

The future of agroecological weed management



@agricology www.agricology.co.uk

AGRICOLGY
SUSTAINABLE PRACTICAL FARMING



Royal
Agricultural
University
Cirencester




ROTHAMSTED
RESEARCH


MAPLE FARM
KELSALE



Making peace with the weeds



Chloe MacLaren, Jon Storkey, Alexander Menegat,
Helen Metcalfe & Katharina Dehnen-Schmutz

chloe.maclaren@rothamsted.ac.uk



Purpose of this talk

- Understand weeds and their interactions with the agroecosystem
- So you can make the best use of the tools and techniques available to you
- More practical info from Nicola and Mike to follow 😊



The future of weed management is **coexistence**: the “war on weeds” is futile

262 weed species resistant to 23 of the 26 known herbicide sites of action (167 different herbicides)

International Survey of Herbicide Resistant Weeds, I. Heap. 16/12/2019



“Actual soil erosion rates for tilled, arable land in Europe are, on average, 3 to 40 times greater than the upper limit of tolerable soil erosion.”

– *Verheijen et al, 2009*



Farmland birds in the UK: “Main factors driving declines since 1970 [include] **increased use and efficacy of pesticides** leading to the loss of insect food and weed seeds” – *RSPB 2019*



The future of weed management is **coexistence**: the “war on weeds” is futile

the weeds will always win



we're undermining our farmland



**we're taking everything else down
with us**



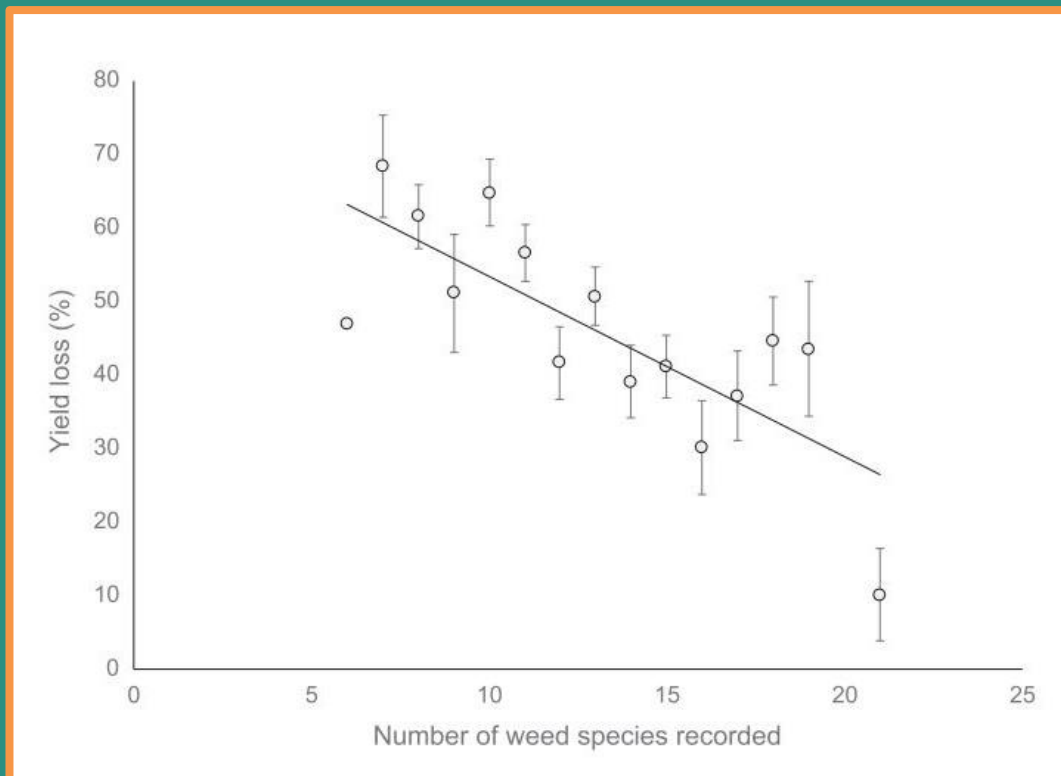
Right ... but weeds compete with my crops?

- **Not always as much as you might think**
- They also provide other benefits (to you and to the environment)
 - habitat for natural enemies, pollinators and wildlife
 - soil health/nutrient cycling/microbes
- When is the cost of getting rid of weeds (effort, money, loss of eco-function) more than the cost of having weeds?



