SINGLE-IMPACT FICHE
ORGANIC FARMING SYSTEMS

IMPACT: CROP YIELD

Data extracted in October 2021
Fiche created in March 2024

Note to the reader: This fiche summarises the effects of Organic farming systems on CROP YIELD. It is based on 11 synthesis papers[1], including from 9 to 150 primary studies.

1. WEIGHT OF THE EVIDENCE

CONSISTENCY OF THE IMPACT

The effect of organic farming systems on crop yield and crop yield stability is reported in **Table 1**.

The table below shows the number of synthesis papers with statistical tests reporting i) a significant difference between the Intervention and the Comparator, that is to say, a significant statistical effect, which can be positive or negative; or ii) a non-statistically significant difference between the Intervention and the Comparator. In addition, we include, if any, the number of synthesis papers reporting relevant results but without statistical test of the effects. Details on the quality assessment of the synthesis papers can be found in the methodology section of this WIKI.

- Crop yield per unit of area: 9 synthesis papers reported average (along different cropping seasons) crop yield losses in organic cropping systems compared to conventional systems (see Table 1). The reported average yield-losses are in the range of 5-30%. One study (Ponisio et al, 2015, ref. 13) reports that yield gaps of organic versus conventional cropping systems drop from -25% to -8% when considering full productivity of diversification techniques (multi-cropping and crop rotations, respectively), instead of considering only the main cash-crop yield (typically done by all other studies).
- Non-significant crop yield gaps were reported for perennial crops, by 2 synthesis papers.
- 2 synthesis papers also compared the yield variability in subsequent cropping seasons between organic and conventional systems. These studies showed either non-significant effect (for absolute yield stability), or a negative effect, for relative yield stability (i.e. per unit of crop yield).
- The reported effects concerned a large range of crop species (like cereals, legume crops, horticulture, and vineyards).

All selected synthesis papers included studies conducted in Europe (see **Table 2**).

Table 1: Summary of effects. Number of synthesis papers reporting positive, negative or non-statistically significant effects on environmental and climate impacts. The number of synthesis papers reporting relevant results but without statistical test of the effects are also provided. When not all the synthesis papers reporting an effect are of high quality, the number of synthesis papers with a quality score of at least 50% is indicated in parentheses. The reference numbers of the synthesis papers reporting each of the effects are provided in **Table 3**. Some synthesis papers may report effects for more than one impact or more than one effect for the same impact.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Increase crop yield	Crop yield	Organic cropping systems	Conventional	0	9 (0)	2 (0)	0
		Organic systems	Conventional	0	0	0	1
Increase crop yield	Crop yield stability	Organic cropping systems	Conventional	0	1	2	0

QUALITY OF THE SYNTHESIS PAPERS

The quality of each synthesis paper was assessed based on 16 criteria regarding three main aspects: 1) the literature search strategy and primary studies selection; 2) the statistical analysis conducted; and 3) the evaluation of potential bias. We assessed whether authors addressed and reported these criteria. Then, a quality score was calculated as the percentage of these 16 criteria properly addressed and reported in each synthesis paper. Details on quality criteria can be found in the methodology section of this WIKI.

2. IMPACTS

The main characteristics and results of the 11 synthesis papers are reported in **Table 2** with the terminology used in those papers, while **Table 3** shows the reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**. Comprehensive information about the results reported in each synthesis paper, in particular about the modulation of effects by factors related to soil, climate and management practices, are provided in the **summaries of the synthesis papers** available in this WIKI.

[1] Synthesis research papers include either meta-analysis or systematic reviews with quantitative results. Details can be found in the methodology section of the WIKI.

Table 2: Main characteristics of the synthesis papers reporting effects on crop yield. The references are ordered chronologically with the most recent publication date first.

