FARMING PRACTICE
ORGANIC FARMING SYSTEMS

IMPACT: CROP YIELD

Reference 12

Lesur-Dumoulin, C; Malezieux, E; Ben-Ari, T; Langlais, C; Makowski, D. 2017 Lower average yields but similar yield variability in organic versus conventional horticulture. A meta-analysis. Agronomy for Sustainable Development 37, 45 10.1007/s13593-017-0455-5

Background and objective

Conflicting results about yield variability among species outlines that little is known on the relative variability of yields between sites and between years in organic management systems compared to conventional ones. To compare organic and conventional horticultural crops, analyse average yield differences and assess yield variability across experiments and across years.

Search strategy and selection criteria

A systematic literature review was performed to collect published papers comparing yields in organic versus conventional horticultural crops. They first listed the references mentioned in review papers (Stanhill 1990; Offermann and Nieberg 2000; Pretty and Hine 2001; Kaval 2004; Badgley et al. 2007; Seufert et al. 2012). Then, the search was extended using Web of Science with the following equation: « (horticulture* or vegetable* or (tree crop*)) AND organic AND yield* ». The terms in the first bracket were used to select papers dealing with horticultural crops. The other terms were used to select papers dealing with organic farming and reporting yield data. The search equation was applied to the paper titles with no date limit. The references listed in the retrieved articles were also screened. The literature search was completed by November 2014. An initial selection was made by analysing titles and abstracts. The full texts of the selected papers were then examined. The criteria for selecting the papers were as follows: 1) yield data (or yield ratios) were reported for individual crop species in both organic and conventional treatments; 2) the organic treatment was certified organic, biodynamic or followed organic standards (including in transition to organic horticulture); 3) the reported data were primary data coming from experimental stations or on-farm trials (i.e. farm surveys were not included to avoid confounding effects due to farm characteristics) and were not already reported in other papers; and 4) yield data obtained in organic and conventional treatments were obtained in the same sites during the same time periods.

Data and analysis

1) Data extraction: from the text, tables and digitised figures of the selected papers and were included in a dataset. Each study was related to an experimental site, with each experimental site including one or several comparisons between an organic and a conventional treatment for a given species. Each experiment can include several years of comparison. In addition to yield data or yield ratios, other characteristics were also extracted: type of crop (tuber root, vegetable, spice, fruit tree, small fruit, other fruit), crop common name, crop scientific name, crop life duration (perennial vs. annual crop), legume versus non-legume crop, type of harvested organ (root, fruit, bulb, leafy), country, climate (tropical, temperate, subtropical, Mediterranean), date, organic type (certified, organic standards, biodynamic, in transition) and conventional type (high input, low input). 2) Statistical comparison: The natural log of the response ratio was used as effect size metric. To account for a possible effect of the choice of a statistical model on the results, eight statistical models were compared to estimate the mean effect size (i.e. the mean yield ratio). Two types of yield variance are estimated for each experimental comparison: (i) yield variances across repetitions in organic and conventional treatments for experimental comparisons including standard deviations and number of repetitions and (ii) interannual variances of organic and conventional yields for experimental comparisons including at least 5 years of data.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
52	Studies conducted in experimental stations or on-farm trials (farm surveys excluded) assessing the performance of organic in comparison to conventional horticultural systems.	Organic horticulture	Conventional systems	Metric: Mean yield, yield probability distribution across experiments and interannual yield variances.; Effect size: Ratio of the considered metrics in the intervention to the considered metrics in the control	81.25

Results

- Organic yields are on average at most 10 to 32% lower than conventional yields.
- Yield ratios do not significantly differ across crop types, product types, biological types (lifespan, nitrogen fixing) and climatic conditions.
- Organic horticulture types—certified, organic standards, biodynamic, in transition—and conventional horticulture types—high input and low input—do not show significant effects on yield ratios.
- In horticulture, organic to conventional yield gaps vary greatly across experiments. There is about 90% chance to get a yield ratio higher than 0.5; i.e. yield loss in organic horticulture has a 10% chance to exceed 50%. On the other hand, organic yields have 50–60% chances to reach at least 75% of the conventional yields, and there is a 20% chance to get higher yields in organic systems.
- The study does not find significant differences in yield variances between organic and conventional horticulture, across replicates and years.

Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

The meta-analysis, based on a global comprehensive experimental dataset, shows that yields in organic horticulture are on average 10 to 32% lower than those in conventional horticulture, but they exhibit large variation across experiments.