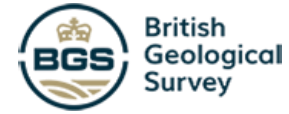
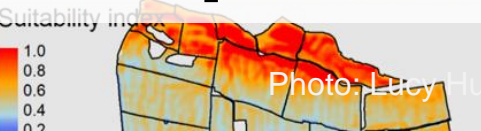
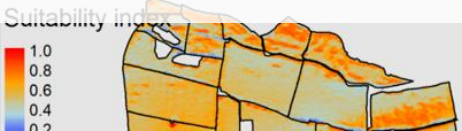
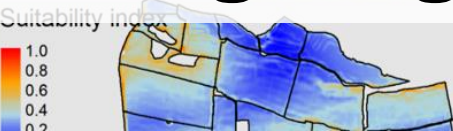


# SESSION 6

Productivity index is derived from NDVI, a measure of 'greenness' from satellite data. It is presented here as the proportional anomaly from fields of the same crop type with an anomaly of 0.1 is 10% higher than average

# Designing future farmed landscapes



Chair: Richard Pywell

funded by



# Tools supporting farmer-led decision making and monitoring

Photo: R Pywell



UK Centre for  
Ecology & Hydrology



ROTHAMSTED  
RESEARCH



British  
Geological  
Survey

*T. August, J. Redhead, V. Bell, M. Brown, R. Pywell*

*funded by*



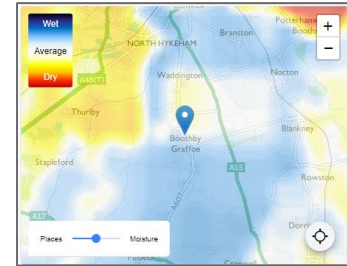
Natural  
Environment  
Research Council



Biotechnology and  
Biological Sciences  
Research Council

## Translating ASSIST outputs into useful tools

- Developing a mapping platform to support environmental land management
- Providing visualisations of land management options
- Supporting farmer-led assessment of habitats
- Distributing up-to-date data on soil moisture



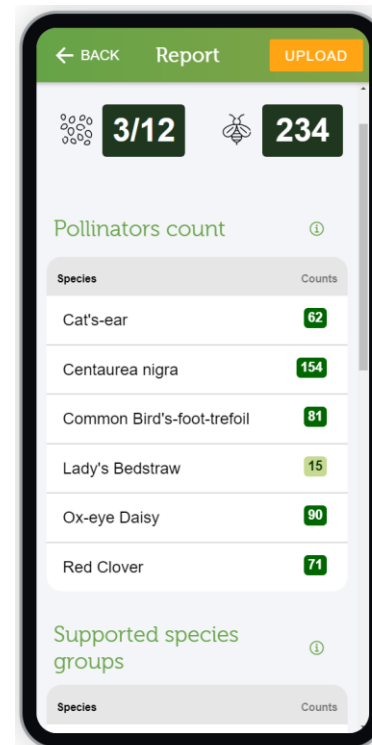
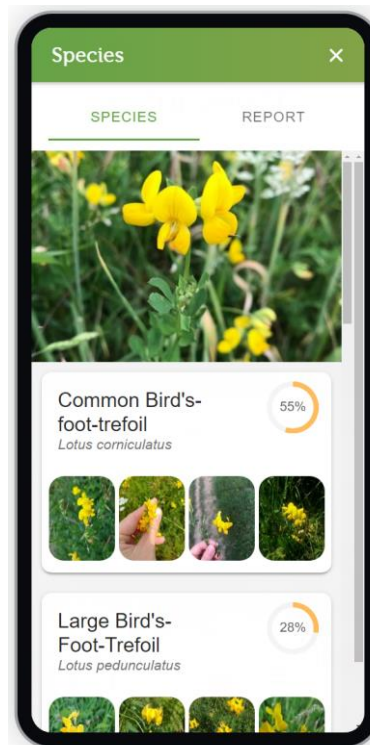


- Map of relative suitability of land for different options
- Free, web-based app for mobile or desktop
- Supports farm environmental planning

[assist-e-planner.ceh.ac.uk](https://assist-e-planner.ceh.ac.uk)

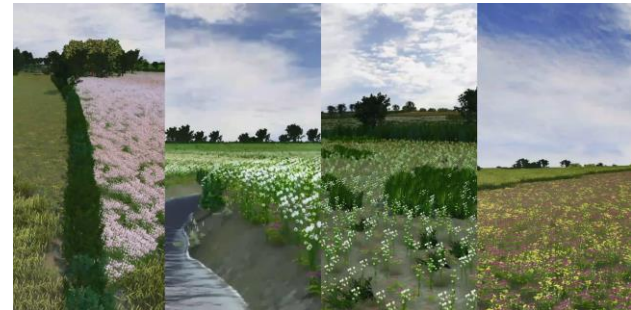
## What does success look like?

- Computer vision used to support plant identification
- Information associated pollinators
- Data on natural enemies
- Supports structured and unstructured observations

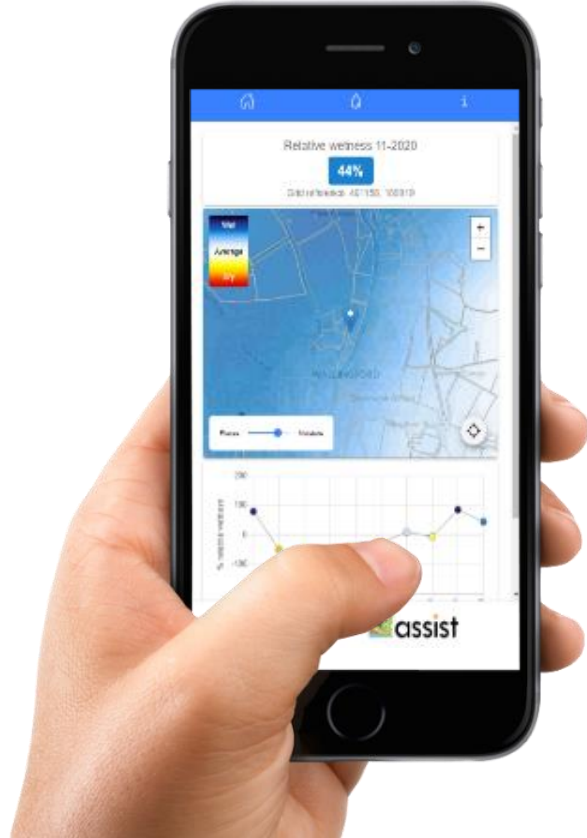




- Bringing future farming landscape to life
- Generating 3D landscapes from satellite data
- Create realistic soundscapes
- Animate land use transitions
- View as images, video or virtual reality

