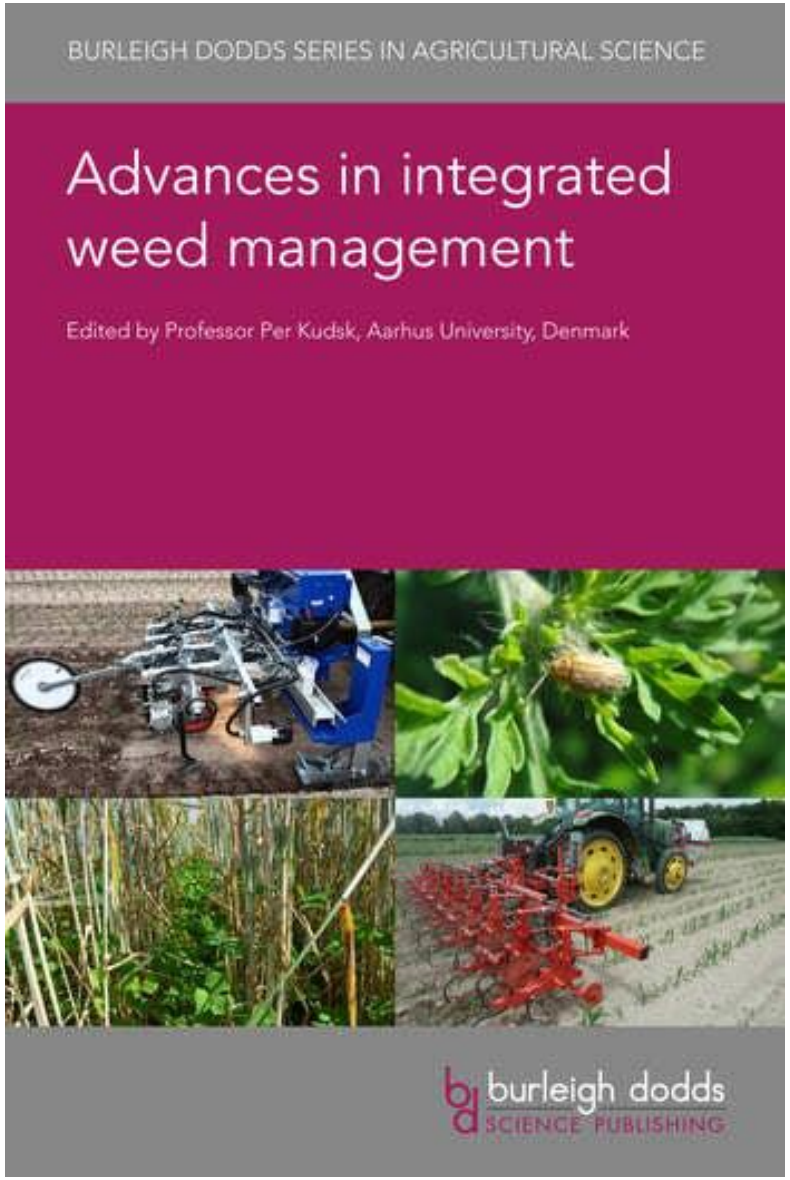
ROTHAMSTED RESEARCH

Perspectives on agroecological weed management

Jonathan Storkey

31st October 2024



Weed management continues to face many challenges, including herbicide resistance, invasive species, climate change and how best to deploy the range of non-chemical control methods available. To tackle these challenges, integrated weed management (IWM) needs to evolve to embrace a more holistic, landscape-based agroecological approach…

including the change in approach to the complex ways weeds interact with their environment and with each other, as well as how some species…contribute to ecosystem services such as soil health.

Kudsk, P. (2021). Advances in integrated weed management (1st ed.). Burleigh Dodds Science Publishing.

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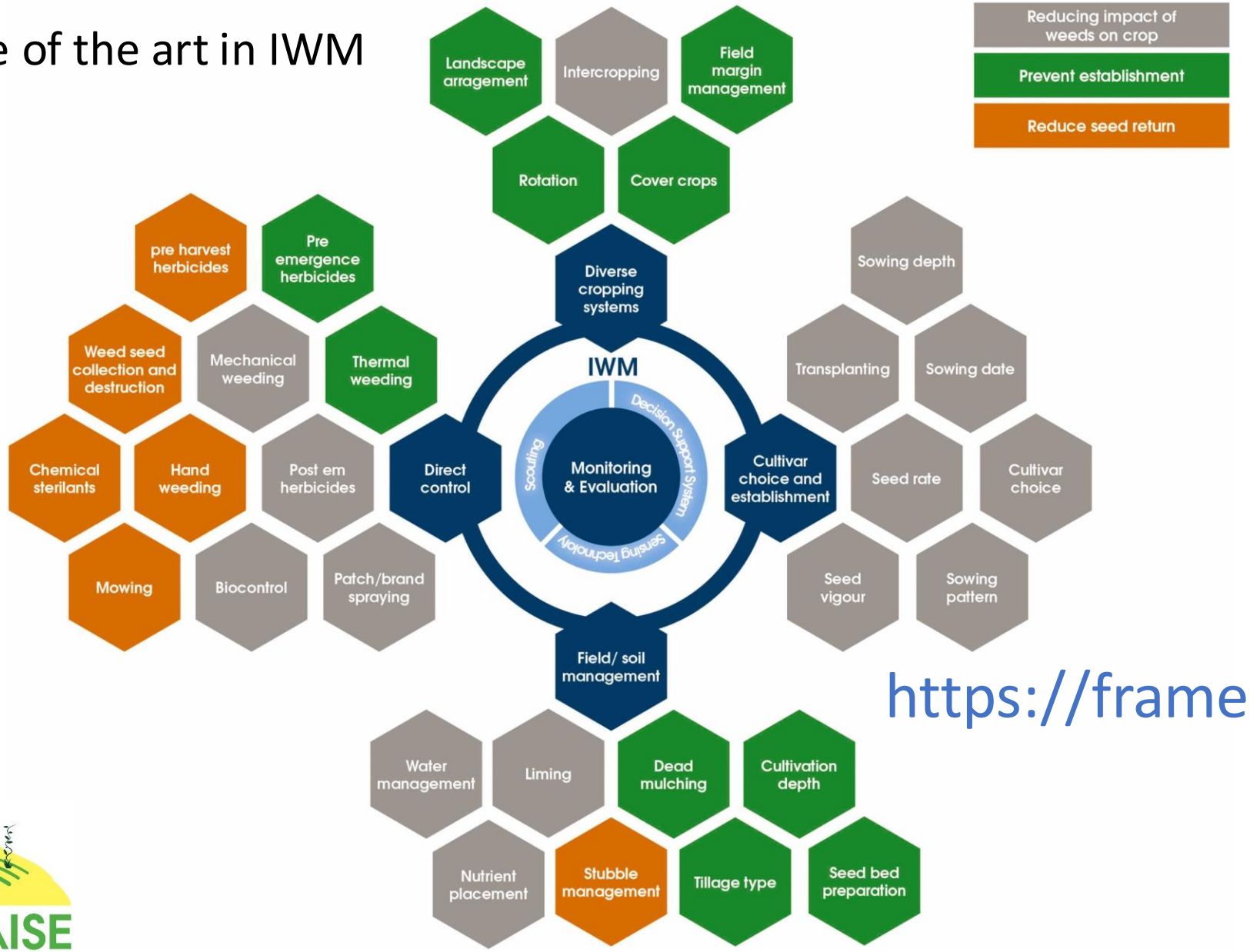
The state of the art in IWM



Marleen Riemens
Wageningen University & Research (WUR)

