FARMING PRACTICE
ORGANIC FARMING SYSTEMS

IMPACT: BIODIVERSITY

Reference 19

Tuck, SL; Winqvist, C; Mota, F; Ahnstrom, J; Turnbull, LA; Bengtsson, J. 2014 Land-use intensity and the effects of organic farming on biodiversity: a hierarchical meta-analysis. Journal of Applied Ecology 51: 746-755. 10.1111/1365-2664.12219

Background and objective

While there is a general consensus that organic farming increases biodiversity when compared to conventional agriculture, the magnitude of this effect seems to vary greatly, particularly among organism groups and across landscapes. Answer the following questions: 1) By how much does organic farming increase biodiversity compared with conventional agriculture? 2) Do the effects of organic farming depend on the organism or functional group, land-use intensity and structure, and crop type? 3) Has the reported effect size of organic farming on biodiversity decreased or remained stable over time? 4) Is there evidence for publication bias in the literature?

Search strategy and selection criteria

They started with the species richness data set published in 2005 by Bengtsson, Ahnstr € om and Weibull, which included 27 studies published before December 2002. They expanded this data set to include an additional 68 studies published between 2003 and 2011. They used the same initial keywords in ISI web of knowledge: biodiversity, biological diversity, conventional farming (agriculture) and organic farming (agriculture). Then, they search for additional studies, so the data set contains results from technical reports as well as peer-reviewed journals.

Data and analysis

The models were fitted to the data using the function metahdep.HBLM (R Core Team). They analysed 184 separate observations for sub-groups within studies – that is, different taxonomic groups or crop types. A random effect was used to account for differences across studies. A grand mean effect size, across subgroups, was calculated using an intercept model. Variables of interest, selected a priori, were included in a metaregression to see whether they explained any differences in biodiversity on organic vs. conventional farms. These variables were functional groups, taxonomic groups, the three landscape measures (see Land-use intensity metrics), crop types and scale of sampling (plot, field, or farm). Uncertainty in the regression coefficients was quantified using 95% credible intervals.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
94	Studies assessing the performance of organic systems in comparison to conventional systems.	Organic systems	Conventional systems	Metric: Species richness, as in the form of raw data or the mean species richness, standard deviation and sample size in both farming systems; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	93.75

Results

- The overall mean log response ratio was 0.296 (95% CI: 0.231 – 0.361); this indicates that species richness on organic farms is on average 34% (95% CI: 26 – 43) higher than conventional.
- They found large differences in the effect of organic farming on different taxonomic and functional groups. Among taxonomic groups, plants benefited the most from organic farming. Arthropods, birds and microbes also showed a substantial positive effect. Among functional groups, the largest effect size was found for pollinators while decomposers showed little effect.
- The crop types showed varying responses, with large positive effect sizes in cereals and mixed farming, and moderate positive effect sizes for all others.
- Increasing landscape intensity affected the magnitude of the effect size in the order: herbivores > 'other' > predators > producers > decomposers > pollinators.
- The funnel plot showed some positive bias. A trim and fill assessment of how publication bias could impact inference produced a negligible reduction in the effect size.

Factors influencing effect sizes

- Organism group : Plants benefited most from organic farming, probably because of restricted herbicide use. Arthropods, birds and microbes also benefited, with varying levels of estimated confidence. Accordingly, most functional groups – herbivores, pollinators, predators and producers – were more diverse in organic farming, with the exception of decomposers.
- Proportion of arable land in the surrounding landscape : The proportion of arable fields in the landscape had any significant overall effect. The difference in diversity between organic and conventional farming generally increased with increasing proportion of arable fields.
- Crop type : In cereal fields, which comprised >50% of the studies, organic farming had large effects, significantly higher than in vegetable crops and orchards. The effect size in both vegetable crops and orchards, although positive, did not differ significantly from zero, but this could be due to small sample sizes.

Conclusion

This analysis shows that organic farming usually has large positive effects on average species richness compared with conventional farming.