IMPACT: CROP YIELD

Reference 9

Knapp, S; van der Heijden, MGA. 2018 A global meta-analysis of yield stability in organic and conservation agriculture. NATURE COMMUNICATIONS 9, 3632
10.1038/s41467-018-05956-1

Background and objective

An important issue that is relevant for the discussion on food security is that of yield stability (i.e., the variability of yield across years). So far, it has not been tested whether yield stability in organic and conservation agriculture differs from that in conventional agriculture. The objective is to perform a meta-analysis to assess temporal yield stability of three major cropping systems: organic agriculture and conservation agriculture (no tillage) vs. Conventional agriculture. Here, only the results comparing organic and conventional systems are considered.

Search strategy and selection criteria

The dataset is from Ponisio et al. (2015) comparing the yields of organic and conventional farming. The search strategy corresponds to the one used by Ponisio et al. Only field experiments containing side-by-side yield comparisons were included in the database to ensure comparability of the cropping system treatments. Only studies including at least four years of observation for the same crops were included. Comparisons where the years of observations were not the same for organic and conventional systems were removed. Comparisons based on units that could not be transformed to tonnes per ha were removed.

Data and analysis

The sampling uncertainty in each observation was taken into account as proposed by Nakagawa et al. (2015). Nonindependence between effect sizes was taken into account following Lajeunesse et al. (2011). Mean effect sizes were estimated using the metfor package in R with REML estimation and a random study effect. The effects of explanatory variables (e.g., crop species, fertilization level, use of green manure) were tested with a separate model for each variable (fixed effects).

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
39	Long-term (at least four years of observation for the same crops) field-scale experiments assessing the performance of organic systems in comparison to conventional systems.	Organic systems	Conventional systems	Metric: Crop yield stability in time (crop yield variability along 4 years): absolute value and relative (variability divided by yield); Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control.	100

Results

- The relative yield stability (i.e. yield stability per unit yield produced) in conventionally managed fields was, averaged over all crops, 15% [2-30%] higher compared to organically managed fields, and this difference was significant.
- Significant increase in realtive yield stability under conventional management for two (soybean and barley) out of five crop species for which enough data (>10 comparisons) were available.
- No significant difference in absolute stability between organic and conventional agriculture.
- The absolute stability of soybean was higher in conventionally managed fields compared to organically managed fields. Results for many other crop species were highly variable and should be interpreted carefully.
- The increased relative stability of conventional agriculture is, in part, due to higher fertilisation levels and related to higher yield. Still, even with equal amounts of nitrogen fertilisation, organic agriculture had significant lower yield (12% [-2% to -21%]). The analysis further indicates that the addition of green manure had a positive impact on yield and the relative stability of organic agriculture.

Factors influencing effect sizes

- Fertilisation regime : Use of green manure and enhanced organic fertilisation reduce the stability gap between organic and conventional agriculture.

Conclusion

While there was a significant difference for relative stability between organic and conventional agriculture, there was no significant difference for absolute stability.