Crop production comes alive

> *"We cannot continue to farm without maintaining the ecosystem on which it depends."*

Innovation ASSIST

Farmers and scientists are working together on a major new study aimed at determining just how useful beneficial insects are for crop performance. *CPM* visits an Oxon farm that's taking part.

By Tom Allen-Stevens

Julian Gold lifts the tile on his slug trap to reveal no fewer than three slugs enjoying the layers mash he's provided — not much of a surprise, bearing in mind the rain that's lashing down. But quickly scurrying away to hide is a carabid beetle.

"We're all quite aware of treatment thresholds for slugs and how we monitor these. But there's no reliable data on thresholds for beneficial species nor how we take account of them. If we really want to deliver on our goals for Integrated Pest Management (IPM), we should be monitoring the two together," he says.

The slug trap is at least 100m from the field edge, which would be a considerable distance from the traditional refuge area of a carabid beetle, a known predator of slugs. Julian's not surprised by the discovery, however, since the trap is just a few yards away from a 6m wildflower strip he's established right in the middle of his field.

The 750ha Hendred Estate, near Wantage, Oxon, is one of 20 farms across southern England taking part in a major new six-year £12M project ASSIST (Achieving Sustainable Agricultural Systems). Funded by BBSRC and NERC, it's led by the Centre for Ecology and Hydrology (CEH) with Rothamsted Research and the British Geological Survey. But what makes this project different is that it's been co-designed with farmers.

ASSIST has the bold ambition to meet the challenge of feeding growing populations without causing unacceptable environmental damage. There are five work packages designed to increase the efficiency of food production, improve resilience to extreme events and crucially reduce the environmental footprint of agriculture.

Sustainable intensification

It's the embodiment of sustainable intensification and a mindset change that Julian believes is long overdue. "We cannot continue to farm without maintaining the ecosystem on which it depends — it would be like a factory continuing its production line while the fabric of the building itself fell to pieces around it," he says.

The farm's been chosen to take part as one with a typical arable rotation, consisting of winter wheat, winter and spring barley, oilseed rape and spring beans on silty clay loam soil over chalk. As farm manager, Julian has a strong interest in soil health, running a controlled traffic farming (CTF) system, and includes cover crops in the rotation as well as compost and manure additions that have led to an organic matter content of around 5-6%. There are also sheep and shoot enterprises on the farm.

Compared with some of the other ASSIST farms, and certainly the national average, Hendred Estate has a relatively diverse ecosystem, with plenty of woodland and shelter belts, wildlife corridors and healthy soils, according to CEH's Prof Richard Pywell, who leads the project. "But each farm is following a specific management routine on three designated fields, and we're closely monitoring wildlife delivery as well as crop results in every field across the six years of the project."

Although only in its second year, this part of the ASSIST project (work package 3 — Testing Sustainable Solutions) puts three farming 'system' treatments to the test. These are based on the outcome of a previous, ground-breaking Defra-funded project carried out from 2005 at the 900ha Hillesden Estate in Bucks. "This ten-year project was essentially the test bed for what was then the new Entry-Level Stewardship scheme (ELS)," continues Richard.

