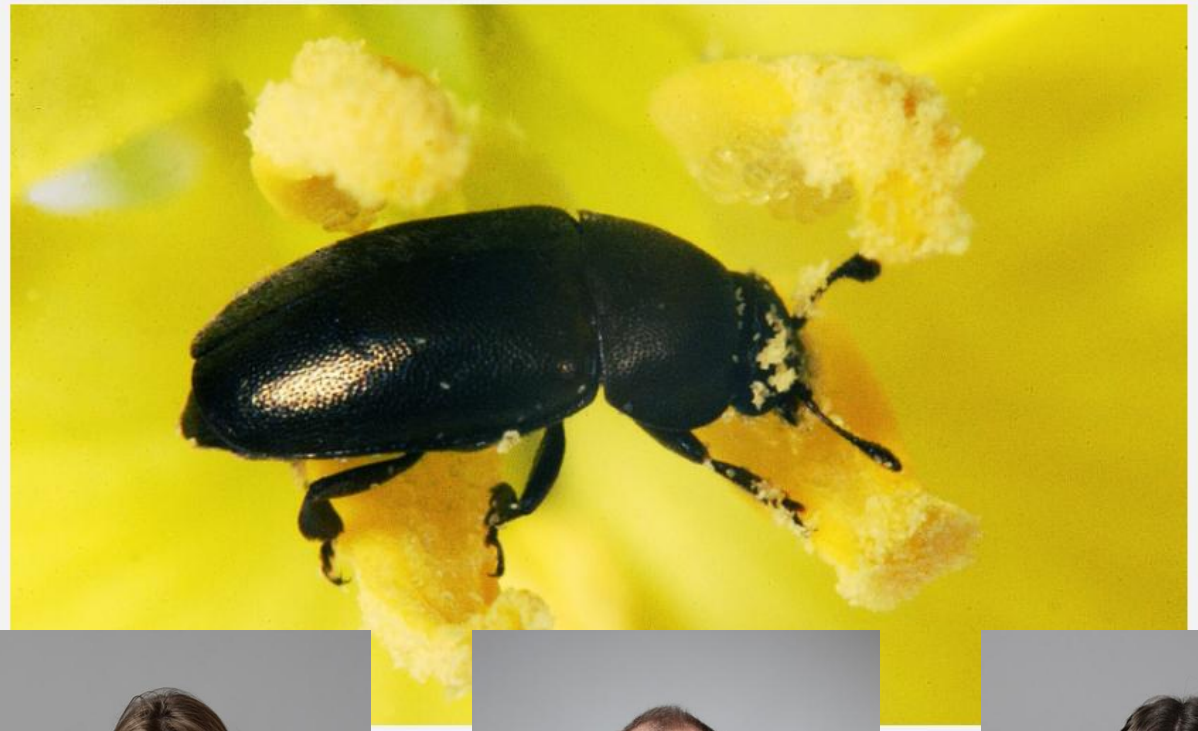
ROTHAMSTED RESEARCH

Is regenerative agriculture compatible with sustainable crop protection?

Jonathan Storkey

27th November 2025



AGROECOSYSTEM HEALTH AND PEST MANAGEMENT

Building of resilient cropping systems at field, farm and landscape scales.

Sam Cook
(Insect pests and beneficials)

Jon West
(Plant pathology)

David Comont
(Weed Ecology)

Lawrence Bramham
(Rothamsted Insect Survey)

Alice Milne
(Agroecosystem modelling)

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Crop protection is largely *reactive* to pests, weeds and diseases that are an emergent property of contemporary cropping systems

- Reduced genetic and functional diversity of crops grown.
- Greater uniformity of disturbance (tillage and pesticides).
- Less un-cropped habitat (quantity, quality and diversity).
- Increased soil fertility.

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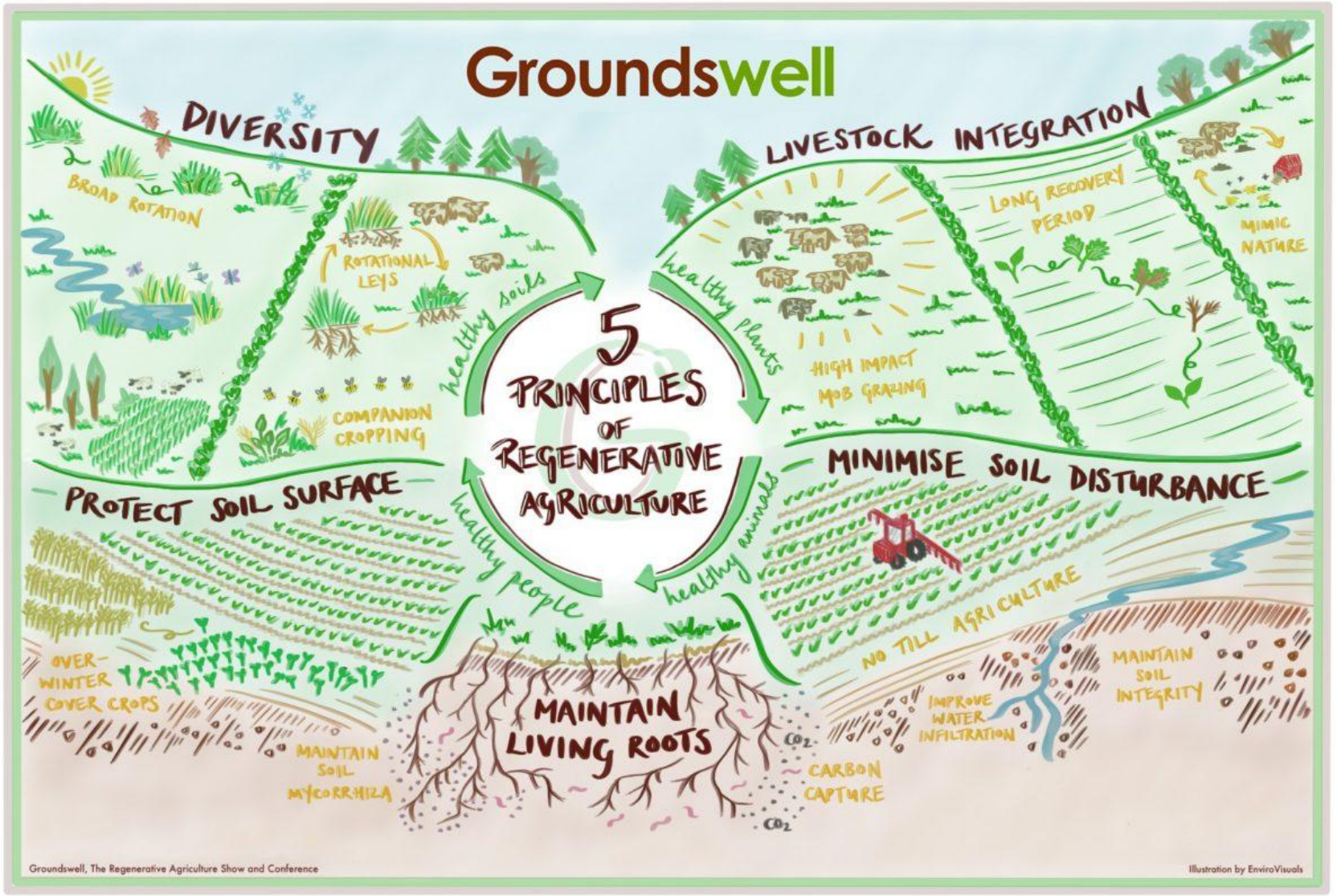
What happens if we change the system (habitat for pests, weeds and diseases)?



