

# The future of agroecological weed management



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**AGRICOLGY**  
SUSTAINABLE PRACTICAL FARMING 





# Making peace with the weeds



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# 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

**the weeds will always win**



**we're undermining our farmland**



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



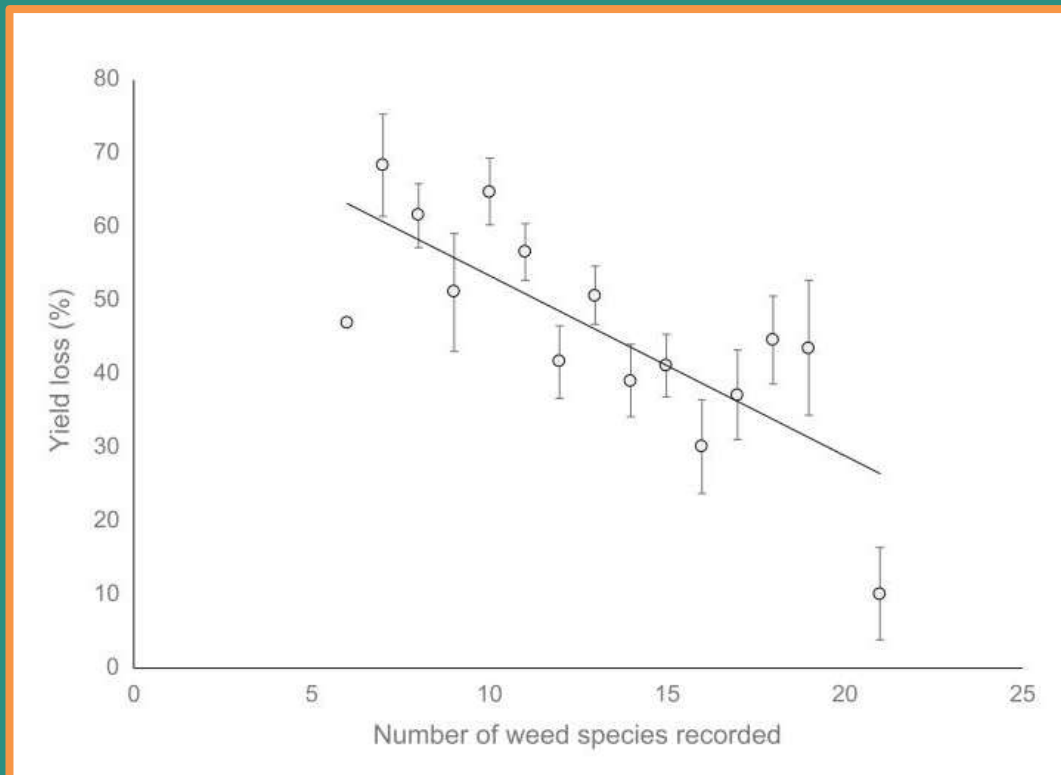
# Right ... but weeds compete with my crops?

- **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.