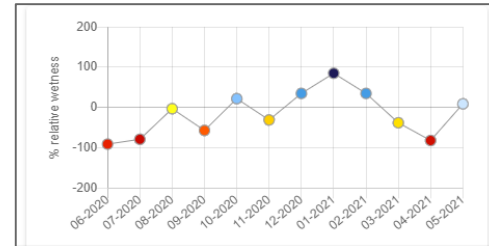


## Soil Moisture App



Supporting farmers by providing easy access to maps of soil moisture

- Monthly, 50m resolution maps
- Timeline of changing wetness
- Free, web-based app for mobile or desktop



# Acknowledgements

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*Acknowledgements: Jonathan Cooper, Helen Davies, Will Bolton, Rod Scott, Rhian Chapman, Robin Hutchinson, Charlotte Johns, Rich Burkmar*





# Tools for exploring impacts of future agricultural land use scenarios



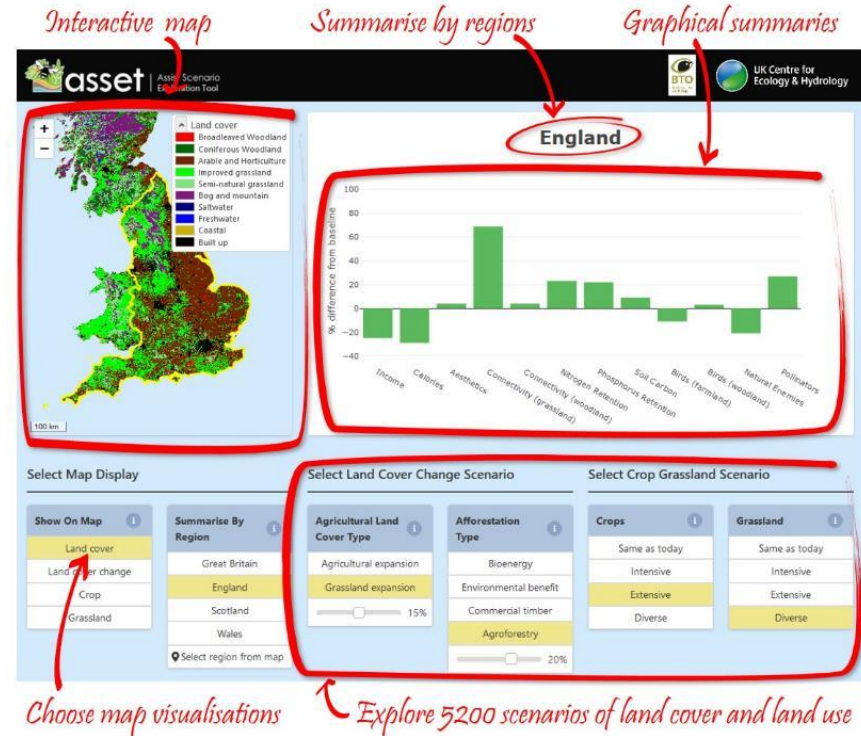
*John Redhead, Rod Scott, Mike Brown, Gary Powney,  
Richard Pywell*

*funded by*



# Background

- ASSIST has a wealth of data of current status and impacts of agricultural land use
- Use to create an intuitive, graphical tool for exploring future scenarios and impacts
- To engage stakeholders with ASSIST challenges (farmers, agribusiness, policy)
- **ASSIST Scenario Exploration Tool (ASSET)**



*Interactive map*

*Summarise by regions*

*Graphical summaries*

**England**

% difference from baseline

Category	% difference from baseline
Income	-15
Calories	-25
Aesthetics	5
Connectivity (woodland)	70
Connectivity (grassland)	5
Nitrogen Retention	25
Phosphorus Retention	25
Soil Carbon	10
Birds (farmland)	-10
Birds (woodland)	5
Natural features	-15
Pollinators	25

