SINGLE-IMPACT FICHE
ORGANIC FARMING SYSTEMS

IMPACT: BIODIVERSITY

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Note to the reader: This fiche summarises the effects of Organic farming systems on BIODIVERSITY. It is based on 10 synthesis papers[1], including from 9 to 94 primary studies.

1. WEIGHT OF THE EVIDENCE

CONSISTENCY OF THE IMPACT

The effect of organic farming systems on biodiversity 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.

- Biodiversity per unit of area: positive effects were found for organic cropping systems (6 high-quality synthesis papers), while no result was available specifically for organic livestock systems (see Table 1). Non-significant effects were found for organic cropping systems in 2 synthesis paper regarding species richness (arthropods, birds, non-bird vertebrates, plants, soil organisms), while having positive effect on abundance. 1 synthesis paper on organic viticulture reported non-statistically tested results.
- For organic systems (as broad category without distiction on different types) other 3 sysnthesis papers agree on positive effects on biodiversity.
- Biodiversity per unit of product: no results were available.

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 biodiversity	Biodiversity per unit of area	Organic cropping systems	Conventional	6 (0)	0	2 (0)	1 (0)
		Organic systems	Conventional	3	0	0	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 10 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.

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

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref4	Studies assessing the performance of organic	Global	59	Organic systems (Cereals, Fruits,	Conventional	Biotic abundance, biotic richness of functional groups	Organic sites had greater biodiversity (34%) than conventional sites. Biodiversity gains increased as average crop field size in the	88%

[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.

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
	systems in comparison to conventional systems.			Oil crops, Pulses, Root, Vegetables)	systems	(Natural enemy, Herbivore, Pollinator, Producer) and taxa (Vertebrate, Arthropod, Microbe, Plant)	landscape increased, suggesting organic farms provide a "refuge" in intensive landscapes.	
Ref5	Field studies assessing the performance of organic in comparison to conventional viticulture systems.	Global	24	Organic systems	Conventional systems	Biodiversity	Biodiversity at different trophic levels was enhanced under organic and biodynamic viticulture compared to conventional management. However, the results are rated as uncertain, due to the lack of quantitative statistical analysis.	25%
Ref6	Studies assessing the performance of organic in comparison to conventional perennial orchards and vineyards.	Global	53	Organic orchards and vineyards	Conventional systems	Biotic abundance, biotic rarefied richness of functional groups (Natural enemy, Herbivore, Pollinator, Producer) and taxa (Vertebrate, Arthropod, Microbe, Plant)	Organic farming significantly restored both biotic richness and abundance in orchards and vineyards, including a variety of (dis)service-providing organisms.	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	Biotic abundance and richness	Higher mean biotic abundance and richness and lower variability (in biotic abundance and richness) in organic systems than in conventional systems.	56%
Ref13	Studies conducted at the scale of individual crop fields rather than using plots on experiment stations assessing the performance of organic systems in comparison to conventional systems.	Global	60	Organic systems	Conventional systems	Biotic abundance, species richness, species evenness	Results suggest that organic farming promotes diverse arthropod metacommunities that may provide temporal and spatial stability of ecosystem service provisioning.	88%
Ref17	Studies assessing the performance of organic systems in comparison to conventional systems.	Global	35	Organic systems	Conventional systems	Species richness was used as the measure of diversity. Abundance was considered as the total number of individuals for the study as well as the totals per trophic guild and per sampling unit.	Organic crops certainly increase the taxonomic richness and abundance of insects as well as the richness of insects within trophic guilds (herbivores, predators, pollinators and parasitoids). Thus, the belief that organic agriculture contributes to the conservation of biodiversity is supported by the analyses performed here for the case of insects. An additional and important result that emerged from this study is that both the agrosystem and the surrounding landscape are relevant to the conservation of biodiversity.	75%
Ref19	Studies assessing the performance of organic systems in comparison to conventional systems.	Global	94	Organic systems	Conventional systems	Species richness, as in the form of raw data or the mean species richness, standard deviation and sample size in both farming systems	This analysis shows that organic farming usually has large positive effects on average species richness compared with conventional farming.	94%
Ref22	Studies conducted in arable crops in Europe and North America assessing the performance of organic systems in comparison to conventional systems.	Europe and North America	12	Organic systems	Conventional systems	Farmland bird abundance	Organic farming systems supported on average higher bird numbers (1 to 3 more birds) than conventional systems. However, this positive effect was significant in less than half of the experiments, showing that the uncertainty about the estimated effects is high. Skylarks nesting territories were two-times higher in legume and set-aside fields than in other crops during the breeding season.	81%
Ref23	Studies assessing the performance of organic systems in comparison to conventional systems.	Global	52	Organic managed farms	Conventional managed farms	1) Richness; 2) total abundance (arthropods, birds, non-bird vertebrates, plants, soil organisms)	Total organism abundance of a broad range of organisms (arthropods, birds, non-bird vertebrates, plants, soil organisms), significantly increased following implementation of organic farming. Change in richness was not predictive of change in eveness.	75%
Ref31	Studies assessing the performance of organic systems in comparison to conventional systems.	Global	66	Organic systems	Conventional systems	Species richness, Species abundance	On average, the increase in species richness was around 30% compared with conventional farming.	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 biodiversity	Biodiversity per unit of area	Organic cropping systems	Conventional	Ref4, Ref6, Ref7, Ref13, Ref23 and Ref31		Ref6 and Ref23	Ref5
		Organic systems	Conventional	Ref17, Ref19 and Ref22			

