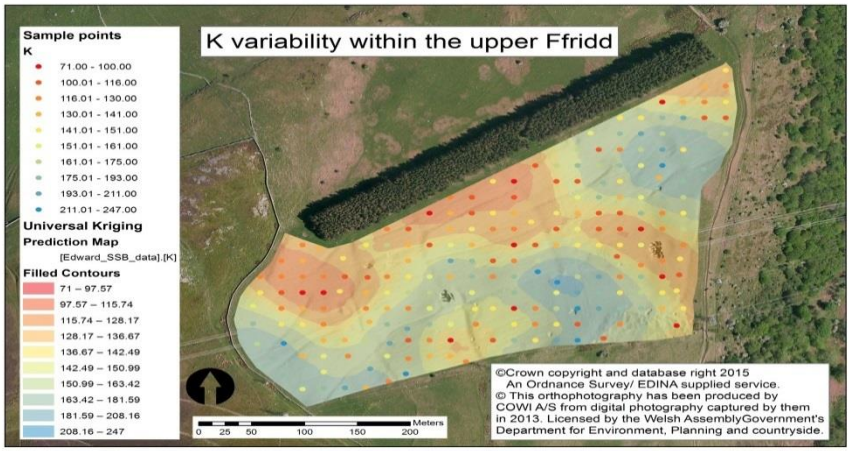
Henfaes: approach

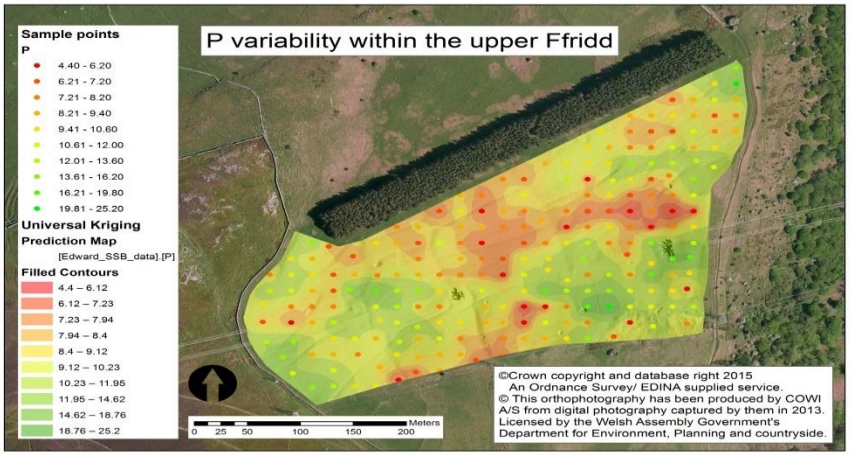
- Lowland fields
  - ± lime/fert, ± re-seed, ± rotational grazing

Ffridd (upland site)









Henfaes: activities to date

- Drilling (with HSG, clover + timothy)

Henfaes: activities to date

- Introduced sheep + lambs
  - Condition-scored and weighed

Henfaes: activities to date

- Grassland quality and quantity

Sward sample weights (Ffridd): 9th Sept 2015

Sample ID	Date of collection	Processing time	Bag wt (g)	Field FW (g)	FW s/s (g)	FW remainder (g)	Reweigh DW + bag (g)	Reweigh DW (g
P1 G1	09/09/15	15:30	7.40	81.74	81.74	0	34.67	27.27
P1 G2	09/09/15	15:30	7.38	133.11	133.11	0	46.65	39.27
P1 G3	09/09/15	15:30	7.28	107.38	107.38	0	40.84	33.56
P1 G4	09/09/15	15:30	7.31	112.27	112.27	0	44.46	37.15
P2B G1	09/09/15	15:30	7.30	463.71	183.25	280.46	45.27	37.97
P2B G2 (bag 1)	09/09/15	15:30	7.29	337.68	183.79	565.12	53.63	46.34
P2B G2 (bag 2)	09/09/15	15:30		411.23				
P2B G3	09/09/15	15:30	7.27	340.99	192.74	148.25	57.07	49.80
P2B G4	09/09/15	15:30	7.30	706.79	152.31	554.48	42.55	35.25
P3B G1	09/09/15	15:30	7.39	139.41	139.41	0	45.91	38.52
P3B G2	09/09/15	15:30	7.31	102.62	102.62	0	38.78	31.47
P3B G3	09/09/15	15:30	7.36	160.74	160.74	0	55.47	48.11
P3B G4	09/09/15	15:30	7.39	128.91	128.91	0	44.44	37.05
P4 G1	09/09/15	15:30	7.35	222.44	222.44	0	49.21	41.86
P4 G2	09/09/15	15:30	7.36	364.89	166.47	198.42	40.21	32.85
P4 G3	09/09/15	15:30	7.42	113.43	113.43	0	37.62	30.20
P4 G4	09/09/15	15:30	7.36	206.12	206.12	0	55.87	48.51