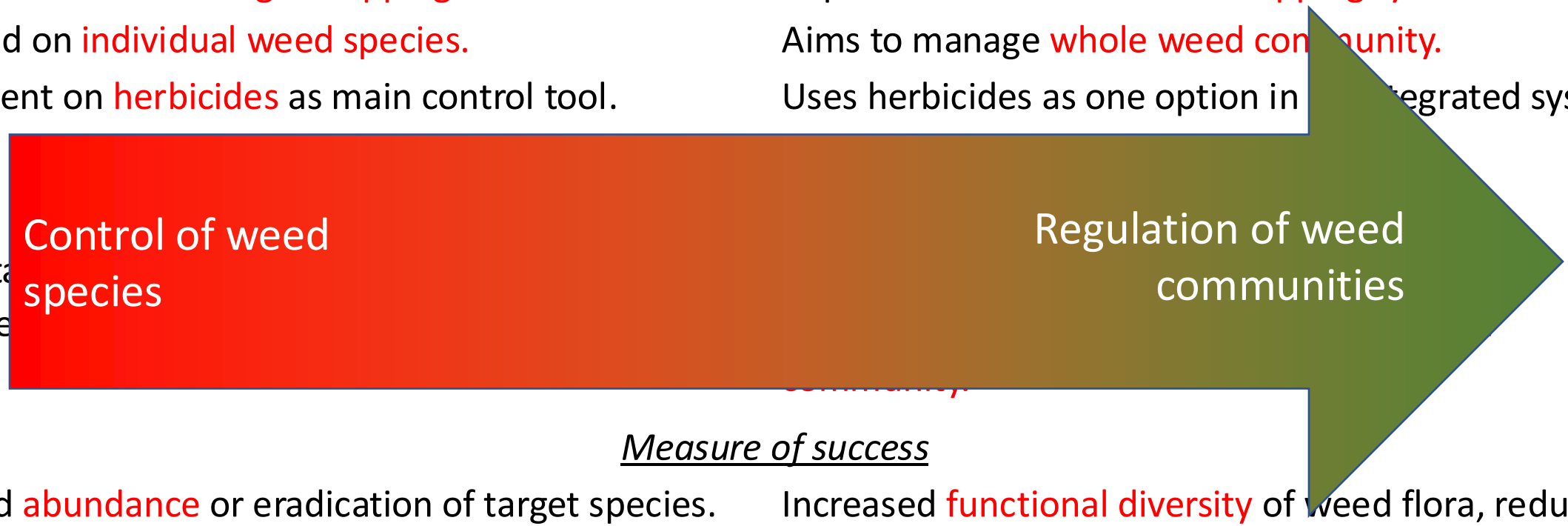
https://framework.iwmtool.eu

IWMPRAISE

Riemens, M., Sonderskov, M., Moonen, A.C., Storkey, J. & Kudsk, P. (2022) An Integrated Weed Management framework: A pan-European perspective. *European Journal of Agronomy*, 133, 13.

IWMPRAISE
EU grant agreement No.727321

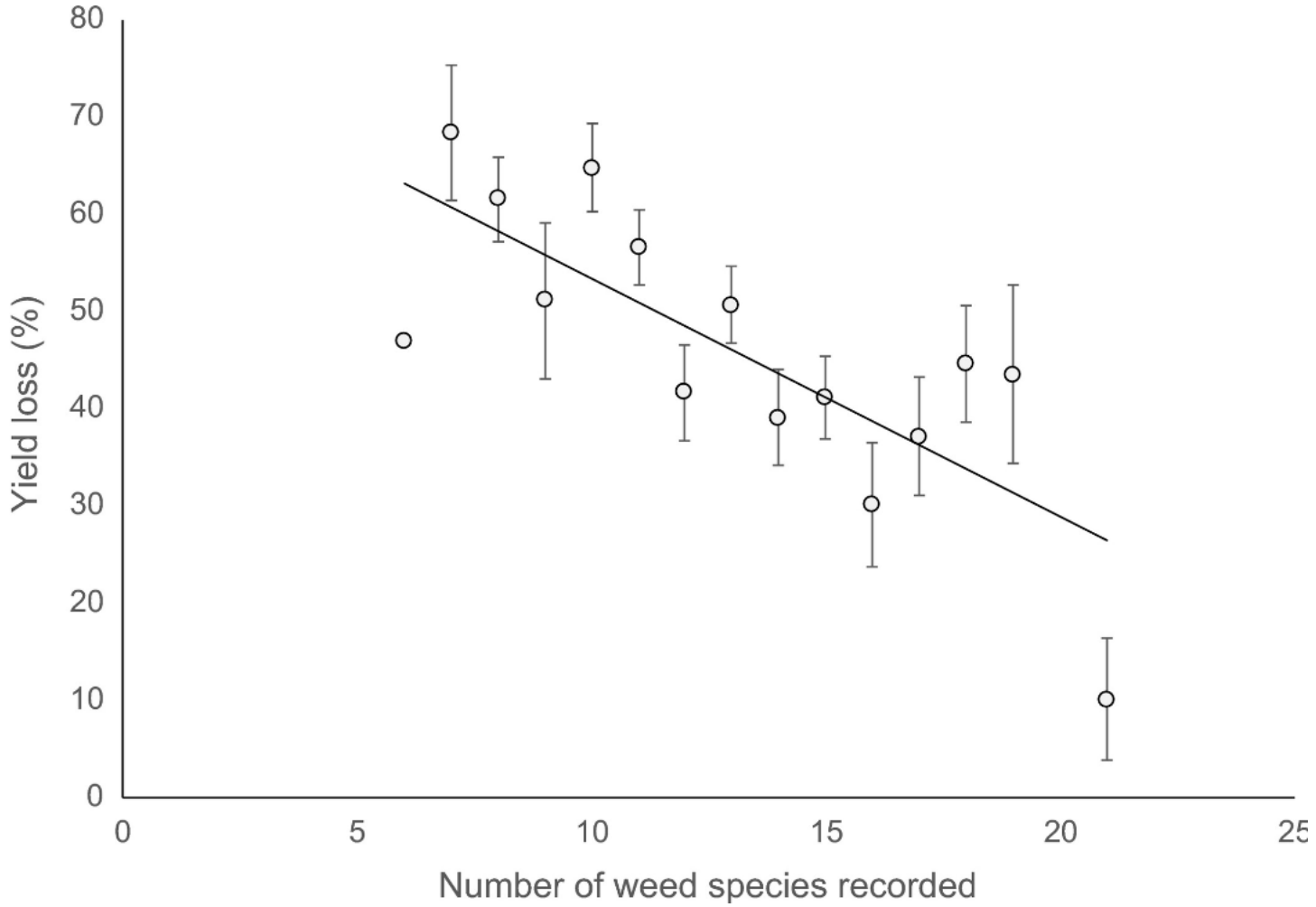
Herbicide-oriented system	Integrated weed management
Characteristics	
Reactive to emerging problematic weeds	Prevents any weed species becoming dominant.
Implemented within single cropping season.	Implemented across whole cropping system.
Focussed on individual weed species.	Aims to manage whole weed community.
Dependent on herbicides as main control tool.	Uses herbicides as one option in integrated system
Understa optimise	community.
Measure of success	
Reduced abundance or eradication of target species.	Increased functional diversity of weed flora, reduced impact of weeds in any single growing season.



Storkey J. (2021). Advances in understanding weed community growth and dynamics. *In* Kudsk P. Chapter 2

ROTHAMSTED RESEARCH

"A more even / diverse weed community* is less competitive in a given crop in the rotation."



Storkey J & Neve P (2018) What good is weed diversity? *Weed Research* 58: 239-243. https://doi.org/10.1111/wre.12310