https://groundswellag.com/wp-content/uploads/2021/02/Groundswell-5-Principles-e1614009904156.jpg

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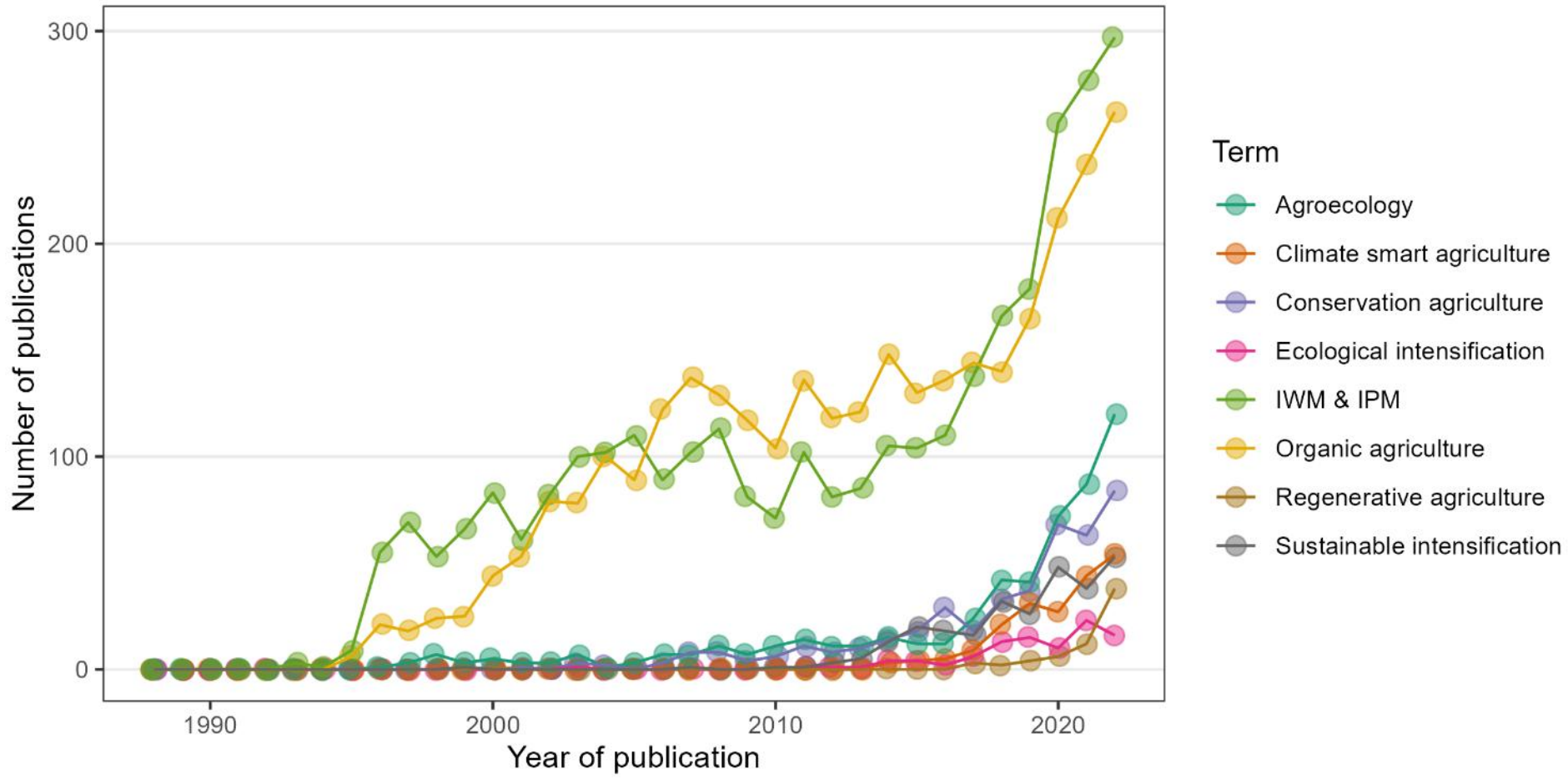
Reconciling multiple outcomes

- How do interventions targeted at e.g. soil health impact pests, weeds and diseases?
- Can systems be managed to regulate pests, weeds and diseases while achieving yield and environmental goals?

Different recipes have different emphases but similar ingredients!



Storkey, J., et al. (2024). Quantifying farm sustainability through the lens of ecological theory. Biol. Rev., 17.