Select Map Display

Show On Map

- Land cover
- Land cover change
- Crop
- Grassland

Summarise By Region

- Great Britain
- England
- Scotland
- Wales

Select region from map

Select Land Cover Change Scenario

Agricultural Land Cover Type

- Agricultural expansion
- Grassland expansion

15%

Afforestation Type

- Bioenergy
- Environmental benefit
- Commercial timber
- Agroforestry

20%

Select Crop Grassland Scenario

Crops

- Same as today
- Intensive
- Extensive
- Diverse

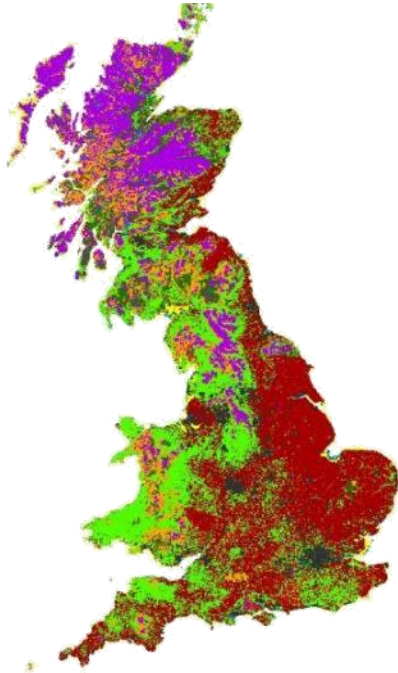
Grassland

- Same as today
- Intensive
- Extensive
- Diverse

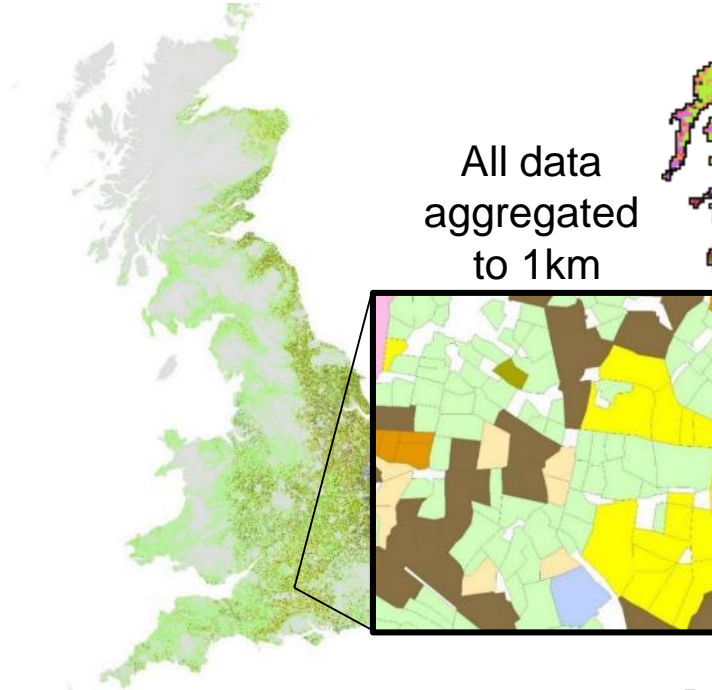
