

OSCAR Case Study: Northumberland, UK

(071201/2011/609681/SER/CLIMA.A.2)

Dr Doug Warner

22nd November 2012



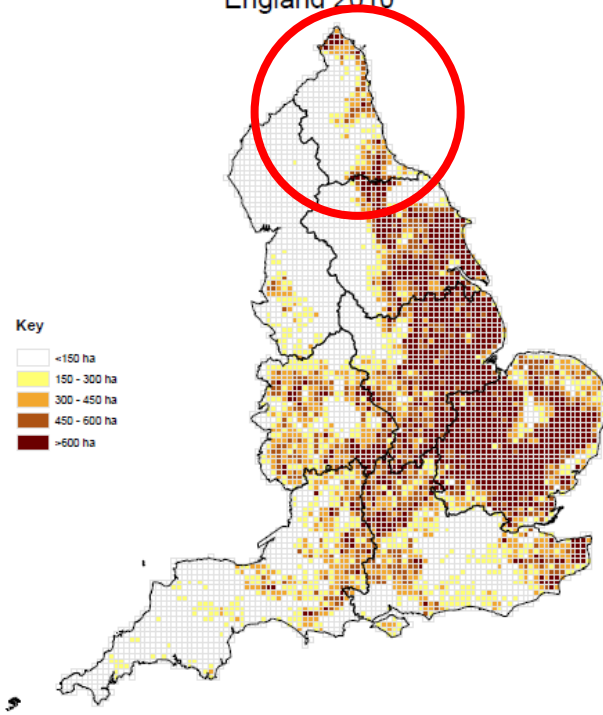
Northumberland, UK



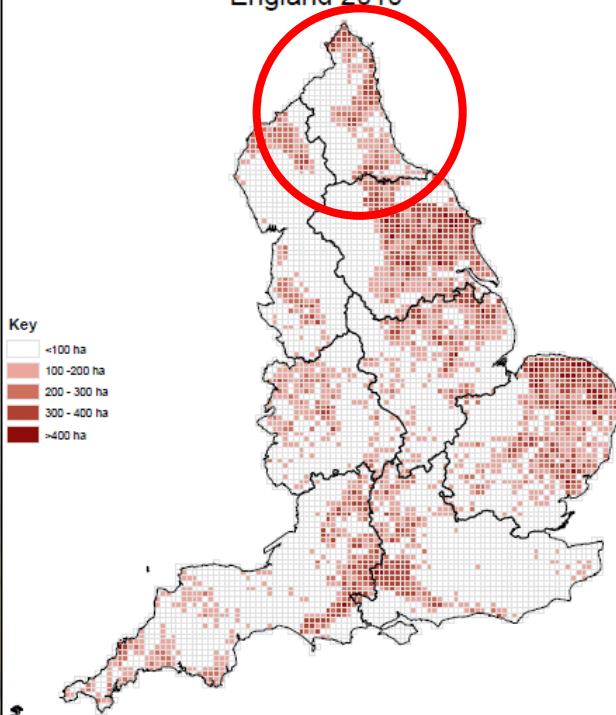
- Area of 5,013 km²
- Includes Heritage coastline and Northumberland National Park
- 13 Special Areas of Conservation (SACs) and 6 Special Protection Areas (SPAs)
- Diversity of agricultural land use

Arable crops in the UK

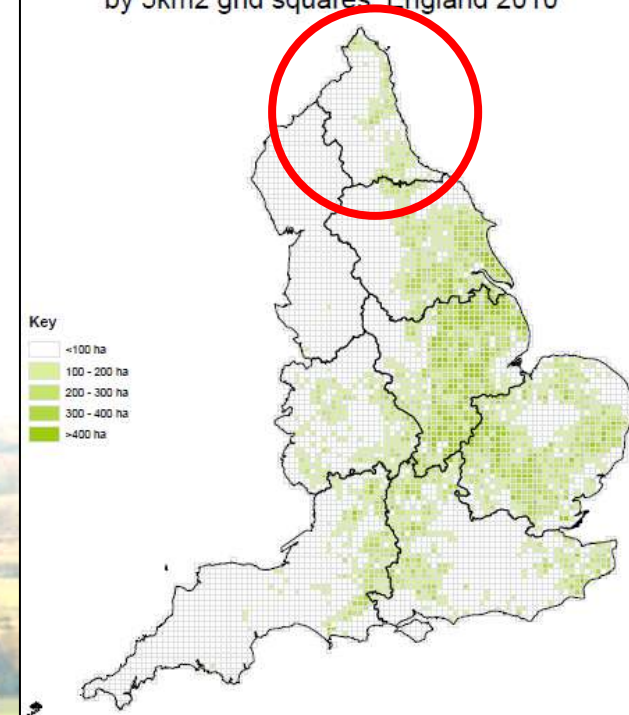
Area of wheat (hectares) by 5km² grid squares: England 2010



Area of barley (hectares) by 5km² grid squares: England 2010

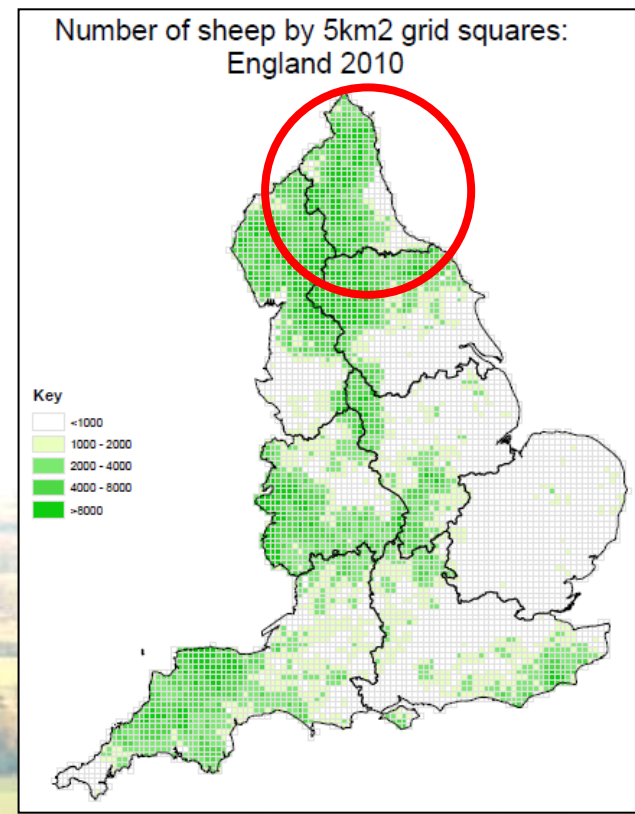
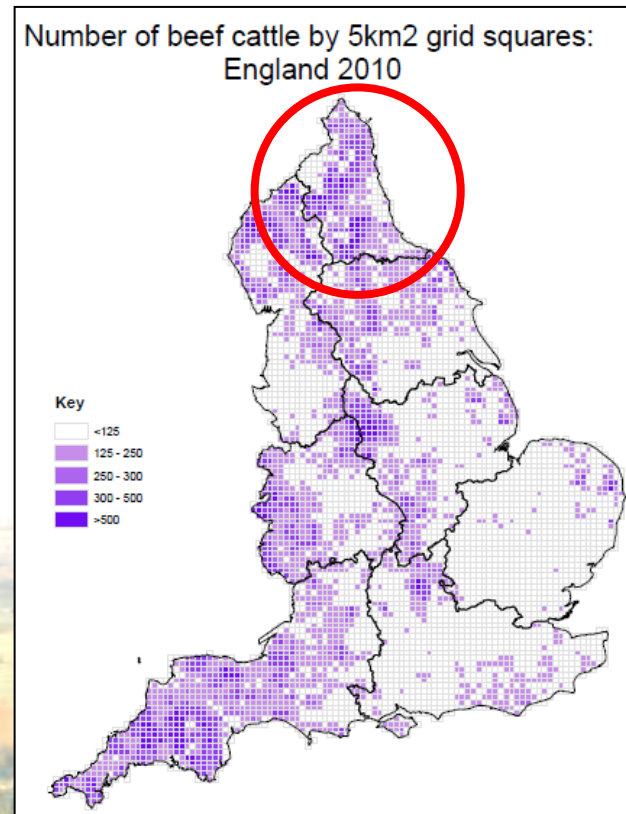
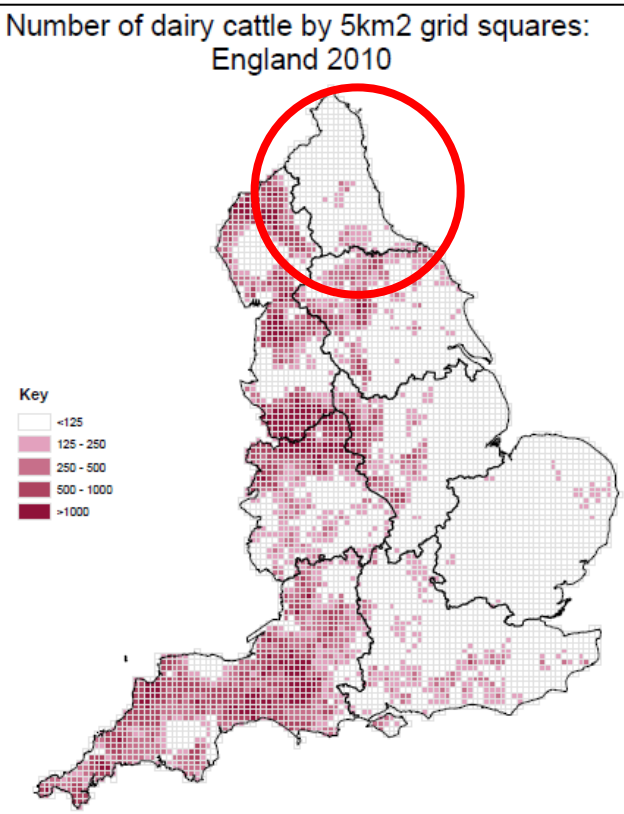


Area of winter oilseed rape (hectares) by 5km² grid squares: England 2010



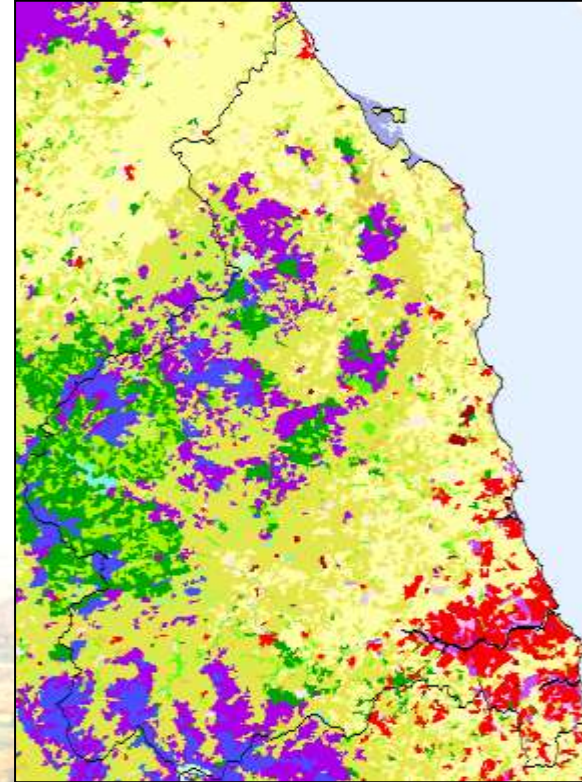
Source: Defra June Survey (2010)

