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The benefits of organic farming for biodiversity

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Summary

Previous studies suggest widespread positive responses of biodiversity to organic farming. Many of these studies, however, have been small-scale. This project tested the generality of habitat and biodiversity differences between matched pairs of organic and non-organic farms containing cereal crops in lowland England on a large-scale across a range of taxa including plants, insects, birds and bats. The extent of both cropped and un-cropped habitats together with their composition and management on a range of scales were also compared. Organic farms was likely to favour higher levels of biodiversity and indeed organic farms tended to support higher numbers of species and overall abundance across most taxa. However, the magnitude of the response differed strikingly; plants showed stronger and more consistent responses than other taxa. Some, but not all, differences in biodiversity between systems appear to be a consequence of differences in habitat quantity.

Key words: Biodiversity; farming systems; organic farming; large-scale; management

Introduction

Loss of biodiversity on agricultural land is underpinned by a reduction in the diversity and complexity of habitats at various scales (Benton *et al*., 2003). Recent reviews of numerous small and local scale organic farming studies investigating biodiversity on organic farms indicate a general trend towards increased species richness and abundance for plants, predatory invertebrates and birds on organic farms which varies across studies and organism groups (Hole *et al*., 2004, Bengtsson *et al*., 2005). The extent to which higher levels of habitat heterogeneity on organic farms compared to their non-organic counterparts (Roschewitz 2005) and the organic system itself influence these findings may be key to recognising potential routes for restoring farmland biodiversity.

This paper presents data from the most comprehensive comparative study to date on the effects of organic and non-organic farms, their management and habitats, on plants, predatory invertebrates, birds and bats in an attempt to shed some light on the factors contributing to any biodiversity differences between organic and non organic systems.

Materials and Methods

Methods are described in detail in Fuller *et al*. (2005). The basic approach was a large-scale comparison of organic and non-organic farms paired on the basis of proximity, crop type and cropping season. Organic farms of at least 30 ha with contiguous organic fields containing arable land were identified from the databases of the Soil Association and Organic Farmers and Growers. The organic target fields covered a range of ages since conversion. Data were collected from 89 pairs of farms with virtually all suitable organic farms in England growing relevant crop types at the time of the study examined for a minimum of three taxa (plants, spiders, carabid beetles). Plants and invertebrates were sampled on the same 89 pairs of cereal fields ('target fields'). All fields sampled in year 1 of 3 were spring cereals, all fields thereafter were winter cereals. Birds and bats were sampled at a larger spatial scale extending over several fields. Habitat data were collected at farm and field levels over three cropping seasons. Farmers were asked 40 questions concerning management of the target field and the whole farm.

Results

Numbers of species, measured as species density and abundance were typically higher on organic farms (Table 1) with differences unevenly distributed across taxa. The strongest and most consistent effects were for plants and the weakest effects were for carabids.

Table 1. *Biodiversity comparisons in favour of organic farming from the full range of comparisons in the study. Significant differences in favour of organic farming are indicated in bold, * indicates a significant difference in favour of non-organic systems*

Taxa	Number of species	Diversity	Abundance
Plants	**3/3**	2/2 **(1)**	2/2 **(1)**
Spiders	4/4 **(1)**	3/4	4/4
Ground beetles	2/4 **(1*)**	1/4	3/4
Winter birds	2/2	2/2	**2/2**
Bats	1/1	**1/1**	1/1

The density (km ha^{-1}) of all boundaries and of hedges was higher on organic than non-organic farms (means of 0.15±0.02 and 0.10±0.01, n=48, $P < 0.05$; 0.12±0.02 and 0.07±0.01, n=48, $P < 0.01$ respectively). The proportion of land that was grass rather than cropped land was much higher on organic than non-organic farms (respective % means of 37.7±3.5 and 17.2±2.5, n=56, $P < 0.001$). Organic target fields were smaller than their non-organic pairs (7.3±0.5 ha and 10.7±0.9 ha, n=89, $P < 0.001$). There were also marked differences between systems in hedgerow structure around the target fields (Fig. 1). Height ($P < 0.05$), base width ($P < 0.05$) and top width ($P < 0.01$) were greater on organic farms and there were higher numbers of gaps in hedgerows ($P < 0.05$) surrounding non-organic fields. There were no significant differences between systems in the number of trees and the number of tree and shrub species recorded in hedges.