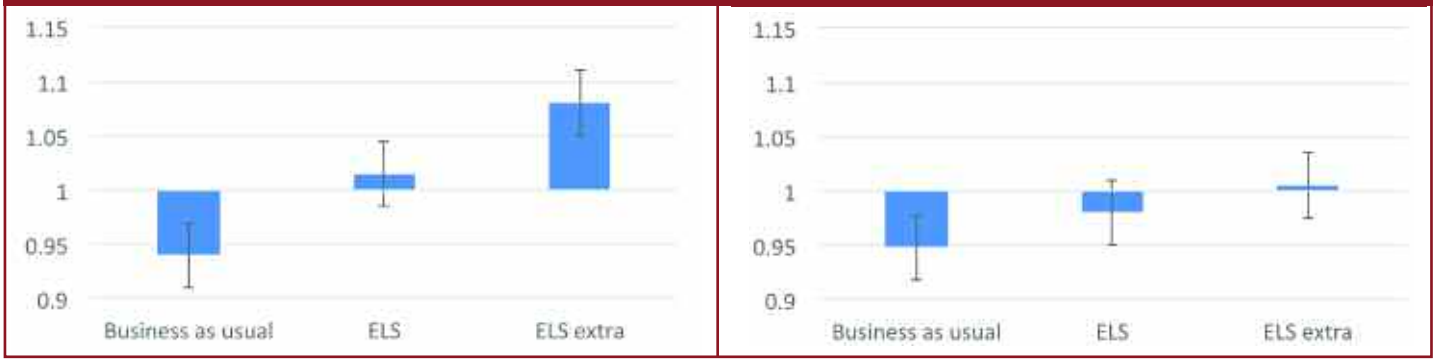
"We divided the heavy-land estate, which was running a winter wheat, winter oilseed rape and spring beans rotation, into 50-60ha arable farmlets. Across these were applied one of three management routines that varied how the fields were managed for their wildlife."

It was the first time fully replicated farm-scale trials had been used to assess the effect on wildlife of different approaches across a standard arable rotation:

1. **Business as usual (BAU)** — these fields were farmed according to cross-compliance conditions, with land cropped to the field edge.

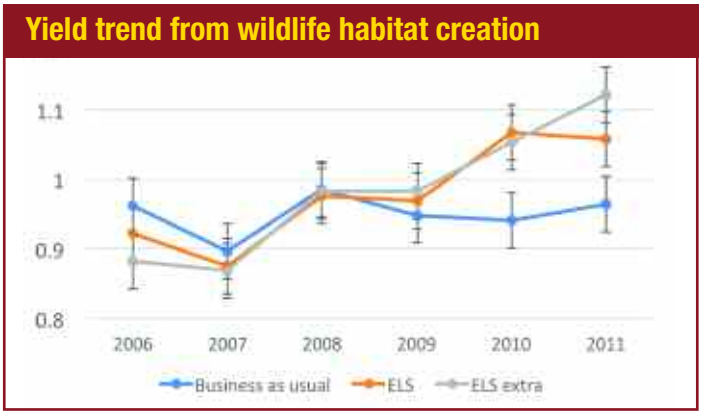
There are treatment thresholds for slugs but currently no reliable data on thresholds for beneficial species, such as carabid beetles.

Yield impact of wildlife habitat management



Source: CEH, 2015; Yield shown as a ratio of regional yield, averaged for all crops and all years for cropped area (left) and whole field net of land removed for wildlife habitat creation (right).

Yield trend from wildlife habitat creation



Source: CEH, 2015; Yield shown as a ratio of regional yields for all crops for whole field net of land removed for wildlife habitat creation.

2. **ELS treatment (ELS)** — 3% of the land was taken out of production to create wildlife habitats at the field edge and in awkward field corners, in line with management options under typical ELS.
3. **ELS extra (ELSX)** — 8% of the previously cropped land was taken out of production and sown with enhanced habitats of perennial native wildflowers and fine-leaved grasses. Other mixes, some annual, were planted to offer a variety of foraging, planting and refuge habitat for pollinators and birds.

Guidance on seed mixes and management was provided by Marek Nowakowski of Wildlife Farming Company, while the CEH team set about monitoring the outcomes. "We studied everything you could possibly imagine over the six cropping years. Part of it focused on beneficial diversity, while we were also analysing crop yield," recalls Richard.

"We looked at variation within the field, as well as the effects on the whole field or block, and recorded the classic reduction of yield you tend to see at the field edge." The yields over six years were compared with average yields achieved across the South East — on the cropped area of the BAU treatment it fell below the regional average by around 6% (see chart above).

But it was what the researchers found on the ELS and ELSX blocks that totally transformed thinking on land use and the value of beneficial insects. "Yield actually increased significantly on the ELS cropped land while on ELSX it was a full 8% above the regional average. This meant, once you take into account the land taken out of production, there was no net loss of overall crop production from introducing these wildlife areas."