*Choose map visualisations*

*Explore 5200 scenarios of land cover and land use*

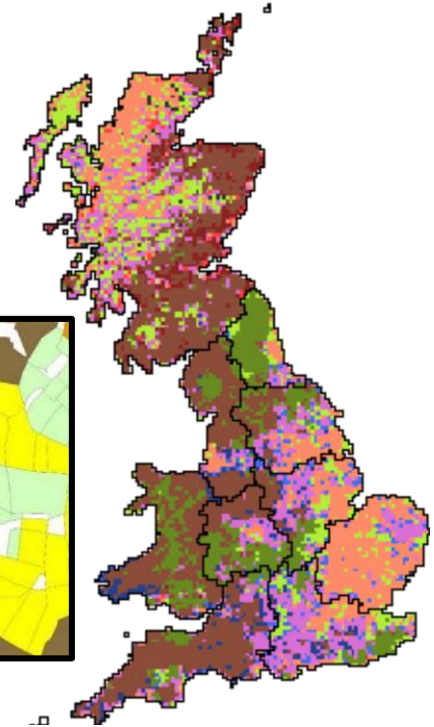
## Baseline data



UKCEH Land  
Cover Map

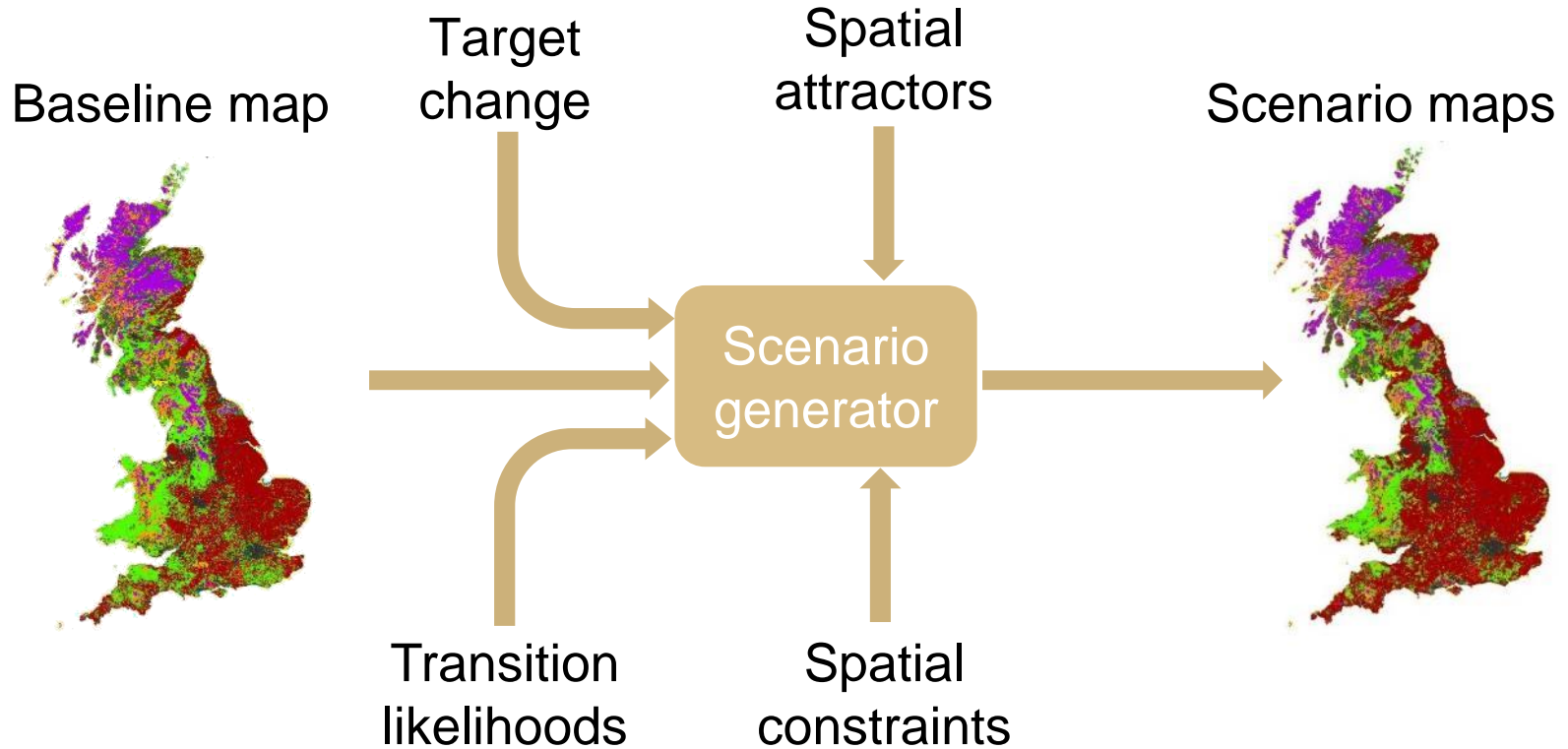


UKCEH Land Cover<sup>®</sup>  
*Plus: Crops*



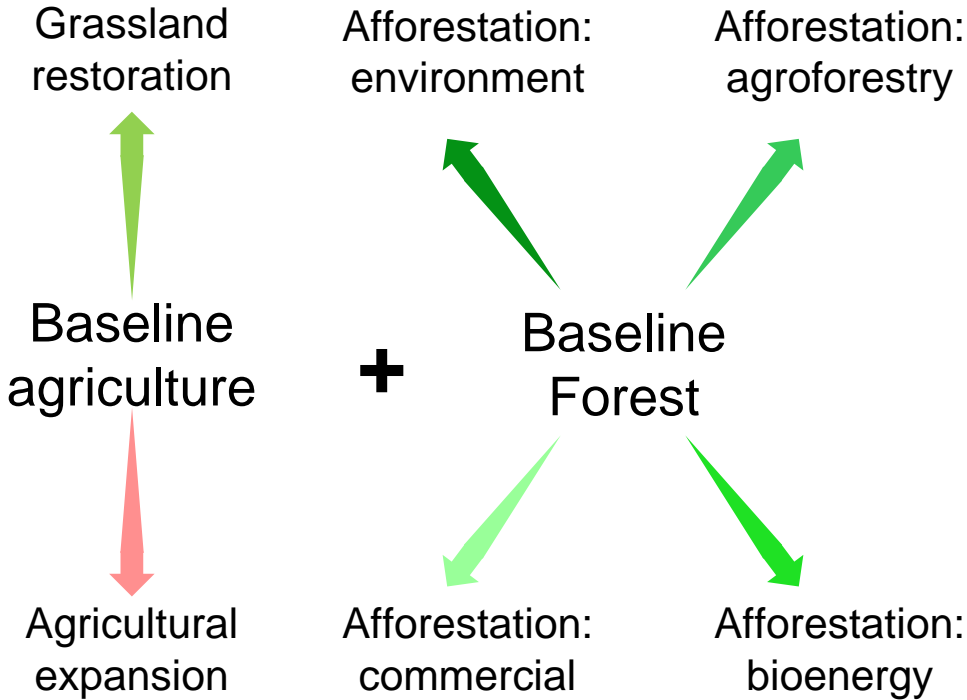
AgCensus  
livestock data

## Generating scenarios

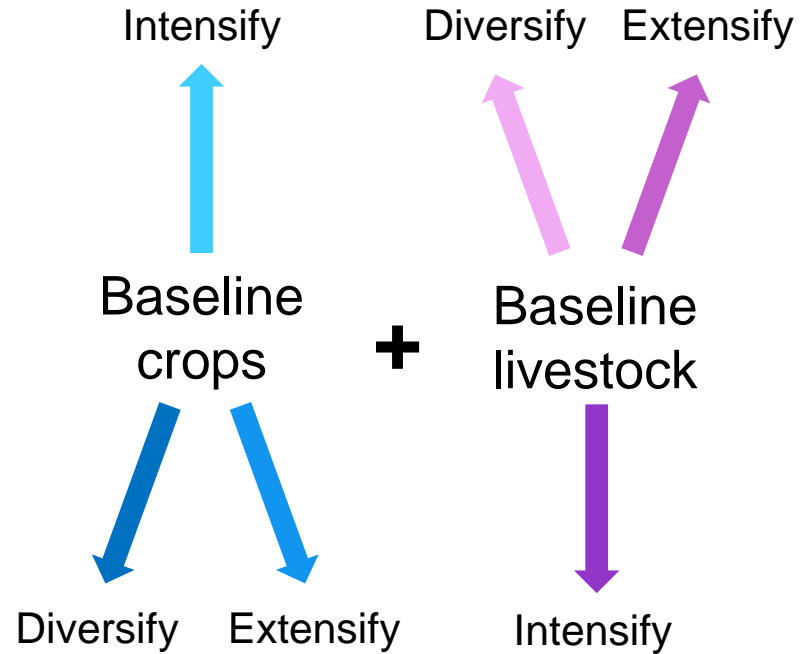


## Scenarios

### Land cover



### Land use



**= 5200 scenario combinations**

## Modelling impacts

- Use validated models to predict 12 key indicators of social, economic and environmental impact

Nutrition  
(Kcal)



