Achieving Sustainable Agricultural Systems

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• 6 year Government funded research programme
• Uniting expertise in crop and environmental science, with support from the farming industry
• Co-develop ecologically-based sustainable agricultural systems that are efficient & resilient to future shocks
• Provides data, tools & a long-term research infrastructure for the farming industry
Improving biological pest control
Diversity is the key to effective IPM

- Meta-analysis concluded natural pest control most effective where:
  - Management enhanced the functional diversity of predator traits / characteristics
  - Hunting strategy, prey preference, size, habitat (ground, foliage) etc
Habitat for beneficials

- Study of four commercial farms comparing flower-rich vs. typical grass margins
- Sowing flowers increases abundance & diversity of ‘beneficials’

Woodcock et al. Agriculture, Ecosystems, Environment 2016; https://doi.org/10.1016/j.agee.2016.06.023
Flower-rich habitats support increased natural pest control

- Pest control from predators greatest adjacent flower-rich margins
- Spill-over of beneficiais declines after 50m from field edge

Woodcock et al. Agriculture, Ecosystems, Environment 2016; https://doi.org/10.1016/j.agee.2016.06.023
Diversity brings resilience in conventional farming systems

- Impact of field-realistic pesticide exposure on predator aphid feeding after 1 and 5 days
- This is a measure of how resilient individual species are to pesticides (toxicodynamics)

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The Hillesden Experiment
The Hillesden farm platform

• 12-year study on a 1,000ha commercial arable farm

• Fifteen 50-60ha ‘farmlets’ = three treatments replicated FIVE times:
  - Control business as usual - 0% land removed from production
  - 3% land removed from arable production and turned to two wildlife habitats
  - 8% land removed for six wildlife habitats

• Precision yield data to target habitat creation in awkward/low yielding areas (margins & corners)

https://agzeroplus.org.uk/hillesden
Using wildlife to support increased yields

Yield mapping direct from harvesting machinery

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Yield as Ratio of Regional/National average

- Cross Compliance
- ELS
- ELS Extra

8% land out of production into wildlife habitats
3% land out of production into wildlife habitats
0% out of production

Yields increased over time in fields with wildlife habitat creation, despite removal of cropped land from field edges.
Can promoting natural pest control work in the real world?
Multi-farm Experiment

- Network of 20 commercial arable farms
- Real-world test of eco-agriculture with agri-tech farming
- Opportunity for technology transfer & complementary research
- Similar experiment on grass farms
Maximising the spatial delivery of services

On each farm:
- Three fields
- On same soil
- Same crop rotation

a) Cross-compliance (no enhancement)

Control
Business as Usual

b) Out-of-crop enhancement only

Treatment 2
SUPPORTING
Soil & beneficials + Cover crops + Flower margins

c) Out and in crop enhancement

Treatment 3
MAXIMIZING
Soil & beneficials + Cover crops + Compost/FYM + Flower margins + In-field strips

Habitat creation | In-crop ES delivery | Spill-over of ES

Field margins

To support pest control, pollination and in field delivery of soil biota

In-field strips
In-field strips working in with tramlines

• Strips programmed in with tramlines as headlands
• Farm ‘around’ the ends so no increase in corners
Impacts on yield

- 18 sites for 4 years
- Cereals and oilseed rape crops
- Sustainable management systems treatments 2 & 3 have positive effects on yield
- The more complex system (Treat.3) is on average better
- It takes time for biological systems to respond
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Preliminary results using Information Theoretic multi-model averaging based on plot level yield measures
Statistical approach looking at direct and indirect drivers of yield, including combined area of field margins and infield strips (green infrastructure)

Overall tested model

Positive effects

Negative effects

Aphid parasitism

Field margin plant diversity

Parasitoid numbers

Ground beetle numbers

Yield

Ratio Green infrastructure to cropped area

Worm counts

Cover Crops

Beetle predation rates

Intra-guild predation

PROFIT?
Decision Support Tools

AgZero+
Towards sustainable, climate-neutral farming

Natural Environment Research Council
Biotechnology and Biological Sciences Research Council
UK Centre for Ecology & Hydrology
ROTHAMSTED RESEARCH
British Geological Survey
National Centre for Earth Observation
Plymouth Marine Laboratory
Practitioner biodiversity monitoring

- **Mobile App** to enable non-specialists to monitor habitats
- **AI image** recognition for automatic ID of plant species and habitats from photos
- **Contextual information** to improve accuracy
- Survey function and data provided on associated beneficial insects
- In development.....**Ground beetles (IPM), Moths, Worms (soil health)**
Natural pest control is a ‘black box’ - Is management working to increase pest control?

Pitfall trapping

AI image recognition of pitfall trap contents (~90% accurate)

- Abundance of predators
- How effective are they
- Long-term goal is to relate these to thresholds for spraying
Practical guides to sustainable farming

Video series exploring ways that farmers can reduce their carbon footprint, make best use of pesticides and help bring wildlife back to their farms.

Part of the AgZero+ programme: https://agzeroplus.org.uk/

1. In-field wildflower strips and hedges - a practical guide to sustainable farming
   UK Centre for Ecology & Hydrology • 256 views • 3 months ago

2. Feeding farmland birds in winter - a practical guide to sustainable farming
   UK Centre for Ecology & Hydrology • 205 views • 3 months ago

3. E-Planner: Enhancing farm environmental decisions | AgZero+
   UK Centre for Ecology & Hydrology • 291 views • 2 months ago

4. E-Surveyor: Monitoring farmland biodiversity
   UK Centre for Ecology & Hydrology • 196 views • 1 month ago

5. Encouraging beneficial insects on your farm
   UK Centre for Ecology & Hydrology • 171 views • 4 weeks ago

6. Soil carbon on your farm | AgZero+
   UK Centre for Ecology & Hydrology • 4 views • 10 hours ago
Conclusions

1. Mechanistic experiments show it is possible to increase natural pest control
2. This is important for increasing resilience of farming systems
3. Co-design with farmers resulted in practical approaches to achieving this (strips = SFI)
4. Multi-site experiments on commercial farms show yield benefits in the real world
5. AI-driven decision support tools (with training & advice) will support future IPM
Special thanks to all the ASSIST farmers and the UKCEH and RRes field teams

https://www.ceh.ac.uk/e-surveyor