Insect conservation

Although insects are capable of causing immense damage to crops, this is largely due to the way in which we farm, creating attractive monocultures of lush crops and failing to exploit the natural regulatory mechanisms that exist. Crop damage is caused by relatively few species, whereas many more species are beneficial: parasitising crop pests, pollinating crops, or breaking down organic matter. With so many potential benefits, how can we enhance their presence?

Text: John Holland

The plight of pollinating insects, especially the decline in domesticated bees, has attracted much media attention during past months, feeding on a growing concern about future global food supplies. There are growing calls for a swing towards a more ecological approach to farming, which would greatly benefit pollinating and other beneficial insects. However, a switch to ecological farming is not always possible, nor does it take place immediately. We therefore need to look at ways of enhancing the presence of insects on "conventional" farms, and to achieve this quickly. One of the best-developed approaches is "conservation biocontrol", which seeks to ensure that a farm's crop management practices are not having a harmful impact. This may involve adopting spray thresholds, or ensuring that non-crop areas are not contaminated with pesticides. The approach can also involve adopting practices to encourage the presence of natural enemies and beneficial insects by manipulating habitats, providing all the resources necessary for their survival.

Going SAFE

A review of natural enemies, their ecology, and of the impact of farming practices in the U.K. helped us identify four "essential requirements" to promote their conservation, summarised in the acronym SAFE: Shelter, Alternative prey, Floral resources, and an appropriate Environment.

Shelter habitats are needed as many species overwinter outside of the cropped area and benefit from habitats that provide appropriate environmental conditions and protect them from predation. Tussocky grasses along field boundaries have been shown to support a range of *Coleoptera* and *Araneae*, and the woody structure of hedgerows and woods can provide suitable conditions for species that disperse more widely. Such habitats may also allow pests and their parasitoids to survive the winter or the periods when the land is not being cultivated, thus ensuring their survival into the following season. A range of important natural enemies, including beetle larvae, parasitoids and spiders, also overwinter within the soil. Intensive tillage can destroy natural enemies, although the impact of this will vary according to the vulnerability of the insects at different life stages and the timing of cultivations. The majority of invertebrates will not emerge until spring, so cultivations that occur before then can be more damaging.

Predators also need sources of *alternative prey* when there are insufficient pests for them to feed on. These may be

found in either non-crop habitats or within crops.
Floral resources are utilised by a broad range of predators and parasitoids. They provide energy and can act as an alternative food source. Many facets of the biology of parasitoids (including, longevity, mortality rates and fecundity) are influenced by these food sources, and these can significantly affect the levels of biocontrol achieved. Locating these resources close to the crop improves their efficiency.
The *environment* in which the natural enemies occur must be appropriate. Invertebrates have different preferences for environmental conditions (humidity and temperature) and/or vegetation structures, often according to their foraging strategies. They can also require areas that are free of harmful pesticides or agricultural practices (e.g. tillage).

Trying it out The SAFE approach was tried out on a 250 hectare arable farm at Loddington (in Leicestershire, central England). This is a farm established as part of the Allerton Research and Educational Trust in 1992, set up to "advance public education in different farming methods and the effect thereof on the environment and fauna". Early research by the Trust identified that many predatory beetles and spiders overwinter at the base of tussock-forming grasses that typically occur along field boundaries. They then disperse into the field in the spring, where they help to control crop pests. Many of these species walk into the crop, which limits their dispersal distance. To facilitate an even and rapid coverage of these predators over large fields, 2m-wide raised banks (or "beetle banks") were created in the middle of the fields by ploughing furrows together. These were then sown with tussock-forming grasses such as cock's-foot (*Dactylis glomerata*) and timothy (*Phleum pratense*). When we studied the dispersal of the natural enemies we determined that the maximum distance between the banks or the field margin should not exceed 150 m.
We established beetle banks across the largest fields at Loddington, and widened and made other improvements to the grassy areas alongside the hedgerows. Further shelter was provided for insects overwintering within the fields by switching from a predominantly ploughed-based cultivation system to minimum tillage. We identified that up to 1.5 million insects per hectare overwinter in the soil, usually as larvae, and many of these are destroyed by intensive cultivation. Minimum tillage allows them to complete their lifecycle undisturbed. In a similar way, ditches are now cleared out less frequently to reduce disturbance.
Crop pests rarely form all of a natural enemy's diet; they also feed on, or parasitise other insects. The key to ensuring the presence of a range of alternative prey is plant diversity, which strongly influences insect diversity. This plant diversity can be created by allowing some weeds to survive within the crop, by having a diverse crop rotation, by establishing additional uncropped habitats and by not being too tidy and allowing vegetation to naturally regenerate in areas not

Feeling at home. Photo: Peter Thompson

used for production. At Loddington, the heavy clay soil has a relatively poor diversity of weed flora, although some weeds are very competitive and can threaten production, making it difficult to reduce the use of herbicides. Conservation headlands were established around the edges of the cereal fields, where only certain herbicides (and no insecticides) are allowed. This approach has been shown to encourage natural enemies. These insects also provide a source of food for bird life.

A five-course rotation of wheat, barley, oilseed rape, wheat and beans is used, although other crops have also been grown over the years (such as linseed, oats and more recently hemp). Individual crop types are spread across the farm, and a range of minor crops (e.g. kale, millet, cereals, quinoa and linseed) are also sown. As a "wild bird seed mix", these crops provide for farmland birds.

Flower-rich habitats are essential for insects, and should be provided on all farmed land. Early in the year, hedgerows provide an abundance of flowers, and many of them have been improved at Loddington through coppicing, hedge laying and replanting. Hedges are cut on a two-year rotation, leaving berries for birds to forage on in mid-winter. To encourage pollinating insects, a legume/grass/wild flower mix has been established either along field margins or in areas that are difficult to cultivate. These are cut in the autumn to reduce the competition from the grasses. More floral resources are provided in the woodland which has been thinned, allowing in more light and rejuvenating the ground flora.

What have we learned?

The different habitats around the farm provide a diverse range of environments, and thereby cater to the requirements of a diverse array of insects. Minimum tillage leaves stubble on the soil surface, creating structural diversity for spiders, allowing predatory insect larvae to survive and encouraging detritivores that act as alternative prey. Experience has shown that, when pesticides are used, an air-assisted sprayer helps ensure an accurate application, thereby minimising the drift to non-cropped areas. On the other hand, these efforts also carry some hidden costs, which need to be taken into consideration. Our conservation work, for example, means that that machinery has to travel further and the extra headland areas takes some land out of production, possibly reducing yields.

There are many other approaches that can be used to encourage beneficial insects and reduce pests, some of which (like intercropping or companion planting) have been well researched. It is still necessary, however, to continue studying the ecology of beneficial insects and their interactions with farming systems and the landscape in order to arrive at better farming systems and devise better plant mixes. In the meantime, we advocate the SAFE approach in all farming systems as this may help offset or reverse the declines of those species that urgently require help, such as bees.

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More information

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Sharing, discussing and enjoying the results of the SAFE approach. Photos: Peter Thompson