Farm  
income



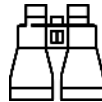
Nitrogen  
retention



Pollinators



Aesthetics



Soil carbon



Pest  
control



Landscape  
connectivity



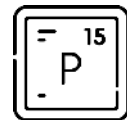
Woodland  
birds



Farmland  
birds



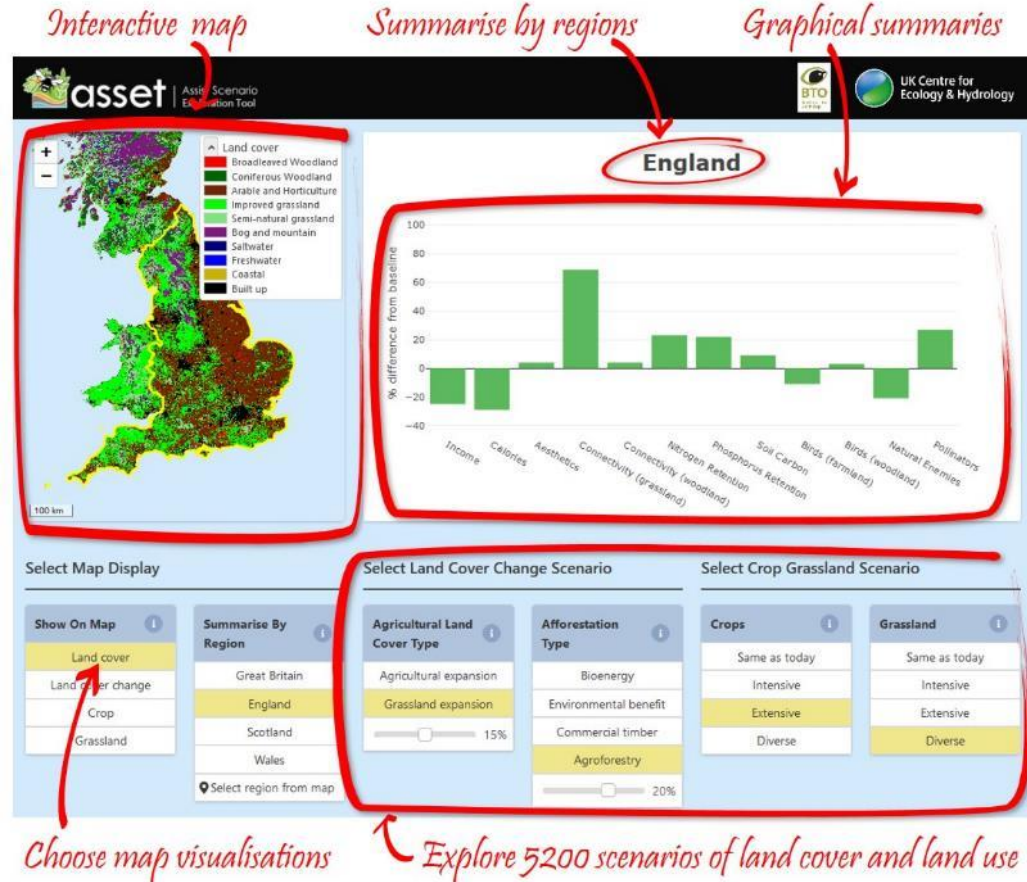
Phosphorus  
retention



# The ASSET interface

- All scenarios and models pre-run to produce a data cube
- Web-based tool to explore scenario maps and impacts
- Summaries by region
- Links to models and data sources

[eip.ceh.ac.uk/asset](http://eip.ceh.ac.uk/asset)



*Interactive map*

*Summarise by regions*

*Graphical summaries*

**England**

**Select Map Display**

Show On Map
Land cover
Land cover change
Crop
Grassland

**Summarise By Region**

Great Britain
<b>England</b>
Scotland
Wales

Select region from map

**Select Land Cover Change Scenario**

Agricultural Land Cover Type	Afforestation Type
Agricultural expansion	Bioenergy
Grassland expansion	Environmental benefit
<input type="checkbox"/> 15%	Commercial timber
	<b>Agroforestry</b>
	<input type="checkbox"/> 20%

**Select Crop Grassland Scenario**

Crops	Grassland
Same as today	Same as today
Intensive	Intensive
<b>Extensive</b>	Extensive
Diverse	<b>Diverse</b>

*Choose map visualisations*

*Explore 5200 scenarios of land cover and land use*

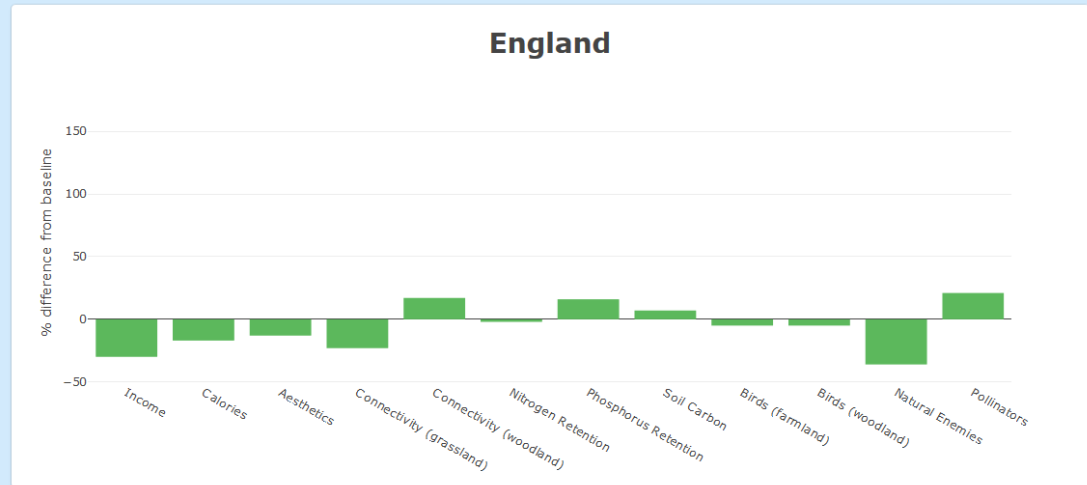
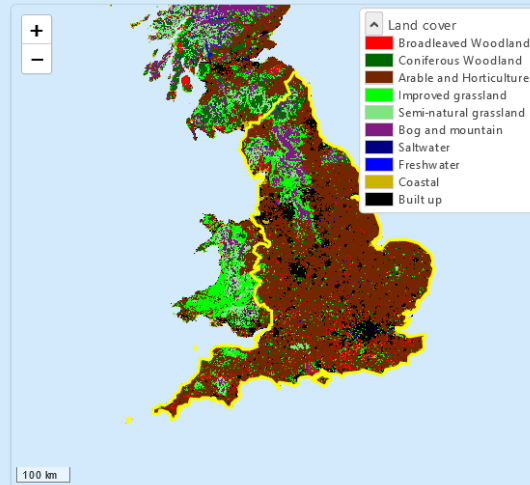
**Land cover**

- Broadleaved Woodland
- Coniferous Woodland
- Arable and Horticulture
- Improved grassland
- Semi-natural grassland
- Bog and mountain
- Saltwater
- Freshwater
- Coastal
- Built up

**% difference from baseline**

Category	% difference from baseline
Income	-15
Calories	-15
Aesthetics	5
Connectivity	65
Connectivity (Grassland)	5
Nitrogen Retention	20
Phosphorus Retention	20
Soil Carbon	10
Birds (woodland)	-10
Birds (farmland)	5
Natural Enemies	-15
Pollinators	25

# Extreme land sharing example



## Select Map Display

Show On Map <span>i</span>
Land cover
Land cover change
Crop
Grassland

Summarise By Region <span>i</span>
Great Britain
England
Scotland
Wales
Select region from map

## Select Land Cover Change Scenario

Agricultural Land Cover Type <span>i</span>
Agricultural expansion
Grassland expansion
<input type="checkbox"/> 30%

Afforestation Type <span>i</span>
Bioenergy
Environmental benefit
Commercial timber
Agroforestry
<input type="checkbox"/> 30%

