SINGLE-IMPACT FICHE – ORGANIC SYSTEMS

IMPACT: BIODIVERSITY

Data extracted in October 2021

Note to the reader: This fiche summarises the impact of organic systems on BIODIVERSITY[1]. It is based on a review of 10 peer-reviewed synthesis research papers[2]. Each synthesis paper includes a number of individual studies, which ranges in this case from 9 to 94.

1.WEIGHT OF THE EVIDENCE

- CONSISTENCY OF THE IMPACT: The effect on BIODIVERSITY of organic cropping systems, as compared to conventional systems, are reported as:
    - Biodiversity per unit of area: positive effects were found for organic cropping systems (9 high-quality synthesis papers), while no result was available specifically for organic livestock systems (see Table 1). No significant effects were found in one synthesis paper for species (arthropods, birds, non - bird vertebrates, plants, soil organisms) richness, while having positive effect on abundance and evenness. Negative effects were found in one synthesis paper for predator communities evenness. One synthesis paper on organic viticulture reported uncertain results (lacking full statistical analysis).
    - Biodiversity per unit of product: no results were available.

  All the synthesis studies reviewed included experiments conducted in Europe.

Table 1. Summary of effects. The effect with the higher score is marked in bold and the cell coloured. The numbers between parentheses indicate the number of synthesis papers with a quality score of at least 50%. Details on quality criteria can be found in the next section. Some synthesis papers reported effects for more than type of system.

Impact	Metric	Impacts per unit of agricultural land				Impacts per unit of product			
		Positive	Negative	No effect	Uncertain *	Positive	Negative	No effect	Uncertain *
Organic cropping systems									
Increase Biodiversity		9 (9) **	1 (1)	1 (1)	1 (0)				

* Number of synthesis papers that report relevant results but without statistical test comparison of the intervention and the control.

** One synthesis paper reports positive effect of organic farming, specifically for farmland birds abundance (Wilcox et al., 2013).

- QUALITY OF THE SYNTHESIS PAPERS: *The quality score summarises 16 criteria assessing the quality of three main aspects of the synthesis papers: 1) the literature search strategy and studies selection; 2) the statistical analysis; 3) the potential bias. Details on quality criteria can be found in this document →.*

[1] Biodiversity was assessed as species richness, abundance and evenness, concerning a large range of organisms, in particular arthropods (especially insects), farmland birds, and soil organisms.

[2] Research synthesis papers include meta-analysis or systematic reviews.

As shown in the "Quality score" in **Table 2,** the quality the 10 synthesis papers retrieved ranged from 25% to 94%. The least frequently satisfied quality criteria were: "Search string", "Number of studies of each step", "Individual effect sizes", "Individual studies weighted", "Heterogeneity of results analysed" and "Publication bias analysed".

2. IMPACTS

The main characteristics and results of the 10 synthesis papers[1] are summarized in **Table 2**. The references are ordered according to their publication date.

Table 2. Main characteristics of the synthesis papers reporting impacts on biodiversity. All detailed results of each synthesis study are reported in the summary reports →.

Reference	Population	Geographical scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Bengtsson, J; Ahnstrom, J; Weibull, AC. 2005	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%
Crowder, DW; Northfield, TD; Gomulkiewicz, R; Snyder, WE. 2012	Studies assessing the performance of organic systems in comparison to conventional systems.	Global	52	Organic managed farms	Conventional managed farms	Richness, evenness, and total abundance (arthropods, birds, non-bird vertebrates, plants, soil organisms)	Total organism abundance and rarefied evenness 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%
Doring, J; Collins, C; Frisch, M; Kauer, R 2019	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%
Katayama, N; Bouam, I; Koshida, C; Baba, YG 2019	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 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%

Reference	Population	Geographical scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Lichtenberg, EM et al. 2017 *	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%
Montañez, MN; Amarillo-Suárez, A. 2014	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%
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	Studies assessing the performance of organic systems in comparison to conventional systems.	Global	59	Organic systems (Cereals, Fruits, Oil crops, Pulses, Root, Vegetables)	Conventional systems	Biotic abundance, biotic richness of functional groups (Natural enemy, Herbivore, Pollinator, Producer) and taxa (Vertebrate, Arthropod, Microbe, Plant)	Organic sites had greater biodiversity (34%) than conventional sites. Biodiversity gains increased as average crop field size in the landscape increased, suggesting organic farms provide a "refuge" in intensive landscapes.	88%
Smith, OM; Cohen, AL; Rieser, CJ; Davis, AG; Taylor, JM; Adesanya, AW; Jones, MS; Meier, AR; Reganold, JP; Orpet, RJ; Northfield, TD;	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%

Reference	Population	Geographical scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Crowder, DW 2019								
Tuck, SL; Winqvist, C; Mota, F; Ahnstrom, J; Turnbull, LA; Bengtsson, J. 2014	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%
Wilcox, JC; Barbottin, A; Durant, D; Tichit, M; Makowski, D. 2013	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%

* Full authorship: 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.

3. KNOWLEDGE GAPS

Bengtsson et al., 2005	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.
Crowder et al., 2012	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.
Doring et al., 2019	The contribution of an enhanced biodiversity to abundance and biodiversity of antagonistic insects in the vineyard should be further investigated and quantified.

Katayama et al., 2019	Future meta-analytic studies should focus on the role of large-scale factors on biodiversity and ecosystem services in orchards/vineyards.
Tuck et al., 2014	More studies are needed in tropical, subtropical and Mediterranean climates
Wilcox et al., 2013.	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.

4. SYSTEMATIC REVIEW SEARCH STRATEGY

Keywords	TOPIC: ("organic farm*" OR "organic agriculture" OR "organic system*" OR "organic product*") AND TOPIC: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") TOPIC: ((organic near/4 farm*) OR (organic near/4 agric*) OR (organic near/4 produc*) OR (organic near/3 livestock) OR (organic near/3 animal)) AND TOPIC: ("animal*" OR "livestock" OR "ruminant*" OR "small ruminant*" OR "cattle" OR "dairy cattle" OR "dairy" OR "beef cattle" OR "sheep" OR "ewe*" OR "lamb*" OR "swine" OR "pig*" OR "porcine*" OR "goat*" OR "rabbit*" OR "poultry" OR "chicken*" OR "broiler*" OR "turkey*" OR "hen*" OR "horse*" OR "mule*" OR "milk" OR "egg" OR "beef" OR "cheese" OR "meat" OR (animal near/2 protein*) OR "yogurt" OR "bacon" OR "pork") AND TOPIC: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis")
Search dates	No time restrictions
Databases	Web of Science and Scopus, run for the first time in July 2020 and updated in September 2021 and October 2021.
Selection criteria	Four main criteria led to the exclusion of a synthesis paper: (1) the paper does not deal with organic systems; (2) the paper does not assess the impacts of organic systems in comparison to another cropping system; (3) the paper report results on the effect of specific farming practices (e.g. organic fertilisation, green manure, alternative pest control techniques, etc.) which are part of organic systems, instead of the effect of the whole farming system; (4) the paper is neither a meta-analysis nor a systematic review including quantitative results. Synthesis papers that passed the relevance criteria were subject to critical appraisal carried out on paper-by-paper basis. From the 220 potentially relevant synthesis papers, 140 were excluded after reading the title and abstract, and 50 after reading the full text according to the above-mentioned criteria. Finally, 30 synthesis papers were selected for organic farming systems, from which 10 were relevant for this impact.