Linking Biodiversity & Profitable Farming: Introducing Hillesden and ASSIST

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1. Designing & testing habitat for ‘beneficials’

2. Benefits to the farm business: Hillesden

3. Where next? The ASSIST programme
1) Designing Habitat for ‘Beneficials’
• Six commercial farms
• Six new AES prescriptions tested
• Conventional crop control
• 5 years monitoring
Multiple Benefits from Wildflower Margins

GHG capture

Pollinator richness

Pollination

Soil carbon by %LOI

Crop to the edge

Grass margin £70 ha⁻¹

Wildflower margin £280 ha⁻¹

Crop
Grass
Wildflower

Crop
Grass
Wildflower

Nutrient cycling

Earthworm abundance

Pest control

Natural enemy diversity

Crop
Grass
Wildflower

Crop
Grass
Wildflower

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

The BUZZ Group
OPERATION Pollinator
Multifunctional Landscapes
Enhancing Natural Pest Control
Natural pest control

**Surface active predators**

- Average abundance per wheat tiller
- Field margin type
- Enhanced vs. Grass

**Sward active/flying predators**

- Average abundance per wheat tiller
- Distance to margin (m): 10m vs. 50m

Image credit: Roselle Hyman, CEH
Testing this in the under field conditions

- Natural pest control reduced the survival of aphid colonies
- The best pest control is next to flower rich field margins
- Spill-over into the crop remains a problem

Colony survival when open to all predators

![Graph showing days to aphid colony death at different distances from the edge, with bars for flower rich and grass only conditions.](image-url)
Benefits to Pollinator Populations
Pollinator methods

Field surveys
• Sampled DNA from live queens and workers in every habitat patch across the 20km$^2$ landscape (ca. 3,200 bees)

Molecular genetics
• Genotyped samples then grouped individuals into nests and ‘families’

Landscape modelling
• Relate bumblebee data to detailed maps of the landscape obtained using field surveys and high-resolution aerial remote sensing data
Effects of habitat on bee foraging distance

The more flowers in the landscape, the less distance bumblebees forage for resources.

Redhead et al (2016) Ecological Applications
First evidence that habitat creation benefits bumblebee populations

“Family lineage survival”

Cover of semi-natural vegetation within 1000m of the colony

n = 456 colonies

Letter

Bumblebee family lineage survival is enhanced in high-quality landscapes

Claire Carvell, Andrew F. G. Bourke, Stephanie Dreier, Stephen N. Freeman, Sarah Hulmes, William C. Jordan, John W. Redhead, Steirian Summer, Jieliang Wang & Matthew S. Heard
2) Benefits to the Farm Business: Hillesden Farm Platform
Hillesden Farm Platform

- Commercial 1000ha lowland arable farm
- Heavy soil growing autumn-sown crops (WW / OSR & beans)
- FIFTEEN 50-60ha ‘farmlets’ = three treatments replicated FIVE times:
  - Cross Compliance (0% land removed)
  - Typical Entry Level AES (3% land removed for two wildlife habitats)
  - Entry Level Extra AES (8% land removed for six wildlife habitats)
- Habitat creation in awkward/low yielding areas (mostly margins/corners)
- Test bed for AES policy

![Legend]

- Crop yield values
- Water resource protection
- Pollinator habitat

![Winter Wheat Group 4 Break-even Point]

- Gross Margin
- Total Fixed Costs
Abundance of ‘Beneficials’

(a) crop pollinators

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Total Crop Pollinators (ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business as usual</td>
<td>100</td>
</tr>
<tr>
<td>ELS</td>
<td>200</td>
</tr>
<tr>
<td>ELS Extra</td>
<td>500</td>
</tr>
</tbody>
</table>

(b) Predators of Crop Pests

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Total Predators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business as usual</td>
<td>400</td>
</tr>
<tr>
<td>ELS</td>
<td>600</td>
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<tr>
<td>ELS Extra</td>
<td>1400</td>
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</tbody>
</table>

Image credits: Steve Falk and Dave Campbell. CC BY-NC-ND 2.0
Effects on yield (6yrs): all crops

a) Cropped area

Yield as Ratio of Regional average

Cross Compliance | ELS | ELS Extra

b) Whole field

Yield as Ratio of Regional average

Cross Compliance | ELS | ELS Extra

Image credit: Sebastian Dahler CC BY-NC-ND 2.0
Effects on yield: Beans

**a) Cropped area**

Yield deficit as ratio of national average:

- Cross Compliance
- ELS
- ELS Extra

**b) Whole field**

Yield deficit as ratio of national average:

- Cross Compliance
- ELS
- ELS Extra

Image credit: Wikipedia Commons
Crop yield performance

Yield as Ratio of Regional/National average

- Cross Compliance
- ELS
- ELS Extra

2006 2007 2008 2009 2010 2011

Image credit: Wikipedia Commons
The Theory: Ecological intensification

‘Optimal management of ecological processes and beneficial biodiversity to improve agricultural productivity, efficiency and resilience to future shocks’

Integrated within precision farming systems

PROCEEDINGS B
rspb.royalsocietypublishing.org

Wildlife-friendly farming increases crop yield: evidence for ecological intensification

Richard F. Pywell¹, Matthew S. Heard¹, Ben A. Woodcock¹, Shelley Hinsley¹, Lucy Ridding¹, Marek Nowakowski² and James M. Bullock¹
3) What next?
• 5+ year £11M research programme
• Uniting expertise from NERC and BBSRC institutes, with support from the farming industry
• Develop innovative farming systems to increase efficiency of food production & resilience to future shocks
• Reduce the environmental footprint of agriculture
WP1 LIMITATIONS ON CROP PRODUCTIVITY

- Understanding limitations on crop yield
- Overcoming the yield gap
- Influence of bio-physical factors on yield resilience
- Predicting future crop yields

Data collection & analysis

- Detailed infield measures
- National surveys

- Long-term yield data
- Crop input data
- Soil data

The Yield Gap

- Potential yield
- Socio-economic factors
- Lack of pollination
- Pests, weeds & disease
- Limited availability of water & nutrients

Image credit: Wikipedia Commons
WP2 Environmental impacts of future agriculture

- Predict impacts of current and future agriculture
- Inform future mitigation strategies

- Scenarios of intensification/ extensification
- New process models of water quality and GHG emissions
- Predict resilience of beneficial biodiversity
- Complement national monitoring

Image credit: Marek Nowakowski
WP3 Sustainable solutions

• Network of 18 commercial study farms
• Real world test of ecological intensification with best agri-tech farming
• Co-designed by industry
• Enhance soil function, pollination & pest control
• Opportunity for technology transfer/complementary research
• Bringing the ‘Beneficials’ into the field
• Infield strips of bespoke flower habitat for natural enemies & pollinators
WP4 Synthesis: optimisation of future landscapes

- Develop modelling framework to optimise farm management for multiple objectives (production, ecosystem services, biodiversity):
  - Where to intensify/extensify production (WP1),
  - Impacts of changed agricultural management on natural capital and biodiversity (WP2), and
  - Application of intervention measures to mitigate/enhance these effects (WP3)
  - Build resilient future agro-ecosystems
Thank you

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