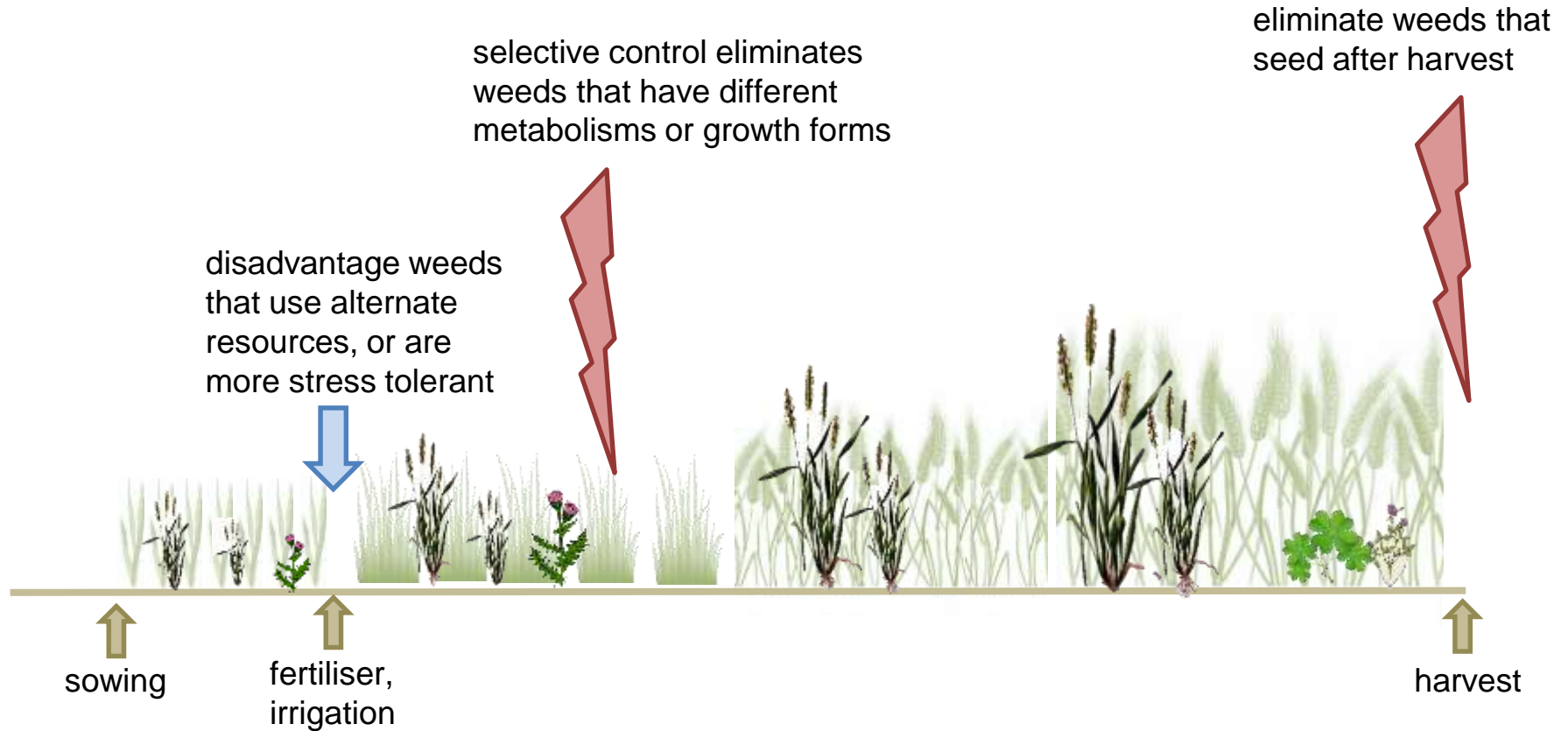
# How do we get there?