ROTHAMSTED RESEARCH

Combining ingredients of ‘regenerative farming’ in a new experiment


Winter wheat

Oilseed rape

2 Crops

+


Field beans


Spring barley

4 Crops

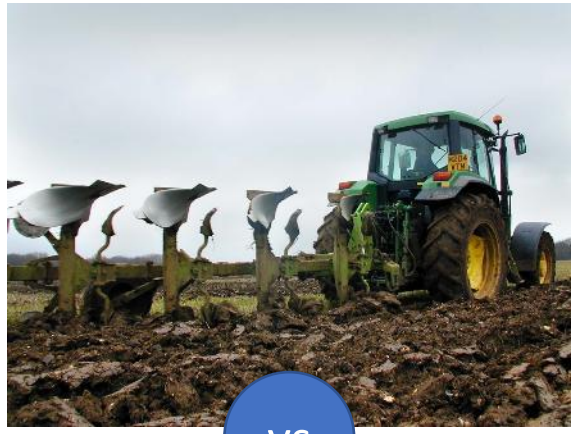
+


Sugar beet / Linseed


Perennial ley

6 Crops

Three contrasting rotations



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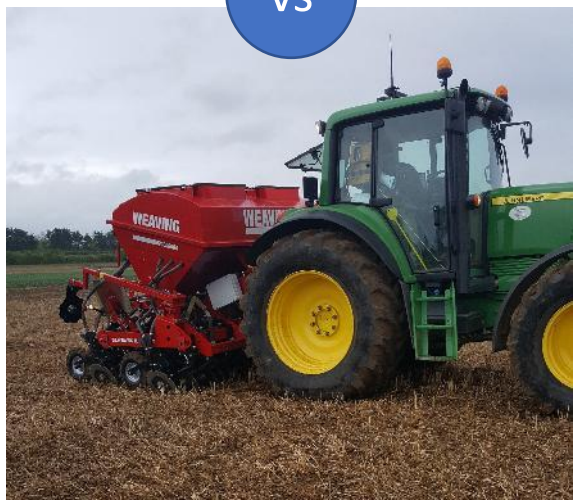
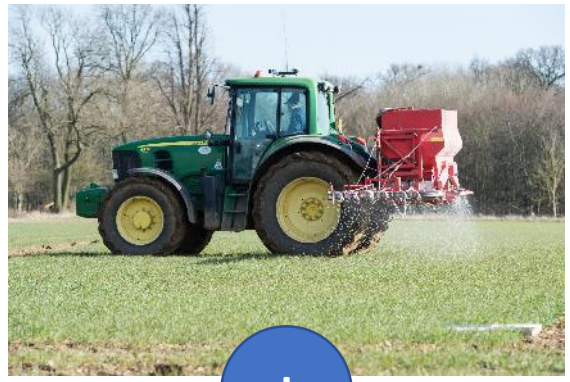


Annual plough vs. Zero till



+

Organic amendments

+ ‘Smart crop protection’ vs. conventional control treatment

Li X. et al. (2023) *Agronomy for Sustainable Development* Vol. 43: 60

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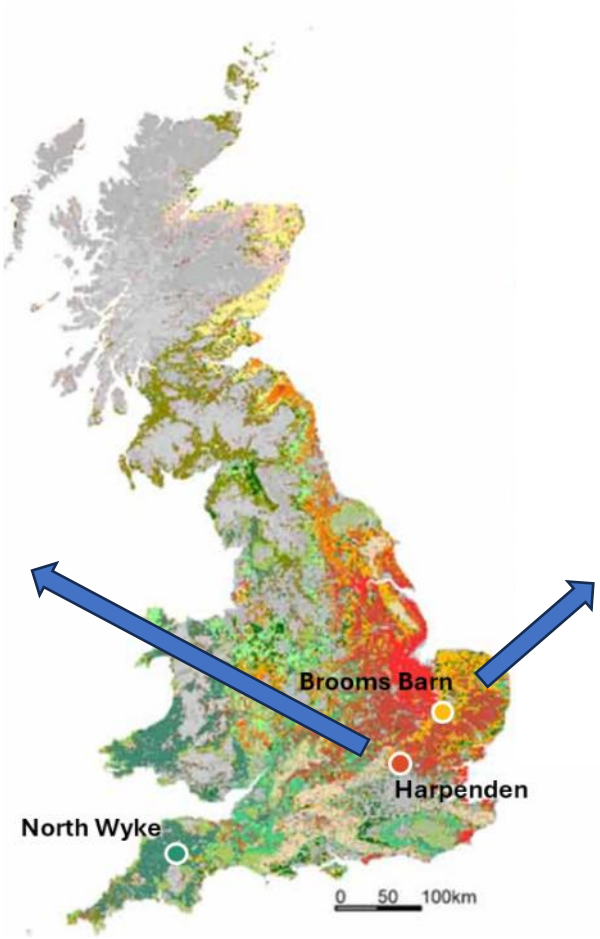
Started in 2017 at Brooms Barn (Suffolk) and 2018 at Harpenden (Hertfordshire)



We are seeing benefits of regenerative practices for:
1) Spring barley yields (at Brooms barn)

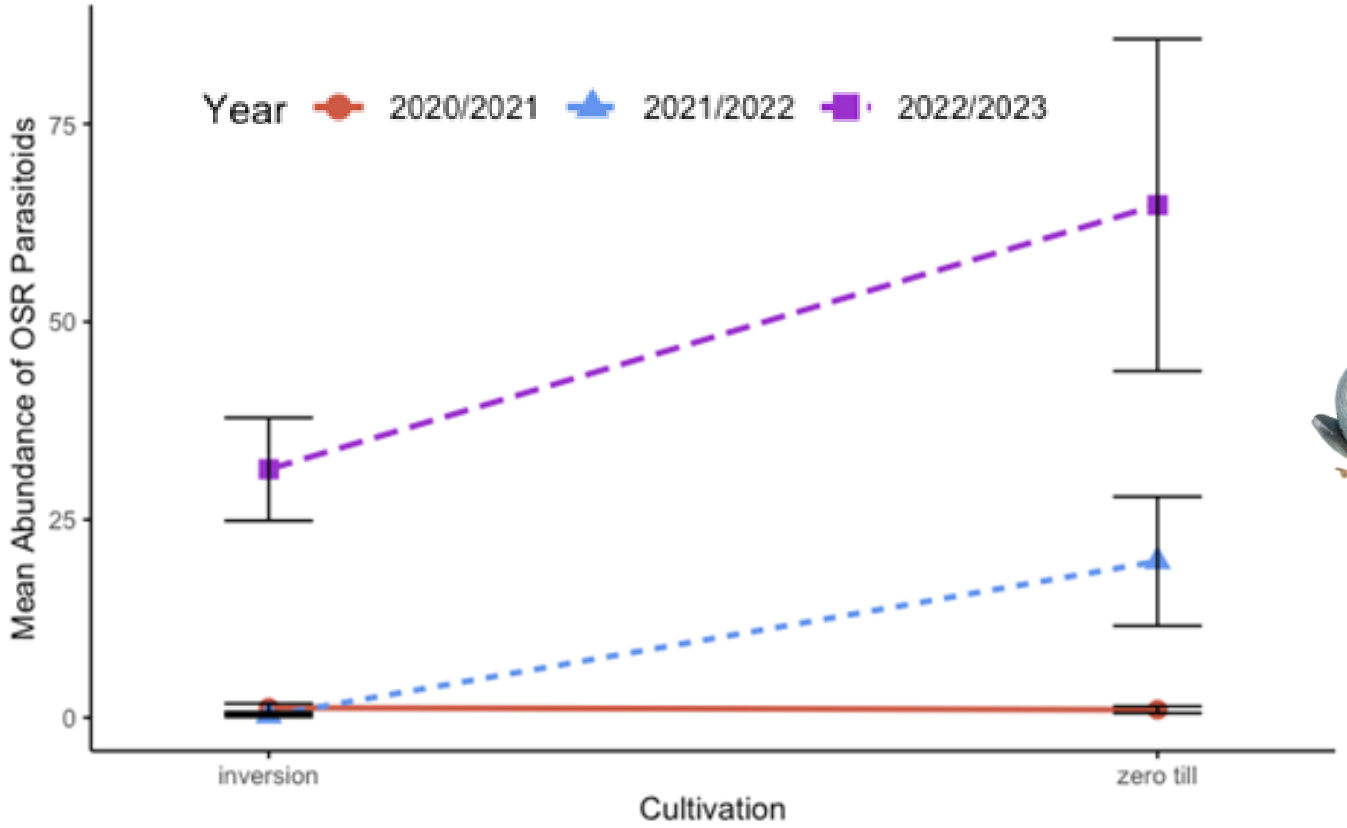
Rotation	Cultivation	Bare fallow	Compost + cover crops
5 Year Rotation	Inversion	4.68	5.04 (↑8%)
	Reduced tillage	3.85	4.60 (↑19%)
7 Year Rotation	Inversion	5.39	6.01 (↑12%)
	Reduced tillage	3.84	5.01 (↑30%)

We are seeing benefits of regenerative practices for:
2) Soil organic carbon (at both sites after 6 years)

Site	Cultivation	Bare fallow	Compost + cover crops
Brooms Barn	Inversion	0.71	0.78 (↑10%)
	Reduced tillage	0.84	0.95 (↑13%)
Harpenden	Inversion	1.60	1.70 (↑6%)
	Reduced tillage	1.71	1.84 (↑8%)

But what about crop protection?