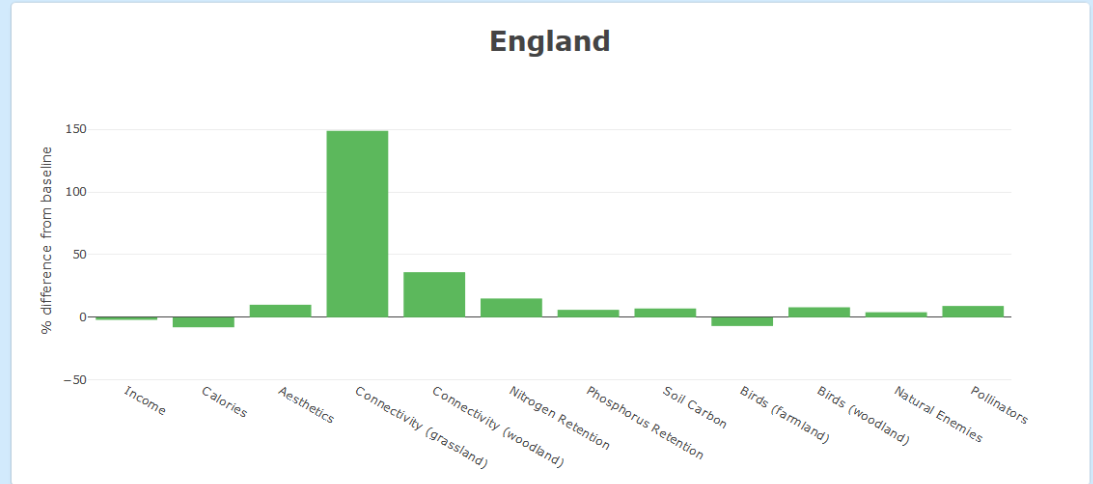
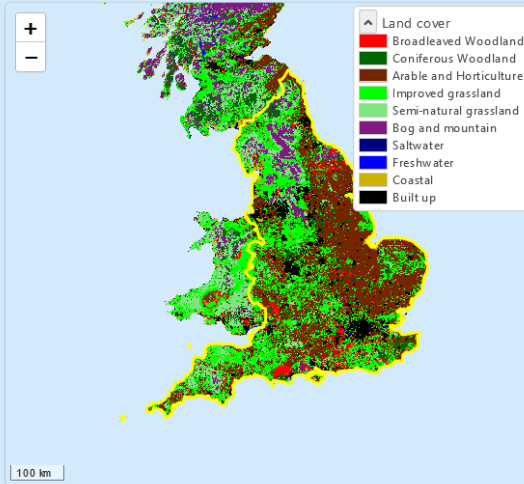
## Select Crop Grassland Scenario

Crops <span>i</span>
Same as today
Intensive
Extensive
Diverse

Grassland <span>i</span>
Same as today
Intensive
Extensive
Diverse



# Extreme land sparing example



## Select Map Display

Show On Map	Summarise By Region
Land cover	Great Britain
Land cover change	England
Crop	Scotland
Grassland	Wales
	Select region from map

## Select Land Cover Change Scenario

Agricultural Land Cover Type	Afforestation Type
Agricultural expansion	Bioenergy
Grassland expansion	Environmental benefit
	Commercial timber
	Agroforestry

30%

## Select Crop Grassland Scenario

Crops	Grassland
Same as today	Same as today
Intensive	Intensive
Extensive	Extensive
Diverse	Diverse

## Using ASSET

- Used for public, stakeholder and policymaker interaction
- Basis for VR worlds built on scenarios
- Scenario impacts explored in detail<sup>1</sup>



<sup>1</sup>Redhead, J.W, Powney, G., Woodcock, B.A & Pywell, R.F. (2020) Effects of future agricultural change scenarios on beneficial insects, *J. Env. Man.*, 265, 110550

## Acknowledgements

**UKCEH:** *Jim Bacon, Jon Cooper, Simon Wright, Tom August, Lucy Ridding, Bruno Osorio, Jeannette Whittaker, Susan Jarvis, Pete Henrys, Emily Upcott, Mike Wilson, Ben Woodcock*

**BTO:** *Gavin Siriwardena*

**Rothamsted Research:** *Taro Takahashi, Martin Blackwell*

**Defra:** *Andy Cuthbertson, Luke Spadavecchia*



# Managing Trade-offs Between Food Production, Biodiversity And The Environment

Photo: Graham Shephard



UK Centre for  
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British  
Geological  
Survey



Natural  
Environment  
Research Council



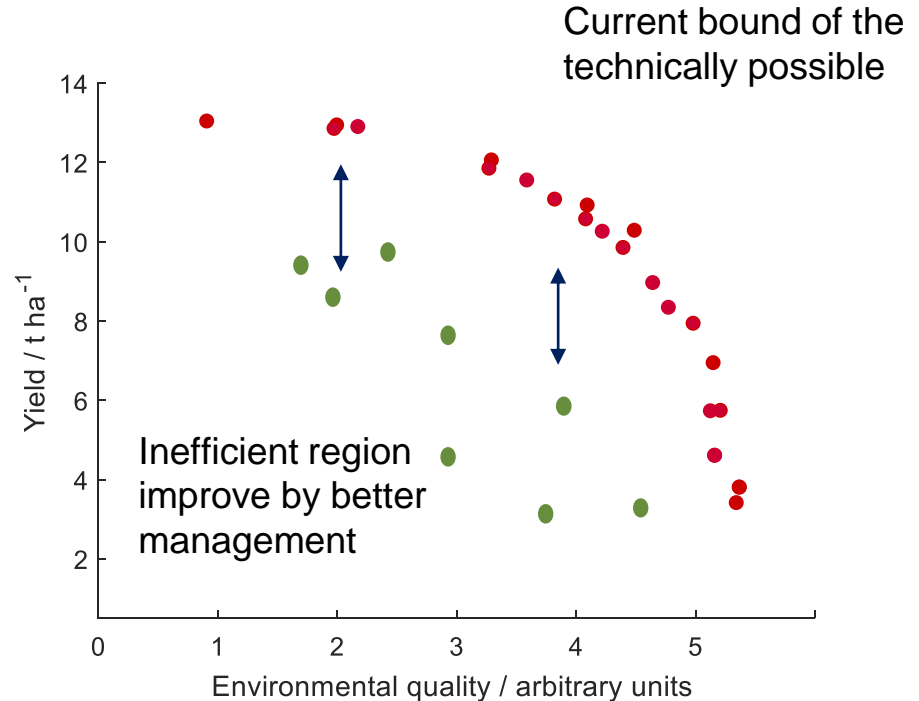
Biotechnology and  
Biological Sciences  
Research Council

*RRes: A.E Milne, H. Metcalfe, R.T. Sharp, J. Storkey, A.P Whitmore*  
*UKCEH: V. Bell, D. Cooper, P. Henrys, S. Jarvis, J. Redhead, J.M. Bullock*