- 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

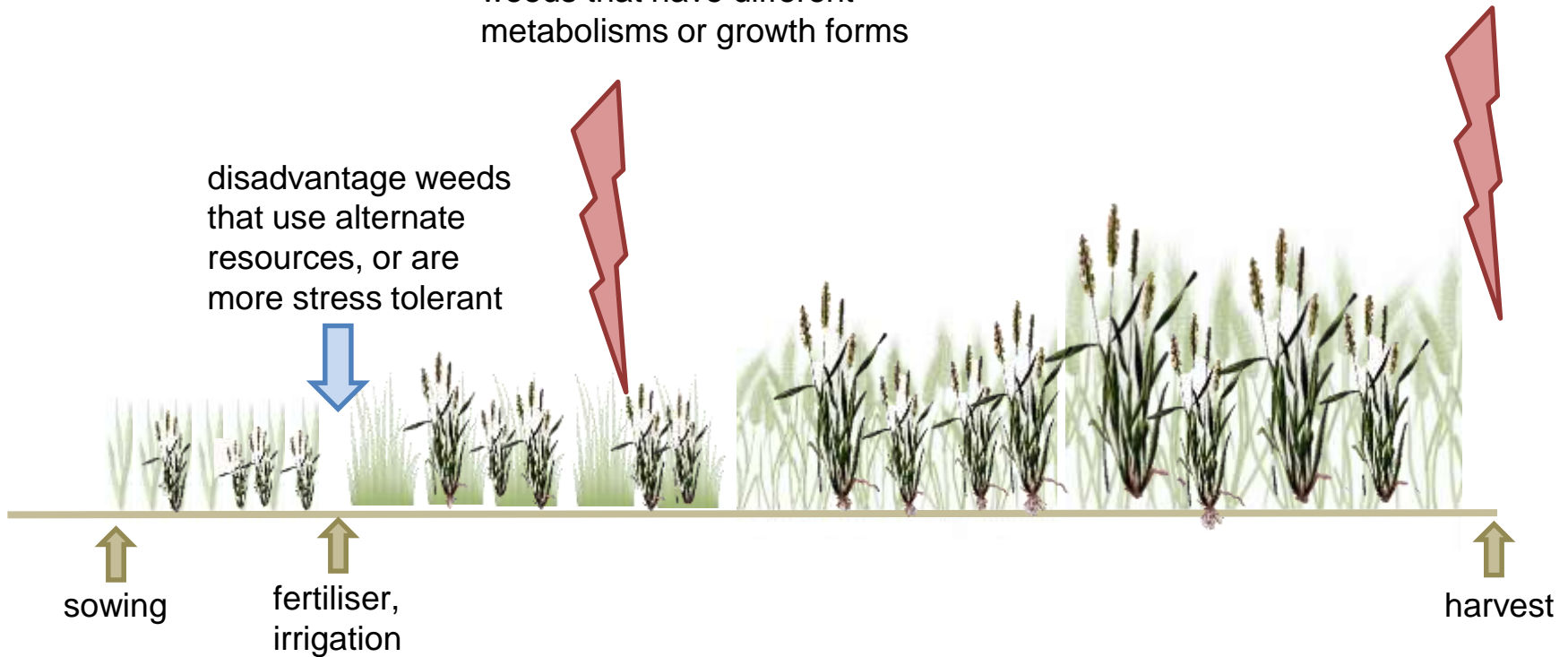


## 2. try to avoid doing the same thing(s) every year

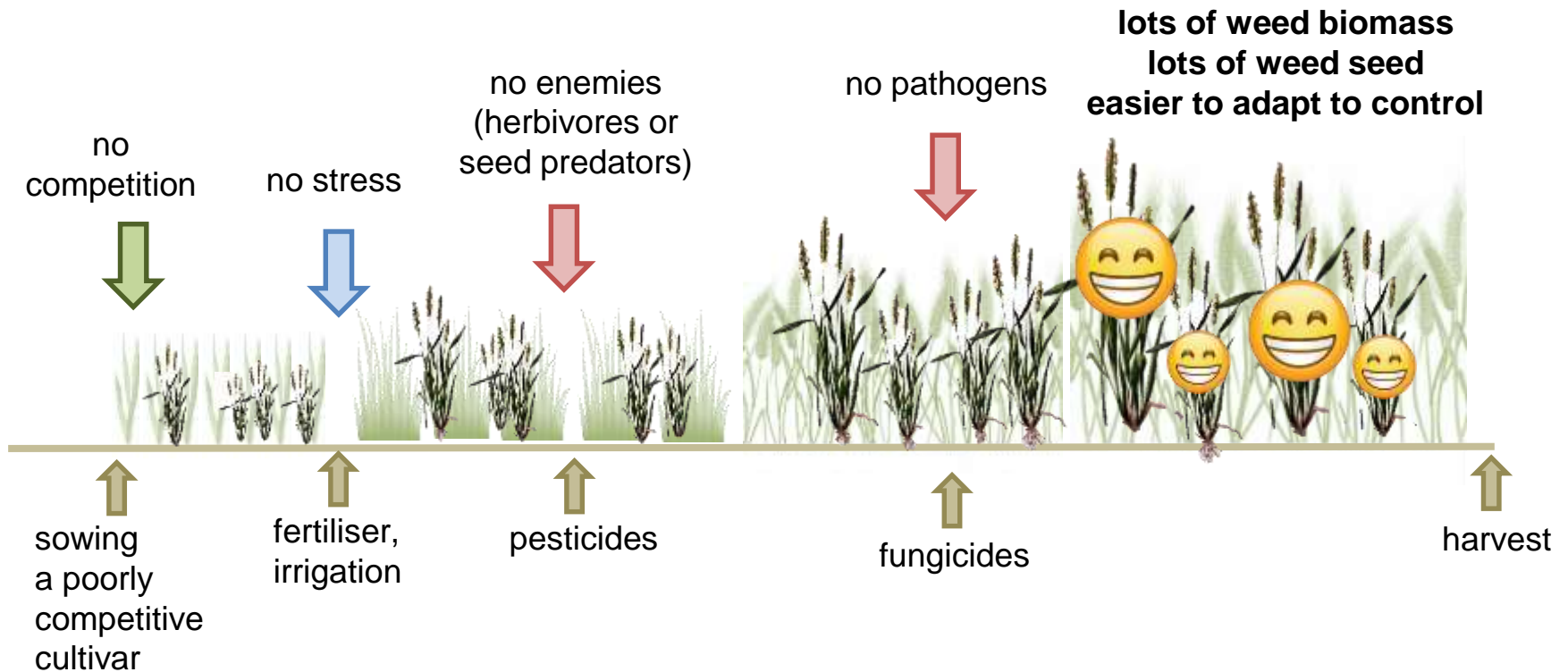
selective control eliminates weeds that have different metabolisms or growth forms

