The biodiversity benefits of organic farming

New research confirms more biodiversity on organic farms

Contrary to the impression created by media reports (see below), research published by teams from the Universities of Leeds and York have confirmed previous findings that biodiversity is greater on organic farms than on conventional farms.

Results published in the journal Ecology Letters by Gabriel et al (2010) show that, compared to paired conventional farms, the organic farms studied had:

- an overall 12% increase in biodiversity,
- more plant diversity,
- greater floral diversity,
- more earthworms,
- more insects,
- more butterflies,
- increased numbers of some types of birds

Also:

- The biodiversity benefits in areas with a high proportion of organic farming were higher than in those with a low proportion.

And most notably:

- Conventional farms in landscapes with a high level of organic farming also had a higher level of biodiversity.

The study paired 16 conventional farms matched for size and enterprise type with 16 organic farms in England. It therefore excluded "typical conventional farms....larger and less mixed (that) might be expected to have even lower biodiversity levels" (Gabriel et al, 2010).

These results add to the evidence of previous studies (see back cover) and a number of policy statements – e.g. The English (Anon 2002) Scottish (Anon 2003) and Welsh (Anon 1999) Organic Action Plans – that highlight the biodiversity benefits of organic farming.

Results misrepresented

The press coverage of this research, however, projected a largely negative view of organic agriculture.

Ben Webster in The Times (Webster 2010) declared that "Study spikes organic food claims". This was the direct result of a press release put out by Leeds University (Anon 2010b) and an interview given by Leeds team leader Prof. Tim Benton.

"Organic farming shows limited benefit to wildlife" headlined the press release and then went on to say "Organic farms may be seen as wildlife friendly, but the benefits to birds, bees and butterflies don't compensate for the lower yields produced". The Times quoted Prof. Benton, "Our results show that to produce the same amount of food using organic rather than conventional means, we'd need to use twice the amount of land for agriculture.

In fact the published paper didn't conclude this and didn't even discuss it. It reported only cereal yields (mainly winter wheat) and livestock units per ha of grazed land, but made no reference to other outputs or inputs such as bought in feed. It did not discuss productivity and offered no opinion on the balance between biodiversity and farm production.

According to the press release and The Times interview, Prof Benton believes that "To meet future demands of food production, we will need to keep farming our most productive areas in the most intensive way we can – and potentially offset that by managing some of our remaining land exclusively as wildlife reserves."

This kind of approach has become known as "land sparing versus land sharing" (see box, page 2). A second paper published (also in Ecology Letters) by the Leeds team with researchers from York University (Hodgson et al. 2010) pursued this perspective and asked what they describe as a crucial question: *"What is the net effect on wildlife when the land being converted to wildlife-friendly farming has a lower yield, and so more land, somewhere, must be farmed to provide the same harvest?"*

And again; more benefits

In the paper the authors present a methodology which, they believe, enables them to calculate the *"critical organic: conventional yield ratio that determines…the optimal solution to maximising butterfly abundance whilst maintain yield".* It is they say *"the first quantitative assessment of the land sharing/land sparing trade-off for one exemplar taxon: butterflies."*

As before, a press release – this time from York University (Anon 2010a) – encouraged negative press comments about organic farming, even though the research itself again shows real benefits;

- Organic farms support a higher density of butterflies than conventional farms, though less than designated reserves.
- Organic farms boost butterfly numbers in the surrounding landscape.
- If uncultivated land on conventional farms (e.g. field margins) are not managed as butterfly reserves (i.e. they are managed

Land-sparing and land-sharing

While the biodiversity benefits of organic farming are generally accepted, the apparent trade-off in terms of reduced yields has led to a consideration of alternative management strategies known as "land sparing and land sharing" (Green et al. 2005). "Land-sparing" describes an approach whereby agricultural land is farmed as intensively as possible, with the conservation of wildlife within separate "nature reserves". In contrast, "land-sharing" describes wildlife-friendly farming such as organic systems, where biodiversity is managed within the agricultural system.
It is argued that the "best" strategy depends on the balance between a species population size and farming intensity, so that if a slight decrease in farming intensity (and subsequent drop in productivity) causes a considerable increase in population size, land-sharing is the optimal strategy. Conversely, if a large decrease in intensity resulted in minimal population gains, land-sparing is the best option.

as normal) organic yields have to be only 35% that of the conventional yield to have a better butterfly/yield ratio.

- If conventional farms create and maintain butterfly reserves alongside commercial cropping then organic farms have to achieve 87% of the conventional yield to have a better butterfly/yield ratio.

Questions need to be raised about what exactly constitutes a "nature reserve" in this context and about the likelihood of conventional farms and nature reserves being consistently managed on a widespread basis; not to mention the difficulty of getting a satisfactory amount and breadth of information on inputs and yield.

A particularly pertinent weakness of this example though is that the choice of winter wheat for the sample crop gives a distorted view of the performance of organic farming relative to conventional cereal production. Almost any other cereal, and several other crops, would provide a higher relative organic yield and so give a very different butterfly/yield ratio.

