FARMING PRACTICE
ORGANIC FARMING SYSTEMS

IMPACT: EUTROPHICATION (LCA)

Reference 11

Clark, M; Tilman, D. 2017 Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice. ENVIRONMENTAL RESEARCH LETTERS 12 6 10.1088/1748-9326/aa6cd5

Background and objective

Understanding how alternative agricultural production systems, agricultural input efficiency, and food choice drive environmental degradation is necessary for reducing agriculture's environmental impacts. Recent increases in the number of published LCAs enables more complete analysis of the comparative impacts of organic and conventional systems across a range of environmental indicators and foods. This meta-analysis aims at comparing the impacts of agricultural production systems, agricultural input efficiency and food choice these comparisons for five environmental indicators: greenhouse gas emissions (GHGs), land use, fossil fuel energy use, eutrophication potential, and acidification potential. We focus here on eutrophication potentials.

Search strategy and selection criteria

The search was conducted in Web of Knowledge, PubMed, AGRICOLA, and Google Scholar for food LCAs published before July 2015. The author's analyses include all relevant pre-farm and on-farm activities (fertilizer production and application, seed production, farm energy use, feed and fodder production, manure production (when used for fertilizer), manure management, infrastructure construction, etc) and their associated environmental impacts up until a food leaves the farm. Our analyses are thus of 'cradle-to-farm gate' activities; a paucity of data on post-farm gate impacts limited our ability to analyze them in a balanced manner, although a previous analysis showed that the vast majority of a food's greenhouse gas emissions stem from 'cradle-to-farm gate' activities. Several publications were excluded because a lack of defined system boundaries made direct comparisons with other LCAs impossible. In addition, some LCAs conducted by for-profit companies were excluded because of potential biases.

Data and analysis

The log ratio of impacts of different production systems by food item within each publication was calculated. These log ratios were then aggregated foods into groups of similar food types (cereals; fruits; vegetables; pulses, nuts and oil crops; dairy and eggs; and meats) to improve the power of statistical tests. The significance of differences between alternative production systems was tested using t-tests on the response ratio.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
164	LCA studies assessing the performance of organic systems in comparison to conventional systems. Emissions are accounted for all 'cradle-to-farm gate' activities.	Organic Cereals, Organic pulses and oil crops, Organic fruits, Organic Vegetables, Organic meats, Organic dairy products and eggs	Conventional systems	Metric: Eutrophication potential per unit of product (a measure of nutrification) is reported in PO_4 equivalents and includes eutrophication potential from phosphate, nitrogen oxides, ammonia, and ammonium, among others. Eutrophication is a measurement of the increase in nutrients entering an ecosystem. Eutrophication has substantial environmental impacts including, but not limited to, algal blooms and aquatic dead zones. Emissions are accounted for all 'cradle-to-farm gate' activities.; Effect size: Ratio of the considered metrics in the intervention to the considered metrics in the control.	62.5

Results

- Organic systems, as average, have 37% higher eutrophication potential (p = .0383; n = 20) than conventional systems per unit of food.
- For organic cereals, vegetables and meats eutrophication potentials per unit product resulted significantly higher, as compared to conventional products.
- For organic pulses, oil crops, dairy products and eggs, eutrophication potentials per unit product resulted in no significant change, as compared to conventional products.
- The differences in environmental impacts between organic and conventional systems are primarily driven by differences in nutrient management techniques. Organic agriculture is largely dependent on manure as a nitrogen input in contrast to conventional agriculture's use of synthetic fertilizers.
- NULL

Factors influencing effect sizes

- No factors influencing effect sizes to report

Conclusion

Organic systems (all systems. as average) 37% higher (p = .0383; n = 20) eutrophication potential per unit of product than conventional systems. For organic cereals, vegetables and meats eutrophication potentials per unit product resulted significantly higher, as compared to conventional products. For organic pulses, oil crops, dairy products and eggs, eutrophication potentials per unit product resulted in no significant change, as compared to conventional products.