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Tuomisto HL; Hodge ID; Riordana P; Macdonald DW 2012 Does organic farming reduce environmental impacts? – A meta-analysis of European research Journal of Environmental Management 112, 309-320 10.1016/j.jenvman.2012.08.018

Background and objective

Organic farming is often perceived to have generally beneficial impacts on the environment compared to conventional farming. A meta-analysis was used to evaluate the results of peer-reviewed studies comparing the nutrient losses, biodiversity impacts, greenhouse gas (GHG) emissions, eutrophication potential, acidification potential, energy use and land use in organic and conventional farming systems in Europe. Here, only results on total nitrogen, ammonia and phosphorous losses are reported.

Search strategy and selection criteria

The following search term combinations were used: (organic AND conventional AND farming) OR (organic AND conventional AND agriculture). The preliminary search was refined to the subject areas "agriculture", "plant sciences", "environmental sciences & ecology" and "biodiversity & conservation" 1) the study was related to European farming systems, 2) the study compared organic and conventional farming and provided quantitative results on at least one of the following aspects: soil organic carbon, land use, energy use, GHG emissions, eutrophication potential, acidification potential, nitrogen leaching, phosphorus losses, ammonia emissions or biodiversity, and 3) the paper was published in a scientific peer-reviewed journal. All types of studies (i.e. original field investigations, modelling studies and Life Cycle Assessment studies) were included in the study.

Data and analysis

The median values of the response ratios for each impact category were calculated. The normality of the data was tested by using the Kolmogorov–Smirnov test. Not all impact ratios were normally distributed, therefore a Wilcoxon Signed Rank test was used to determine whether the median impact ratios were significantly different from zero. The correlations between some farming practices and environmental impacts were examined using the Spearman Rank test. SPSS 14.0 software was used for the statistical analyses.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
71	Field studies, modelling studies and Life Cycle Assessment studies assessing the performance of organic systems in comparison to conventional systems in Europe.	Organic systems	Conventional systems	Metric: Nitrate leaching and P losses per unit of area; Nitrate leaching per unit of product; Effect size: Considered metrics: total nitrogen, ammonia and phosphorous losses (per unit of land and per unit of product). Effect sizes: standardized difference of the considered metrics between organic systems and conventional systems.	68.75

Results

- Median response ratios showed that nitrogen leaching per unit of area was 31% lower from organic farming compared to conventional farming and 49% higher per unit of product.
- The median response ratio of N leaching per unit of area based on original field investigations alone (-0.1053) was not significantly different from zero, whereas the median response ratio of model based studies (-0.4032) was significantly different from zero. Results suggest that modelling studies may overestimate the benefits of organic farming in the reduction of nitrogen leaching.
- There was a large but insignificant correlation between nitrogen input and nitrogen leaching in the 'field experiments' group (Spearman's Rho = -0.80, N = 5, P = 0.10), whereas there was no correlation in the 'models' group (Spearman's Rho = -0.07, N = 31, P = 0.71). There was no correlation between the proportion of grass in the rotation and nitrogen leaching response ratio (Spearman's Rho = -0.13, N = 18, P = 0.60).
- Median ammonia emissions followed a similar trend with organic systems having 18% lower emissions per unit of area and 11% higher per unit of product. However such changes were not statistically significant.
- The median response ratio for phosphorus losses showed 1% lower emissions from organic systems. This change was not statistically significant.

Factors influencing effect sizes

- Nitrogen input : Nitrogen input correlates positively (but effect not statistically significant) with nitrogen losses.

Conclusion

Nitrate leaching per unit of area is significantly lower for organic farming. Changes for phosphorous losses per unit of area are not significant. Nitrate leaching per unit of product are significantly higher for organic farming.