But what about crop protection? Some good news for beneficial biodiversity



Beth Roberts (2025) *PhD Thesis, Bristol University*

ROTHAMSTED RESEARCH

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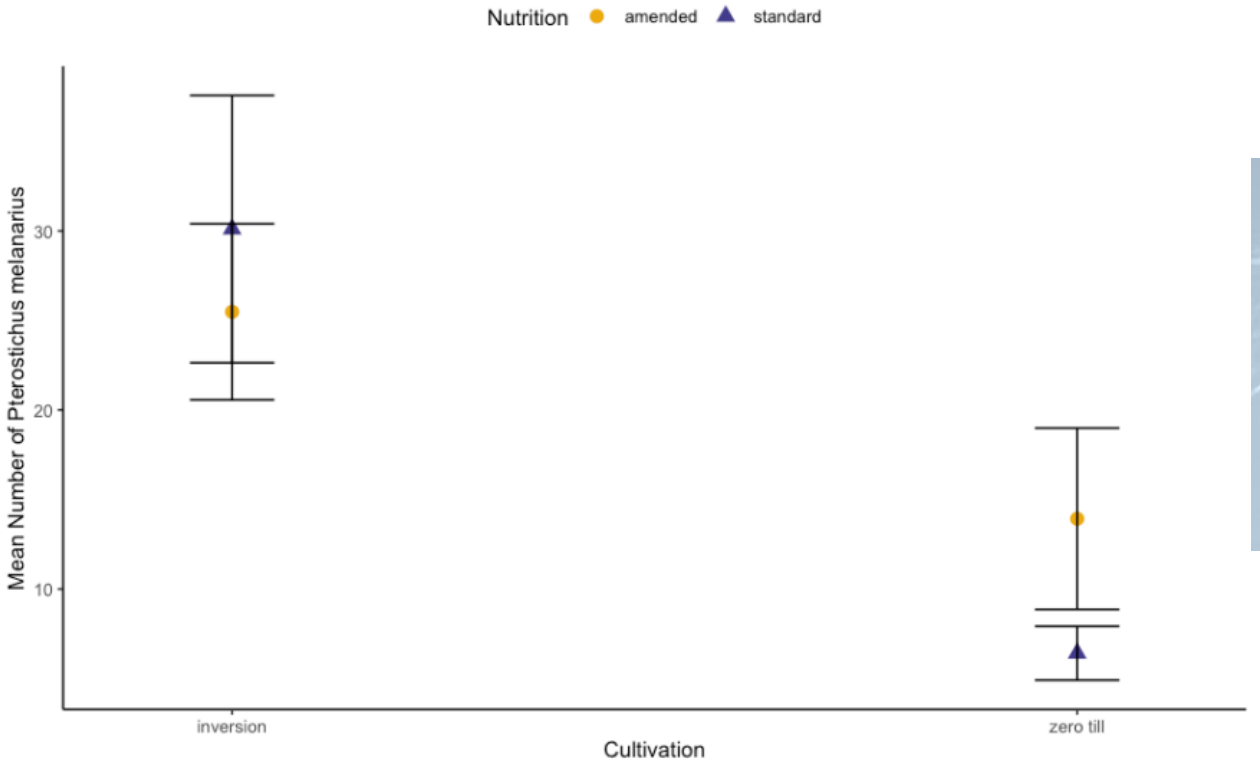