Livestock in the UK

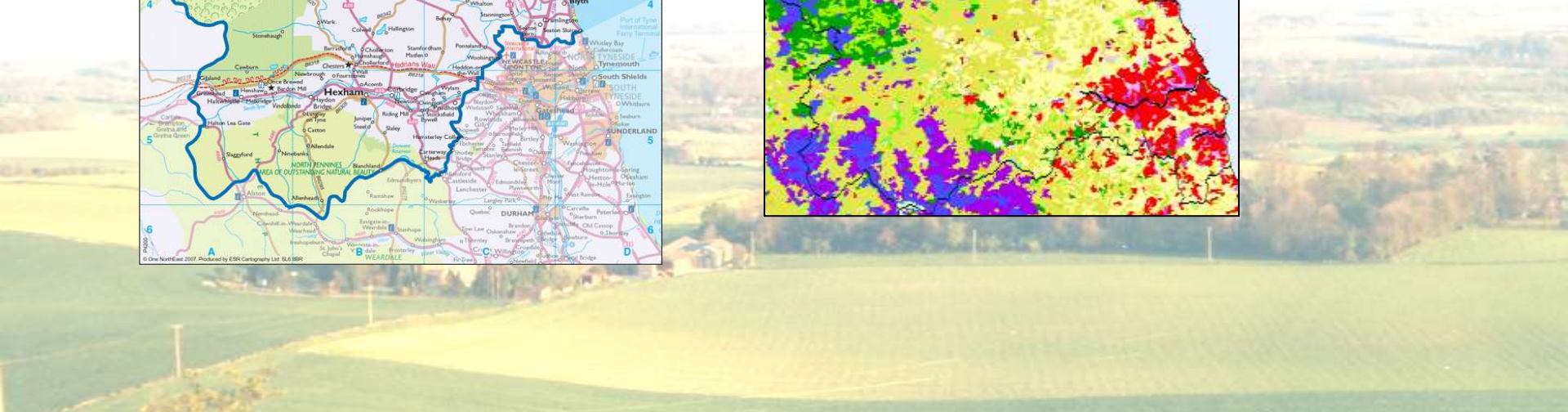


Source: Defra June Survey (2010)

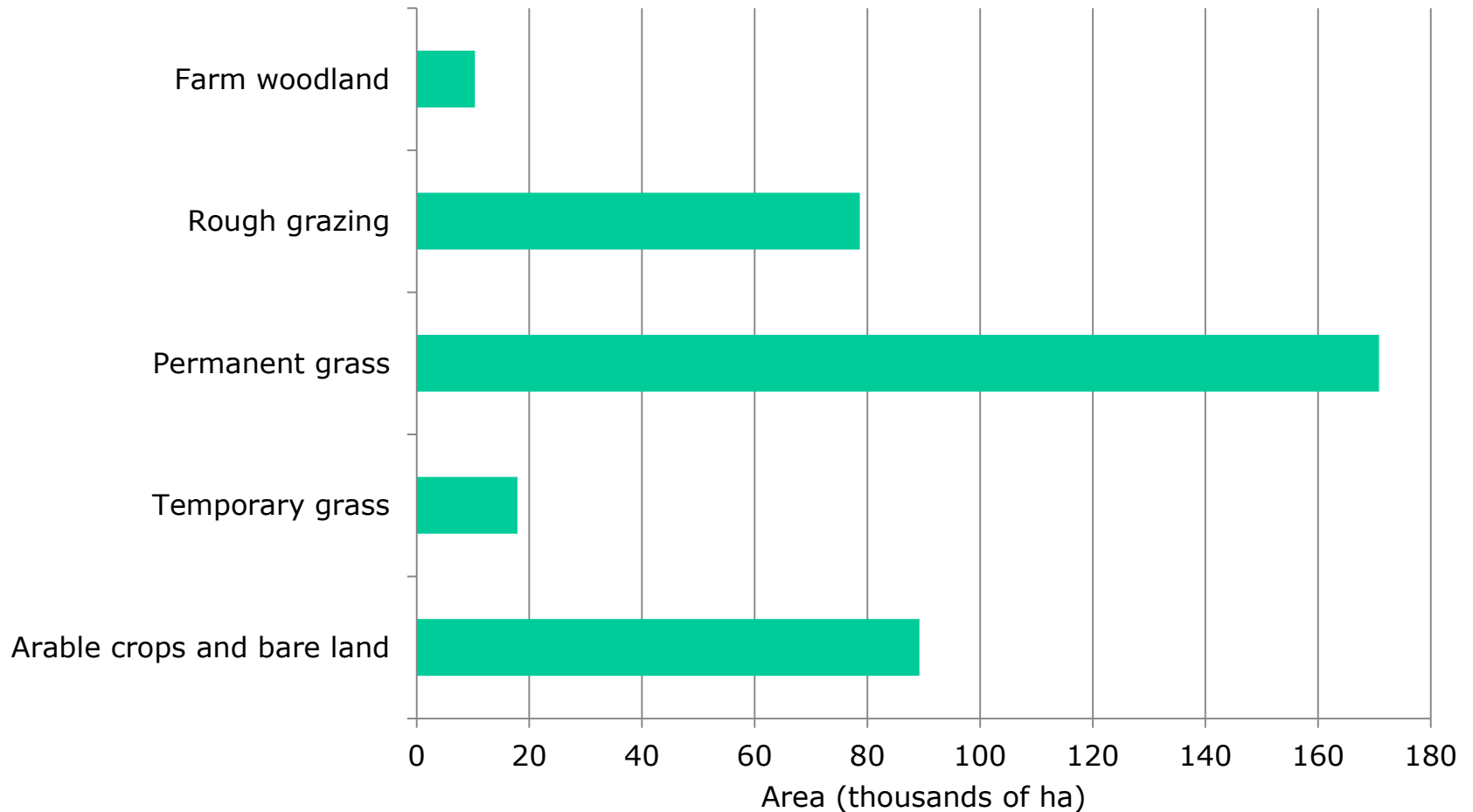
Land use (Corrine)



- Non-irrigated arable land
- Pastures
- Broad-leaved forest
- Coniferous forest
- Mixed forest
- Natural grasslands
- Moors and heathland
- Transitional woodland-shrub
- Sparsely vegetated areas
- Peat bogs

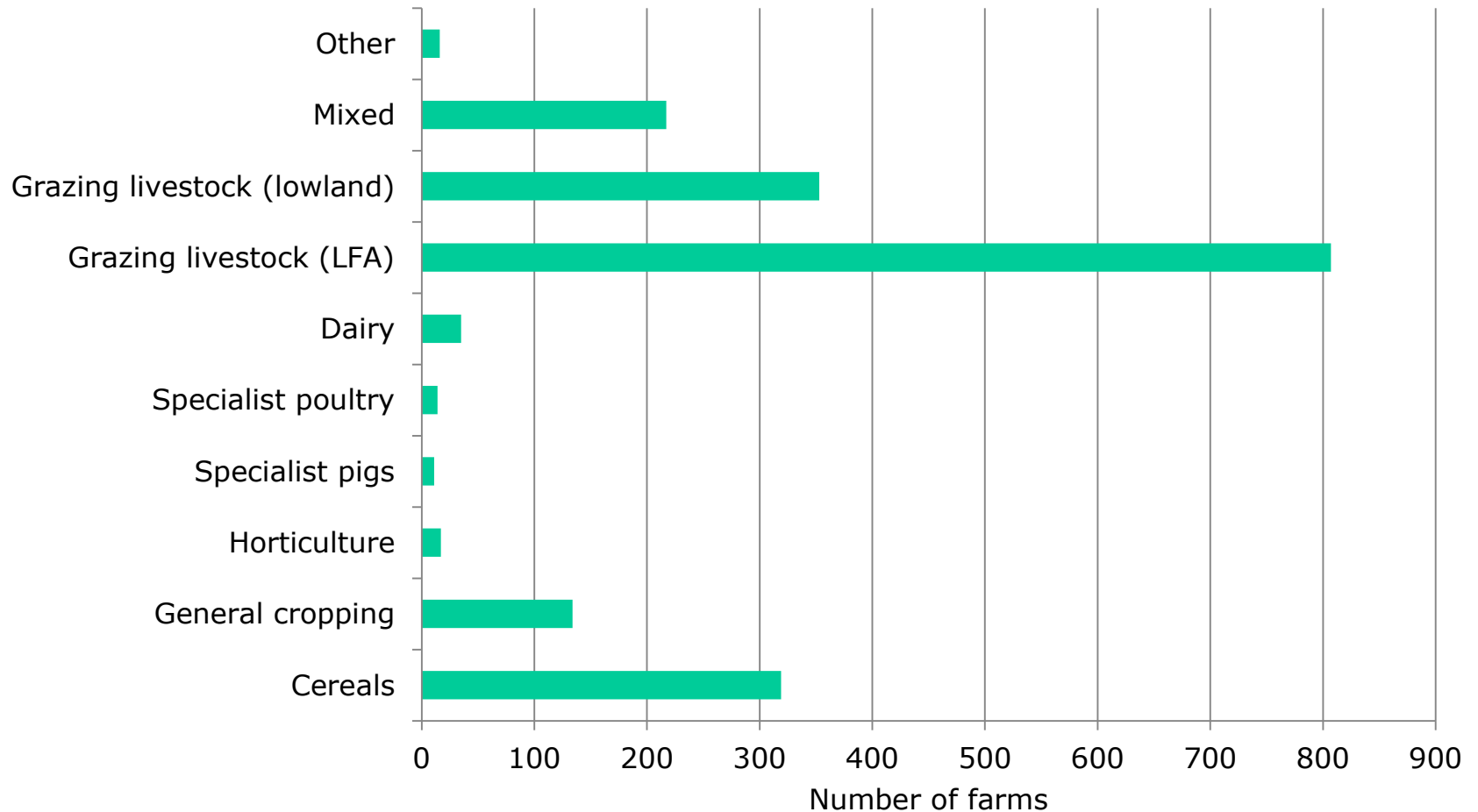


Land use in Northumberland



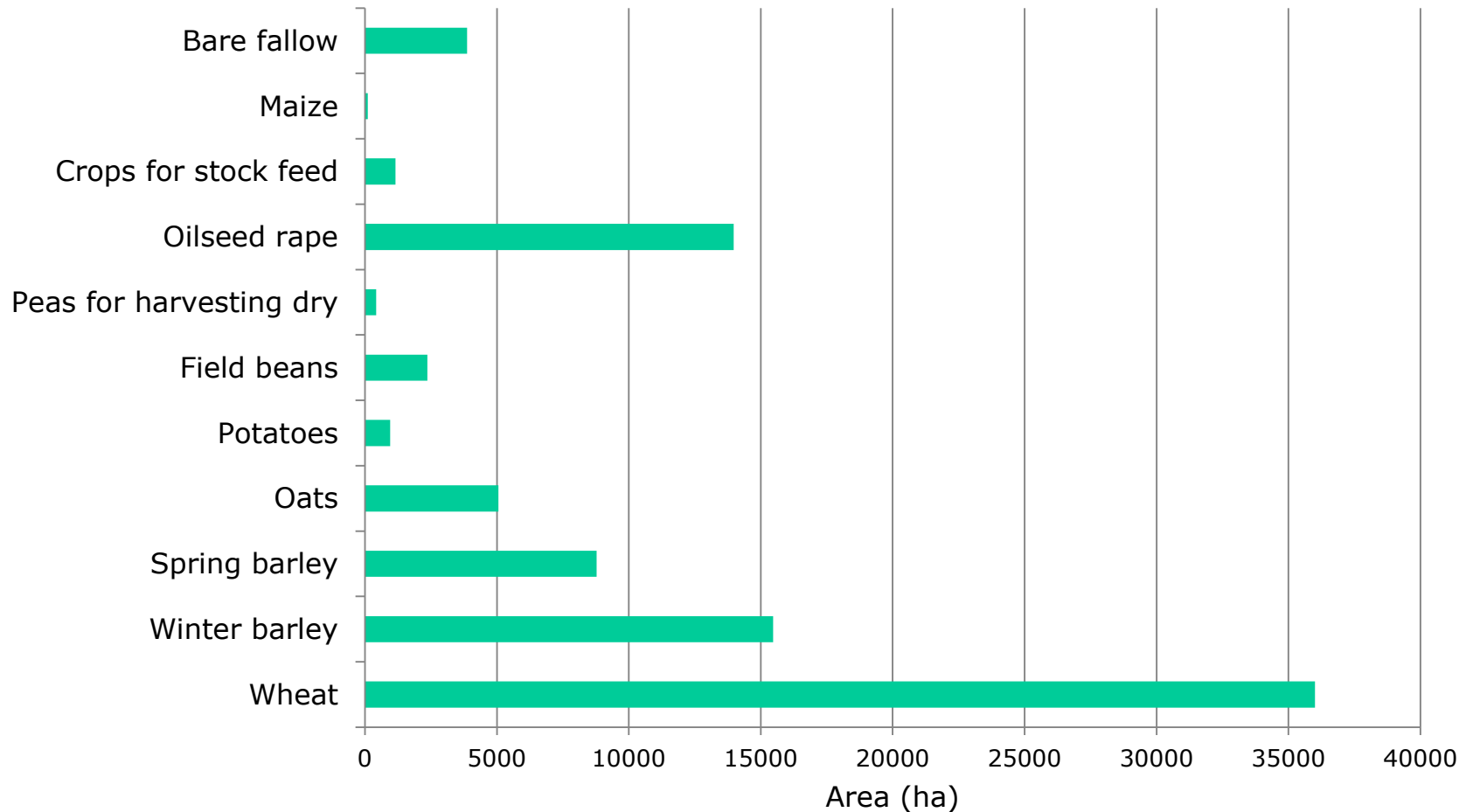
Source: Defra June Survey (2010)