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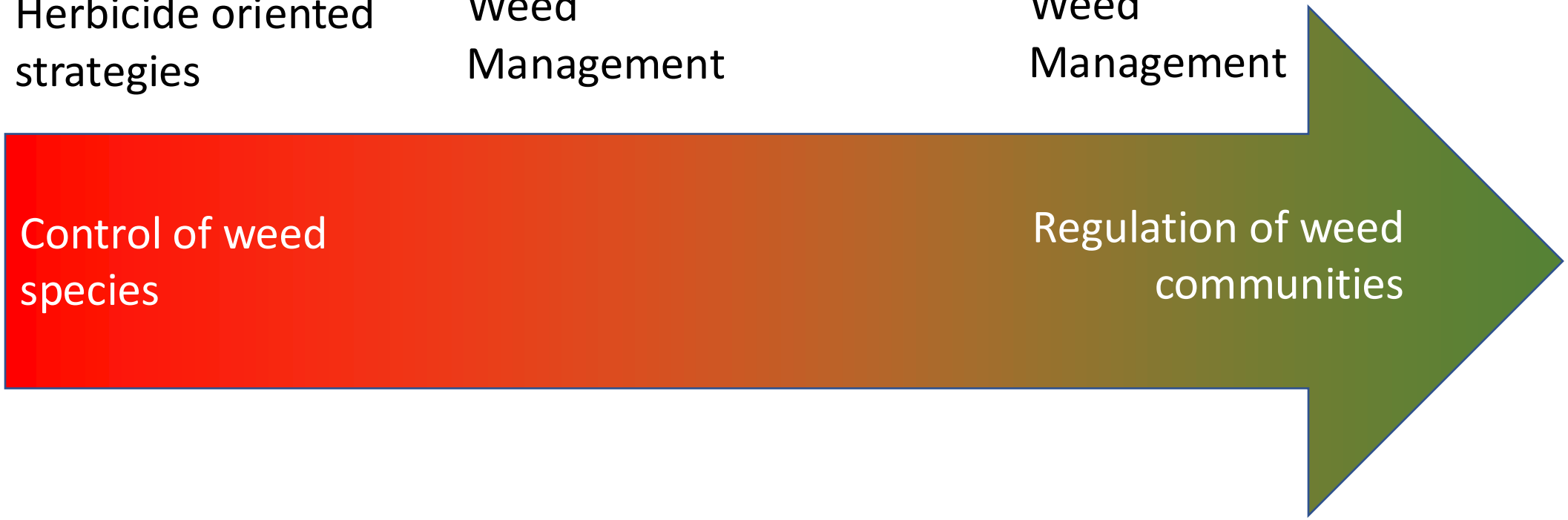
Conventional, Herbicide oriented strategies

Integrated Weed Management

Agroecological Weed Management



Agronomy for Sustainable Development (2020) 40: 24
https://doi.org/10.1007/s13593-020-00631-6

REVIEW ARTICLE

An ecological future for weed science to sustain crop production and the environment. A review

Chloe MacLaren[1,2] · Jonathan Storkey[1] · Alexander Menegat[3] · Helen Metcalfe[1] · Katharina Dehnen-Schmutz[2]

Accepted: 26 June 2020 / Published online: 8 July 2020

Abstract

Sustainable strategies for managing weeds are critical to meeting agriculture's potential to feed the world's population while conserving the ecosystems and biodiversity on which we depend. The dominant paradigm of weed management in developed countries is currently founded on the two principal tools of herbicides and tillage to remove weeds. However, evidence of negative environmental impacts from both tools is growing, and herbicide resistance is increasingly prevalent. These challenges emerge from a lack of attention to how weeds interact with and are regulated by the agroecosystem as a whole. Novel technological tools proposed for weed control, such as new herbicides, gene editing, and seed destructors, do not address these systemic challenges and thus are unlikely to provide truly sustainable solutions. Combining multiple tools and techniques in an Integrated Weed Management strategy is a step forward, but many integrated strategies still remain overly reliant on too few tools. In contrast, advances in weed ecology are revealing a wealth of options to manage weeds *at the agroecosystem level* that, rather than aiming to eradicate weeds, act to regulate populations to limit their negative impacts while conserving diversity. Here, we review the current state of knowledge in weed ecology and identify how this can be translated into practical weed management. The major points are the following: (1) the diversity and type of crops, management

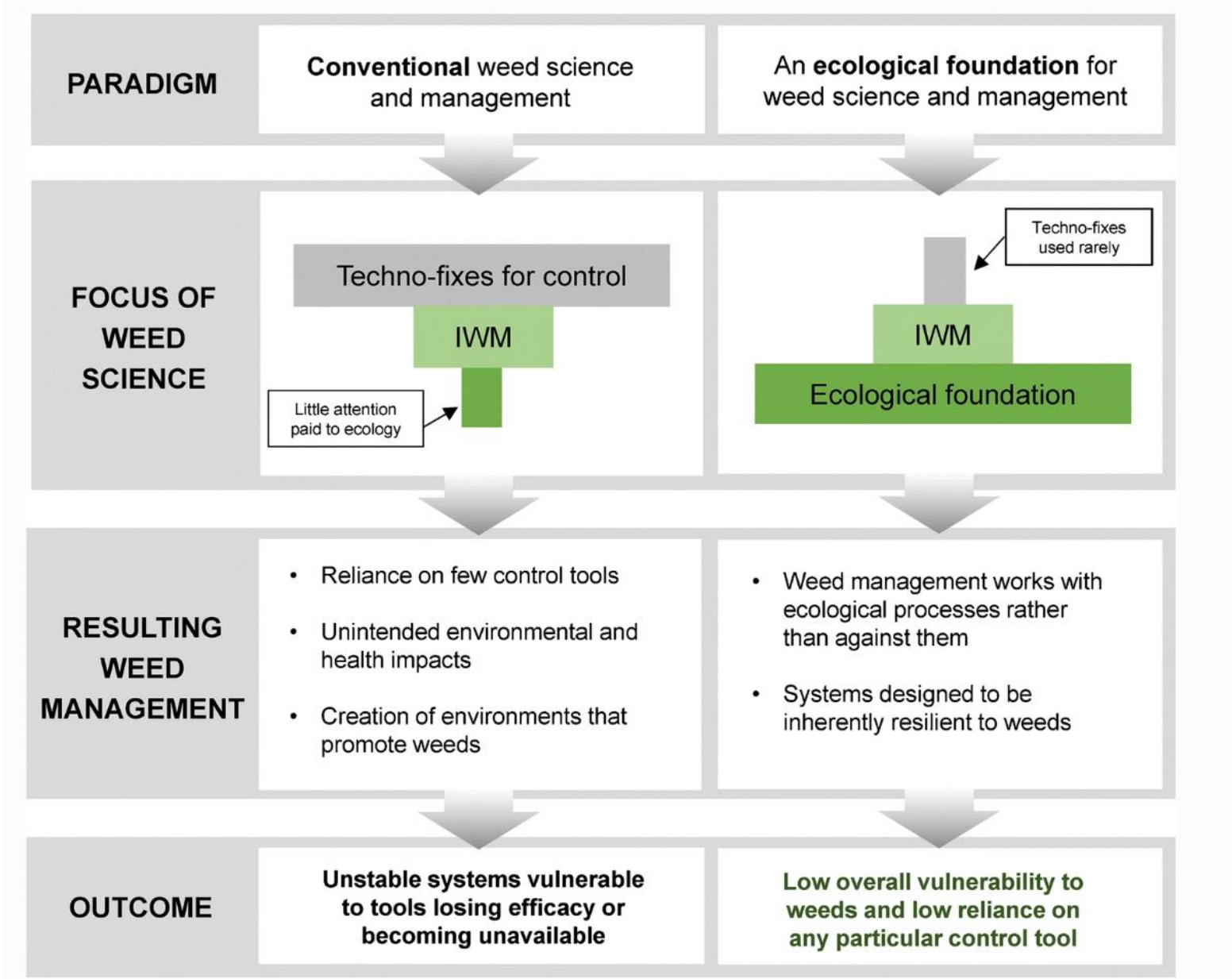
Chloe MacLaren
(EU fellow at Swedish University of Agricultural Science)

Highly Cited Paper

(>160 citations since 2020)

https://doi.org/10.1007/s13593-020-00631-6

ROTHAMSTED RESEARCH



https://doi.org/10.1007/s13593-020-00631-6

ROTHAMSTED RESEARCH

Agronomy for Sustainable Development (2024) 44:7
https://doi.org/10.1007/s13593-023-00941-5

REVIEW ARTICLE

Landscape perspectives for agroecological weed management. A review

Sébastien Boinot[1] · Audrey Alignier[1,2] · Jonathan Storkey[3]