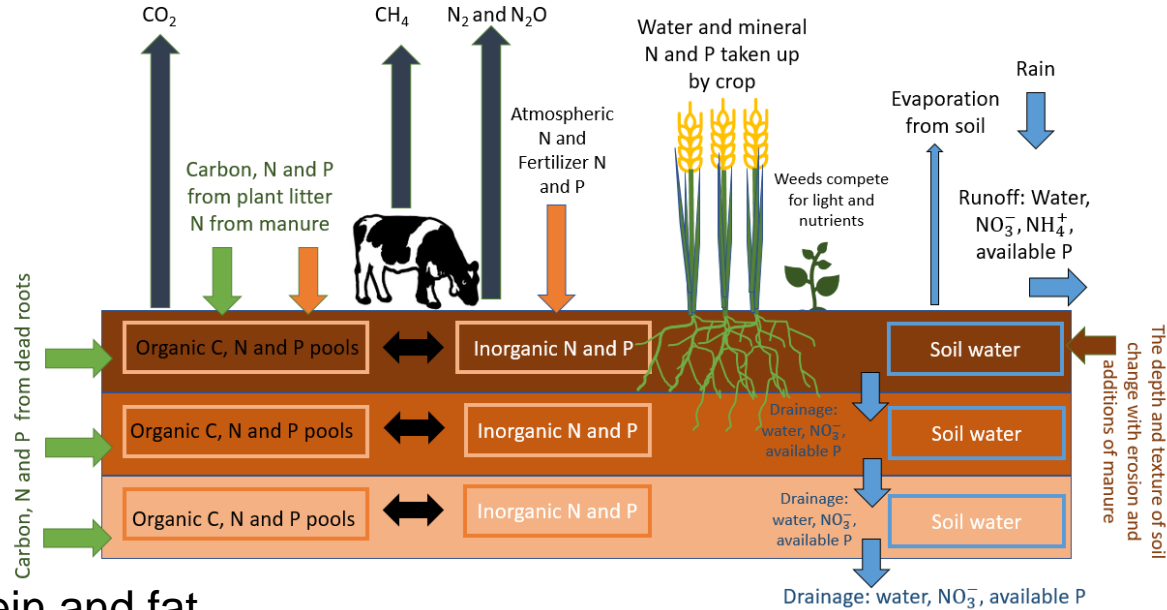
*funded by*

# Trade-offs between food production, biodiversity and the environment.

- Trade-offs between agricultural production and environmental quality are well documented
- These can be depicted using a Pareto front
- Sufficient data are rarely available to assess trade-offs



- Simulates over 18 key crops
- Soil-water dynamics
- Carbon and nutrient dynamics
- Gas fluxes
- Trait based weed model
- Pesticide impacts (EIQ)
- Estimate production in kcal, protein and fat
- Part of the LTLS framework



# Trade-offs evaluated under various scenarios

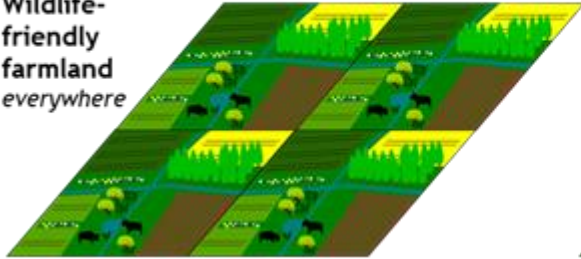
- Life without glyphosate
- Impacts of aligning production with healthier diets
- Land use change: using scenarios from ASSET



The Eat Lancet Plate

## Land sharing

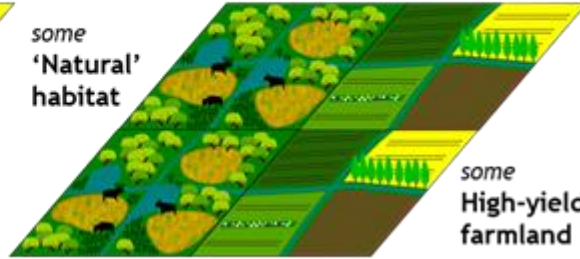
Wildlife-friendly farmland everywhere



15% increase in arable land  
less intensive inputs

## Land sparing

some 'Natural' habitat

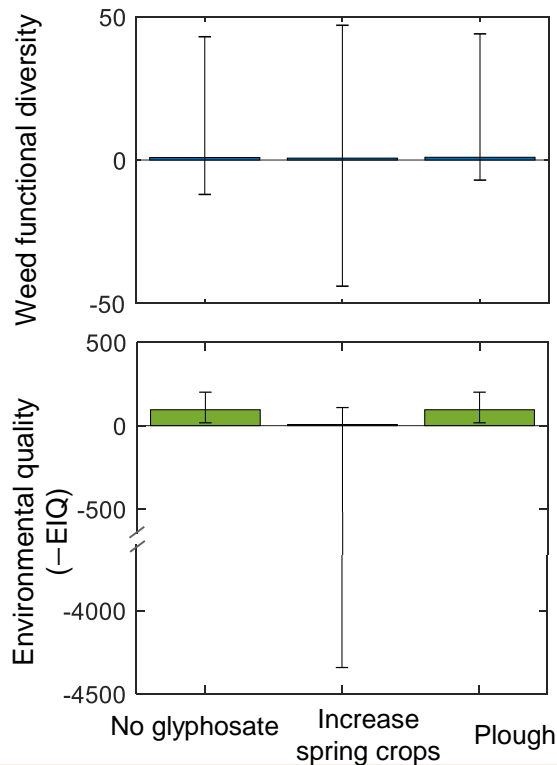
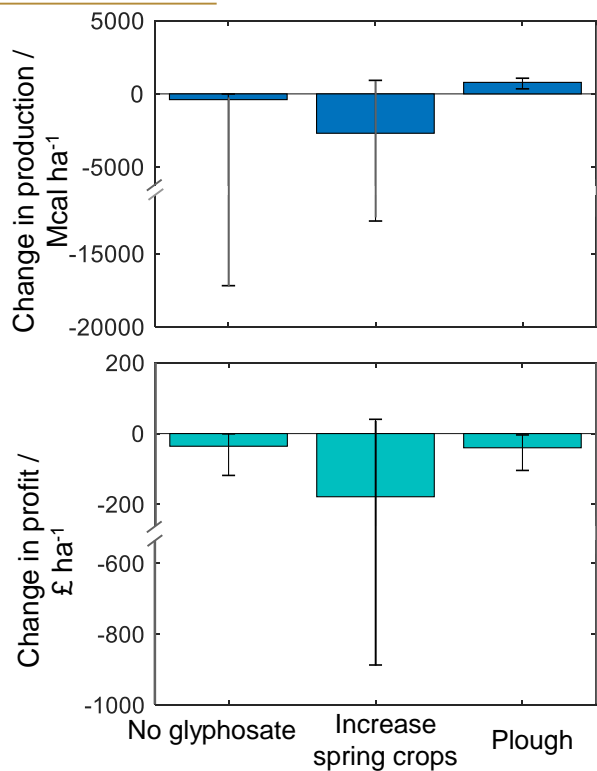