3. FACTORS INFLUENCING THE EFFECTS ON BIODIVERSITY

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

Factor	Reference number
Addition of compost	Ref5
Crop field size	Ref4

Factor	Reference number
Crop type	Ref19
Diversity of cover crops	Ref5
Experiment scale	Ref17
Herbicide application	Ref5
Landscape structure and heterogeneity	Ref31
Organism group	Ref19
Pest management strategies	Ref5
Proportion of arable land in the surrounding landscape	Ref19
Taxon	Ref23

4. KNOWLEDGE GAPS

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

Ref Num	Gap
Ref5	The contribution of an enhanced biodiversity to abundance and biodiversity of antagonistic insects in the vineyard should be further investigated and quantified.
Ref6	Future meta-analytic studies should focus on the role of large-scale factors on biodiversity and ecosystem services in orchards/vineyards.
Ref19	More studies are needed in tropical, subtropical and Mediterranean climates
Ref22	1) Few publications provided quantitative information that both linked bird populations to farming practices and could be combined with metrics from other studies; 2) publications often did not provide detailed information on the agricultural characteristics of the fields or farms used in the study; 3) the large diversity of bird metrics used in the literature. Only a few metrics, such as mean bird abundance per ha, were used in several articles; 4) Authors commonly failed to provide measures of variation or replicate numbers for the metrics measured.
Ref23	A key challenge for future research lies in unraveling the ecological processes that allow independent movement in evenness and richness, despite their often similar contributions to ecosystem function. Experiments that separately manipulate richness from evenness, and vice versa, could provide a particularly powerful way to uncover the contribution of each biodiversity facet to ecosystem health and food-web interactions.
Ref31	In studies of farmland biodiversity, the farmers themselves are often ignored. The attitude of individual farmers, rather than which farming system is used, is probably the most important factor determining biodiversity at the farm level.

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
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: 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: 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
Ref13	Lichtenberg, EM; Kennedy, CM; Kremen, C; Batary, P; Berendse, F; Bommarco, R; Bosque-Perez, NA; Carvalheiro, LG; Snyder, WE; Williams, NM; Winfree, R; Klatt, BK; Astrom, S; Benjamin, F; Brittain, C; Chaplin-Kramer, R; Clough, Y; Danforth, B; Diekotter, T; Eigenbrode, SD; Ekroos, J; Elle, E; Freitas, BM; Fukuda, Y; Gaines-Day, HR; Grab, H; Gratton, C; Holzschuh, A; Isaacs, R; Isaia, M; Jha, S; Jonason, D; Jones, VP; Klein, AM; Krauss, J; Letourneau, DK; Macfadyen, S; Mallinger, RE; Martin, EA; Martinez, E; Memmott, J; Morandin, L; Neame, L; Otieno, M; Park, MG; Pfiffner, L; Pocock, MJO; Ponce, C; Potts, SG; Poveda, K; Ramos, M; Rosenheim, JA; Rundlof, M; Sardinas, H; Saunders, ME; Schon, NL; Sciligo, AR; Sidhu, CS; Steffan-Dewenter, I; Tscharntke, T; Vesely, M; Weisser, WW; Wilson, JK; Crowder, DW.	2017	A global synthesis of the effects of diversified farming systems on arthropod diversity within fields and across agricultural landscapes.	23, 11, 4946-4957.	10.1111/gcb.13714

Ref Num	Author(s)	Year	Title	Journal	DOI
Ref17	Montañez, MN; Amarillo-Suárez, A.	2014	Impact of organic crops on the diversity of insects: a review of recent research.	Revista Colombiana de Entomología 40: 131 - 142.	www.scielo.org.co/scielo.php?pid=S0120-04882014000200001&script=sci_abstract
Ref19	Tuck, SL; Winqvist, C; Mota, F; Ahnstrom, J; Turnbull, LA; Bengtsson, J.	2014	Land-use intensity and the effects of organic farming on biodiversity: a hierarchical meta-analysis.	Journal of Applied Ecology 51: 746-755.	10.1111/1365-2664.12219
Ref22	Wilcox, JC; Barbottin, A; Durant, D; Tichit, M; Makowski, D.	2013	Farmland Birds and Arable Farming, a Meta-Analysis.	Sustainable Agriculture Reviews 13: 35-63.	10.1007/978-3-319-00915-5_3
Ref23	Crowder, DW; Northfield, TD; Gomulkiewicz, R; Snyder, WE.	2012	Conserving and promoting evenness: organic farming and fire-based wildland management as case studies.	Ecology 93: 2001–2007.	10.1890/12-0110.1
Ref31	Bengtsson, J; Ahnstrom, J; Weibull, AC.	2005	The effects of organic agriculture on biodiversity and abundance: a meta-analysis.	Journal of Applied Ecology 42: 261-269.	10.1111/j.1365-2664.2005.01005.x