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Biodiversity Impacts of Organic Farming: review of the evidence

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Organic Farming

- Agroecological approach
  - Management of biological processes
  - Supported by wide range of organisms
  - Beneficial interactions and synergies between farm components (soil, soil organisms, plants, humans and wider environment)
- Definition

"Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles *adapted to local conditions, rather than the use of inputs with adverse effects.*

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IFOAM International Federation of Organic Agriculture Movements

2005 reviews

- Hole, D. G., A. J. Perkins, et al. (2005). Does organic farming benefit biodiversity? *Biological Conservation*

- Bengtsson, J., J. Ahnstrom, et al. (2005). The effects of organic agriculture on biodiversity and abundance: a meta-analysis. *Journal of Applied Ecology*

Conclusions:

- Positive response of a wide range of taxa to organic farming
- On average 30% higher species richness and 50% higher abundance in organic farming systems
- Responses varied between taxa and in different landscapes
- Largest responses at plot scale

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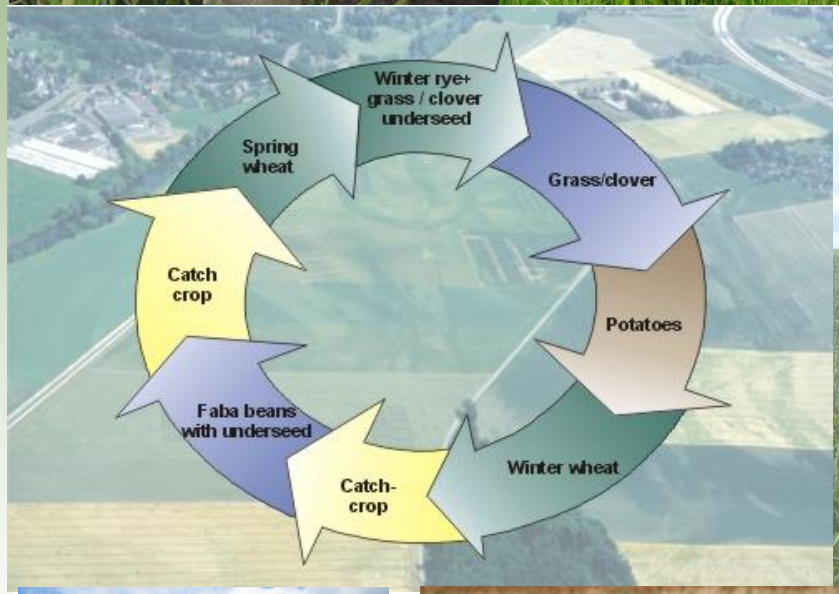

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Methodological constraints

- Variation in organic farming standards;
- Selection of appropriate controls taking into account landscape characteristics;
- Pairing of organic and conventional farms;
- Variation in spatial scales of study;
- Limited temporal replication of studies;

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Evidence of biodiversity impacts: 39 comparative studies since 2005

co-funded by Organic Centre Wales

Plants

- Organic fields can support:
  - 68-105% more species
  - 74-153% greater abundance *Fuller et al 2005*
- Differences in community composition:
  - Dominance of stress-tolerant species in organic systems and ruderal species on conventional *Petersen et al 2006*
  - Higher proportion of insect-pollinated species in organic fields *Gabriel & Tscharntke 2007*
  - More rare species in organic systems *Aavik & Liira 2010*
- Higher diversity in semi-natural habitats on organic farms *Petersen et al 2006, Boutin et al 2008*
- Higher within-field diversity of plants in organic, even in complex landscapes *Gibson et al 2007*

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Invertebrates: pollinators

- Enhanced species richness and abundance of butterflies and bees *Rundlöf & Smith 2006, Feber et al 2007, Holzchuh et al 2007, 2010, Rundlöf et al 2008, Gabriel et al 2010, Hodgson et al 2010*
- Landscape-scale effects – butterfly diversity on conventional farms correlated with proportion of organic farms in landscape *Rundlöf et al 2008, Hodgson et al 2010*
- Mediated through organic farming effects on floral resources and no pesticides

Invertebrates: predators and parasitoids

Mixed responses:

- Higher abundance or species richness of predators (spiders, ground and rove beetles) *Schmidt et al 2005, Gabriel et al 2010, Diekötter et al 2010*
- Some taxa had negative or neutral responses to organic systems *Clough et al 2007, Gabriel et al 2006, Fuller et al 2005*
- Higher species richness of parasitoids *Macfadyen et al 2009b* but no sig diff difference found by *Macfadyen 2009a, Crowder et al 2010*

Invertebrates: pests

Mixed responses:

- Lower abundance of aphids in organic systems *Roschewtiz et al 2005*
- Higher aphid abundance on organic farms (but below economic threshold) *Macfadyen et al 2009a*
- More species of herbivores on organic farms *Macfadyen et al 2009b*
- Complex interactions with resources (food, nesting, overwintering), landscape and pest/predator/parasitoid communities

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Soil fauna

- Higher microbial biomass and diversity in organic soils

  van Diepeningen et al 2006, Esperschütz et al 2007, Oehl et al 2004, Gosling et al 2010, Verbruggen et al 2010

- Different communities in organic and conv soils *Oehl et al 2004*

Vertebrates: birds

- Species-specific responses:
- e.g. No sig diff in total territory densities but skylark and lapwing at greater abundances on organic farms *Kragten and de Snoo 2008*
- Higher diversity on conventional but generalist species and crow family in higher densities on organic farms *Gabriel et al 2010*
- Higher winter abundance of 6 species (stock dove, starling, jackdaw, linnet, woodpigeon, greenfinch) on organic farms but interaction with landscape *Chamberlain et al 2010*
- Interaction with landscape characteristics such as complexity and length of hedges *Batary et al 2010, Geiger et al 2010*

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Ecosystem Services

Pest control – mixed responses

- No difference in parasitism rates of aphids *Roschewitz et al 2005, Macfadyen et al 2009a*
- Herbivores attacked by more parasitoid species on organic farms *Macfadyen et al 2009b*
- Greater evenness of natural enemies promoted pest control in organic systems *Crowder et al 2010*

Economic value of ecological services: organic fields US $1610 – 19,420 ha^{-1} yr^{-1}; conventional fields US $460 – 14,570 ha^{-1} yr^{-1} *Sandhu et al 2008*

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Summary

Responses	Plants	Inverts	Soil microbes	Birds	Mammals	Landscape	Ecosystem services	Total
Positive	16	17	8	12	4	1	3	61
Negative		5		1				6
No effect	2	4	1	2	1		2	12

Results from research literature: responses to organic farming

Key conclusions

- Taxon/species-specific responses e.g. birds, beetles, earthworms
- Interaction with landscape characteristics – greatest effects of organic management in simple landscapes
- In complex landscapes, within-field biodiversity often higher in organic systems
- Methodological issues……
  - e.g. pairing field/farm design
  - winter wheat as sample crop – doesn't reflect crop diversity of organic farms

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Knowledge gaps:

- Biodiversity and ecosystem services (total productivity) within organic systems
- Upland and grassland systems

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