The effect on individual crops was also analysed. "For wheat and OSR, this roughly replicated the average across all crops. But for beans there was a yield boost of 25% and 35% respectively for ELS and ELSX, compared with BAU. It's clearly a crop that's reliant on insect pollination — critically, wildlife friendly farming appears to increase yields of this important protein crop," he notes.

What's more, the benefits appear to accrue over time. "We didn't see any significant differences in the first three years of the trial. But thereafter, yields in ELS and ELSX began to diverge, improving significantly over BAU, even after taking into account land removed from production (see chart left). This shows, once these habitats are established, they can increase overall crop production," Richard concludes.

Species richness

Not surprisingly, there were clear differences also in the abundance and species richness of beneficial insects found through the intensive monitoring. But here, again, there were some landmark findings, he notes. "We found significantly more pollinators and predators of crop pests in ELSX, but there was no difference on average between BAU and ELS.

"What's more, we discovered insect pollinators and predators don't travel far — at 50m into the crop, the beneficial effects peter out."

And these are the findings that have been fed through to ASSIST. "The first thing we did was carry out an industry-wide questionnaire. The main challenge facing the industry on pest control is the reduction in available active ingredients. There are also concerns over public perception and resilience in the face of extreme weather events."

Julian Gold is one of 20 farmers who have established in-field wildflower strips as part of his involvement with the ASSIST project.

Crucially, the 20 host farmers were shown the results of the Hillesden project and co-designed the options now implemented across their farms. "There's a strong feeling among those involved that they want to reduce reliance on chemical options, particularly for barley yellow dwarf virus and cabbage stem flea beetle. No one's pretending beneficials can provide 100% protection, but if they can reduce the impact and help crop resilience, that would be a significant benefit."

So a similar regime to Hillesden has now been set up on three separate fields across all 20 farms. On each farm in each year, the crop on all three fields is the same, which is then rotated for the five years, including two spring crops, with ideally a legume crop, as well as cereals. ▸

▸ The treatments are:

1. **Business as usual** – as before.
2. **Supporting ecosystem** – a cover crop is grown in two of the five years and there's a wildflower margin on two sides of the field.
3. **Enhancing ecosystem** – in addition, compost/manure is applied once during the rotation, while wildflower margins and in-field strips ensure no part of the field lies more than 50m from a beneficial refuge area.

A team of eight scientists undertake the same intensive monitoring, visiting sites every two weeks, while additional soil samples are taken to assess sub-surface biota. "We've also introduced some novel methods of monitoring beneficial activity, such as plasticine slugs — we examine these for bite marks to assess carabid activity. We're also working closely with David Whattoff of METOS UK to trial and develop their innovative in-field camera recognition system — a relatively inexpensive piece of kit that will automatically identify pest and hopefully soon beneficial activity and relay the information back to you," says Richard.

Richard Pywell and his team have been closely monitoring the activity of pollinators and other beneficial insects on the ASSIST farms.

"But what really brings this project alive is the innovation the farmers themselves introduce to it. It's not high-tech, but it's a way of thinking that's just as effective — growers are now well practised in cultural methods to help tackle blackgrass, and applying the same thinking brings significant progress for IPM."

And these differences are beginning to come clear for Julian. "If you assess it purely on a cost basis, the enhanced system really doesn't stack up — in fact, it probably costs extra in terms of the hassle factor of dealing with in-field strips," he says. "But it makes you focus far more on how you're maintaining your ecosystem — suddenly the cost of a pyrethroid spray becomes far more than just its financial outlay."

There are other rewards — previously an AHDB Monitor farmer, Julian often hosts visits from other farmers. "I always bring them to this field and show them the in-field strips. This is where we have our most interesting discussions, and it's where crop production comes alive." ■

How to create and manage an in-field margin

While field margins should be 6m wide and at least run the length of the two longest sides of a field, in-field strips run though the centre. They're similar to older beetle banks, but don't involve a raised bank and are also 6m wide.

