FARMING PRACTICE
ORGANIC FARMING SYSTEMS

IMPACT: CROP YIELD

Reference 16

Ponisio, LC; M'Gonigle, LK; Mace, KC; Palomino, J; de Valpine, P; Kremen, C 2015 Diversification practices reduce organic to conventional yield gap Proc. R. Soc. B 282, 20141396 10.1098/rspb.2014.1396

Background and objective

How organic agriculture may contribute to world food production has been subject to vigorous debate over the past decade. The objective is to develop a hierarchical meta-analytic framework that overcomes the methodological pitfalls of previous studies comparing organic to conventional agriculture by accounting for both the multi-level nature of the data and the yield variation within studies

Search strategy and selection criteria

Search engines: Academic Compete Search, Google Scholar and Web of Science. The last search was conducted in January 2013. Studies were excluded if: (i) comparisons of subsistence yields (unimproved agriculture) against improved agricultural methods and (ii) comparisons of yields taken from different years.

Data and analysis

A hierarchical meta-analytic model was built to generate an estimate of the yield gap. 1) for non-independant studies, a combined response ratio and corresponding standard error for the entire study is calculated. 2) hierarchical regression model in a Bayesian framework to account for the dependencies in the yield data: traditional random effects model is expanded by considering random variation (i.e. random effects): between studies, within a study between years and within a year between response ratios; model selection (i.e. see whether the data supported adding a layer of hierarchy): sequentially added random effects and examined the posteriors of the parameters + DIC. 3) this model was extended in order to analyse additional explanatory variables (crop type and management practives). Used JAGS through the R package rjags interface to implement MCMC sampling. Credible intervals around parameter estimates were calculated as the 2.5% and 97.5% quantiles of the posterior.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
115	Studies assessing the performance of organic systems in comparison to conventional systems.	Organic systems	Conventional systems	Metric: Crop yield; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	81.25

Results

- Organic yields were 19.2% lower than conventional yields, with a 95% credible interval ranging from 15.5% to 22.9%.
- Conventional yields were significantly higher than organic for all crop types and the yield ratios of most crop types did not vary significantly from one another.
- The authors found that multi-cropping and crop rotations can improve yields in organic systems; yield differences dropped to 9+-4% and 8+-5% when diversification techniques (multi-cropping and crop rotations, respectively) were used.
- The yield gap between organic polycultures and conventional monocultures (9 ± 4%) was significantly smaller than when both treatments were monocultures (17 ± 3%) or both polycultures (21 ± 6%). We found a similar result with crop rotations. The yield gap was smaller when the organic system had more rotations (8 ± 5%) compared with when both treatments had a similar number of rotations (20 ± 2%) or did not have crop rotations at all (16 ± 5%).
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Factors influencing effect sizes

- Crop diversification strategies : Multicropping, crop rotations and the use of cover crops reduce the yield gaps of organic farming.

Conclusion

This meta-analysis found relatively small, and potentially overestimated, differences in yield between organic and conventional agriculture (i.e. between 15.5 and 22.9%), despite historically low rates of investment in organic cropping systems.