Yield loss: not all weeds are equal

- Evidence from Rothamsted: Storkey and Neve 2018, Weed Research



Yield loss assessed by comparing herbicide-free plots to herbicide plots



Yield loss: not all weeds are equal

- Recent study from France
 - Adeux et al 2019, Nature Sustainability
- Different cropping systems in long-term experiment have led to different weed communities
- Compared unweeded and ‘zero weeds’ plots



Yield loss: not all weeds are equal

- Across all weed communities:
 - Crop yield declined by 30% in unweeded plots (expected)
- Between six distinct weed communities, in unweeded plots
 - Four weed communities decreased yields (20-55%)
 - Two communities had **no effect** on yields (0%)
 - Yield loss decreased with weed diversity
 - Yield loss was not strongly related to weed density
 - Yield loss was highest in communities **dominated** by blackgrass and cleavers, and lowest with speedwell or field pansy + diversity



For yield loss, the question is not “how weedy is the field?” but “**which weeds are there, and how many different species?**”

The same question is important to ecosystem function and biodiversity support

We want:

Farming systems that are **resistant** to outbreaks of problematic weeds but that are capable of **fostering** a diverse weed community to sustain ecosystem services.



How do we get there?

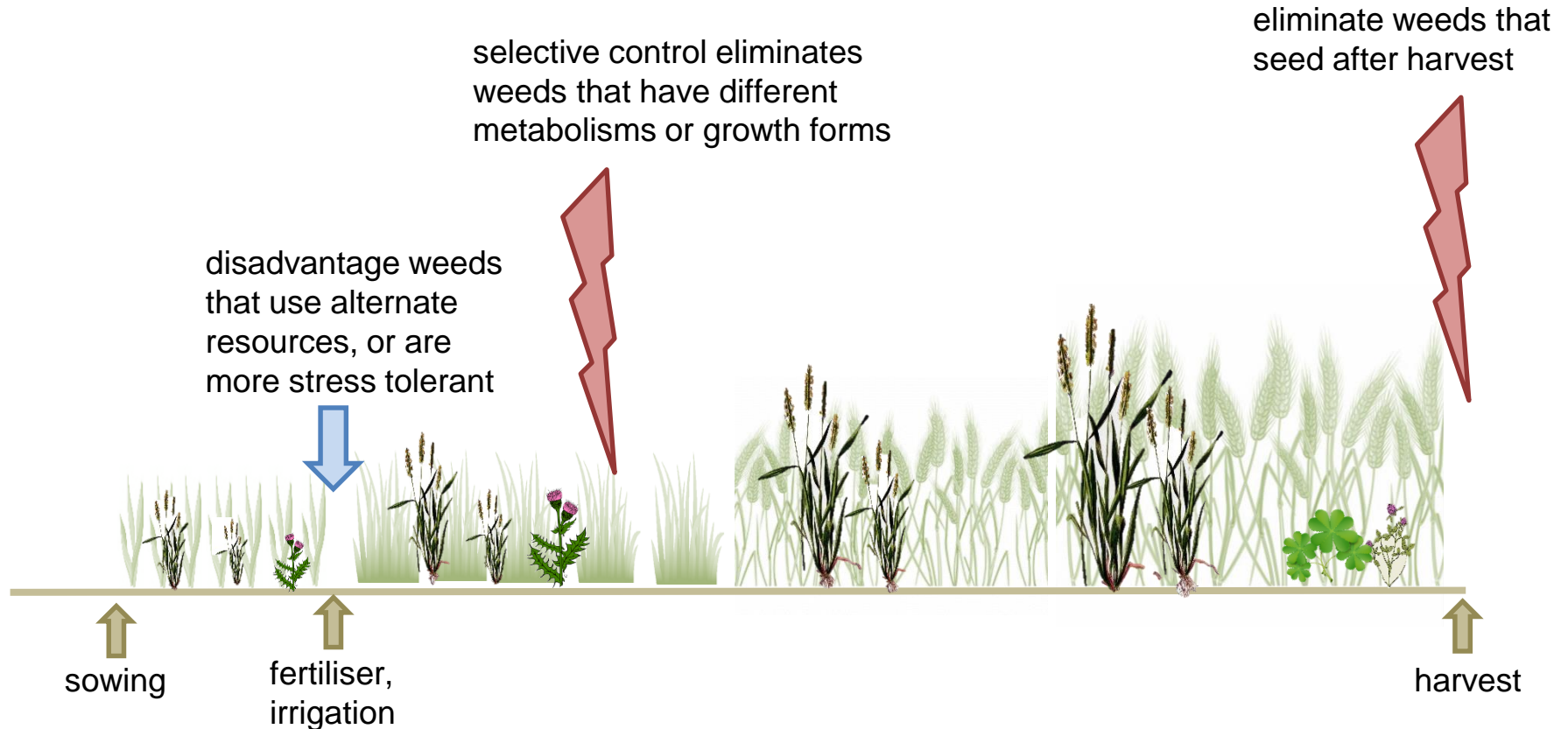
- Most yield loss from weeds is caused by **competition** for resources: light, nutrients, water
- The most competitive weeds are those that are either or both:
 - **very similar to the crop**
 - **faster to access resources than the crop**
- Systems should suppress competitive species while favouring diversity