Accepted: 15 December 2023 / Published online: 25 January 2024

Abstract

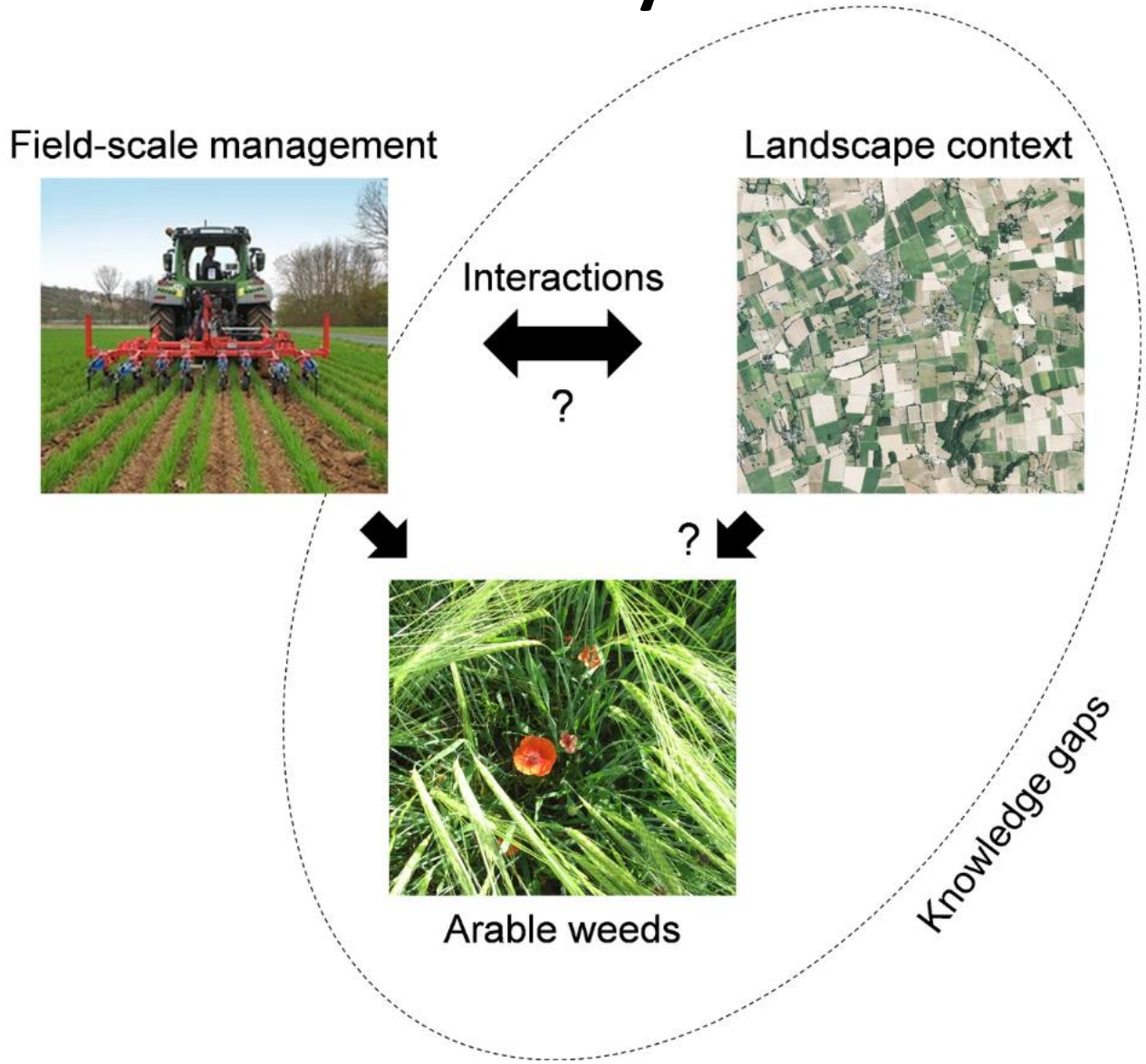
Faced with the biodiversity extinction crisis and climate change, alternative approaches to food production are urgently needed. Decades of chemical-based weed control have resulted in a dramatic decline in weed diversity, with negative repercussions for agroecosystem biodiversity. The simplification of cropping systems and the evolution of herbicide resistance have led to the dominance of a small number of competitive weed species, calling for a more sustainable approach that considers not only weed abundance but also community diversity and composition. Agroecological weed management involves harnessing ecological processes to minimize the negative impacts of weeds on productivity and maximize biodiversity. However, the current research effort on agroecological weed management is largely rooted in agronomy and field-scale farming practices. In contrast, the contributions of landscape-scale interventions on agroecological weed management are largely unexplored (e.g., interventions to promote pollinators and natural enemies or carbon sequestration). Here, we review current knowledge of landscape effects on weed community properties (abundance, diversity, and composition) and seed predation (a key factor in agroecological weed management). Furthermore, we discuss the ecological processes underlying landscape effects, their interaction with in-field approaches, and the implications of landscape-scale change for

Seb Boinot
INRAE

https://doi.org/10.1007/s13593-023-00941-5

ROTHAMSTED RESEARCH

Arable fields are not closed systems



How does the landscape context determine the effect of a field scale intervention (IWM)?

How can landscapes be managed to regulate weeds?

https://doi.org/10.1007/s13593-023-00941-5

ROTHAMSTED RESEARCH

assist | Achieving Sustainable Agricultural Systems

Future Farming: bringing together the best of nature-based and agri-tech solutions