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref1	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.	Global	80	Organic crops (Cereals, legumes, vegetables, others)	Conventional systems	Crop yield, Crop productivity	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.	88%
Ref4	Studies assessing the performance of organic systems in comparison to conventional systems.	Global	78	Organic systems (Cereals, Fruits, Oil crops, Pulses, Root, Vegetables)	Conventional systems	Crop yield	Organic sites had lower yields (18%).	88%
Ref5	Field studies assessing the performance of organic in comparison to conventional viticulture systems.	Europe, South Africa, USA, Australia	17	Organic systems	Conventional systems	Vine yield, Pruning material production	A yield decrease of 18 % in organic and biodynamic viticulture compared to conventional viticulture was observed when all available data from scientific field trials were assessed.	50%
Ref6	Studies assessing the performance of organic in comparison to conventional perennial orchards and vineyards.	Global	29	Organic orchards and vineyards	Conventional systems	Crop yield	Organic orchards and vineyards show significantly reduced crop yield compared to conventional systems.	94%
Ref7	Previous meta-analyses assessing the performance of organic systems in comparison to conventional systems.	Global	9	Organic systems (annual and perennial crops)	Conventional systems	Crop yield	Lower mean yield and higher yield variability in organic systems than in conventional systems. No significant difference in perennials crop yield.	56%
Ref9	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.	Global	39	Organic systems	Conventional systems	Crop yield stability in time (crop yield variability along 4 years): absolute value and relative (variability divided by yield)	While there was a significant difference for relative stability between organic and conventional agriculture, there was no significant difference for absolute stability.	100%
Ref12	Studies conducted in experimental stations or on-farm trials (farm surveys excluded) assessing the performance of organic in comparison to conventional horticultural systems.	Global	52	Organic horticulture	Conventional systems	Mean yield, yield probability distribution across experiments and interannual yield variances.	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.	81%
Ref16	Studies assessing the performance of organic systems in comparison to conventional systems.	Global	115	Organic systems	Conventional systems	Crop yield	This meta-analysis found relatively small, and potentially overestimated, differences in yield between organic and conventional agriculture (i.e. between 15.5 and 22.9%), despite historically low rates of investment in organic cropping systems.	81%
Ref24	Studies conduced in food and fodder crops assessing the performance of organic systems in comparison to conventional systems.	Global	150	Organic cropping systems	Conventional systems	Crop yield	This review and meta-analysis of yield data comparing organic and conventional agriculture showed that currently organic yields of individual crops are on average 80% of conventional yields.	62%
Ref26	Studies assessing the performance of organic systems in comparison to conventional systems.	Global	66	Organic systems	Conventional systems	Crop yield	Overall, organic yields are 25% lower than conventional. But these yield differences are highly contextual, depending on system and site characteristics.	94%
Ref27	Field studies, modelling studies and Life Cycle Assessment studies assessing the performance of organic systems in comparison to conventional systems in Europe.	Europe	71	Organic systems	Conventional systems	Crop yield	This meta-analysis has showed that organic farming in Europe has generally significantly lower yields (-25% in average). However, no comprehensive statistical analysis was performed and the results are set as uncertain.	69%

Table 3: Reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Increase crop yield	Crop yield	Organic cropping systems	Conventional		Ref1, Ref4, Ref5, Ref6, Ref7, Ref12, Ref16, Ref24 and Ref26	Ref4 and Ref7	
		Organic systems	Conventional				Ref27
Increase crop yield	Crop yield stability	Organic cropping systems	Conventional		Ref9	Ref9 and Ref12	

3. FACTORS INFLUENCING THE EFFECTS ON CROP YIELD

Table 4: List of factors reported to significantly affect the size and/or direction of the effects on crop yield, according to the synthesis papers reviewed.

Factor	Reference number

Factor	Reference number
Best practices	Ref26
Crop diversification strategies	Ref16
Fertilisation	Ref1
Fertilisation regime	Ref9
Negative effect	Ref4
Nitrogen input	Ref26
Soil pH	Ref26
Type of crop	Ref26
Water management	Ref26

4. KNOWLEDGE GAPS

Table 5: Knowledge gap(s) reported by the authors of the synthesis papers included in this review.