Limitations of the study

Indeed, because of the paucity of information about the total input, productivity and other ecosystem services of the farms' studied; the results and conclusions of the paper need to be treated with some caution.

Such limitations are acknowledged to some degree by the authors when they state that *"Organic farms tend to grow a wider range of crops per farm than conventional farms and this might cause increased biodiversity at the farm scale, but it would be difficult to make a controlled comparison between this and the same food grown on several specialized conventional farms"* but are ultimately dismissed when they argue that *"our data pertain to crops that have been and are likely to remain staples in the European environment"*.

It is unfortunate that the generally positive findings about organic farming's role in biodiversity protection in this research has been obscured by negative press releases and largely overlooked in subsequent press coverage.

Both these projects have much to commend them and offer insights about the dynamics of biodiversity on organic and conventional farms that are valuable and should be examined further. They make a valid contribution to understanding the complex real world of farming systems, food production and land(scape) management but as the papers demonstrate such studies are difficult and the conclusions that can be drawn from them are necessarily limited.

Therefore the presentation of the research in the media is concerning. To draw conclusions about the overall outputs from a mixed farm, that is producing a range of products (grass, livestock, etc) as well as a range of other ecosystem services, from only one crop is very questionable. To extrapolate those limited results to draw conclusions at a whole farm level, let alone at the level of a region or a whole country is unsound. To present that extrapolation as the conclusions of very narrow research is bordering on disingenuousness.

These papers present a static view of broad acre agriculture and the food system in Europe. Conventional and organic agriculture will change. We have already seen changes to conventional agriculture in taking up practices such as the use of fertility building crops and wider rotations that were once the preserve of organic. In its current state organic agriculture is diverse in its use of cropping, varieties, livestock species and breeds but it is also changing in response to the market and to climate change and is likely to become even more diverse – with intercropping, mixed cropping and agroforestry being introduced onto organic farms. These papers capture nothing of this nor do the authors give any indication that they understand it is happening.

Being serious about "Feeding the World"

How our farming systems and land management can be developed to meet the demands society places on them now and in the future is obviously of critical importance. The apparent conflicts between food production, economics and livelihoods, ecosystem services including biodiversity, energy requirements, landscape and leisure within the context of finite and diminishing resources pose immense challenges.

It is highly unlikely that these challenges can be dealt with by adjusting land management and agricultural technology in isolation. Diet, distribution systems, access to land and water, how we use energy and materials, speculative trade, development strategies, poverty and gender are all in the mix. The "land sharing or land sparing" perspective ignores all of these factors. As the International Assessment of Agricultural Knowledge Science and Technology for Development (IAASTD) (IAASTD 2009) made clear, "feeding the world" is about all of these things and agro-ecology is of primary importance.

Ecological thinking should not be limited to the biological world. It has a wider relevance – certainly to the whole food system and relations within it. The concept of "land sharing or land sparing" is not ecological; it is mechanistic, inappropriate and out of time.

This briefing was prepared by Lawrence Woodward, Dr Jo Smith, Dr Bruce Pearce, Prof. Martin Wolfe and Prof. Nic Lampkin.

Evidence of organic farming's benefits to biodiversity

These new studies are the latest to show the biodiversity benefits of organic farming. Many other studies published over the last decade demonstrate:

Greater plant biodiversity

- Greater floral species richness and abundance within the crop, crop margins and non-farmed areas on organic farms (Roschewitz et al. 2005; Shepherd et al. 2003; Bengtsson et al. 2005; Hole et al. 2005; Fuller et al. 2005; Gabriel et al. 2006).
- Up to six times more species within the crop on organic farms compared to conventional farms (Shepherd et al. 2003).
- More frequent occurrence of rare arable species on organic farms (Hole et al. 2005).

More invertebrate biodiversity

- Positive effect of organic farming on insect species richness (Bengtsson et al. 2005). Higher abundance of predatory insects but lower abundance of non-predatory insects and pests in organic systems (Bengtsson et al. 2005).
- Average activity density of carabids, staphylinids and spiders in organic systems almost twice that of conventional systems (Mader et al. 2002). Higher abundance and greater species richness of ground beetles in organic fields (Hole et al. 2005). Organic farming enhanced abundance of spiders by 62% compared to conventional systems (Schmidt et al. 2005).
- Higher bee diversity recorded in organic fields (Holzschuh et al. 2007).
- Species richness and abundance of butterflies higher in organic than in conventional systems in simple landscapes (Rundlöf and Smith 2006). The amount of organic farming in the surrounding landscape increases butterfly species richness on nearby conventional land (Rundlöf et al. 2008).
- Significantly higher abundance of non-pest butterfly species on organic farms (up to twice that of conventional farms); no difference between organic and conventional systems in abundance of two pest species (large white and small white) (Feber et al. 1997).