UK Centre for Ecology & Hydrology

ROTHAMSTED RESEARCH

BGS British Geological Survey

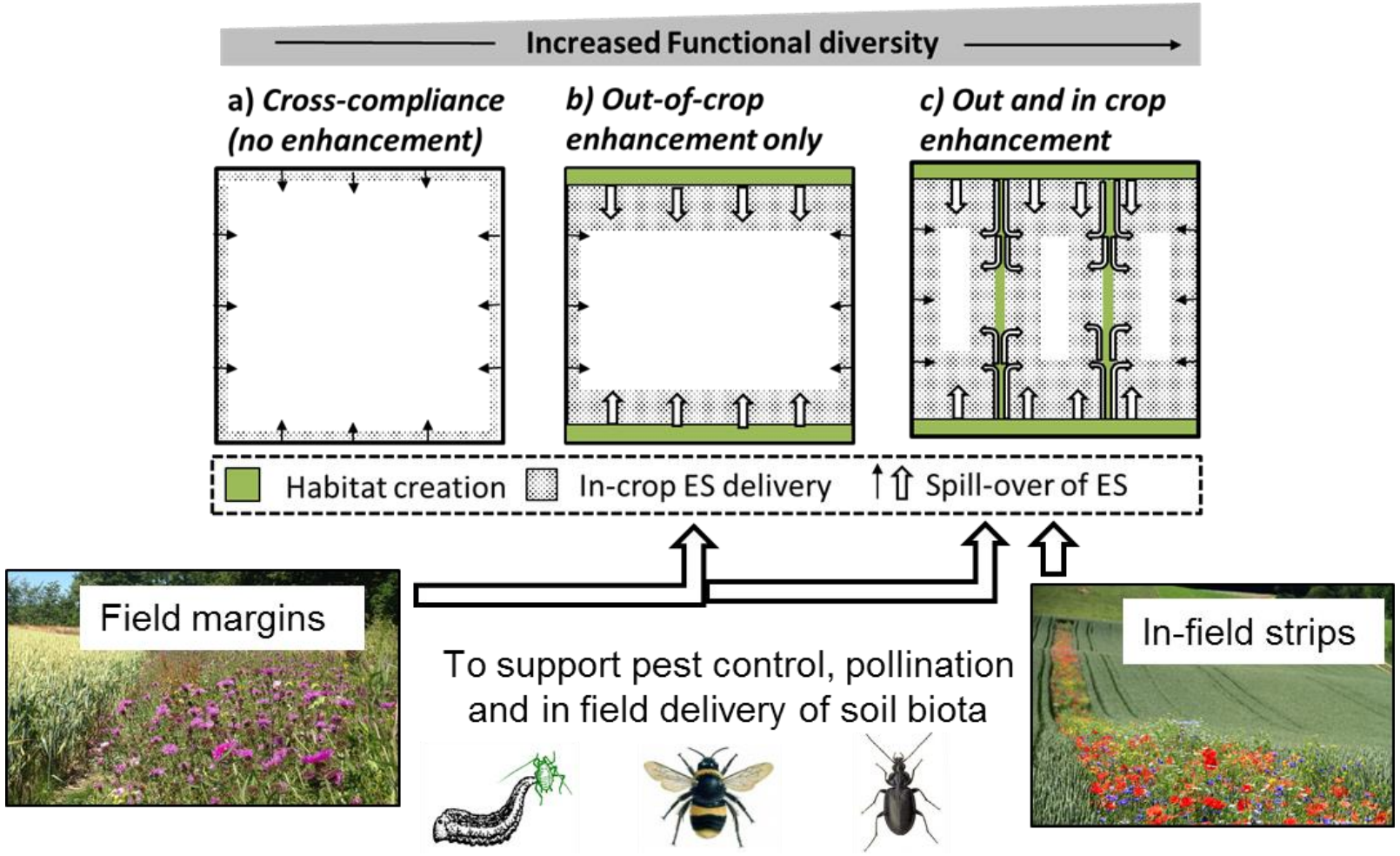
funded by

UKRI Natural Environment Research Council

UKRI Biotechnology and Biological Sciences Research Council

https://assist.ceh.ac.uk/

A field-scale experiment on commercial farms



UK Centre for Ecology & Hydrology

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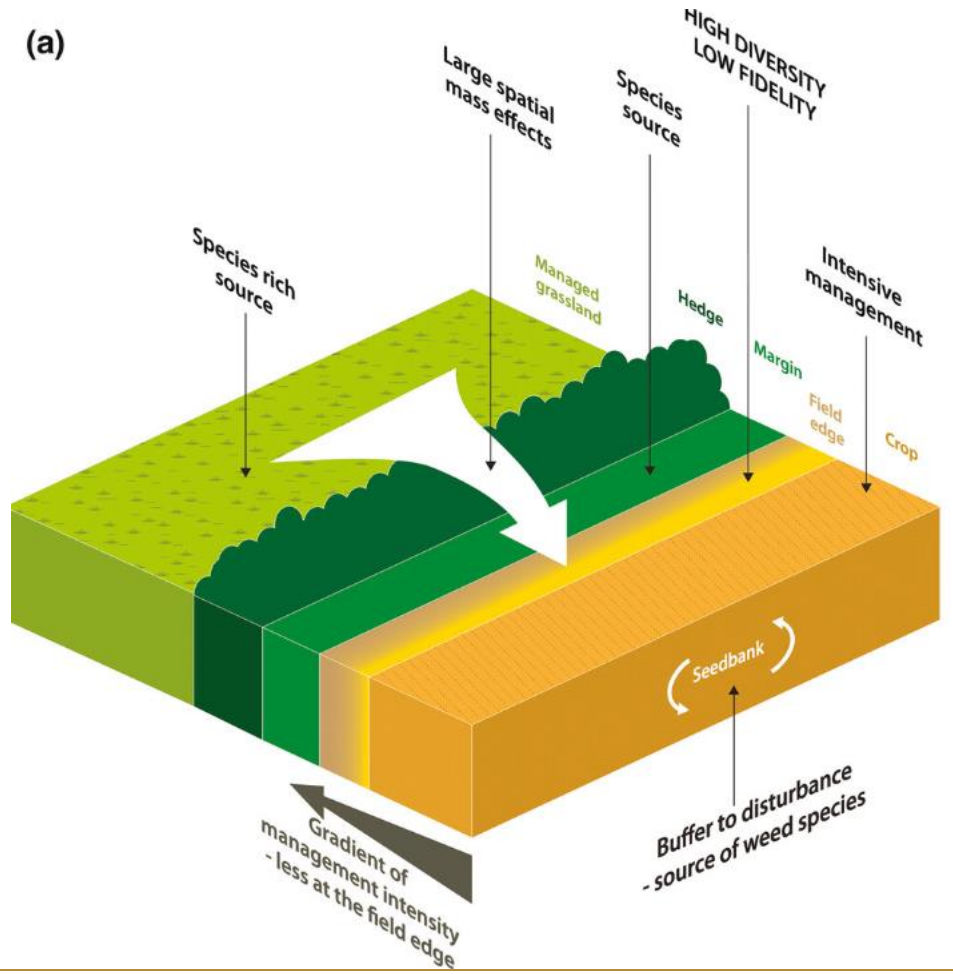
BGS British Geological Survey

What is the effect of the new landscape features on weeds?



Helen Metcalfe
Senior scientist, Rothamsted Research

Received: 26 November 2018 | Accepted: 26 March 2019
DOI: 10.1111/1365-2664.13414

RESEARCH ARTICLE

Journal of Applied Ecology | BRITISH ECOLOGICAL SOCIETY

The contribution of spatial mass effects to plant diversity in arable fields

Helen Metcalfe[1] | Kirsty L. Hassall[2] | Sébastien Boinot[3] | Jonathan Storkey[1]

[1]Sustainable Agricultural Sciences, Rothamsted Research, Harpenden, Hertfordshire, UK
[2]Computational and Analytical Sciences, Rothamsted Research, Harpenden, UK

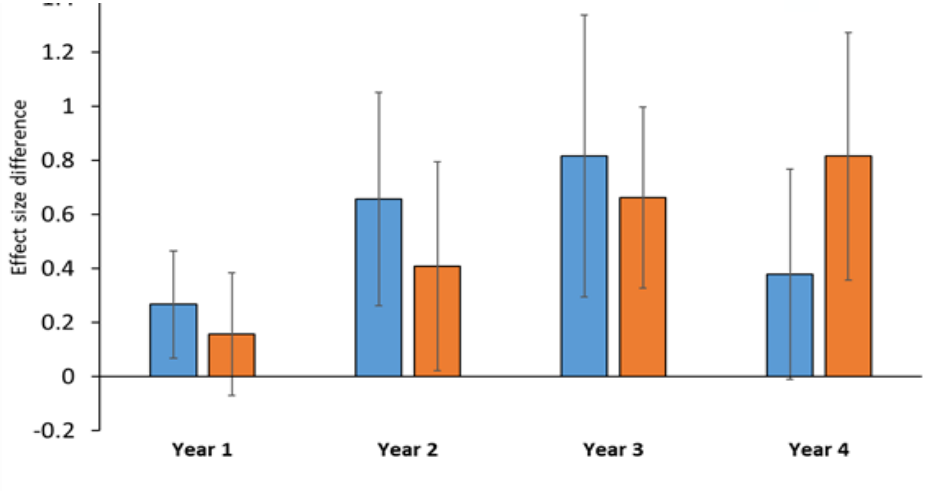
Abstract

1. In arable fields, plant species richness consistently increases at field edges. This potentially makes the field edge an important habitat for the conservation of the ruderal arable flora (or 'weeds') and the invertebrates and birds it supports

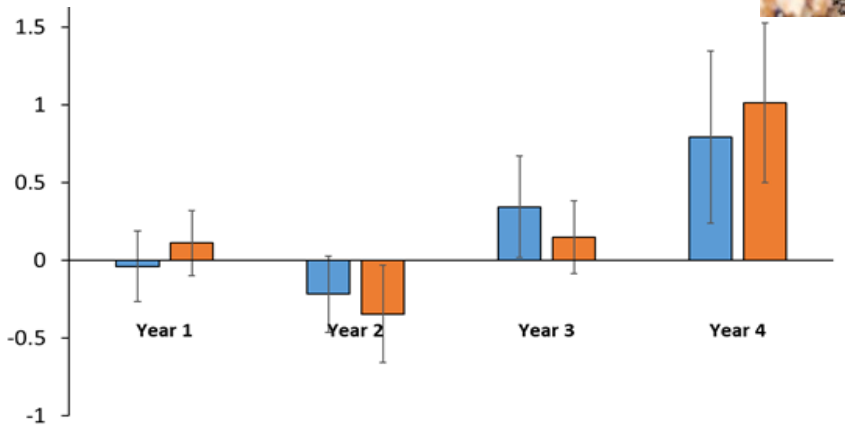
UK Centre for Ecology & Hydrology | ROTHAMSTED RESEARCH | BGS British Geological Survey

Build-up of natural capital and ecosystem services

Soil fauna



Slug predation rates



- It took several years for new habitats to deliver enhanced ecosystem services.
- Investment in natural capital was reflected in increased yields (paper in preparation)