Land use in Northumberland



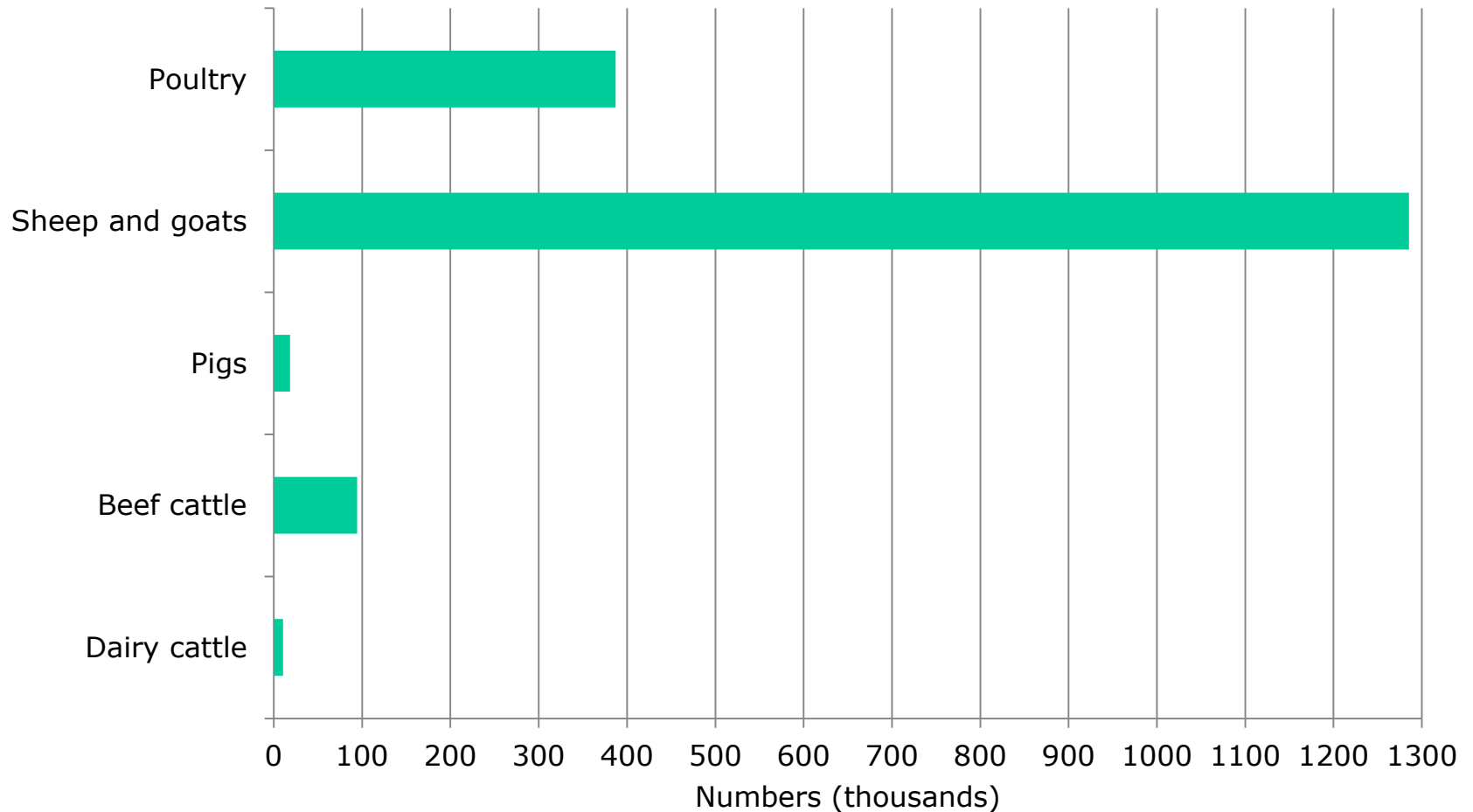
Source: Defra June Survey (2010)

Land use in Northumberland: Arable



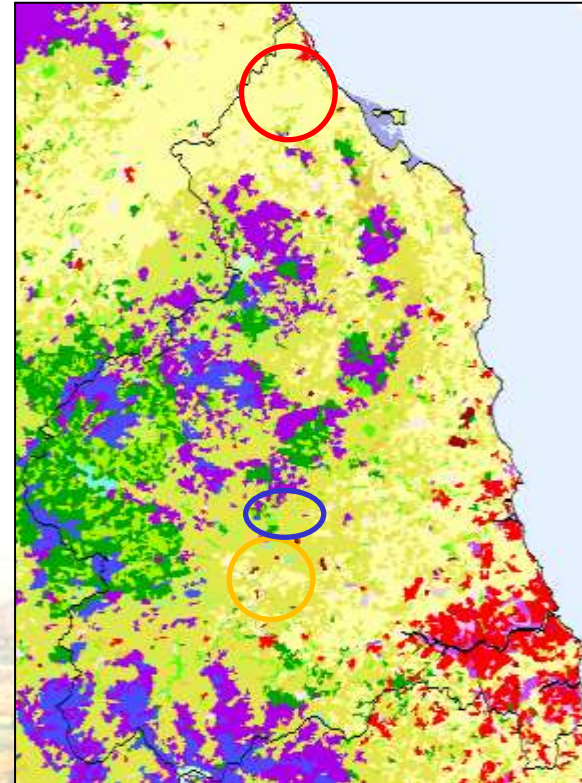
Source: Defra June Survey (2010)

Land use in Northumberland: Livestock



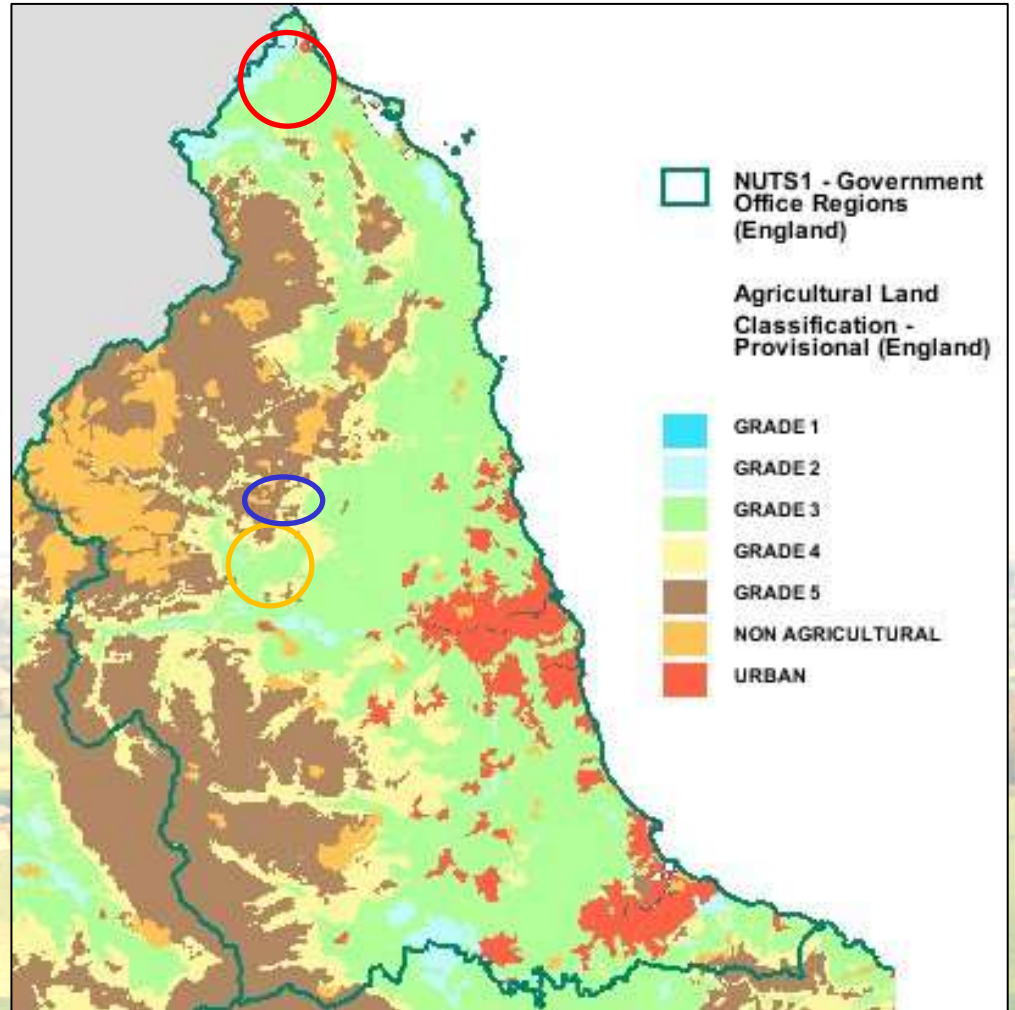
Source: Defra June Survey (2010)

Case studies and land use (Corrine)



