

Reference 26

Seufert, V; Ramankutty, N; Foley, JA 2012 Comparing the yields of organic and conventional agriculture NATURE 485, 229–232. 10.1038/nature11069

Background and objective

Organic farming—a system aimed at producing food with minimal harm to ecosystems, animals or humans—is often proposed as a solution. However, critics argue that organic agriculture may have lower yields and would therefore need more land to produce the same amount of food as conventional farms, resulting in more widespread deforestation and biodiversity loss, and thus undermining the environmental benefits of organic practices. To examine the relative yield performance of organic and conventional farming systems globally.

Search strategy and selection criteria

The references included in previous studies were considered and then the search was extended by using online search engines (Google scholar, ISI web of knowledge). Reference lists of published articles were considered as well. Studies were only included if they: 1) reported yield data on individual crop species in an organic treatment and a conventional treatment; 2) the organic treatment was truly organic; 3) reported primary data; 4) the scale of the organic and conventional yield observations were comparable; 5) data were not already included from another paper 6) reported the mean (X), an error term (standard deviation (s.d.), standard error (s.e.) or confidence interval) and sample size (n) as numerical or graphical data, or if X and s.d. of yields over time could be calculated from the reported data. For organic and conventional treatments to be considered comparable, the temporal and spatial scale of the reported yields needed to be the same, that is, national averages of conventional agriculture compared to national averages of organic agriculture or yields on an organic farm compared to yields on a neighbouring conventional farm—not included were, for example, single farm yields compared to national or regional averages or before–after comparisons.

Data and analysis

To calculate the cumulative effect size, each individual observation was weighted by the inverse of the variance. To test the influence of categorical variables on yield effect sizes, between-group heterogeneity was examined.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
66	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	93-75

Results

- The average organic-to-conventional yield ratio from the metaanalysis is 0.75 (with a 95% confidence interval of 0.71 to 0.79); that is, overall, organic yields are 25% lower than conventional. But these yield differences are highly contextual, depending on system and site characteristics. The range is from 5% lower organic yields (rain-fed legumes and perennials on weak-acidic to weak-alkaline soils), 13% lower yields (when best organic practices are used), to 34% lower yields (when the conventional and organic systems are most comparable).
- Under certain conditions—that is, with good management practices, particular crop types and growing conditions—organic systems can thus nearly match conventional yields, whereas under others it at present cannot. Studies that reported having applied best management practices in both systems show better organic performance. Organic yields thus depend more on knowledge and good management practices than conventional yields.
- When organic systems receive higher quantities of N than conventional systems, organic performance improves, whereas conventional systems do not benefit from more N. In other words, organic systems appear to be N limited, whereas conventional systems are not. Indeed, N availability has been found to be a major yield-limiting factor in many organic systems.
- The performance of organic systems varies substantially across crop types and species. For example, yields of organic fruits and oilseed crops show a small (-3% and -11% respectively), but not statistically significant, difference to conventional crops, whereas organic cereals and vegetables have significantly lower yields than conventional crops (-26% and -33% respectively).
- NULL

Factors influencing effect sizes

- Nitrogen input : Amount of nitrogen input received
- Water management : Water relations also influence organic yield ratios—organic performance is 235% under irrigated conditions, but only 217% under rainfed conditions.
- Type of crop : Legumes and perennials (and fruits and oilseed crops) show statistically insignificant organic-to-conventional yield differences. However, this is owing to the large uncertainty range resulting from their relatively small sample size.
- Soil pH : Organic crops perform better on weak-acidic to weak-alkaline soils (that is, soils with a pH between 5.5. and 8.0,
- Best practices : Studies that reported having applied best management practices in both systems show better organic performance.

Conclusion

Overall, organic yields are 25% lower than conventional. But these yield differences are highly contextual, depending on system and site characteristics.