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?

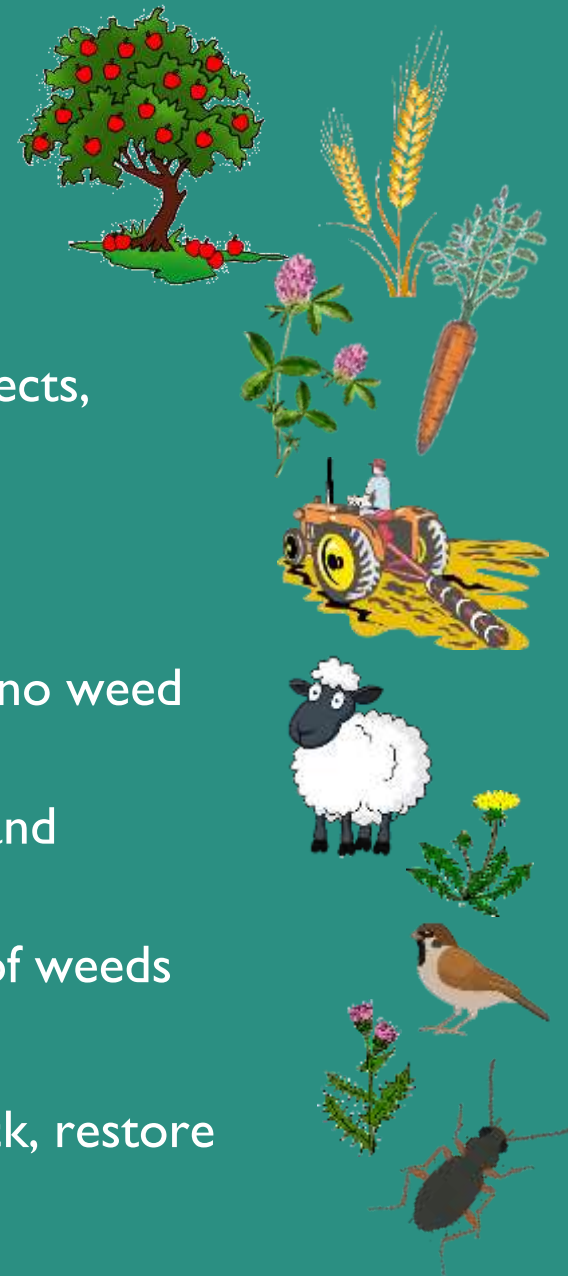
- crops, management, livestock, habitats, microbes, insects, wildlife
- in time and space

## • Why?

- change the **type and timing of practices each year** so no weed species are consistently favoured
- crop diversity in the landscape limits space available and interrupts dispersal
- 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?