Beth Roberts (2025) *PhD Thesis, Bristol University*

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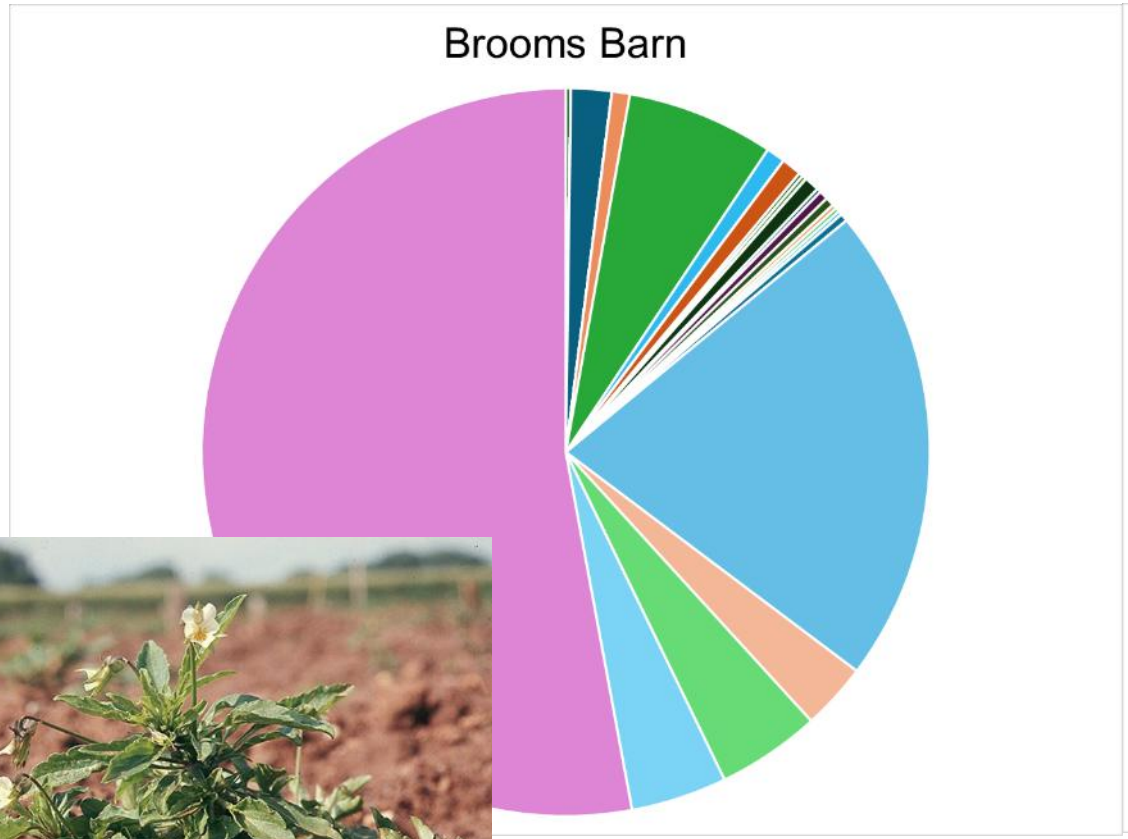
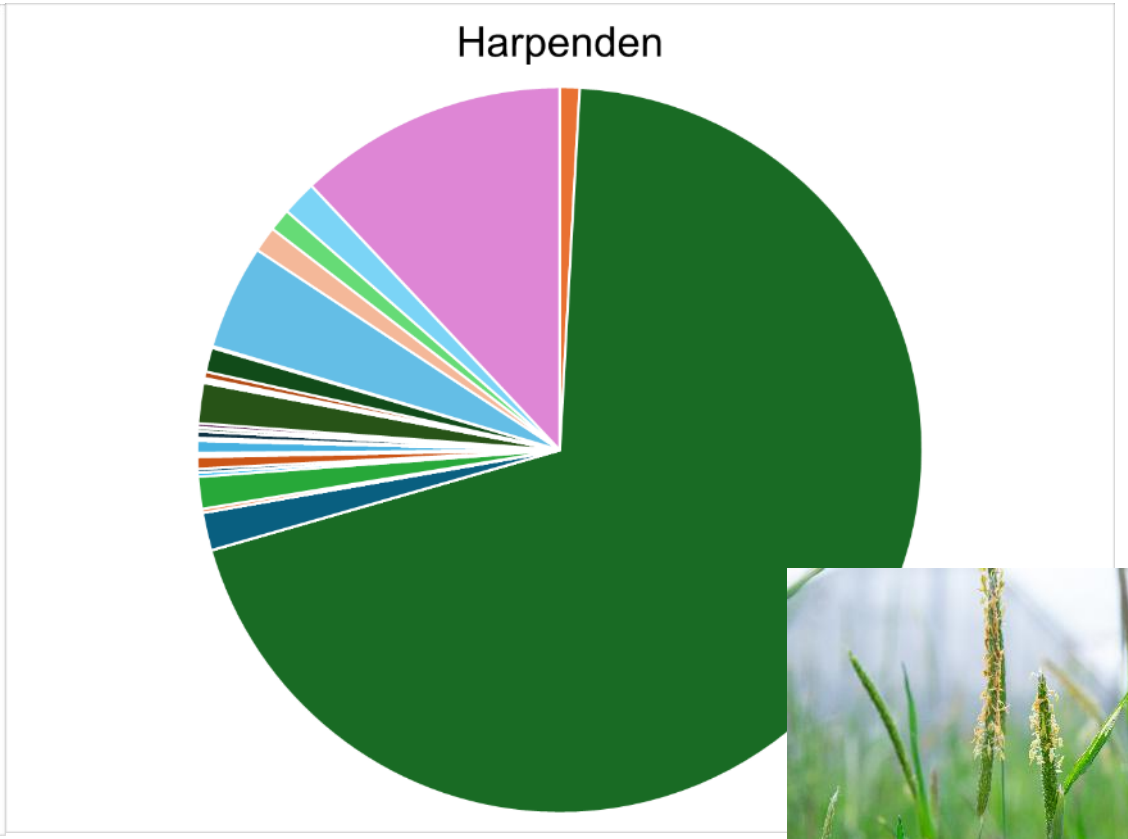
What about weeds? Contrasting communities at two sites





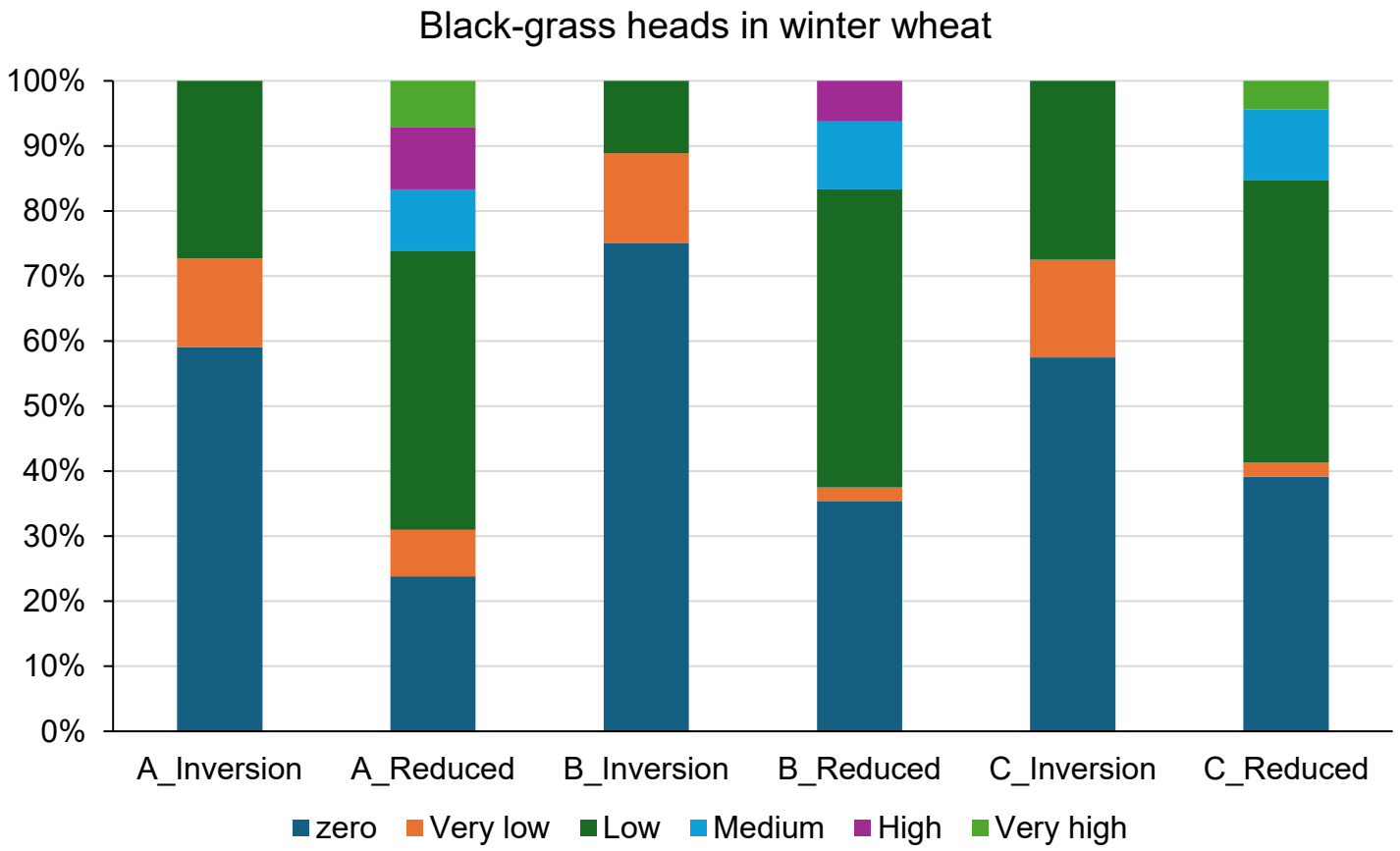
Regenerative treatments are having a bigger (negative) impact on weeds at Harpenden