 **what not to do!**



1. try to avoid consistently penalising weeds for being different to the crop

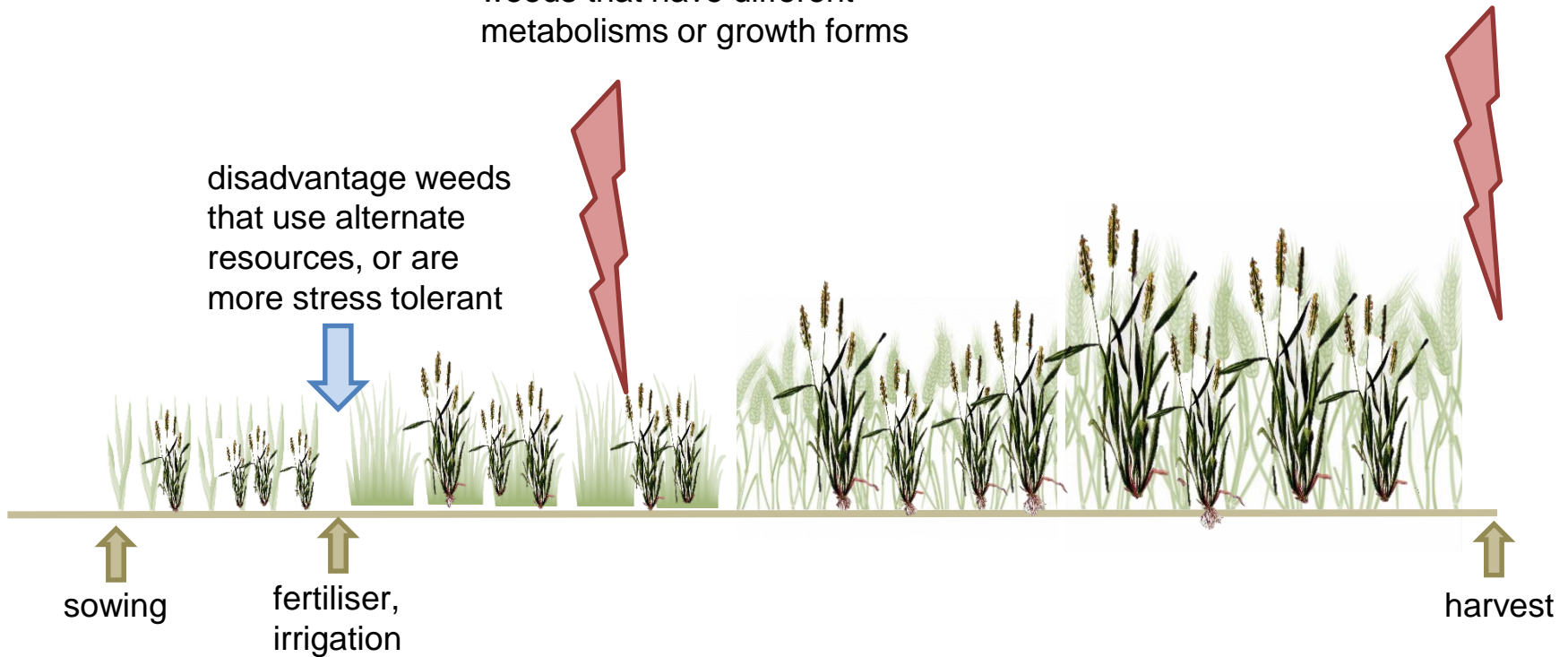


2. try to avoid doing the same thing(s) every year

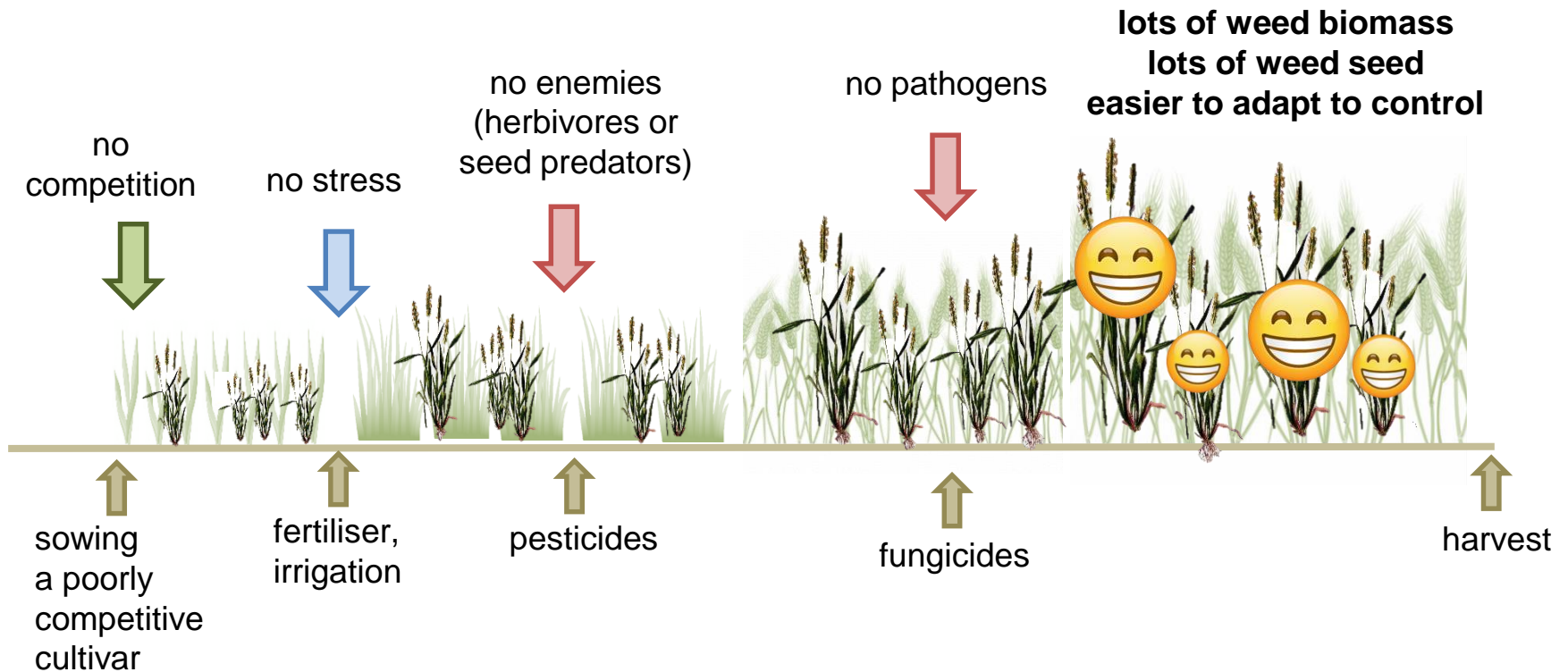
selective control eliminates weeds that have different metabolisms or growth forms

eliminate weeds that seed after harvest

disadvantage weeds that use alternate resources, or are more stress tolerant



3. try not to create an environment where the weeds' only worry is resisting control



Key points

- Repetitive, strong control efforts remove diversity whilst promoting resistant weeds that mimic and compete with the crop
- A resource-rich, enemy-free environment helps weeds survive control and adapt to it



What to do instead?

- Four principles of ecological weed management (IWM+)
 1. Increase diversity in all its forms
 2. Use 'many little hammers' not 'sledgehammers'
 3. Reduce resource availability
 4. Take advantage of the positive functions of weeds

- What, why & how



I. Increase diversity in all its forms

What?

- crops, management, livestock, habitats, microbes, insects, wildlife
- in time and space

• Why?

- change the **type and timing of practices each year and between fields** so no weed species are consistently favoured
- crop and habitat diversity** promote natural enemies of weeds

How?

- crop rotation, intercropping, integrated crop-livestock, restore unfarmed habitat e.g. headlands, fencelines



2. 'Little hammers' not 'sledgehammers'

What?