UK Centre for Ecology & Hydrology

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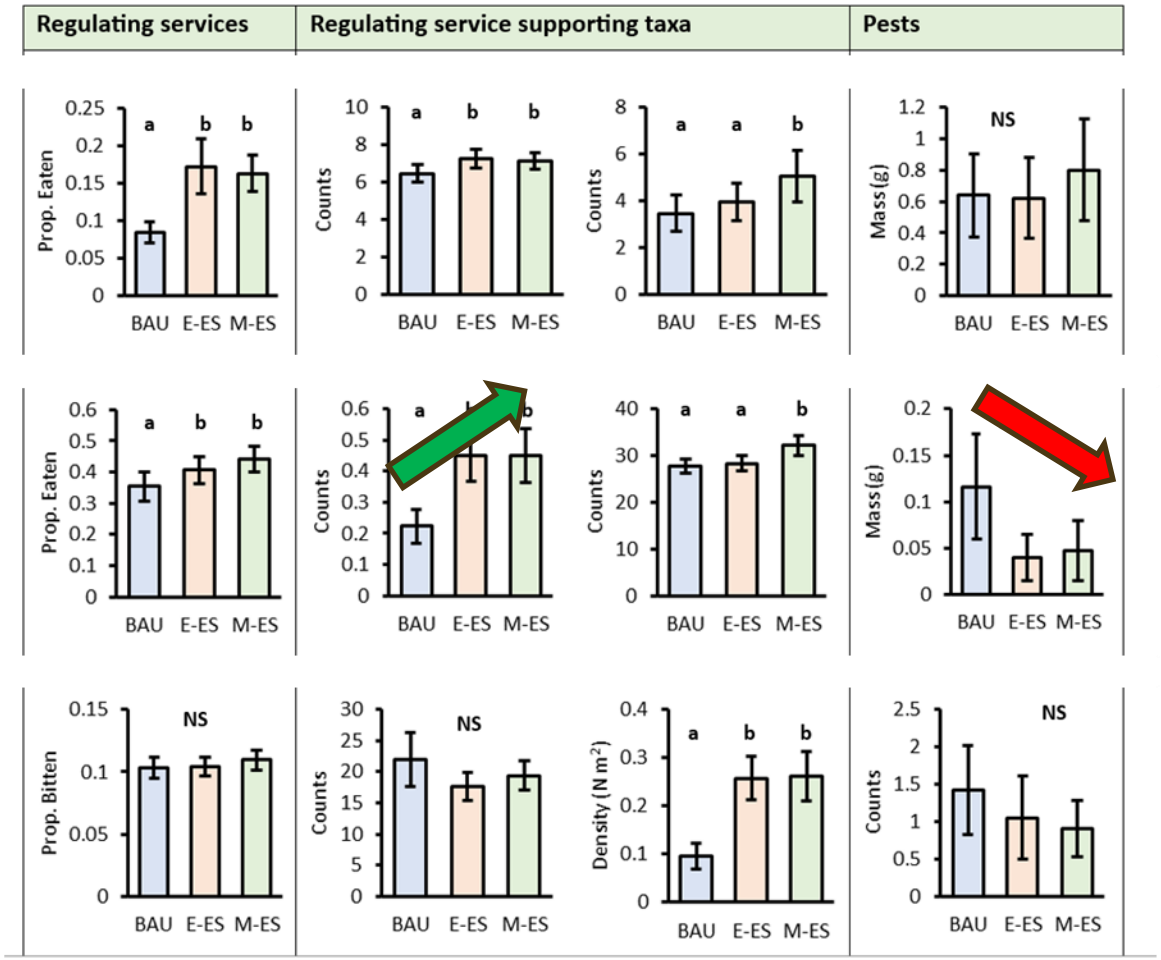
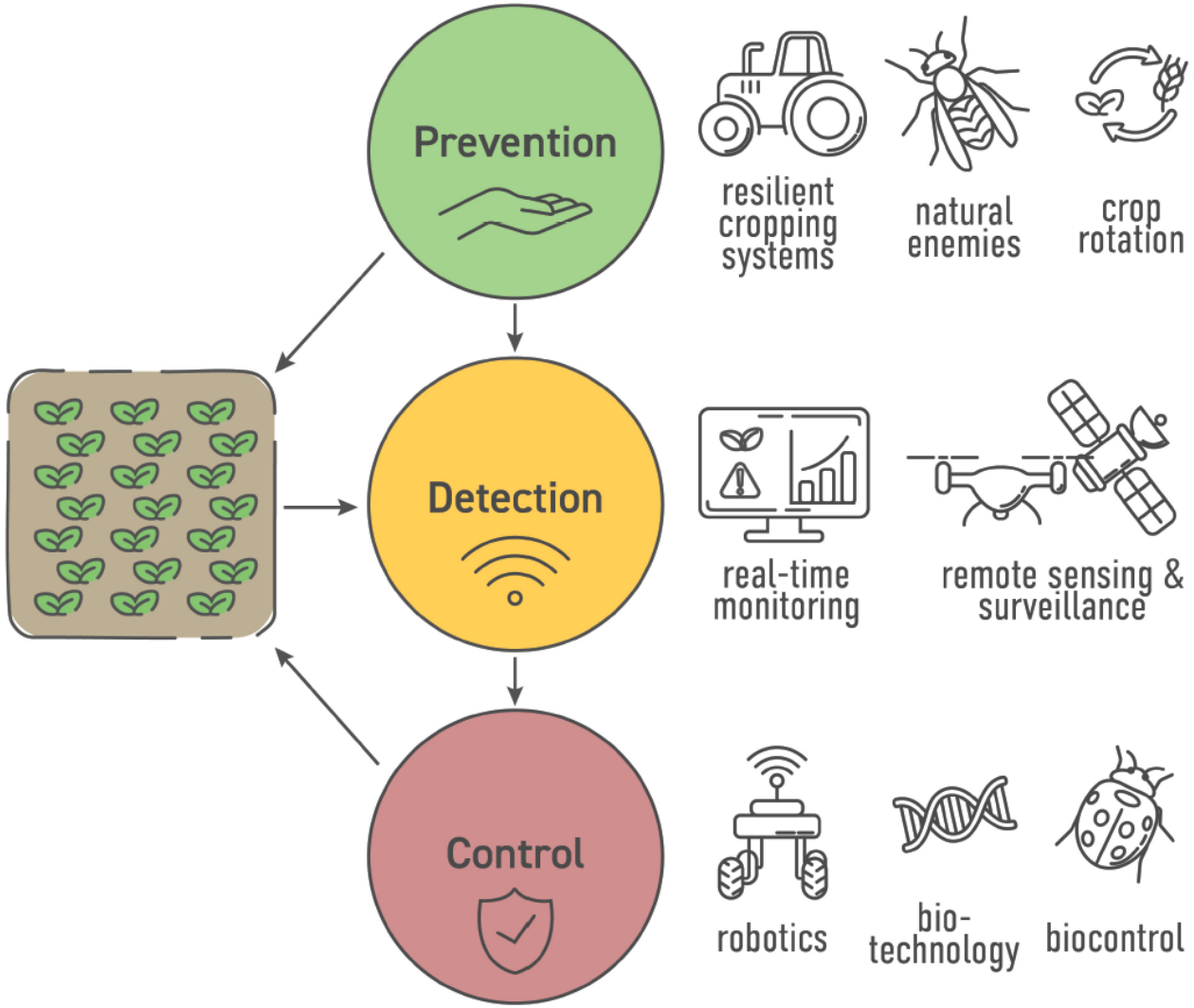
Multiple contributions from in-field strips (in draft)



- Results from 14 farms over 4 years on response of multiple taxa to agroecological treatments.
- Goodies generally increase.
- Baddies are ‘regulated’
- Sown communities degrade slower in field centres, margins tend to act as a barrier to weed ingress.