F Probabilities

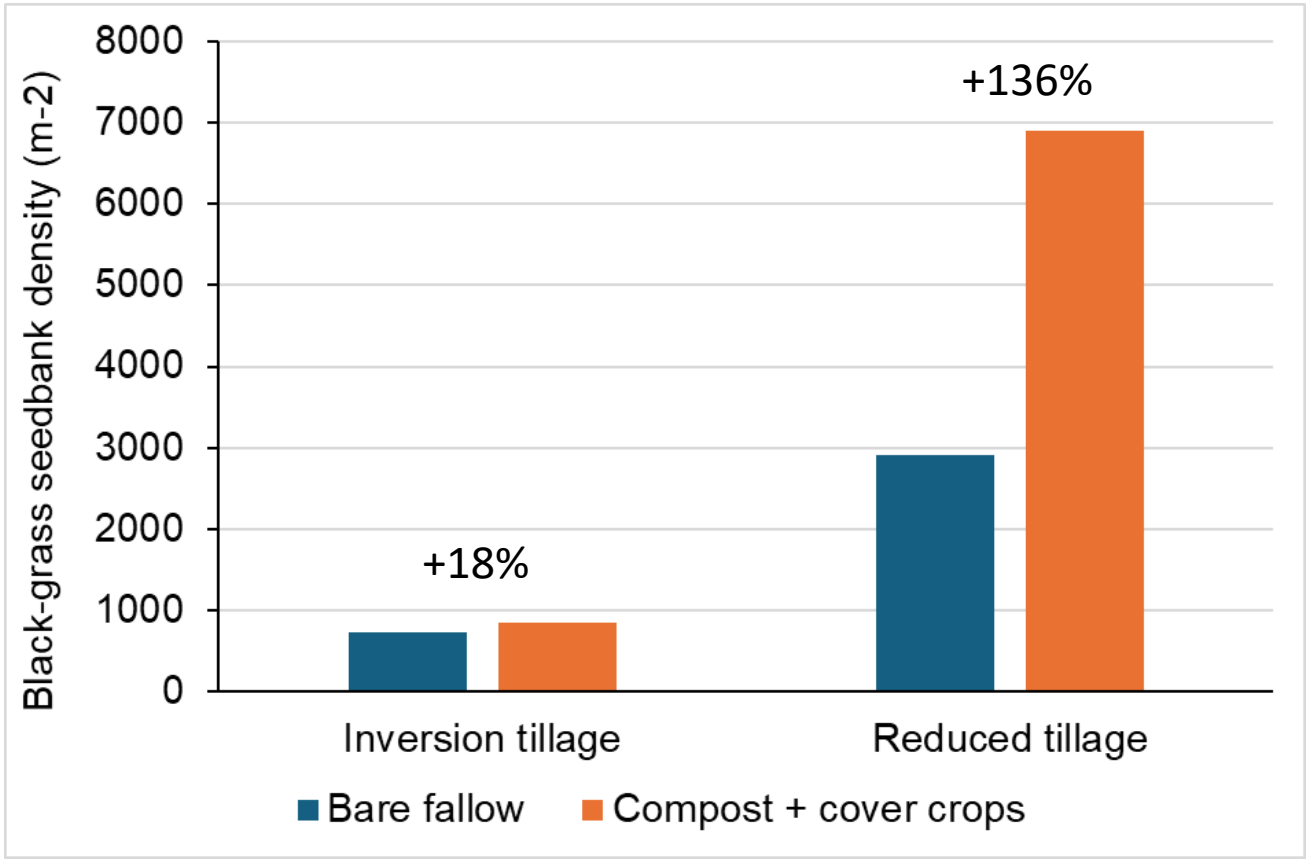
	Weed abundance		Weed diversity	
	Brooms	Harpenden	Brooms	Harpenden
Rotation	0.351	**0.019**	0.129	0.693
Cultivation	0.765	**<0.001**	0.437	0.601
Amendment	0.401	0.742	0.360	0.800
Rot x Cult	0.486	0.238	0.519	**0.004**
Rot x Amend	0.586	0.576	0.194	0.329
Cult x Amend	0.396	0.177	0.685	0.562
Rot x Cult x Amend	0.851	0.380	0.391	0.119

(No effects of the smart crop protection treatment…)

Impact of reduced tillage is worse in some rotations



Over winter cover crops also have a negative effect on black-grass density in following spring barley crop