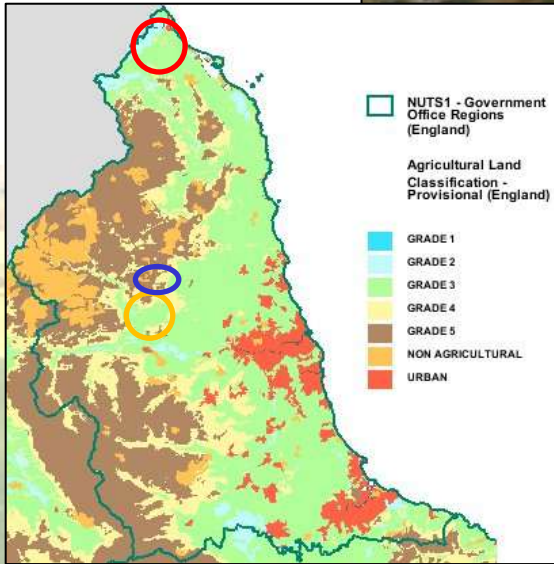
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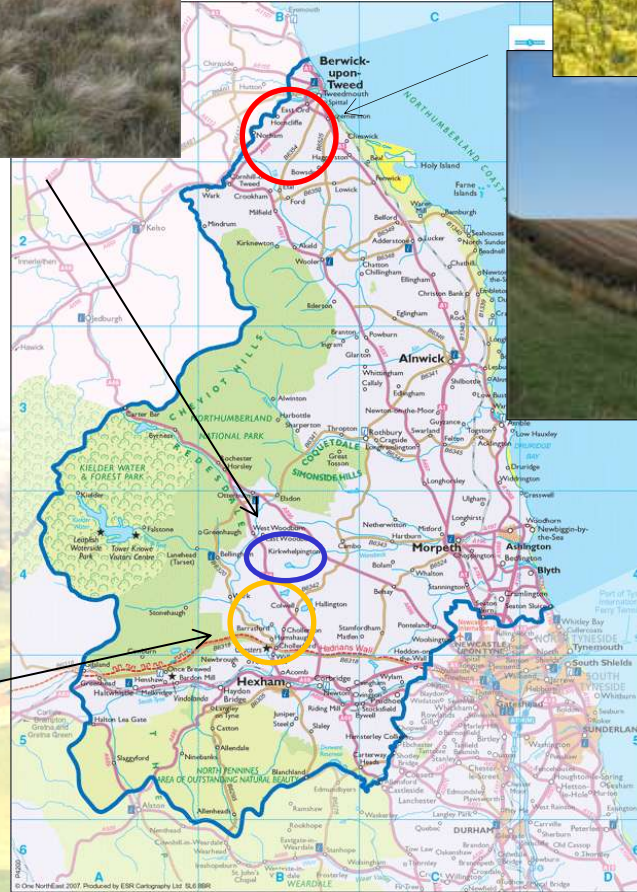
Case studies and Agricultural Land Classification



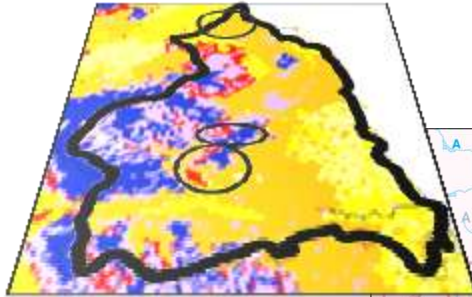
Source: Ordnance Survey; MAGIC

Case studies and Agricultural Land Classification

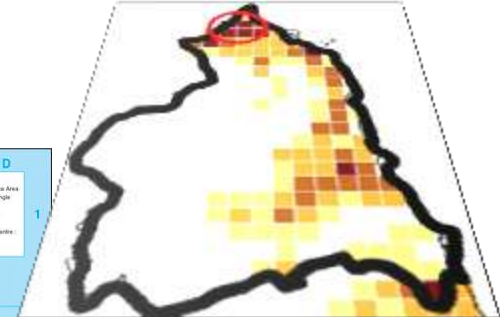




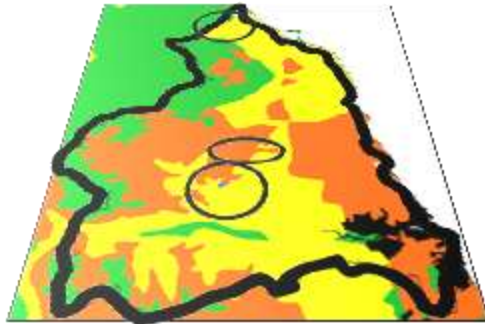
Regional Variation Categories



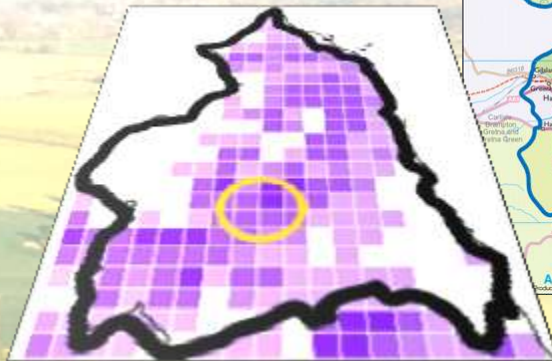
Soil organic carbon



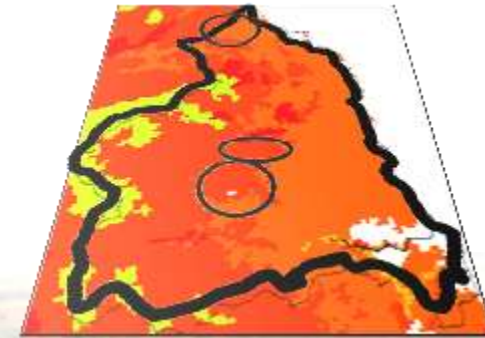
Winter wheat



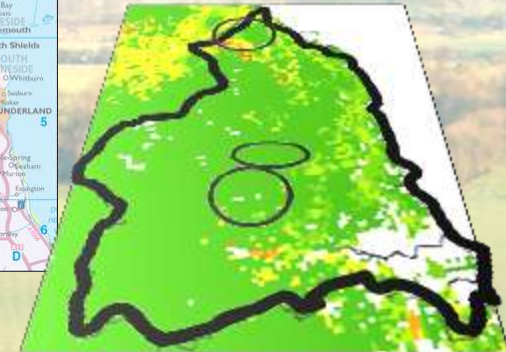
Natural susceptibility to compaction



Beef cattle



Leaching risk



Soil erosion risk



Risk class

The table below shows the average risk class for each NUTS3 area for the criteria shown.

NUTS3	CFF	CST	DEN	DLA	FFR	FLO	LAN	LER	N2K	POL	SER	SOS	FLA	WPS	SCS
Northumberland	2	2	6	4	4	4	1	11	2	6	1	24	3	6	2

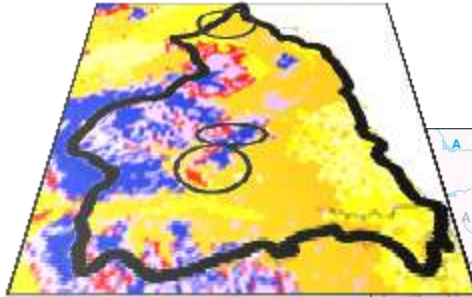
RVC Key

Code	Short name	Description
CFF	CO2 Fossil Fuel	Carbon dioxide from field operations
CST	CO2 Soil Tillage	Carbon dioxide release from soil due to tillage
DEN	Denitrification Risk	N2O from denitrification
DLA	Dilution_A	Water quality (average/typical quality data) dilution
FFR	Forest Fire	Risk of forest fires
FLO	Flooding	Flooding: Projected change in damage of river floods with a 100-year return period between 2071–2100 and 1961–1990
LAN	Landscape	Impact on nationally designated areas of landscape value (National - CDDA) from soil erosion and forest fires
LER	Leaching Risk	Risk of nitrate leaching
N2K	Natura 2000	Risk to biodiversity in Natura 2000 sites from temperature increase
POL	Pollination	Risk to pollinators
SER	Soil Erosion	Soil erosion increase due to increase in rainfall and increase in heavy rainfall
SOS	SOM Stress	Loss of Soil Organic Matter due to hotter and drier conditions
FLA	Filter_A	Water quality (average/typical quality data) filtration
WPS	Water Provision	Water provision and water stress
SCS	Soil Compaction	Susceptibility to soil compaction

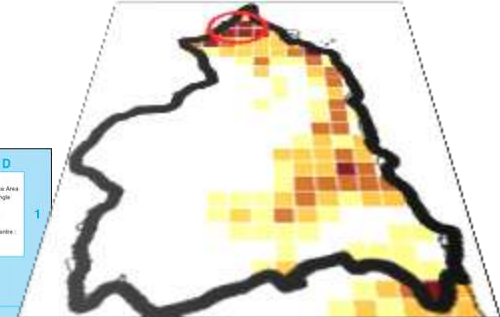
Colour code key



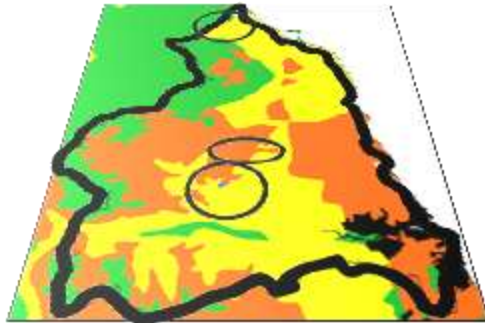
Case study 1



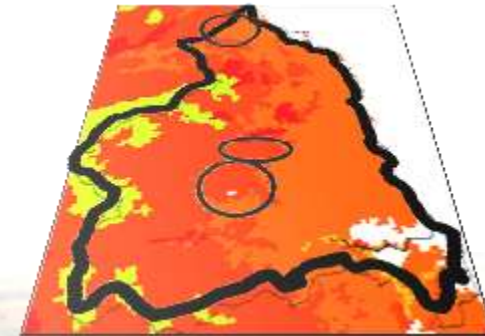
Soil organic carbon



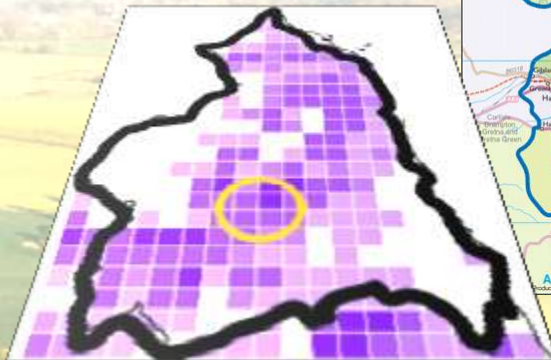
Winter wheat



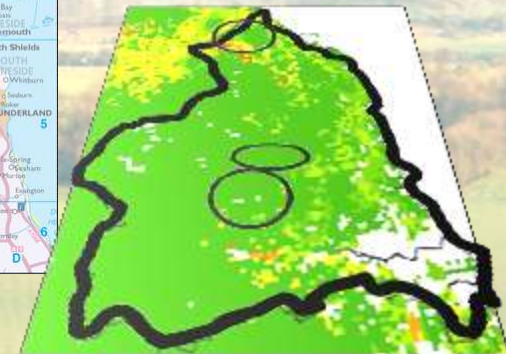
Natural susceptibility to compaction



Leaching risk



Beef cattle



Soil erosion risk

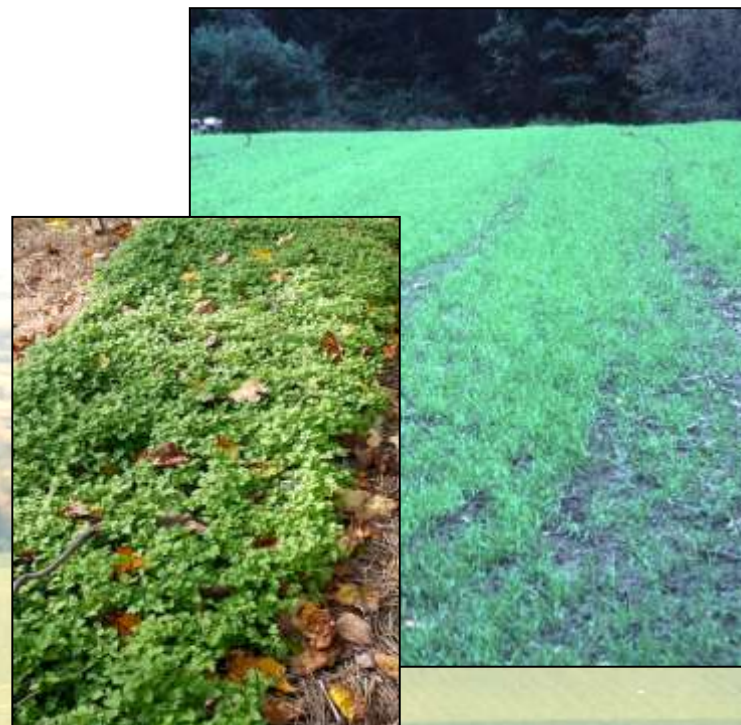
Case study 1

GHG Hotspot: Spring sown crop (spring barley) preceded by fallow (autumn and winter) within the rotation vulnerable to soil erosion