(Ben Woodcock, Sam Cook et al in prep)

A new project with Copenhagen University, Aarhus University and Sheffield University: One Crop Health



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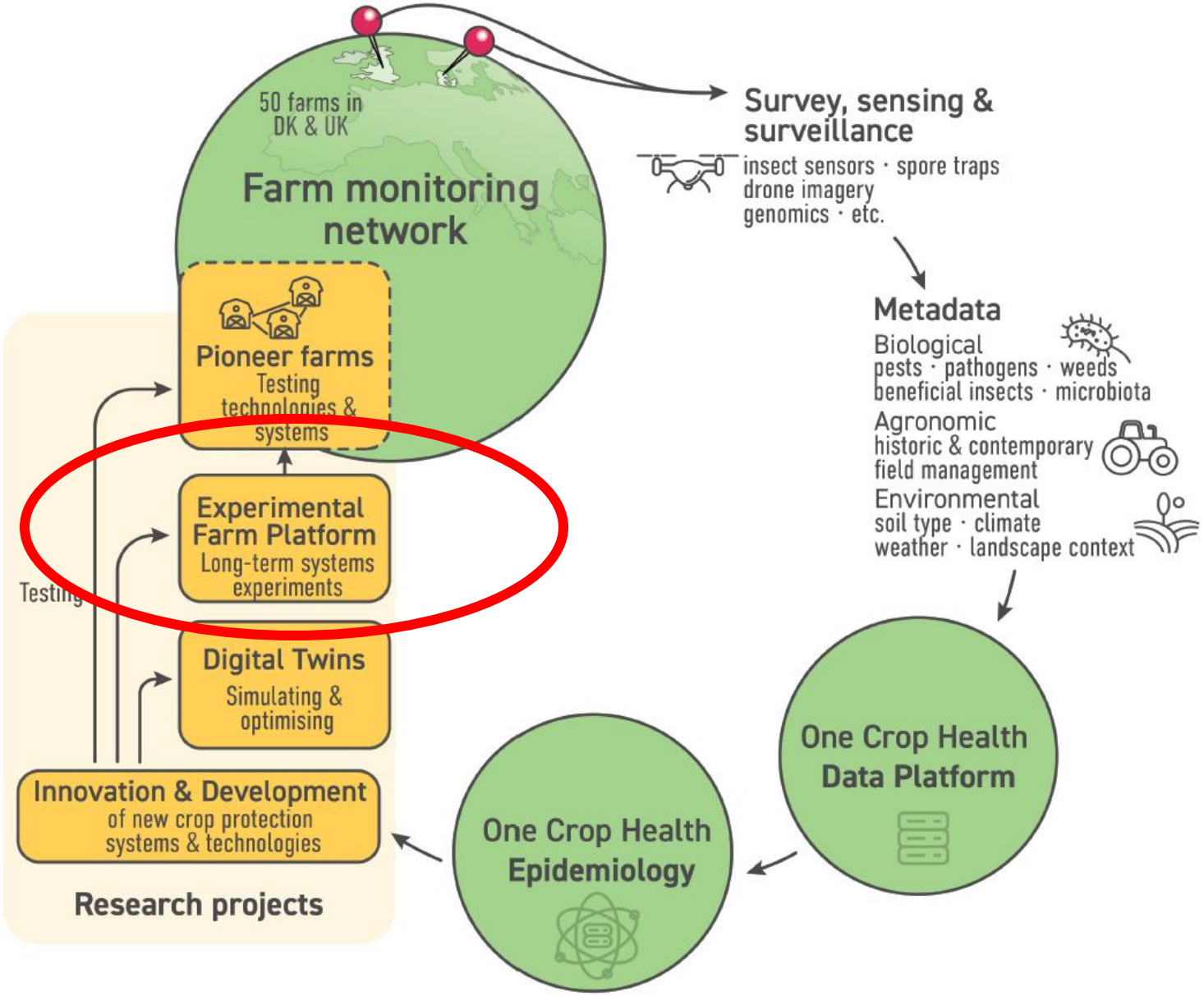
novo nordisk foundation
Benefitting people and society



ROTHAMSTED RESEARCH

novo nordisk foundation
Benefitting people and society

Combining ingredients of ‘regenerative farming’ in a new experiment

Agronomy for Sustainable Development (2023) 43:60
https://doi.org/10.1007/s13593-023-00914-8

RESEARCH ARTICLE

A new Rothamsted long-term field experiment for the twenty-first century: principles and practice

Xiaoxi Li[1,2] · Jonathan Storkey[1] · Andrew Mead[1] · Ian Shield[1] · Ian Clark[1] · Richard Ostler[1] · Beth Roberts[1] · Achim Dobermann[1,3]

Accepted: 2 August 2023

Abstract
Agriculture faces potentially competing societal demands to produce food, fiber and fuel while reducing negative environmental impacts and delivering regulating, supporting and cultural ecosystem services. This necessitates a new generation of long-term agricultural field experiments designed to study the behavior of contrasting cropping systems in terms of multiple outcomes. We document the principles and practices of a new long-term experiment of this type at Rothamsted, established at two contrasting sites in 2017 and 2018, and report initial yield data at the crop and system level. The objective of the Large-Scale Rotation Experiment was to establish gradients of system properties and outcomes to improve our fundamental understanding of UK cropping systems. It is composed of four management factors—phased rotations, cultivation (conventional vs reduced tillage), nutrition (additional organic amendment vs standard mineral fertilization) and crop protection (conventional vs smart crop protection). These factors were com-