ROTHAMSTED RESEARCH

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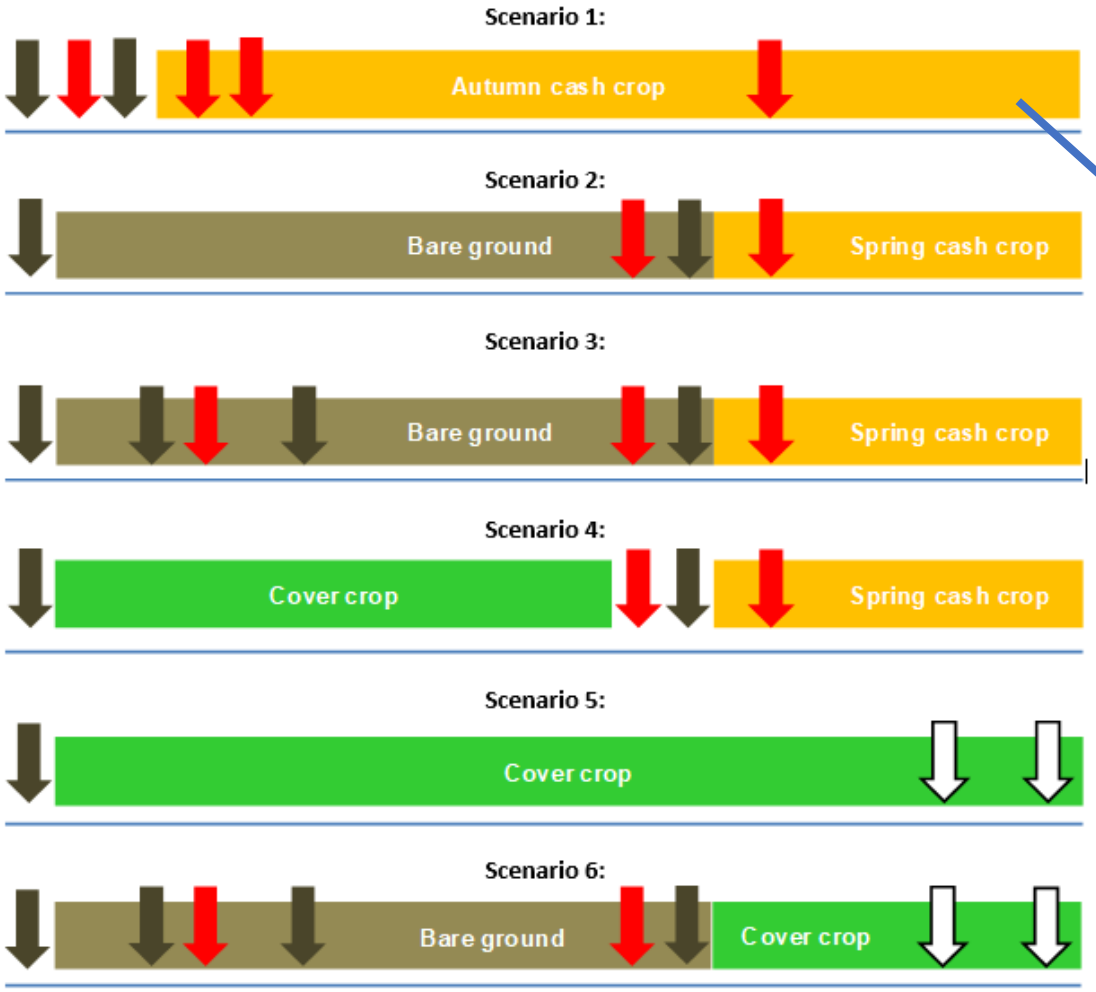

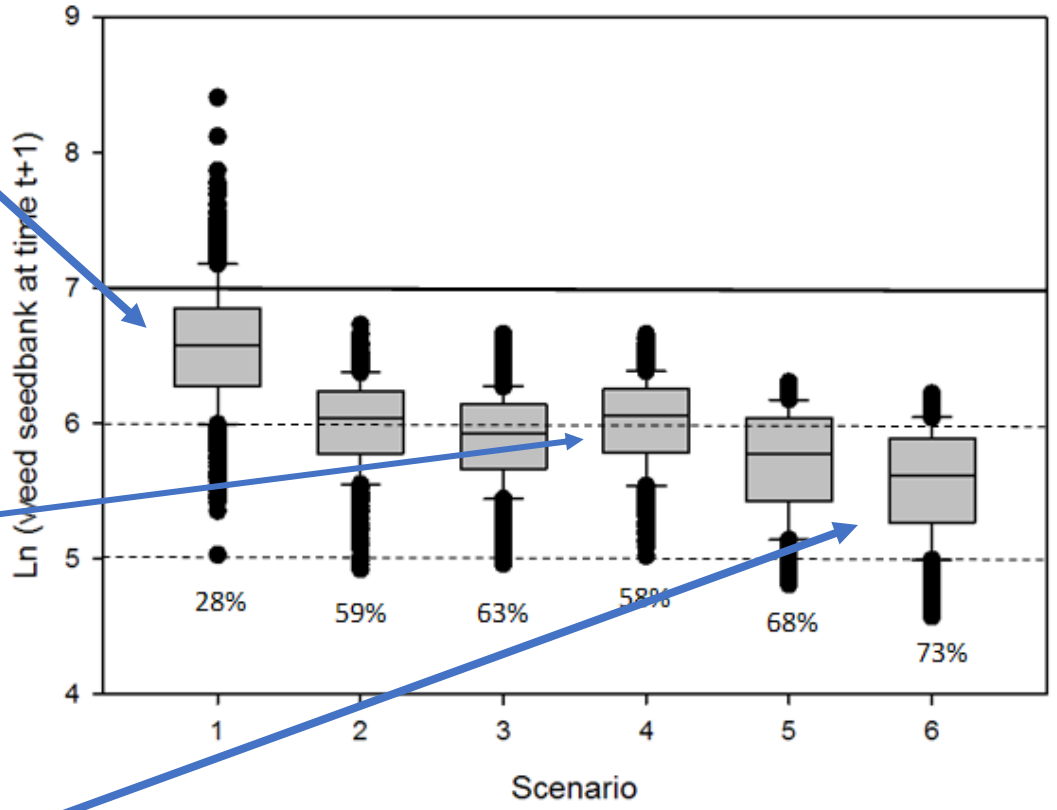

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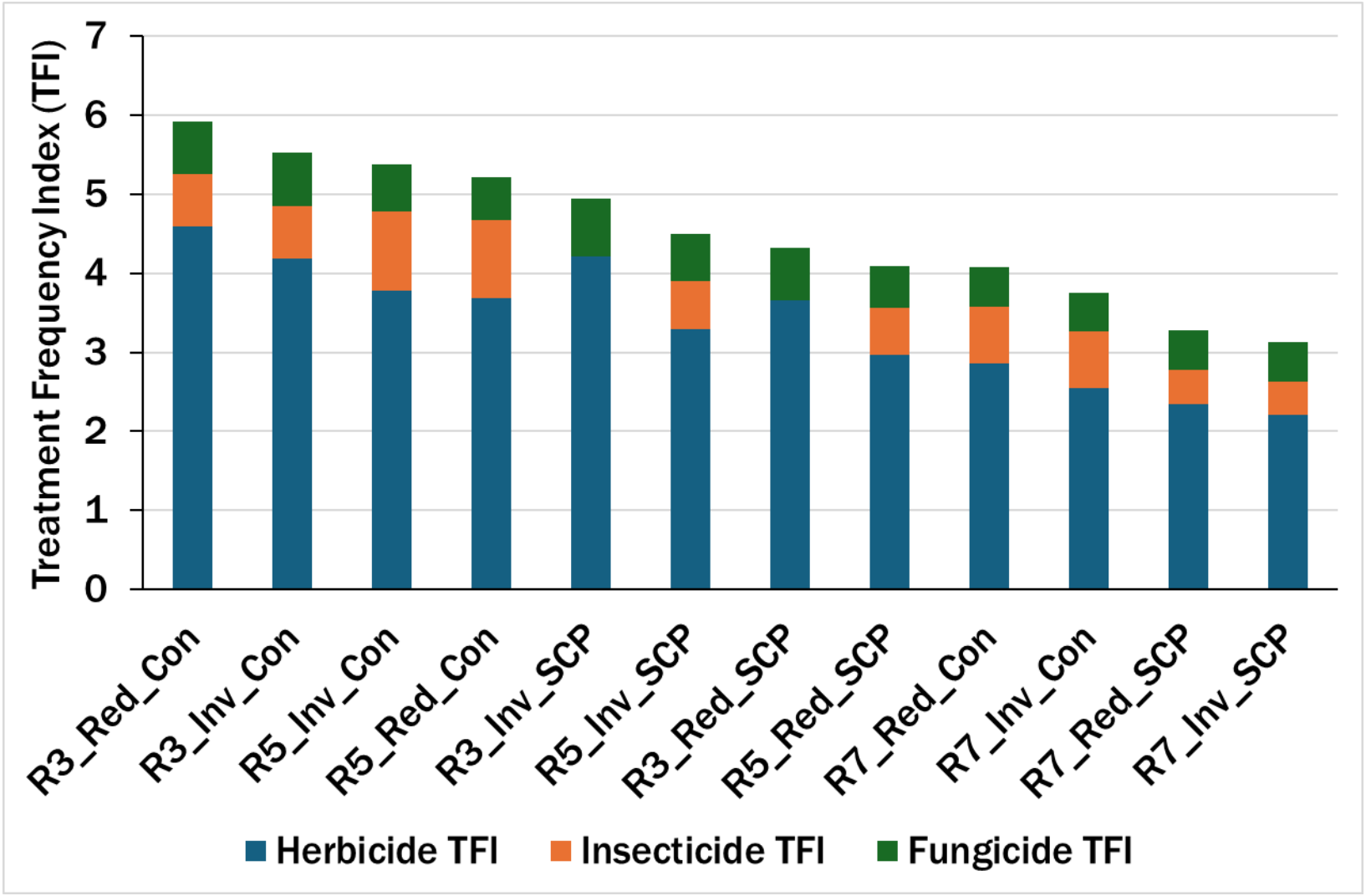
Negative impacts of reduced tillage on weeds reflected in herbicide use