Enhanced soil life biodiversity

- Soil microbial biomass and activity higher in organic systems (Mader et al. 2002).
- Root length colonised by mycorrhizae 40% higher in organic than in conventional systems (Mader et al. 2002). Arbuscular mycorrhizal fungi spore abundance and species diversity significantly higher in organic than conventional systems (Oehl et al. 2004; Verbruggen et al. 2010).
- AMF species richness increased significantly with time since conversion to organic (Verbruggen et al. 2010).
- Biomass and abundance of earthworms higher by a factor of 1.3 to 3.2 in organic plots (Mader et al. 2002).
- General trend for higher earthworm abundance and species richness in organic systems, although some studies have shown lower abundance in organic arable fields, probably as a result of excessive tillage (Hole et al. 2005).

More birdlife biodiversity

- Greater species richness and abundance in organic systems (Bengtsson et al. 2005). More species occurred in organic than in conventional fields, regardless of land-use type (Batary et al. 2010).
- Density over two winters was significantly higher on organic farms for six out of 16 species, and none on conventional, and total abundance of all species combined was higher on organic farms in both winters (Chamberlain et al. 2010).
- Species richness of passerine birds, particularly invertebrate feeders, was higher in organic systems in simple landscapes. Species richness of non-passerines was positively related to organic farming independent of landscape complexity (Smith et al. 2010). This suggests that invertebrate feeders in particular benefit from organic systems in simple landscapes due to increased food resources (invertebrates).

Increased mammal biodiversity

- Activity levels of small mammals (wood mouse, bank vole and common shrew) greater in organic than conventional fields (Hole et al. 2005).
- Total bat activity and foraging activity significantly higher on organic farms by 61% and 84% respectively (Wickramasinghe et al. 2003).

Enhanced landscape

- Organic farms are located in more diverse landscape types, have smaller field sizes, higher, wider and less gappy hedgerows, less frequent hedgerow management, use rotations including grass, are more likely to be mixed (Norton et al. 2009).
- Even within diverse landscapes, organic systems have greater field and farm complexity than non-organic systems (Norton et al. 2009).
- Greater total areas of semi-natural habitat (woodland, field margins and hedgerows) on organic farms (Gibson et al. 2007).

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SCALE : – An integrated analysis of scale effects in alternative agricultural systems

The Rural Economy and Land Use Programme (RELU) was established with funding from three Research Councils (ESRC, BBSRC, NERC), the Scottish Government and Defra. It began in 2004 with a budget of £24 million and is planned to run until 2011. The programme was created to enable researchers to work together across disciplines to investigate the social, economic, environmental and technological challenges faced by rural areas; encourage social and economic vitality; and protect and conserve the rural environment.

Over the past decade it has become widely accepted that organic farming has a positive impact on biodiversity but that more information is needed. One specific need is for a greater understanding of how land management and land use impacts on biodiversity at a farm and landscape level. The SCALE project – looking at a range of factors (ecological, social and economic) within farms across the Southwest and Central England – was established to begin to meet this requirement.

This multidisciplinary project ran from January 2006 until June 2010 and was led by the University of Sussex. Other collaborators were the Universities of Leeds, Manchester, Cambridge and Cranfield; The MaCaulay Institute; Garden Organic and the Organic Research Centre.

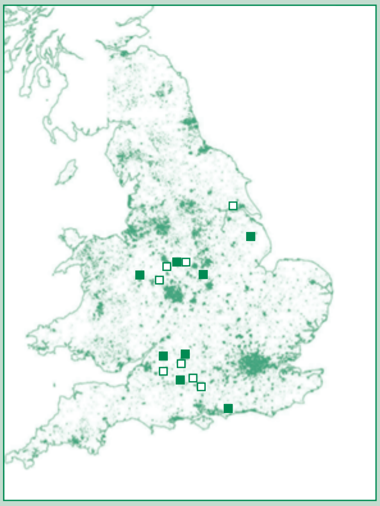

Figure 1:
The map shows the Southern and Central English region project focus and the hot (■) and cold (□) paired farms.

Project summary

The impacts associated with alternative methods of agricultural cultivation, and the factors that drive their adoption, are critically dependent on the scale at which they are applied. Using organic farming as a case study, the project integrated assessment of scale effects by studying 16 organic farms with 16 conventional farms matched for size and enterprise type. The farms were situated in the southwest and central England in landscapes with high ("hot") and low concentrations ("cold") of organic farming (see Figure 1) .

The project addresses two key questions:

1. What influences the spatial concentration of organic farms at a variety of scales?
2. What are the corresponding scale-dependent effects of different farm concentrations on the ecological, hydrological, socio-economic and cultural impacts of those farms?

Within each landscape, organic and conventional farms (on similar soils and landforms and growing similar crops) were studied. In addition a wide range of factors describing the environment such as soil and biodiversity (birds, insects, earthworms and plants); as well as socio-economic and cultural aspects of the farm such as farm economics, on-farm resource use, marketing and supply chain and cross-farm social interactions; farm family cultural attitudes were also studied.

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