Hay/Haylage Analysis

sciantec analytical

Advisory Contact

Llinos Hughes
Prifysgol Bangor University
Aberpwyspregyn, Llanfairfechan Gwynedd, LL33 0LB
Customer Code: SG96

Farm

Kg08

Originator Reference Number: NW 16

Sample Details

Lab Reference: FRG520546 | Description: | Date Cut:
Sample Type: Hay/Haylage | Cut Number: | Additive: | Sample Received: 07/09/2015

Summary		Analysis	Low	Standard	High
Dry Matter	(g/kg)	944	200	750	945
Crude Protein	(g/kg)	180	45	120	180
Oil-B	(g/kg)	30	10	30	50
Ash	(g/kg)	71	25	50	80
NDF	(g/kg)	591	500	700	800
ADF	(g/kg)	235	100	400	500
Sugar	(g/kg)	109	10	200	500

Metabolisable Energy		Analysis	Low	Standard	High
D Value	%	57	50	60	80
ME	(MJ/kg)	9.1	8.0	9.6	10.0

Henfaes: activities to date

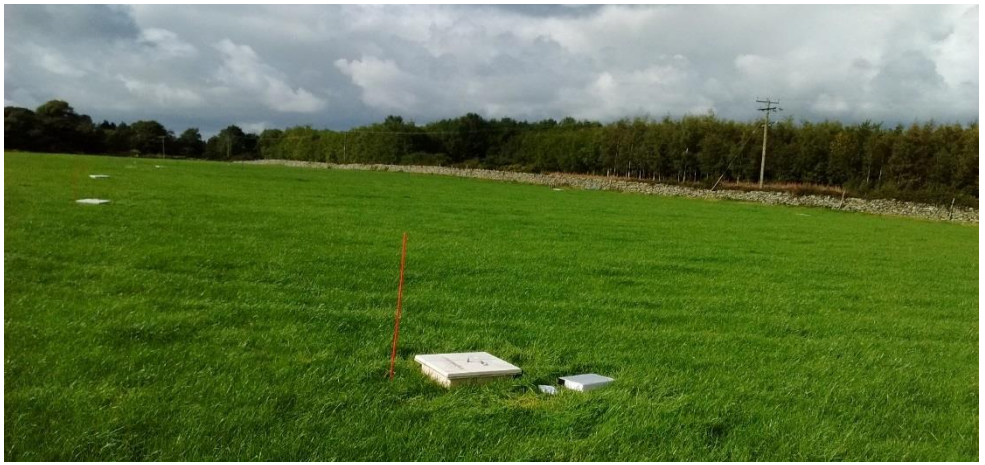
- Stock carrying capacity and performance
  - Will be expressed in two ways
    - kg /ha over time
    - DLWG (kg /lamb and kg /ha)

Henfaes: activities to date

- Greenhouse gas emissions
  - Ffridd

Henfaes: activities to date

- Greenhouse gas emissions
  - Lowland



Livestock production and climate change: friend or foe?

- Pressure on the livestock sector
- All industries need to invest in R & D
- Genetics, technology, soils, animal health, environm etc.
- Profitable, efficient, modern industry
  - Huge potential
- Often win-win scenarios

Livestock production and climate change: friend or foe?

- Measures that can reduce environmental impact without compromising production, e.g.
  - Clover
  - N-sensors
  - Sustainable intensification project
- Doing the basics right
- Industry is engaged and pro-active – asking the questions (and there are many)
- Getting message across effectively depends on the audience

Diolch yn fawr / Many thanks