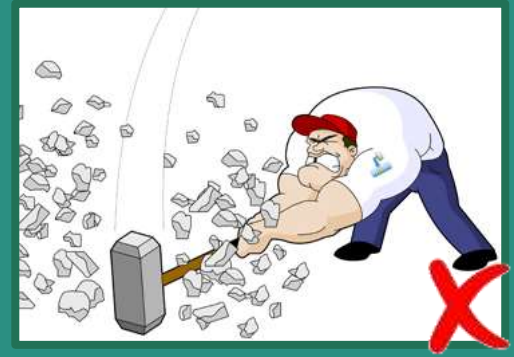
- don't try to kill all the weeds at the same time, every time
- use **multiple soft tactics that vary between years**

### Why?

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

### How?

- 'increase diversity in all its forms'
- particularly choose tactics that favour weeds that diverge from the crops, e.g. competitive crops
- precision control (narrow in both time and space!)



**aim to create  
not to destroy**

# 3. Minimise resource availability but maximise resource diversity

## What?

- reduce the amount of ‘free’ light, nutrients and moisture
- increase the different types of nutrient available

## Why?

- high resource availability selects for **fast-growing weeds**
- resource diversity allows weeds to **diverge from the crop**

## How?

- fertiliser from organic matter (slow-release, more nutrient forms)
- 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
- allow the right weeds to act as spontaneous catch crops and intercrops



## 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!

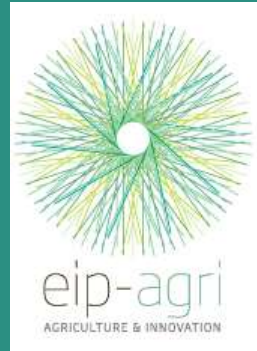
## Acknowledgements

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

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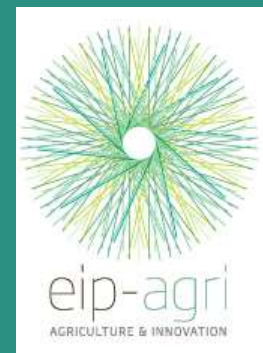
# A vision for the opportunities for precision non-chemical weed management in 2050 and beyond



Nicola Cannon, Bo Melander, Per Ståhl, Stefan Kiefler  
Alistair Murdoch, Margaret R. McCollough, Dirk Jan



# Scale of precision available in 2019



	Chemical options	Non-chemical options
<b>Farm</b>	Easily achieved	Easily achieved
<b>Field</b>	The normal management however now facing challenges of chemical resistance, product withdrawal and environmental pressures.	Used on organic farms or where product specification or challenges in chemical control lead to predominately-mechanical removal techniques.
<b>Site specific</b>	Achievable through either satellite, drone, manual scouting mapping and zoned spray applications.	Achievable through either satellite, drone, manual scouting mapping and then selective use of machinery which is generally restricted to machinery width.
<b>Plant specific</b>	A range of systems are under development but few are commercially available.	Currently predominately achieved through point treatment but mainly through hand weeding.
<b>Leaf specific</b>	Under development but not available commercially	None available



# Mechanical weeding in narrow-spaced crops



- Currently crop competition is the most important method for controlling intra-row weeds
- Row width important
- weed harrowing works by soil coverage and uprooting of weed plants
- depends on a size difference between crop and weed plants; the crop needs to be larger and more firmly anchored than the weeds
- Options of cutting the crop with knives



# Robot-assisted intra-row weeding in row crops

- Some crops more susceptible to yield loss than others
- Most effective when weeds are small
- intelligent weeding has many benefits over the non-intelligent tools
  - more hours of operation (operation is even possible at night time),
  - easier to implement in practice,
  - less risk of crop injury, only one operator is needed,
  - more flexibility in treatment timing in relation to weed growth stage
- Needed in direct sown crops as well as transplants



# Precision tractor and implement implementation



Three main types of:

- Steerable axles/wheels on mounted/semi-mounted implements;
- Installation of side-shift frames between tractor and implement; and
- Side-shiftable lower links of a tractor.