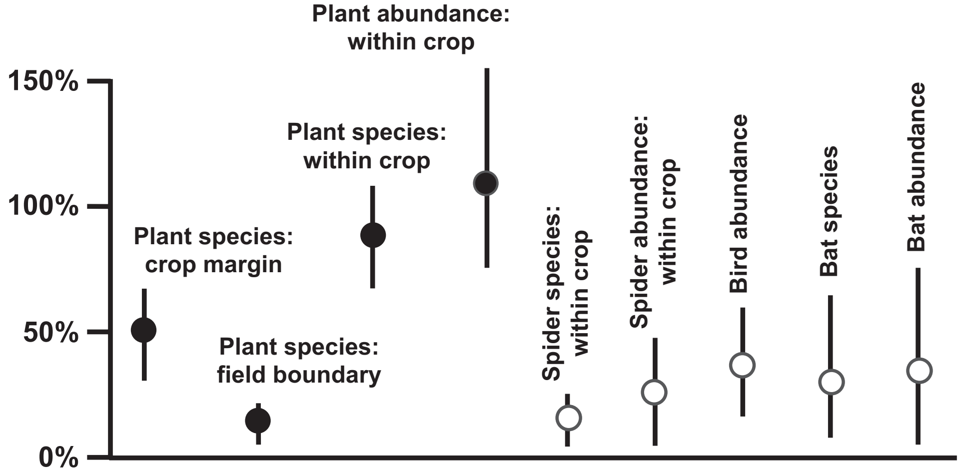

Fig. 1. Estimated scale of responses to organic farming

Based on interviews with farmers we quantified a further range of significant (P <0.05) differences between systems that were likely to influence biodiversity. Organic farmers sowed crops later in all three years. Rotations differed, with organic systems always including a ley as part of a cereal/vegetable rotation. Approximately a fifth (22%) of non-organic farms cropped continuously, but no organic farmers did. Organic farms were more likely to include livestock (and a wider variety of types) and were more likely to use them on arable land. Organic farmers cut their hedges less often and were more likely to use a traditional hedge management method (laying). More organic farms (64%, n = 73) had agri-environment agreements (in addition to the Organic Farming Scheme) than non-organic (43%, n = 87). There were no significant differences between farm types in farm size, woodland area, number of ponds, the extent and management of permanent pasture or whether set-aside was rotated or permanent. More non-organic farmers used natural regeneration as a set-aside option than did organic farmers.

Discussion

The indications from this study, as with previous work (Hole *et al*., 2005), are that organic farming is associated with higher levels of biodiversity. The striking result was that plants were far more consistent and pronounced in their response than other taxa, as in Bengtsson *et al*. (2005).

Whilst the exclusion of synthetic pesticides and fertilisers from organic farming is a fundamental difference between systems the study revealed that organic farms also differ from non-organic farms in the extent, composition and management of habitats. These differences between farming systems are key to understanding biodiversity differences between farms. Organic farming is clearly a complex and well-integrated system approach. Habitat heterogeneity within the system is linked to rotational and cropping practices (usually including livestock) as are the extent and quality of habitat components. The importance of landscape heterogeneity for biodiversity has been recognised in previous studies, e.g. Roschewitz (2005) which showed that conventional vegetation reached similar diversity levels in complex landscapes. This study shows that complex heterogeneous landscapes are as integral to the organic system as the non-use of synthetic pesticides and fertilisers and help to explain the biodiversity advantage which organic farms showed over their non-organic counterparts in this study.

It is possible that the differences in magnitude in species density and abundance between taxa may be accounted for by differential impacts of temporal and spatial scales on the colonisation traits of organisms. Plants are more directly and immediately affected by both pesticide and fertiliser inputs, but have the ability to recolonise from the seed bank immediately following conversion to organic management. For other taxa, recolonisation is affected by proximity of population sources both in time and space. Many organic farms are isolated units, embedded in non-organic farmland managed with conventional levels of pesticide and fertiliser inputs, often coupled with relatively low levels of habitat heterogeneity, which inevitably affects species colonisation. Furthermore, most existing organic farms probably offer insufficient resources to affect population sizes of species with large spatial needs, notably birds.

The extension of organic farming is a potential means of re-establishing heterogeneity of farmland habitats, and thereby enhancing farmland biodiversity. However, the total area of organic farmland relative to non-organic remains small (currently < 3% of English farmland is organic). Strategies aimed at increasing both the total extent of organic farming and the size and contiguity of individual organic farms, could help to restore biodiversity in agricultural landscapes.

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