GHG Hotspot: Spring sown crop (spring barley) preceded by fallow (autumn and winter) within the rotation vulnerable to nitrate leaching

RDP measure: **EJ13 (Winter cover crop)**

- Establish a cover crop by 15 September
- Drill or broadcast a quick-growing cover crop - rye, vetch, *Phacelia*, barley or mustard
- Must provide a dense cover and protect from soil erosion
- No fertilisers or manures
- Destroy cover crop by cultivation in late January or early February, immediately before establishing the following spring crop, to minimise any nitrate losses



Case study 1

GHG Hotspot: Cultivated land within high erosion risk RVCs

RDP measure: **EJ5 (In-field grass areas to prevent erosion and run-off)**

- Establish or maintain a dense grassy area during the first 12 months either by sowing or, ideally, by natural regeneration.
- Regular cutting in the first 12–24 months may be needed to control annual weeds and encourage grasses to tiller. Avoid cutting when the soil is moist to prevent further compaction
- Only apply herbicides to spot-treat or weed-wipe for the control of injurious weeds
- Do not use the grass area for regular vehicular access, turning or storage. There should be no tracks, compacted areas or poaching
- Do not graze

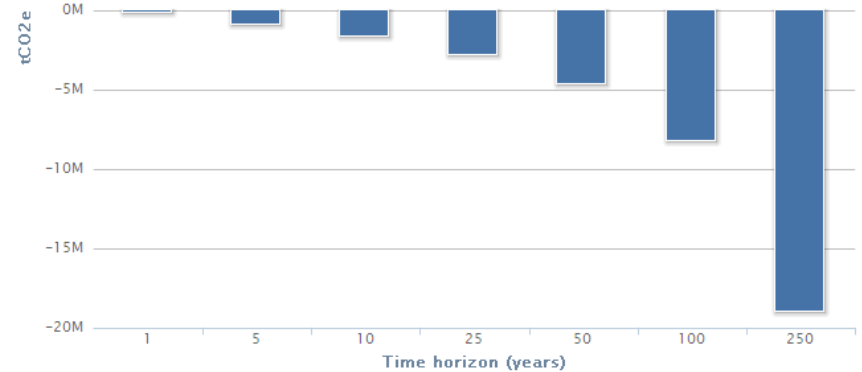


Case study 1

Activity/feature	tCO2e/ha per year	tCO2e/ha per 5 years	tCO2e/ha per 10 years	tCO2e/ha per 25 years	tCO2e/ha per 50 years
Ammonium nitrate (manufacture): Arable	-1.324	-6.621	-13.241	-33.104	-66.208
Biomass: Annual cultivation ¹	8.1	8.1	8.1	8.1	8.1
Biomass: Permanent unimproved grass ¹	-5.9	-5.9	-5.9	-5.9	-5.9
CO2 erosion: Cultivated land	-0.157	-0.785	-1.571	-3.927	-7.854
CO2 erosion: Permanent UI grass (zero grazing)	0	0	0	0.001	0.002
Combine harvester	-0.074	-0.368	-0.736	-1.841	-3.682
Drill	-0.02	-0.102	-0.204	-0.509	-1.018
Drying to 86% DM	-0.014	-0.069	-0.139	-0.346	-0.692
Inorganic N fertiliser operations	-0.041	-0.205	-0.41	-1.026	-2.052
K2O (manufacture)	-0.048	-0.24	-0.48	-1.2	-2.4
Lime (per year ave)	-0.03	-0.151	-0.302	-0.754	-1.508
Mow / strim	0.016	0.08	0.159	0.399	0.798
N2O erosion: Cultivated land	-0.211	-1.055	-2.11	-5.276	-10.552
N2O erosion: Permanent UI grass (zero grazing)	0	0.001	0.002	0.005	0.01
P2O5 (manufacture)	-0.046	-0.23	-0.459	-1.148	-2.297
Pesticide application	-0.058	-0.29	-0.579	-1.448	-2.895

Mitigation EJS (In-field grass areas to prevent erosion and run-off)

The chart and table below show the carbon balance for this operation for the region(s) currently selected over different time horizons.



To view how this carbon balance varies with different regions (within those selected), click on 'Regional breakdown' for a specific time horizon.

	Time horizon (years)						
	1	5	10	25	50	100	250
tCO2e (total)	-149335	-869804	-1642015	-2794092	-4591958	-8187690	-18974887
tCO2e/ha	-10.7	-62.2	-117.4	-199.7	-328.2	-585.2	-1356.1

Summary

Criterion	Data
Mitigation (1 year to 250 years)	-149335 to -18974887 tCO2e
Adaptation (regional risk reduction)	5.8
Production (total per annum)	-198380227

	-4.594	-11.484	.
	-5.79	-14.475	■

Case study 1

GHG Hotspot: Areas of degraded woodland (non-grazed) with reduced biomass and C potential

RDP measure: **HC8 (Restoration of woodland)**

- Exclude livestock
- Remove inappropriate species e.g. Rhododendron
- Undertake planting
- Protect trees from damage
- Re-introduce a selective felling or coppicing cycle to restructure the habitat



Case study 1

GHG Hotspot: Absence of continuous interlinking boundary features (hedgerows) with reduced biomass and C potential

RDP measure: **Hedgerow restoration (UB14) / Enhanced Hedgerow management (EB3/10) / Establishment of hedgerow trees by tagging (EC23)**

- Hedge laying to create a dense barrier, from which regrowth should shoot
- Hedge gapping up - establishing new plants into gaps in an existing hedge
- Maintain hedgerows to a height no less than 2 m in height
- One sapling - at the end of the agreement, there must be a living undamaged tree

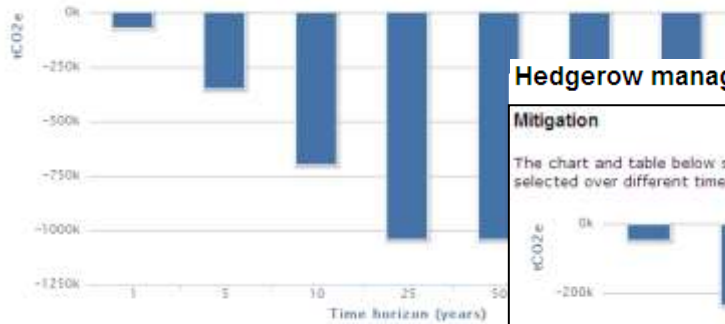


Case study 1

Hedgerow restoration: gapping up

Mitigation

The chart and table below show the carbon balance for this operation for the region(s) currently selected over different time horizons.



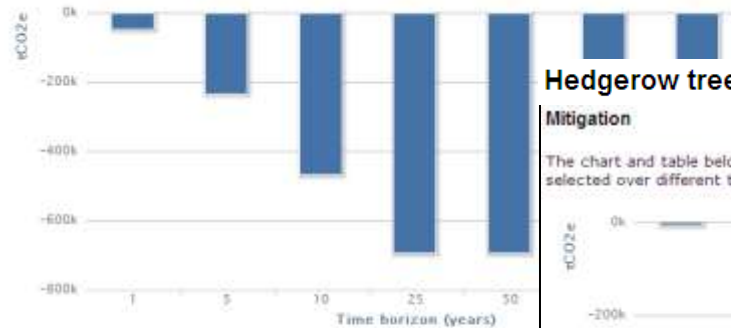
To view how this carbon balance varies with different regions (with 'Regional breakdown' for a specific time horizon).

	Time horizon (years)				
	1	5	10	25	50
tCO2e (total)	-70254	-351269	-702539	-1044314	-1044314
tCO2e/ha	-2.8	-13.9	-27.8	-41.2	-41.2

Hedgerow management: enhanced

Mitigation

The chart and table below show the carbon balance for this operation for the region(s) currently selected over different time horizons.



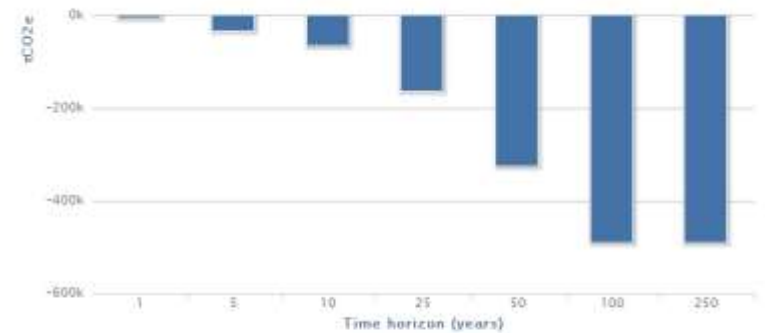
To view how this carbon balance varies with different regions (within those selected), click on 'Regional breakdown' for a specific time horizon.

	Time horizon (years)				
	1	5	10	25	50
tCO2e (total)	-46836	-234180	-468359	-696210	-696210
tCO2e/ha	-1.8	-9.2	-18.5	-27.5	-27.5

Hedgerow trees: establishment by tagging

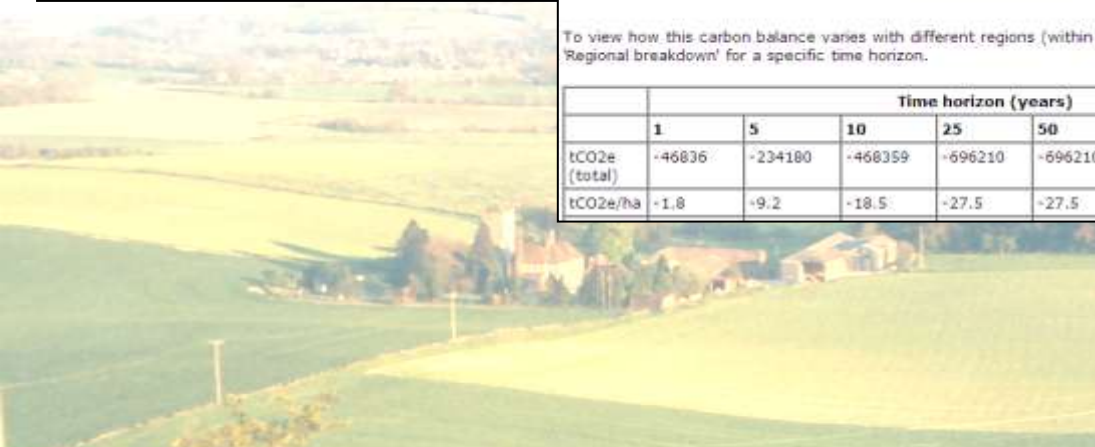
Mitigation

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	Time horizon (years)						
	1	5	10	25	50	100	250
tCO2e (total)	-6516	-32583	-65165	-162913	-325826	-492248	-492248
tCO2e/ha	-0.3	-1.3	-2.6	-6.4	-12.9	-19.4	-19.4