Ref Num	Gap
Ref1	In rotations designed by organic farmers, the years without harvest crops were almost three times more than in conventional rotations. In this analysis, only the harvest crops were taken into account for estimating productivity and the effects of management on livestock production generated during the pasture phase of rotations were ignored due to lack of data.
Ref5	More information about the influence of differing soil moisture content and physiological performance of the management systems on fruit set should be gained in the future.
Ref6	Future meta-analytic studies should focus on the role of large-scale factors on biodiversity and ecosystem services in orchards/vineyards.
Ref12	1) To conduct new experiments in countries from the Southern Hemisphere. 2) To collect standard data on crop management and environmental characteristics.
Ref26	To understand better the performance of organic agriculture, we should: 1) systematically analyse the long-term performance of organic agriculture under different management regimes; 2) study organic systems under a wider range of biophysical conditions; 3) examine the relative yield performance of smallholder agricultural systems; 4) evaluate the performance of farming systems through more holistic system metrics.

5. SYNTHESIS PAPERS INCLUDED IN THE REVIEW

Table 6: List of synthesis papers included in this review. More details can be found in the summaries of the meta-analyses.

Ref Num	Author(s)	Year	Title	Journal	DOI
Ref1	Alvarez, R	2022	Comparing Productivity of Organic and Conventional Farming Systems: A Quantitative Review	ARCHIVES OF AGRONOMY AND SOIL SCIENCE	10.1080/03650340.2021.1946040
Ref4	Smith, OM; Cohen, AL; Reganold, JP; Jones, MS; Orpet, RJ; Taylor, JM; Thurman, JH; Cornell, KA; Olsson, RL; Ge, Y; Kennedy, CM; Crowder, DW	2020	Landscape context affects the sustainability of organic farming systems	PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA 117 6, 2870-2878	10.1073/pnas.1906909117
Ref5	Doring, J; Collins, C; Frisch, M; Kauer, R	2019	Organic and Biodynamic Viticulture Affect Biodiversity and Properties of Vine and Wine: A Systematic Quantitative Review	AMERICAN JOURNAL OF ENOLOGY AND VITICULTURE 70 3, 221-242	10.5344/ajev.2019.18047
Ref6	Katayama, N; Bouam, I; Koshida, C; Baba, YG	2019	Biodiversity and yield under different land-use types in orchard/vineyard landscapes: A meta-analysis.	BIOLOGICAL CONSERVATION 229, 125-133	10.1016/j.biocon.2018.11.020
Ref7	Smith, OM; Cohen, AL; Rieser, CJ; Davis, AG; Taylor, JM; Adesanya, AW; Jones, MS; Meier, AR; Reganold, JP; Orpet, RJ; Northfield, TD; Crowder, DW	2019	Organic Farming Provides Reliable Environmental Benefits but Increases Variability in Crop Yields: A Global Meta-Analysis	FRONTIERS IN SUSTAINABLE FOOD SYSTEMS 3	10.3389/fsufs.2019.00082
Ref9	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
Ref12	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
Ref16	Ponisio, LC; M'Gonigle, LK; Mace, KC; Palomino, J; de Valpine, P; Kremen, C	2015	Diversification practices reduce organic to conventional yield gap	Proc. R. Soc. B 282, 20141396	10.1098/rspb.2014.1396
Ref24	de Ponti T., Rijk B., van Ittersum M.K.	2012	The crop yield gap between organic and conventional agriculture.	AGRICULTURAL SYSTEMS 108, 1–9	10.1016/j.agsy.2011.12.004

Ref Num	Author(s)	Year	Title	Journal	DOI
Ref26	Seufert, V; Ramankutty, N; Foley, JA	2012	Comparing the yields of organic and conventional agriculture	NATURE 485, 229–232.	10.1038/nature11069
Ref27	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

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