FARMING PRACTICE
ORGANIC FARMING SYSTEMS

IMPACT: CROP YIELD

Reference 1

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Background and objective

For decades, there has been debate about the possibility that organic farming can feed the world's population. The most recent studies, analyzing the yields of individual crops, show a yield gap between organic and conventional farming. The rotations and the intensity of soil use are also different between systems and the impact of this factor on productivity has not been assessed. Make a quantitative analysis of the effects of organic farming on the yield and intensity of soil use in comparison to conventional management to estimate its possible effects on the productivity of agroecosystems.

Search strategy and selection criteria

A literature search of yield data was conducted in a two-steps process. In the first, 30 scientific journals in English related to agriculture were reviewed volume by volume from 1980 to 2018, other types of materials (conference proceedings, technology journals, Internet publications, etc.) were discarded. The search was focused in articles in which the yield between two contrasting management treatments: organic (or biodynamic) farming and conventional farming was compared. In the second step, the bibliography cited in these articles was reviewed. 1) in organic management, no synthetic fertilizers or pesticides were applied; these systems were defined as organic by the authors of the studies, 2) in conventional management synthetic products were used; low-input systems (low rates of fertilizers and pesticides) or integrated systems (combinations of fertilizers and pesticides with organic fertilizers) were grouped as conventional (control treatments under conventional management without the addition of inputs were discarded because they were considered unrealistic), 3) the closeness between the treatments ensured similar climatic conditions, 4) different rotations or nitrogen rates in the same experiment (or study) were treated separately as subtreatments and were not averaged except when the rotation or the nitrogen rates were not clearly defined or in cases in which the nitrogen rates were very similar (difference <20 kg N ha−1), 5) when the rotation was changing throughout the experimental period, that of the last period was considered, 6) within the same management treatment different varieties tested were averaged, different years were averaged, and different tillage systems were averaged too, 7) studies in which the yield per unit area could not be extracted or calculated were discarded, 8) the yield of organic and conventional crops corresponded to the same year, data from different years were discarded, 9) the number of replications (production fields in on-farm studies or plots in an experiment) was well defined and was always greater than 1; when there were no true replications, comparisons were discarded (on-farm studies of only 1 field per treatment or non-replicated experiments), 10) when several articles presented data from the same experiment, only data from the longest period under organic management was used to avoid double counting, 11) data on mean yields of unspecified crop rotations were not used and 12) experiments with one treatment installed at one location and the other at a different location were considered as on-farm data.

Data and analysis

A bias-corrected for skewness 95% confidence interval was estimated by bootstrapping resampling methods. If the confidence interval of effect size did not overlap with 1 significant effects (P <0.05) of the organic treatment on yield in relation to the conventional management were recognized.

Number of papers	Population	Intervention	Comparator	Outcome	Quality score
80	Studies comparing organic crops (Cereals, legumes, vegetables, others) with conventional crops. 229 comparisons between organic and conventional management; 47 were on-farm studies and 182 were experiments.	Organic crops (Cereals, legumes, vegetables, others)	Conventional systems	Metric: Crop yield, Crop productivity; Effect size: Logarithm of ratio of the considered metrics in the intervention to the considered metrics in the control	87.5

Results

- In almost all crops and in all continents, a yield gap was observed between organic and conventional farming. The yield gap of organic agriculture was 25%, not depending on the weighting method applied.
- The nitrogen rates applied were not different between organic and conventional agriculture analyzing the total of studies.
- The Soil use index (Soil use index = Years with harvest crops / Years of the whole rotation) allowed to quantify the fractions of years that cash crops were grown and harvested during the rotation in each study. A value of 1 indicates that a crop was harvested every year; a value of 0.5 indicates that only half of the years a crop was harvested, the rest of the time used for cover crops, fallow or grassing crops. Grain crops, vegetables, industrial and woody perennial crops were considered as harvest crops. Forage crops were not included in this category. The soil use index was also significantly different between systems. In organic systems, an average of 10% fewer harvest crops were grown in the rotation than in conventional ones, analyzing the entire dataset, but this percentage was very different depending on the type of study. In the on-farm studies, carried out in production fields under the rotations designed by farmers, the difference was much greater than that observed in experiments designed by researchers. Organic producers included in their rotations more years under pasture, fallow or cover crops than conventional producers (29% vs. 12%). The researchers, on the other hand, designed experiments with soil use indices that varied from 86% in organic farming to 92% in conventional farming; this difference being significant but small.
- The average productivity of organic and conventional systems was estimated through a productivity index that combines the impacts of production systems on both yield and the soil use index. Productivity index = Relative yield (Organic/Conventional) x Soil use index. Affecting the yield gap of organic production by the soil use index of harvest crops in the organic rotations, an average decrease in the productivity of the agroecosystem of ca. 35% was calculated when using the mean soil use index of the entire dataset.
- NULL

Factors influencing effect sizes

- Fertilisation : The response ratio was lower when conventional systems received more nitrogen than organic ones. Conversely, the response ratio tended to increase as organic farming received more nitrogen than the conventional management. In the first case, the average response ratio was 0.65 increasing to 0.85 in the second.

Conclusion

The yields under organic farming were on average 25% lower than the conventional ones, reaching a yield gap of 30% for cereals. The intensity of soil use was also lower in organic systems, the size of the reduction depending on the type of study: field experiments (7%) or on-farm studies (20%). Combining the yield gap with the reduction in the number of crops harvested in the rotation, a productivity gap of 29% to 44% was estimated depending on the type of crops included in the rotation.