Case study 1

My Operations

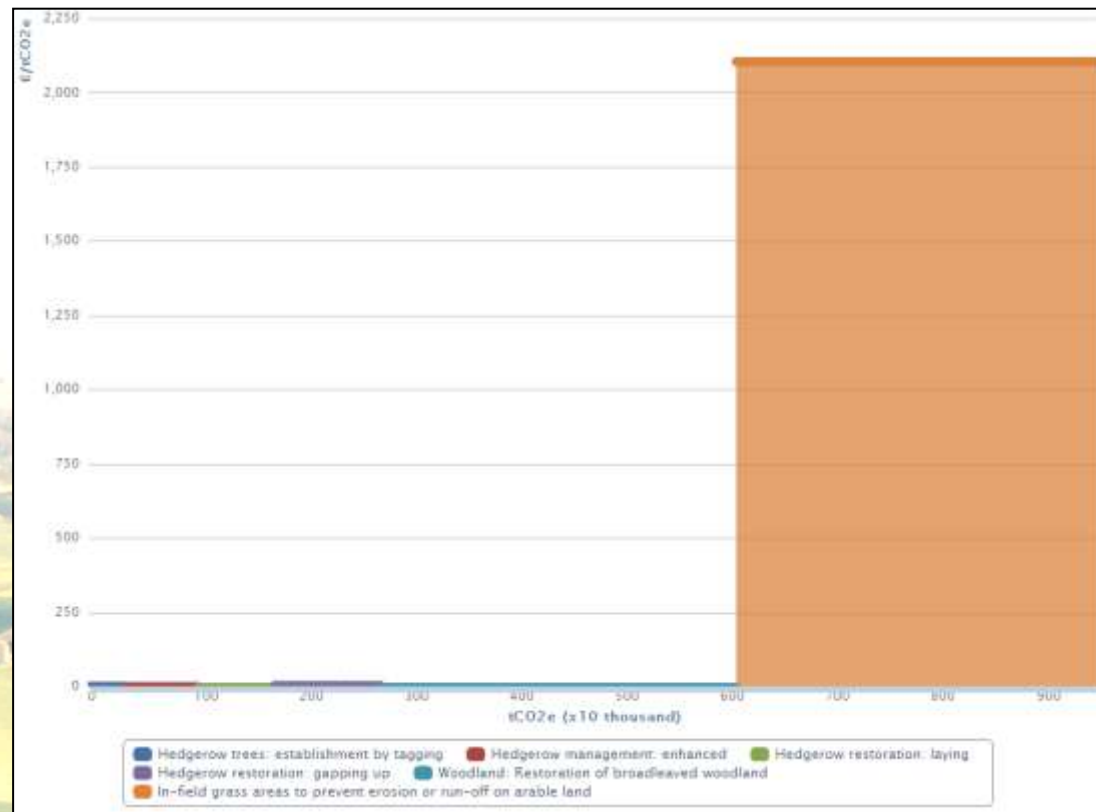
Ranked by total regional impact using the 50 year time horizon.

Operation name ↓	Mitigation ↓	Adaptation ↓	Production ↓	Combined ↓	Data Quality
In-field grass areas to prevent erosion or run-off on arable land	100	100	-100	33	▬▬
Woodland: Restoration of broadleaved woodland	73	0			
Hedgerow restoration: gapping up	23	0			
Hedgerow restoration: laying	15	0			
Hedgerow management: enhanced	15	0	0	5	▬▬
Hedgerow trees: establishment by tagging	7	0	0	2	▬▬

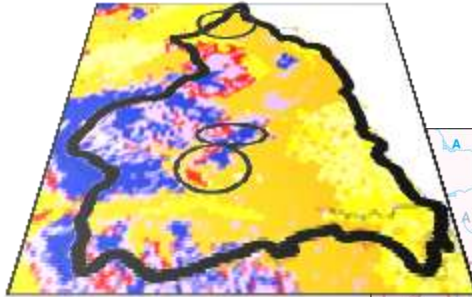
Activity/feature	Impact category	Regional risk reduction
Habitat for pollinators	Risk of decline in population of pollinators	0.6
Infiltration rate increase / surface run-off decrease	Risk of water quality decrease (due to lack of filtration)	0.2
Infiltration rate increase / surface run-off decrease	Risk of increase in soil erosion	0.8
Infiltration rate increase / surface run-off decrease	Risk of flooding	4
Pollutant load (decrease)	Risk of water quality decrease (due to lack of filtration)	0.2

Case study 1

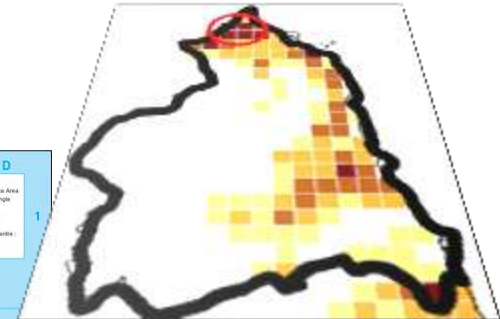
- EJ13 (Winter cover crops) additional costs from sowing (seed and drilling) and destruction by cultivation, **no impact on yield**, the IF payment (£65 ha⁻¹) covers the additional machinery operation and seed
- EJ5 (In-field grass areas to prevent erosion and run-off) **100% loss of yield**
- Boundary features implemented on existing non cropped land (**no loss of yield**)



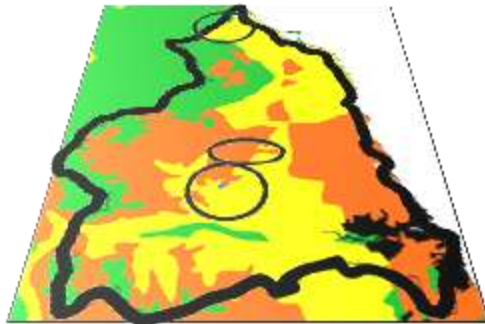
Case study 2



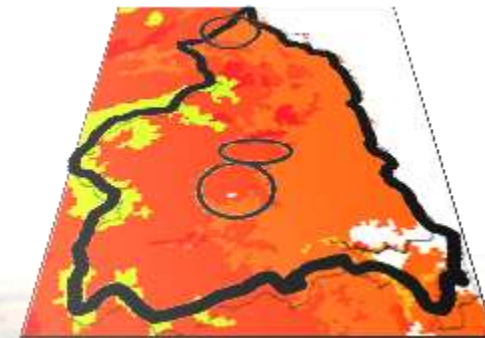
Soil organic carbon



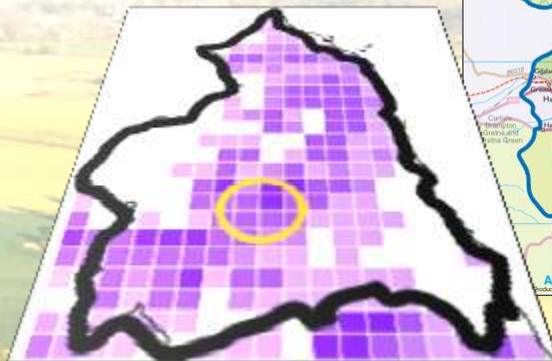
Winter wheat



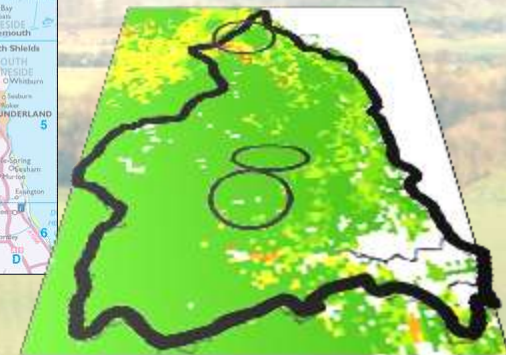
Natural susceptibility to compaction



Leaching risk



Beef cattle



Soil erosion risk

Case study 2

GHG Hotspot: High stocking rates on soils susceptible to compaction (RVC classes moderate-high)

RDP measure: **Seasonal livestock removal on grassland with no input restriction HJ7**

- Supports the removal of livestock at specific times of the year to reduce compaction and run-off.
- For use on soils that are prone to waterlogging, compaction or poaching - applies to the whole field.
- Removing livestock from land parcels receiving this supplement must not cause soil damage on other parcels.



Case study 2

GHG Hotspot: High stocking rates on grazing land adjacent to a watercourse resulting in soil (bank) erosion and N deposition into the water)

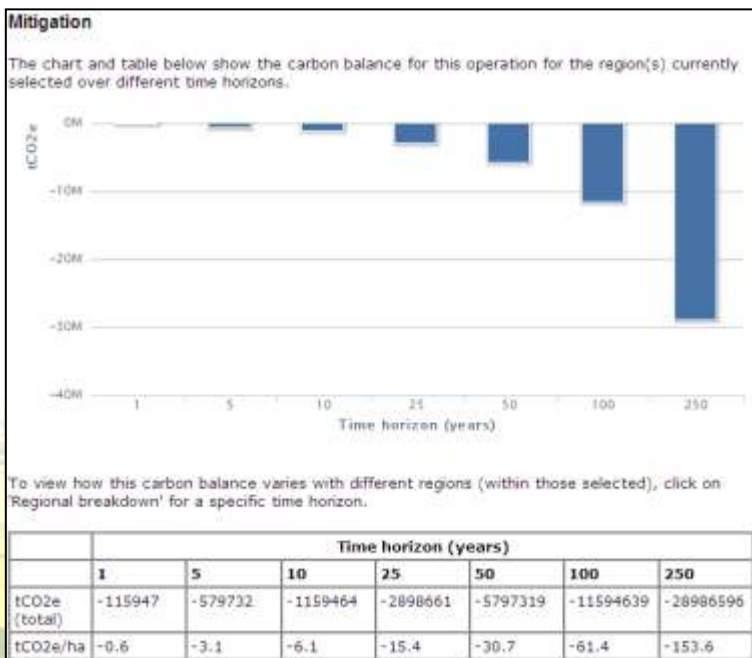
RDP measure: **HJ11 (Maintenance of watercourse fencing)**

- Maintain fencing in stock-proof condition
- Prevents sedimentation and deposition into the watercourse of N and P in surface run-off

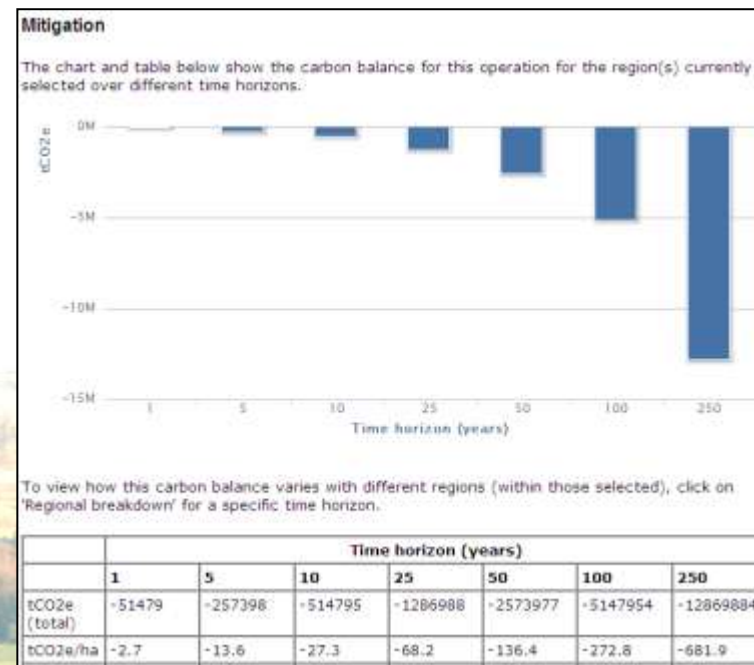


Case study 2

Grassland: Seasonal livestock removal on lowland temporary grassland (cattle) with no input restriction



Exclusion of livestock (SIG sheep lowland) next to watercourse (using fencing)



Case study 2

GHG Hotspot: High stocking rates, N deposition and supplementary N application to periodically marshy (during winter) grassland with associated increased de-nitrification risk and emission of N₂O from soils.