ROTHAMSTED RESEARCH

Combining ingredients of ‘regenerative farming’ in a new experiment


Winter wheat


Oilseed rape

2 Crops

+


Field beans


Spring barley

4 Crops

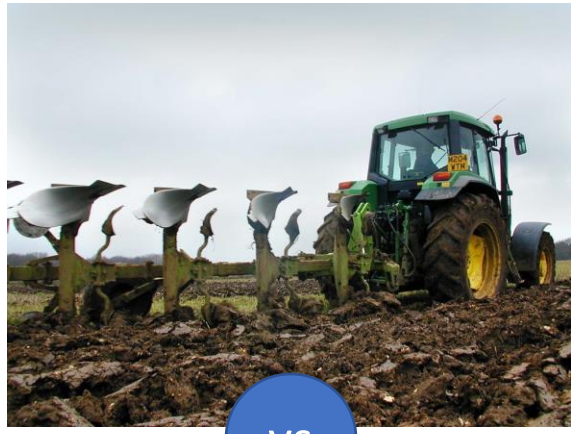
+


Sugar beet / Linseed


Perennial ley

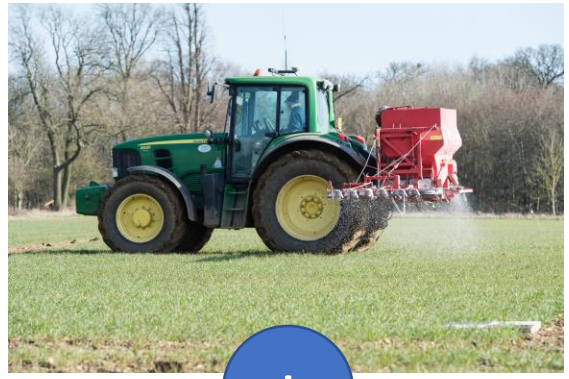
6 Crops

Three contrasting rotations



vs

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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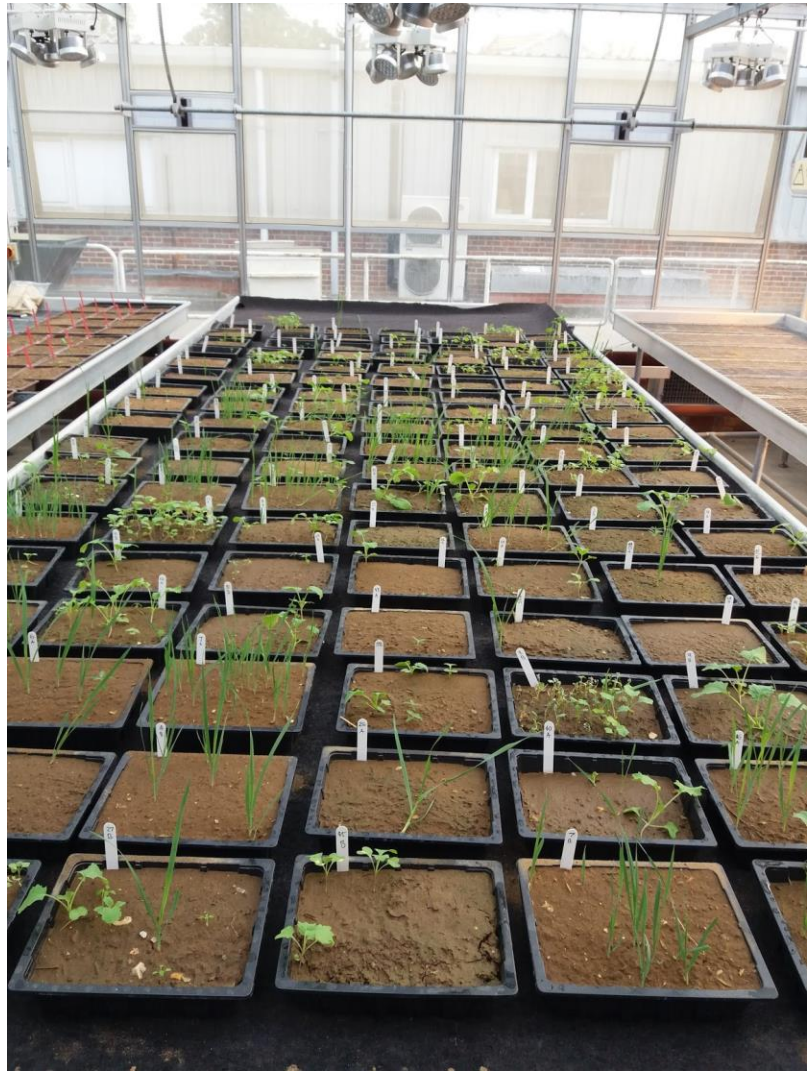
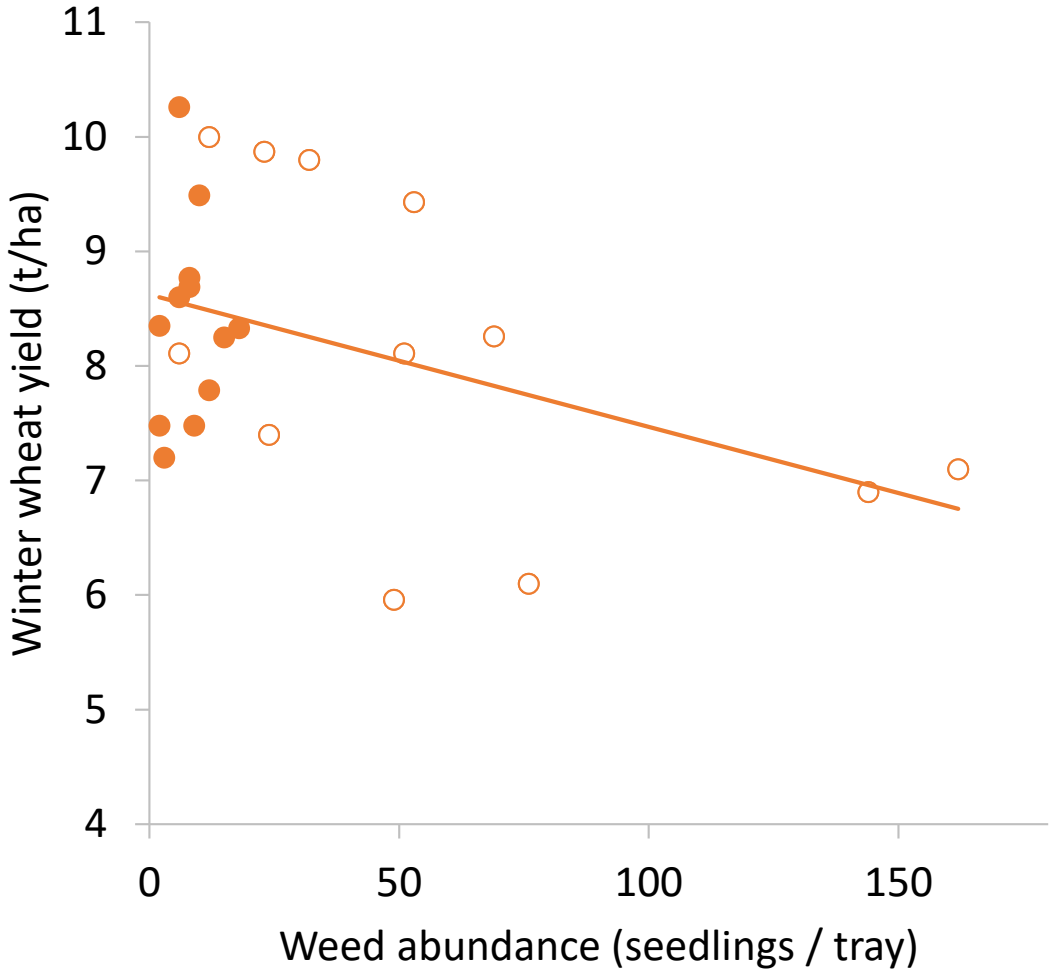
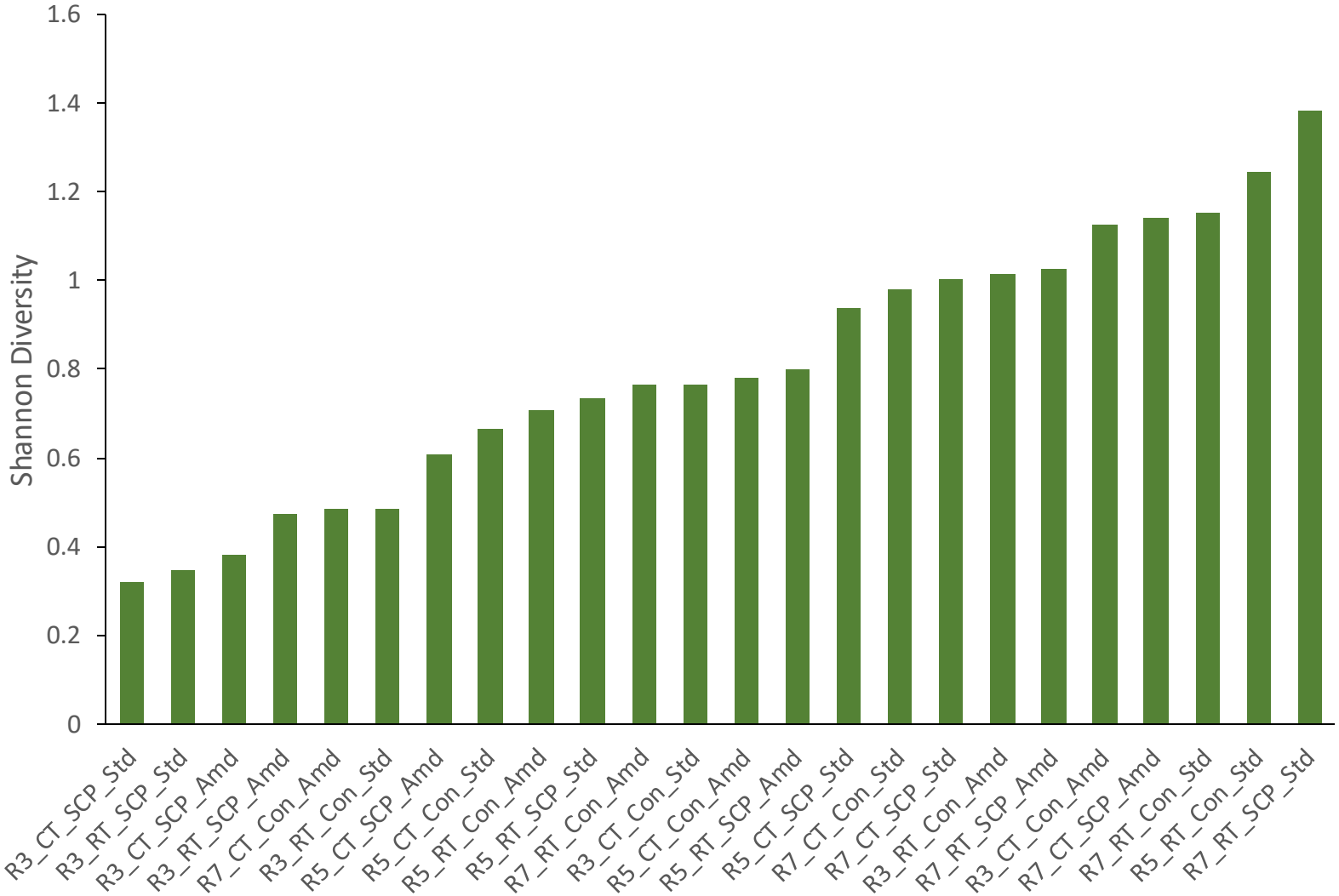
Response of individual weed species





- Black-grass populations building up on reduced tillage plots (open circles) at Harpenden but not Brooms Barn.

Response of weed communities preceding winter wheat at Brooms Barn



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Thank you

31st October 2024