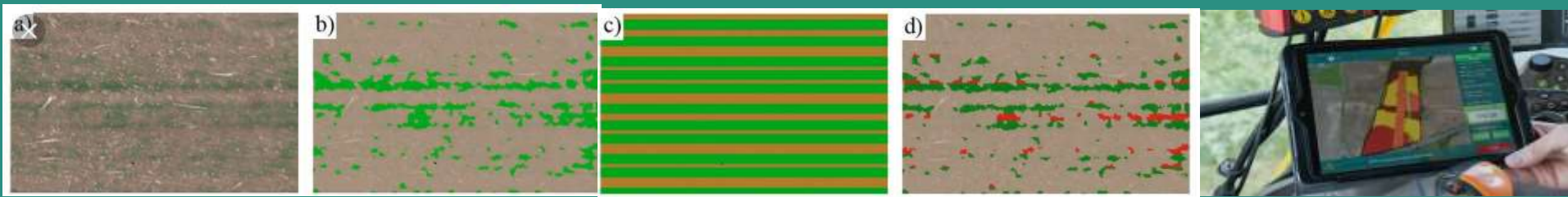
Require:

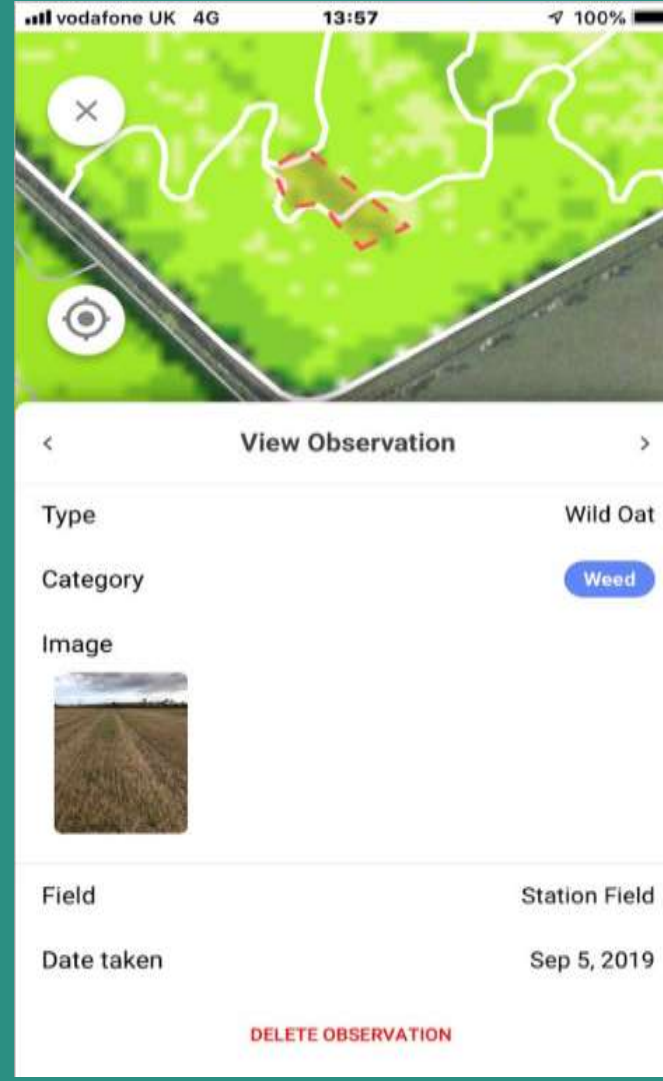
- GNSS guidance system achieving Differential (DGPS) or RTK accuracy
- very precise hydraulic flotation through electrical SCV 's allow precise steering of the implements
- multiple GNSS-signals or camera-based, row detection information must be computed by the tractor's own computer system and the separate components and systems must be compatible



# High definition weed mapping and site specific weeding

- Weed patches need to be mapped and geo-referenced
- Image capture and analysis are frequently used for weed sensing and mapping.
  - Light intensity at the time of image capture can effect performance and the ability to discriminate weed and crop plants due to changes in the red, green and blue components of the light.
- The need for the farmer to purchase such technology can be over-stated!
  - Start up businesses
  - Free EU Sentinel satellite service
- Easy to automate 80% of a process but even though the last 20% may be technically feasible, it may not be an economic proposition.
- **Ground truthing essential**