- don't try to kill all the weeds at the same time, every time

Why?

- avoid creating strong selection pressure for hard-to-control, competitive, crop-mimicking weeds

How?

- use **multiple soft tactics that vary between years**
- 'increase diversity in all its forms'
- precision control (narrow in both time and space!)



**aim to create
not to destroy**

3. Minimise resource availability

What?

- reduce the amount of ‘free’ light, nutrients and moisture

Why?

- high resource availability selects for **fast-growing, resource-hungry weeds**

How?

- slow-release nutrients (e.g. legume residues)
- precision fertiliser placement and irrigation
- competitive crops and crop mixes, mulches/residues



4. Take advantage of the positive effects of weeds

What?

- weeds can help to maintain soil health and support beneficial insects and microbes, and to prevent erosion and leaching

Why?

- why not?

How?

- manage for a diverse weed community



Key points

- The future of weed management is **co-existence**
- Aim for farming systems that are **resistant** to outbreaks of problematic weeds but that are capable of **fostering** a diverse weed community
- Follow these **four principles of weed management**:
 - Increase diversity in all its forms
 - ‘Little hammers’ not ‘sledgehammers’
 - Reduce resource availability
 - Take advantage of the positive effects of weeds



Thanks for listening!

Acknowledgements

- Co-authors: Jon Storkey, Alexander Menegat, Helen Metcalfe, Katharina Dehnen-Schmutz
- Agricology: Katie Bliss

chloe.maclaren@rothamsted.ac.uk