ONE CROP HEALTH

How can we expand the ‘opportunity space’ to identify systems that better reconcile benefits of regen ag with sustainable crop protection?

(with thanks to Louise Johns)

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UNIVERSITY OF COPENHAGEN

AARHUS UNIVERSITY

University of Sheffield

novo nordisk foundation

The OCH project

WP1: Farm monitoring network:

100 farms, where we monitor:

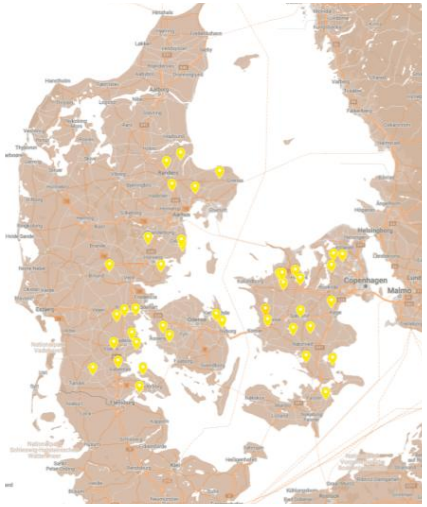
- Pest, weed and disease pressures
- Beneficial agrobiodiversity: soil microbiota and natural enemies
- Farmers provide data on management practices

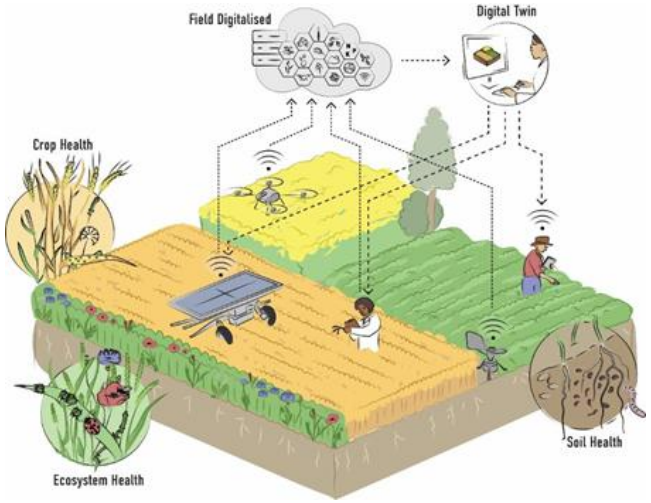
WP2: Long term field experiments:

- Use to validate PWDB and E*M relationships identified from farm network
- Allow manipulation of management practices e.g. crop rotation, cultivation, nutrition and crop protection.

WP3: Digital twins, models & tools:

- Using data from WP1 & 2
- Data infrastructure and management
- Simulating PWDB interactions & with E*M
- Virtual farm systems: digital twins





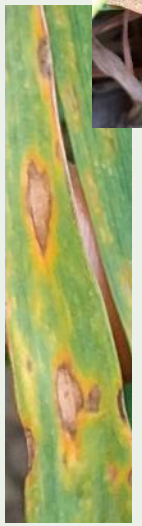
WP4: Research projects (PhDs)

Explore new approaches for crop health through PWD prevention, detection and control, and promoting beneficial biodiversity.

April

Whole field	Crop	Weeds	Diseases	Pests	Photo quadrats
Metadata e.g. Rain, dew, wind speed, photo etc	growth stage, GAI, % damage (e.g. herbivory)	ID, count, % coverage for BLW & grass	6 plants: ID, severity, total % disease	in OSR, 3 plants: count pollen beetles, CSFB larvae parasitism	For later analysis

Powdery mildew



Tan spot

Phoma

June/July

Weeds	Diseases	Insect pests & beneficials
Wheat only: Weeds above crop (BGRI protocol)	4 wheat & 3 OSR plants per point • OSR score stem disease only • Wheat: head, stem, Lvs1&2. Sampled for key diseases:	Key species: aphids, ladybirds, hoverflies, lacewing, cereal leaf beetle Also recorded any other insects seen

FHB

Eyespot

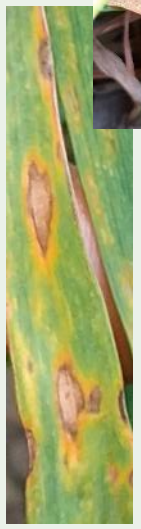
Take-all (soil)

Phoma stem canker

B.brassicae aphids & parasitoid wasp

Ladybird larva attacking an aphid

October

Weeds	Diseases	Insect pests & beneficials	Soil
As for spring - quadrats ID, count, % coverage for BLW & grass weeds	As for summer survey: 6 plants per point: ID, severity, total % disease Samples: Phoma lesions	As for summer, survey 6 plants per point for all species + 3 plants per point CSFB shot holing and more larval burden	Cores
	 Powdery mildew  Tan spot  Phoma		

Phys/chem properties (Stephan Haefele)
Microbial ecology (Tim Mauchline)
Species in soil (Natasha de Vere & Zhao)
Seed decay/longevity in soil (Paul Neve & Leon)
Earthworm eDNA (Penny Watt & Sabine)
Disease suppressive soils (Tim Daniels & Kellis)

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Thank you

27th November 2025