RDP measure: **EK3 (Permanent grassland with very low inputs)**

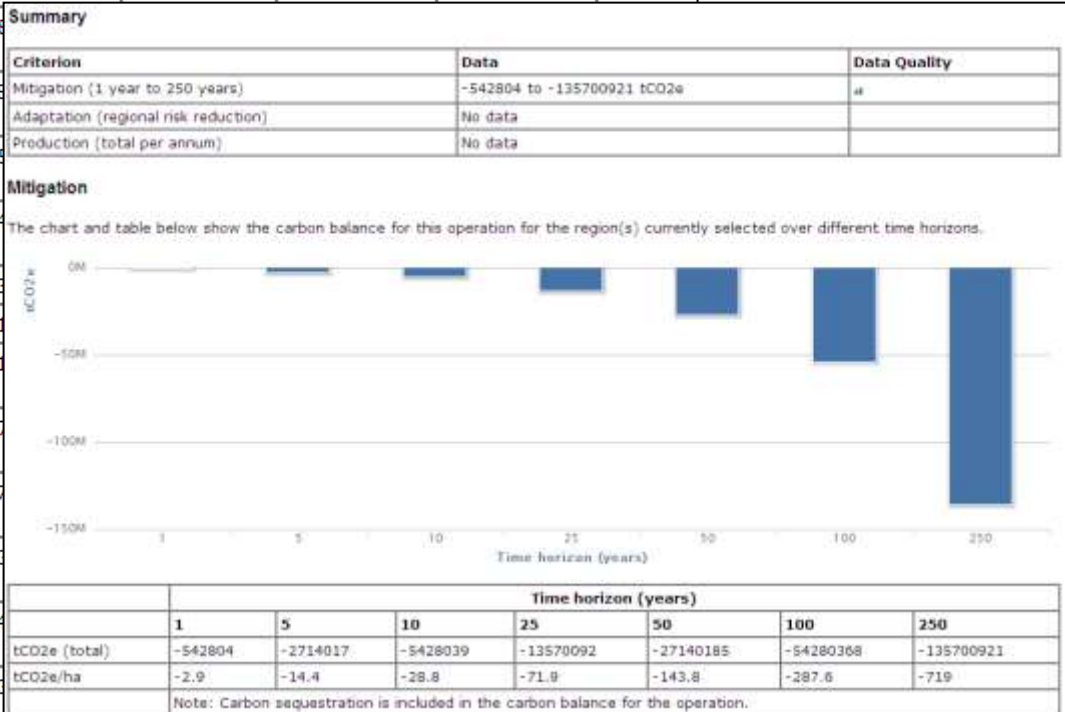
- No fertilisers or manures except max 12.5 t ha⁻¹ FYM.
- Do not supplementary feed



Case study 2

Activity/feature	tCO2e per year	tCO2e per 5 years	tCO2e per 10 years	tCO2e per 25 years	tCO2e per 50 years	tCO2e per 100 years	tCO2e per 250 years	Data Quality
Ammonium nitrate (manufacture): Grassland (livestock)	-80987	-404933	-809867	-2024667	-4049334	-8098668	-20246671	■■■
Biomass: Permanent semi-improved grass ¹	1113530	1113530	1113530	1113530	1113530	1113530	1113530	■■■
Biomass: Permanent unimproved grass ¹	-1113530	-1113530	-1113530	-1113530	-1113530	-1113530	-1113530	■■■
Chain harrow	-4185	-20926	-41851	-104628	-209256	-418511	-1046278	■■■
CO2 erosion: Permanent SI grass	-15	-77	-154	-385	-771	-1541	-3853	■

CO2 erosion: Permanent UI grass	15	77	154	385	771	1541	3853	■
Enteric CH4: SIG cattle lowland	-345465	-1727326	-3454652	-8636630	-17273260	-34546520	-86366300	■
Enteric CH4: UIG cattle lowland	143944	719719	1439438	3598595	7197190	14394380	35985950	■■■
Inorganic N fertiliser operations	-1936	-9678	-19357	-48392	-96784	-193568	-483916	■
K2O (manufacture)	-1416	-7078	-14155	-35388	-70776	-141552	-353880	■
Lime (per year ave)	-4270	-21351	-42703	-106758	-213516	-427032	-1067580	■
Manure CH4: SIG cattle lowland	-6394	-31969	-63939	-159848	-319696	-639392	-1598480	■
Manure CH4: UIG cattle lowland	2708	13542	27083	67708	135416	270832	677080	■■■
Manure N2O: SIG cattle lowland	-295901	-1479506	-2959013	-7397533	-14795066	-29590132	-73975330	■
Manure N2O: UIG cattle lowland	132607	663034	1326068	3315170	6630340	13260680	33151700	■■■
N2O erosion: Permanent SI grass	-17	-86	-172	-430	-860	-1720	-4300	■
N2O erosion: Permanent UI grass	17	86	172	430	860	1720	4300	■

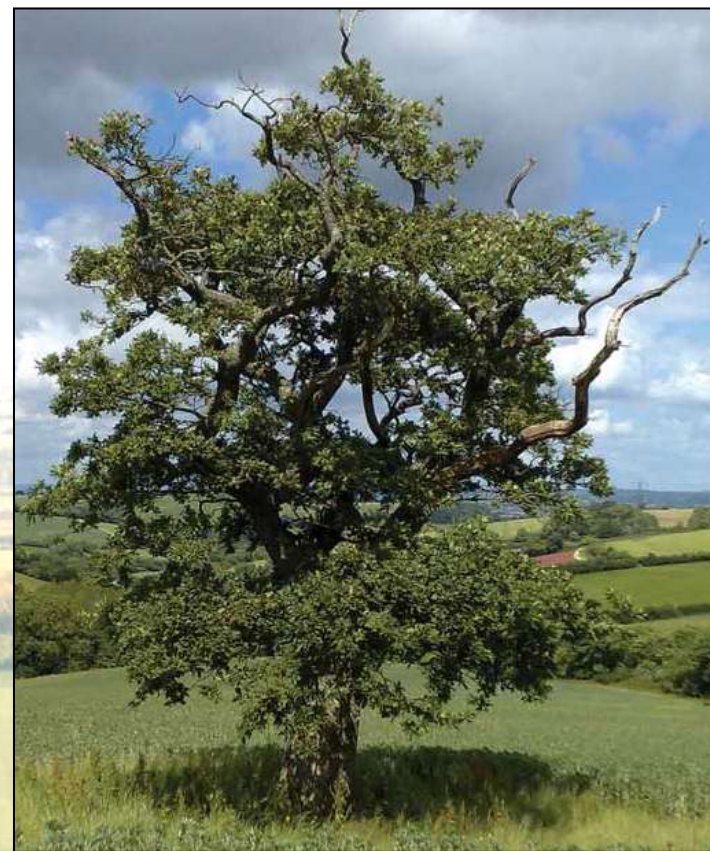


Case study 2

GHG Hotspot: Veteran trees located in fields of temporary grassland at risk of damage to roots during reseeding operations.

RDP measure: **HC6 (Ancient trees in intensively managed grass fields)**

- Establish an unfertilised grass buffer with a radius of at least 15 m around the base of each tree
- Protect trees from damage by livestock including stock rubbing against the trees, bark stripping and soil compaction
- Fencing to protect trees from livestock available



Case study 2

GHG Hotspot: Grazing by sheep within woodland fragments on an 'accidental' basis (access gained via poorly maintained boundaries as opposed to deliberate introduction)

RDP measure: **Sheep fencing around small woodlands (UC5)**

- Provision of new fencing to prevent access to woodland by livestock.
- Only adjacent to small areas of predominantly native woodlands, in particular ancient woodlands.
- Woodland parcels less than 3 ha in size comprising at least 50 per cent native species.
- New fencing must result, or contribute to, the effective exclusion of stock



Case study 2

My Operations

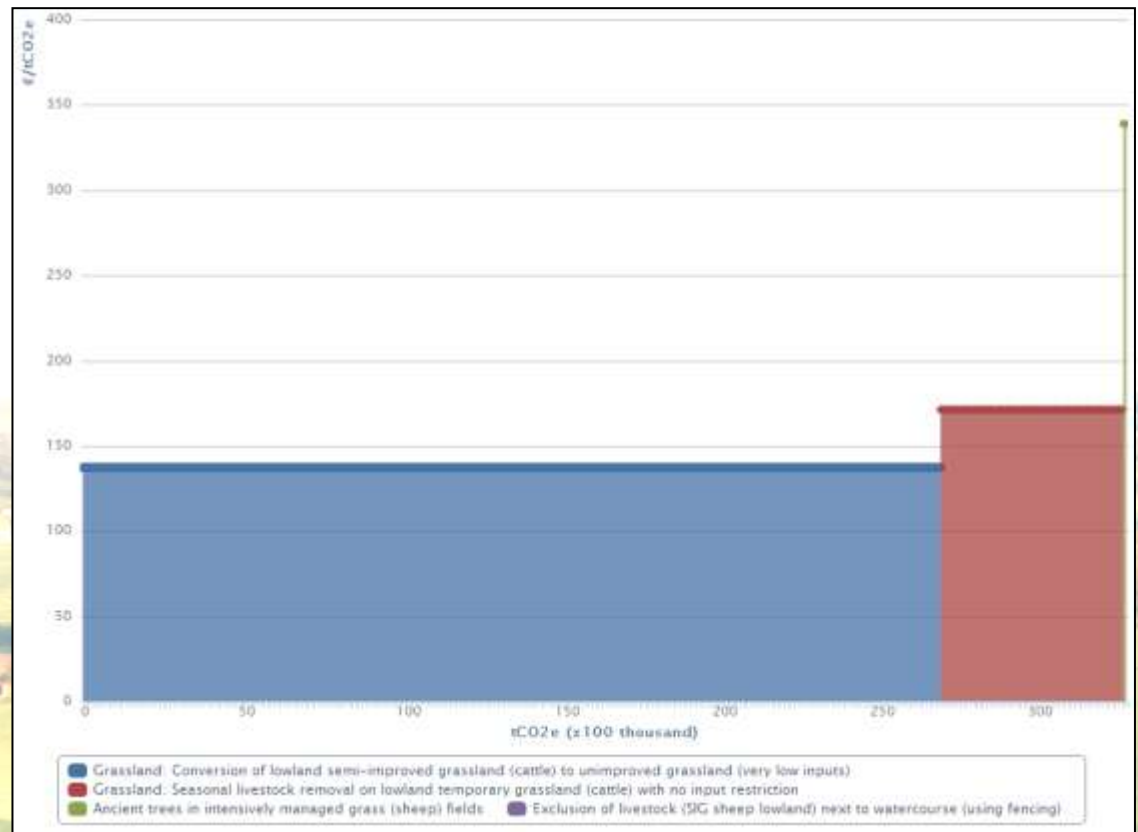
Ranked by total regional impact using the 50 year time horizon.