The idea is to provide a refuge and feeding area for many of the natural predators which disperse small distances into fields (<50m). So a separation of three to four tramlines (96-108m depending on system) is ideal. To avoid creating lots of new corners in the field that make management difficult, the strips don't need to connect to the headland.

The recommended seed mix is a 4kg/ha of wildflowers with 10kg/ha of grasses. The choice of species is aimed at providing firstly a tussocky refuge habitat for ground-dwelling beneficials, such as ground beetles. Ideally grasses should include crested dogstail, cocksfoot, slender red fescue, tall fescue and meadow fescue in roughly equal proportions. Small amounts (<2%) of meadow foxtail or tufted hair grass could also be added. With the right equipment, it's worth considering sowing the tussocky grasses separately as a protective 'green fence' on the outer edges of the strips, providing protection for the core of flowers in the centre.

The flowers provide nectar — a great source of food for flying beneficials, including bees, hoverflies and parasitic wasps. Those found to work well, as well as species known to be robust and reliable, include common knapweed, wild carrot, yarrow, field scabious, red clover, red campion, oxeye daisy, meadow vetchling, tufted vetch and birdsfoot trefoil.

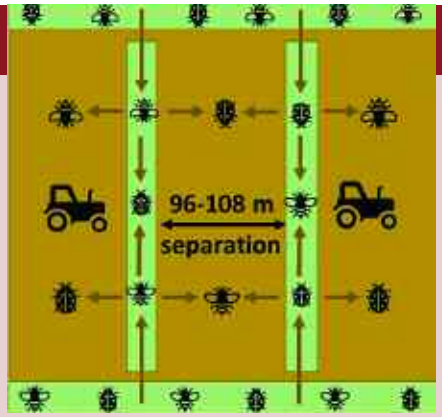
Aim for a seedbed you'd prepare for spring barley — firm, fine and weed free. Soil particles should be fine enough for seeds to remain on the surface when you sow, and that's the aim — so broadcast or drill the seed so that it remains on the soil surface. Rolling promotes seed-to-soil contact and puffy seedbeds should be consolidated before sowing.

In autumn, late July to the end of Aug is the ideal window to sow. If you're delayed to any later than the first week of Sept, it's best to wait until the following April. Treat it like a crop — use glyphosate pre-sowing to ensure the seedbed is weed-free, and if slug pressure warrants it, treat to ensure a good emergence.

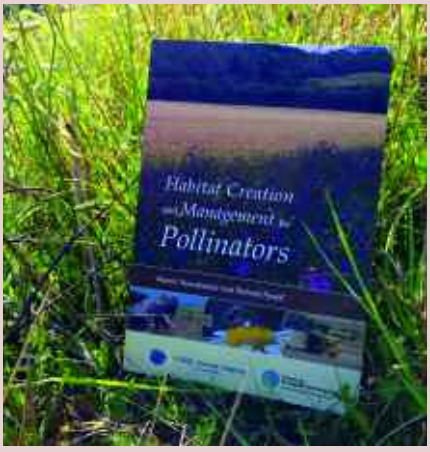
But the species that work best prefer low fertility, so fertiliser and manure applications to the surrounding crop must be kept out of margins and strips — liquid is best or use headland vanes on the spreader and watch for cross winds.

The correct cutting routine is essential for good establishment. In the first year, if annual weed pressure is high, three or more cuts may be necessary. Leaving patches of thick mulch on the surface will smother young grasses and wildflowers, providing a space for annual weeds, so where possible cuttings should be removed, or alternatively cut more frequently.

Autumn-sown margins and strips will generally need their first cut in April, while spring sowings will need a first cut in July. Make a final cut each year when growth has stopped around mid-Sept. In year two onwards, a single autumn cut will be required, depending on weed pressure.



Suggested positioning for 6m wide field margins and in-field strips (in green). Arrows show how in-field strips encourage beneficial insects into the crop to support pollination and natural pest control.



Source: Habitat Creation and Management for Pollinators, Marek Nowakowski (Wildlife Farming Company) and Richard Pywell (CEH), which can be downloaded free from www.ceh.ac.uk/book-habitat-creation-and-management-pollinators