15% decrease in arable land  
more intensive inputs

some High-yield farmland

Thank you to Dr Tom Finch for Image, <https://community.rspb.org.uk/ourwork/b/science/posts/sparing-or-sharing>

# Trade-offs under life without glyphosate



- Ploughing maintains food production ...but we get less profit
- Removing glyphosate increases average weed functional diversity but the response is highly variable
- Environmental impact quotient improves except when more spring crops are introduced

For more details see Metcalfe et al., (2022)



UK Centre for Ecology & Hydrology



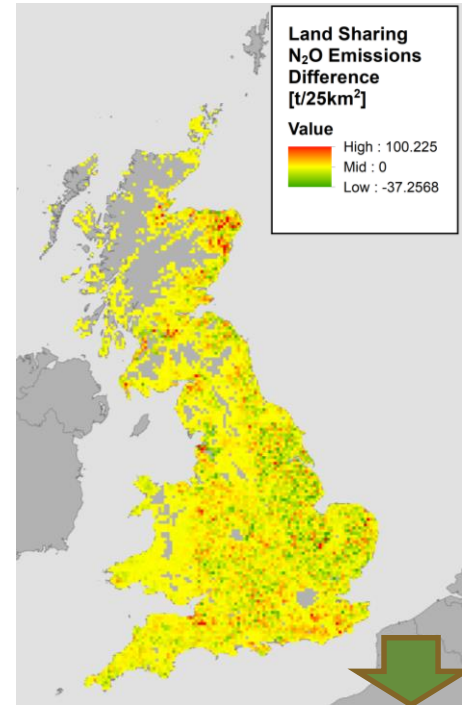
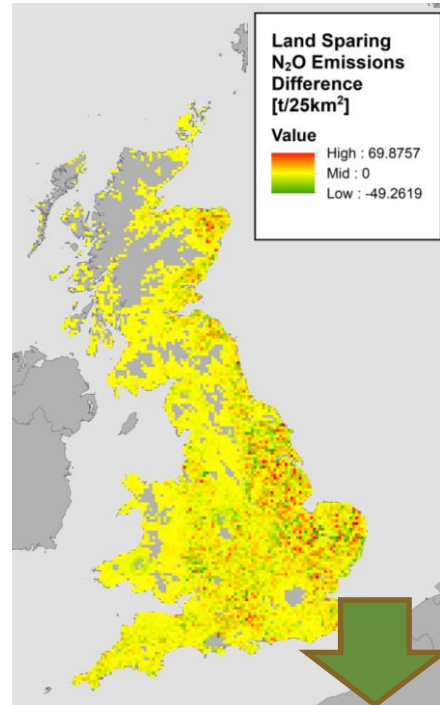
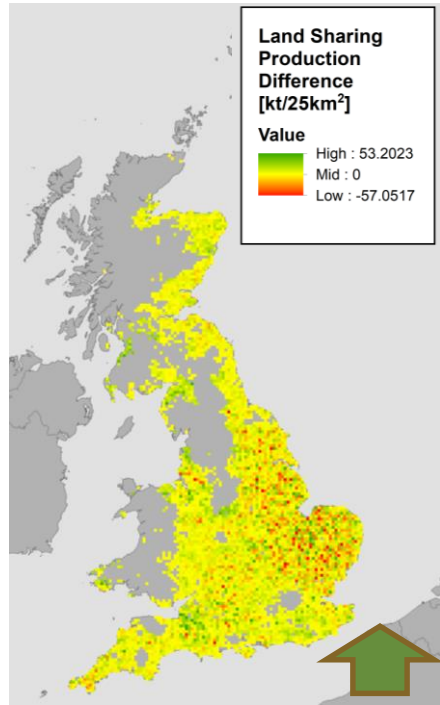
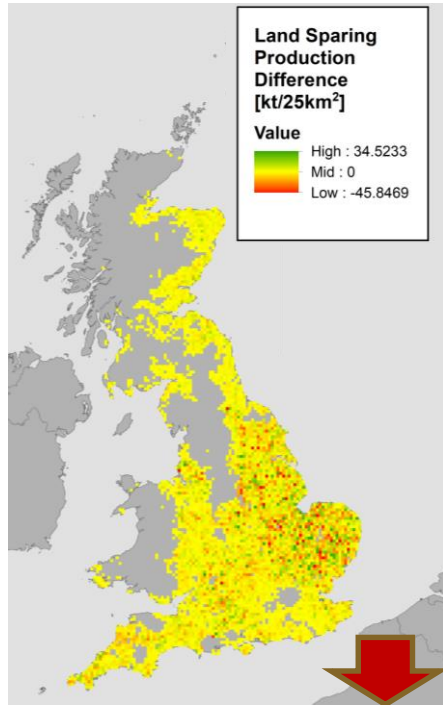
ROTHAMSTED RESEARCH



British Geological Survey



# Trade-offs aligning with a land use change



For more details see Sharp et al., (2022b)

## Conclusions

- Our analysis shows that aligning agriculture with objectives related to health or environment leads to trade-offs
- In our simulations we took a broad approach to aligning with these objectives and we see substantial trade-offs.
- To increase the chance of win-wins we must adopt multiple agroecological approaches, such as those developed in ASSIST



# Acknowledgements

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*The co-authors: Helen Metcalfe, Ryan Sharp, Jon Storkey, **Andy Whitmore***

*UKCEH: Vick Bell, David Cooper, Pete Henrys, Susan Jarvis, J. Redhead, **James M. Bullock***

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*The Funders:*