Operation name ↓	Mitigation ↓	Adaptation ↓	Production ↓	Combined ↓
Grassland: Conversion of lowland semi-improved grassland (cattle) to unimproved grassland (very low inputs)	100	0	0	33
Grassland: Seasonal livestock removal on lowland temporary grassland (cattle) with no input restriction	21	0	0	7
Exclusion of livestock (SIG sheep lowland) next to watercourse (using fencing)	9	100	0	36
Ancient trees in intensively managed grass (sheep) fields	5	0	0	2

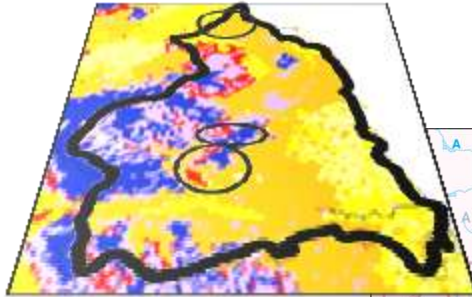
Activity/feature	Impact category	Regional risk reduction
Pollutant load (decrease)	Risk of water quality decrease (due to lack of filtration)	0.4

Case study 2

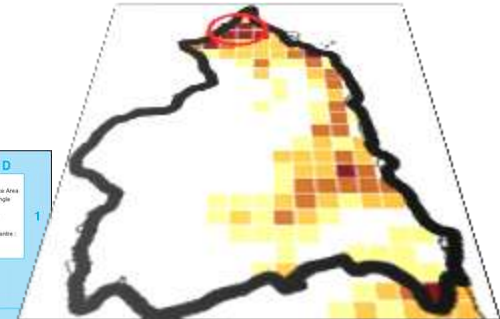
- Seasonal removal of livestock (HJ7) - **no reduction in overall stocking rate**
- Maintenance of watercourse fencing (HJ11) - **no loss of yield**
- EK3 (Permanent grassland with very low inputs) - **reduction of stocking rates**
- Protection of ancient trees in intensively managed grass fields (HC6) - small areas within field



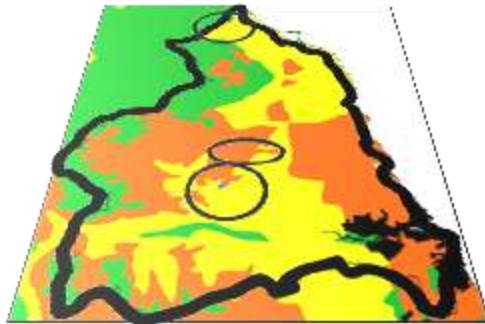
Case study 3



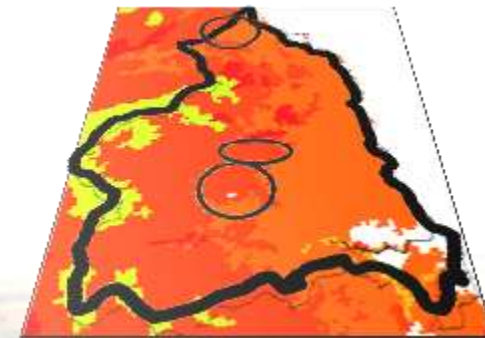
Soil organic carbon



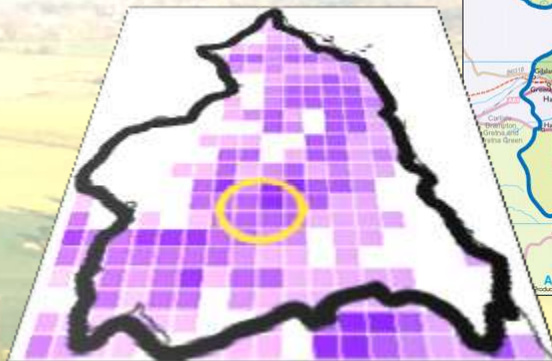
Winter wheat



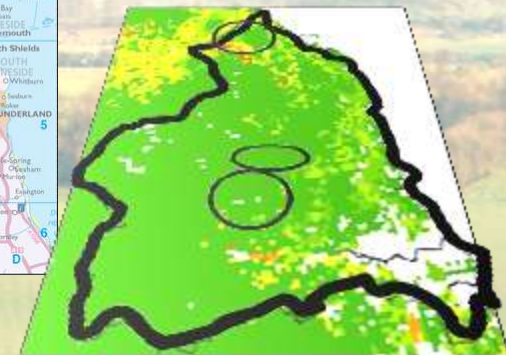
Natural susceptibility to compaction



Leaching risk

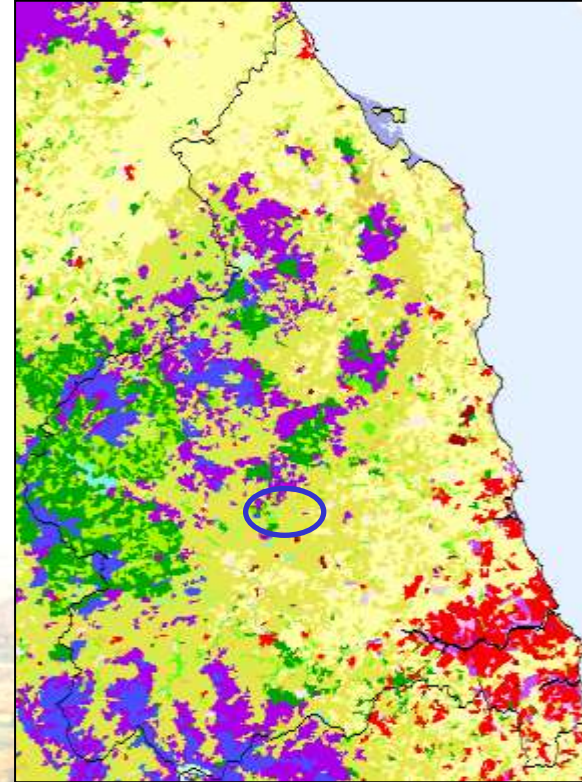


Beef cattle



Soil erosion risk

Land use (Corrine)



- Non-irrigated arable land
- Pastures
- Broad-leaved forest
- Coniferous forest
- Mixed forest
- Natural grasslands
- Moors and heathland
- Transitional woodland-shrub
- Sparsely vegetated areas
- Peat bogs

Case study 3

GHG Hotspot: Degraded high C containing soils (SOC RVC organic mineral and shallow peat soils) formerly upland moorland and subject to drainage

RDP measure: **HL10 (Restoration of moorland)**

- Graze moorland following an agreed stocking calendar
- Drainage ditch blocking or temporary fencing to reduce or exclude grazing
- Provide an area of flood containment and some benefits to flood risk management



2008



Flood fears as river levels rise

Heavy rain that has affected parts of England and Wales may continue to cause flooding for several days, the Environment Agency has warned.

It said that while the rain has eased, river levels are still rising. Flash floods have hit Yorkshire, Shropshire, Herefordshire and Worcestershire.

Northumberland is particularly badly affected with an estimated 1,000 properties flooded in Morpeth.



Morpeth was inundated when the River Wansbeck burst its banks



September 2012



In Murrumbidgee, New South Wales, the River Macintyre burst its banks, and dozens of properties were evacuated.

UK weather: Homes and transport hit by flooding



BBC Weather's Peter Gibbs has the details of why the low pressure system is being recorded as the most intense September storm in 30 years

Case study 3

Activity/feature	tCO2e/ha per year	tCO2e/ha per 5 years	tCO2e/ha per 10 years	tCO2e/ha per 25 years	tCO2e/ha per 50 years	tCO2e/ha per 100 years	tCO2e/ha per 250 years	Data Quality
Ammonium nitrate (manufacture): Grassland (livestock)	0	0	0	0	0	0	0	■
Biomass: Heathland ¹	-0.6	-3	-6	-6.2	-6.2	-6.2	-6.2	■
Biomass: Permanent semi-improved grass ¹	5.9	5.9	5.9	5.9	5.9	5.9	5.9	■
CO2 erosion: Permanent UI grass	0	0.001	0.002	0.005	0.011	0.021	0.054	■
CO2 erosion: Permanent UI grass (zero grazing)	0	-0.001	-0.002	-0.005	-0.011	-0.021	-0.054	■
Enteric CH4: SIG sheep upland LFA	-1.144	-5.718	-11.435					
Enteric CH4: UIG sheep upland LFA	0.163	0.817	1.634					
Fencing	0	0	-0.001					
Manure CH4: SIG sheep upland LFA	0	-0.002	-0.005					
Manure CH4: UIG sheep upland LFA	0	0.002	0.005					
Manure N2O: SIG sheep upland LFA	-0.312	-1.562	-3.124					
Manure N2O: UIG sheep upland LFA	0.312	1.562	3.124					
N2O erosion: Permanent UI grass	0	0	0.001					
N2O erosion: Permanent UI grass (zero grazing)	0	0	-0.001					
SOC: SIG sheep upland LFA to upland organic soil ¹	-1.417	-7.086	-10.871					
Soil N2O: SIG sheep	-0.608	-3.039	-6.077					



Case study 3



Case study 3

GHG Hotspot: Potentially high risk of de-nitrification (RVC class 6) results from deposition of N onto organic soils in an area of high rainfall (>765 mm per year) during the winter

RDP measure: **HL15 - Seasonal livestock exclusion supplement**

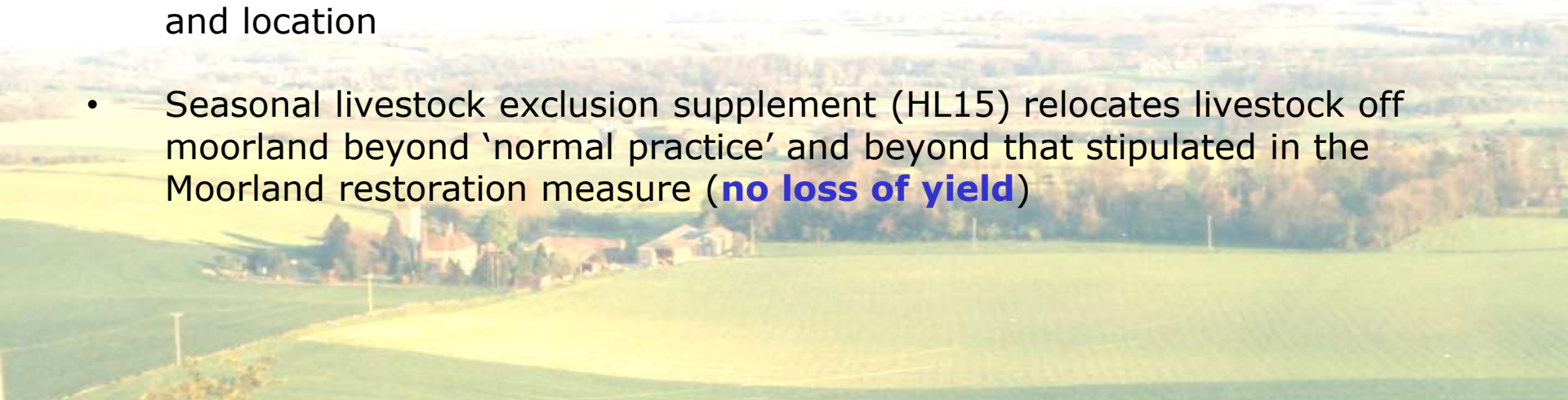
- Supports the removal of livestock from moorland and other rough grassland land for periods of time,
- Allows moorland restoration e.g. heather regeneration



Case study 3

Impact on gross margin

- Moorland restoration (HL10) - **reduce stocking rates by 50%** and removes an assumed 50% of grazing from the moorland during the winter but does not reduce stocking rates overall (the stock are returned the following spring)
- IF payment of £40 ha⁻¹ includes the loss of gross margin and the purchase of winter 'Keep'
- Cost of winter 'Keep' potentially highly variable depending on demand and location
- Seasonal livestock exclusion supplement (HL15) relocates livestock off moorland beyond 'normal practice' and beyond that stipulated in the Moorland restoration measure (**no loss of yield**)



Summary

- Measures available to mitigate GHGs for each of the diverse baseline habitats present throughout Northumberland
- Appropriate targeting to maximise benefits and minimise yield loss e.g. grass areas to reduce erosion
- Attraction to farmers may be subject to variables such as annual fluctuation in costs and demand for resources e.g. winter 'Keep'