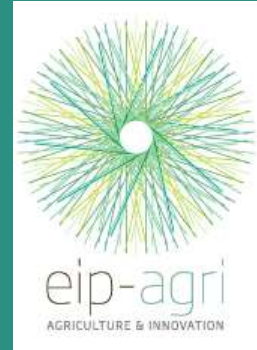
# Single plant detection and non-chemical weed control

- Drone and satellite imaging are not yet accurate enough
  - Error build up in positioning and image rectification
- Weed location and weed species is required
  - weed growth stage and leaf biomass needed
- The root positions are mostly unknown from camera detection
- Methods of destruction after detection
  - electrocution,
  - laser cutting or damaging,
  - defoliation by cutting,
  - mechanical damaging,
  - push into the ground or punch,
  - pull the weed
- Requires hyperspectral cameras with resolution of approx. 1 mm<sup>2</sup>
- **EXPENSIVE!**



# Conclusions

- Systems need to be designed around weed control
  - Drilling row widths
  - Technology enabled machinery
- Weed and crop size are important
- The more precise, the more expensive!



# The Four Principles of Weed Control in Organic Growing

Maple Farm Kelsale, Suffolk



350 acres

Arable, Veg  
Layer hens

Silvopastoral  
Agroforestry





# The Four Principles of Weed Control in Organic Growing

- Principle One: **Bury**



Includes mulches

- Bury, Smother
- Everything from a spade to a plough
- Good for controlling annuals and some perennials



# The Four Principles of Weed Control in Organic Growing

- Principle Two: Sun



- From hand weeding through to most types of mechanical weeding
- Good for annual and perennial weed control



# The Four Principles of Weed Control in Organic Growing

- Principle Two: Sun

Thermal weeding



Cover with Mulch and allow the  
Sun to heat



Don't disturb the top and it can be weed  
free for months

# The Four Principles of Weed Control in Organic Growing

- Principle Three: **Frost**

- Kills Annuals
- Lowers Soil Temperature



# The Four Principles of Weed Control in Organic Growing

- Principle Four: **Competition**

Out compete the weeds

Under sowing with clover



Pea and Barley Companion



# The Four Principles of Weed Control in Organic Growing

- Principle Four: **Competition**

- Vigorous varieties
- Allelopathic properties



# The Four Principles of Weed Control in Organic Growing

- Principle Four: **Competition**

Vetch &  
Rye



# The Four Principles of Weed Control in Organic Growing

1. Sun
2. Bury
3. Frost
4. Competition





Find out more...[@agricology](http://www.agricology.co.uk) and YouTube channel! 😊

## Mulching for Weed Control

29 March 2018

### THE FARM:

The market garden at Daylesford is placed on a gentle, south-facing slope with 6 polytunnels and is located adjacent to the main restaurant/shop/farm complex; a 20 acre field at the heart of the Daylesford Estate. The garden is divided by 10 m fruit tree lined grass avenues forming a grid of land blocks in which the vegetable crops are rotated. Around the garden periphery we have smaller pieces of ground for 2 acres of soft fruit, orchard strips, an acre of polytunnels, and the various infrastructure necessities; packing shed, compost heaps, borehole, water storage tank and propagation area.



### FARM FACTS:

**FARM SIZE:** 20 acres  
**MANPOWER:** 4 FT & incerns/trainees  
**FARM TYPE:** Mixed  
**TENURE:** Owner occupied  
**RAINFALL:** 765 mm  
**ALTITUDE:** 100 m  
**SOIL:** Clay loam  
**APPROACH:** Organic  
**KEY FARMING PRACTICES:**  
 Mulching  
 Novel crops  
 Undersowing  
 Biological control  
 Companion crops  
 Diversified rotation  
 Low input varieties



In this month's Agricolgy vlog, Jez Taylor - head grower at Daylesford Organic Farm in the Cotswolds, discusses how he manages weeds in their organic market garden system, explaining that weeds can have a huge impact on the crops, potentially...



By Jez Taylor

### RELATED CONTENT:

- Organic weed management
- No-dig techniques & soil management to suppress weeds & unexpected results aerating the soil
- Crop rotation and its ability to suppress perennial weeds
- Jez Taylor

### RELATED FARMING THEME:

- Weeds
- Roots & horticulture

### Weeds



Explore our content related to this farming theme  
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