SINGLE-IMPACT FICHE
ORGANIC FARMING SYSTEMS

IMPACT: GLOBAL WARMING POTENTIAL (LCA)

Data extracted in October 2021
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Note to the reader: This fiche summarises the effects of Organic farming systems on GLOBAL WARMING POTENTIAL (LCA). It is based on 4 synthesis papers[1], including from 9 to 164 primary studies.

1. WEIGHT OF THE EVIDENCE

CONSISTENCY OF THE IMPACT

The effect of organic farming systems on Global warming potential (as calculated in LCA-modelling studies aggregating different sources of emissions, including soil, livestock, energy and fertilisers sources and other inputs) 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.

- Per unit of area: 1 synthesis paper reported positive effect on total global warming potential (GWP) (i.e. decrease of GWP) and for N_2O and CH_4 emission (accounted separately) for organic mixed farming (i.e. with livestock and plant production on the same farm).

- Per unit of product: organic cropping systems (fruit production) resulted in 1 synthesis paper reporting positive effect and 2 (1 of low quality) reporting non-significant effect. Organic mixed farming systems and organic systems (as broad category without distiction on different types) resulted in non-signifcant effect, respectively with 1 and 2 (1 of low quality) synthesis papers. Organic livestock products resulted in 2 synthesis papers reporting non-significant effect and 1 reporting negative (for dairy products). Non-statistically tested results were reported in 1 synthesis paper for organic cropping systems and 1 for livestock products.

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	
Decrease global warming potential (lca)	GWP area based	Organic mixed farming systems	Conventional	1	0	0	0
Decrease global warming potential (lca)	GWP CH_4 emission area based	Organic mixed farming systems	Conventional	1	0	0	0
Decrease global warming potential (lca)	GWP N_2O emission area based	Organic mixed farming systems	Conventional	1	0	0	0
Decrease global warming potential (lca)	GWP product based	Organic cropping systems	Conventional	1	0	2 (1)	1
		Organic livestock products	Conventional	0	1 (0)	2 (1)	1
		Organic mixed farming systems	Conventional	0	0	1	0
		Organic systems	Conventional	0	0	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

[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.

The main characteristics and results of the 4 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 Global warming potential (LCA). The references are ordered chronologically with the most recent publication date first.

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref11	LCA studies assessing the performance of organic systems in comparison to conventional systems. Emissions are accounted for all 'cradle-to-farm gate' activities.	Global. The majority of LCA publications included in these analyses are from agricultural systems in Europe, North America, and Australia and New Zealand (86% of systems are from these regions). Systems from China (2%), Japan (2%), the rest of Asia (5%), South America (4%), and Africa (4%) are much less common.	164	1) Organic systems (all); 2) Organic Cereals; 3) Organic pulses and oil crops; 4) Organic fruits; 5) Organic Vegetables; 6) Organic meats; 7) Organic dairy products and eggs	Conventional systems	Global warming potential product based, 'cradle-to-farm gate' LCA	Organic systems (all systems. as average) show comparable GHG emissions per unit of product than conventional systems (no significant change). As compared to conventional products, organic cereals, pulses, oil crops and vegetables, resulted in no significant change for GHG emissions per unit product; organic fruits resulted in significantly lower GHG emissions per unit product; organic meats, dairy products and eggs resulted in no significant change for GHG emissions per unit product.	62%
Ref15	Farm-level studies assessing the performance of organic systems in comparison to conventional systems.	Global	19	Organic livestock and dairy products	Conventional livestock and dairy products	Greenhouse gas emissions (overall) per unit of product (large majority) and per unit of area (few). GHGE studies more often used output-based outcome measures with LCA as the measurement method. EAM (Energy Analysis Method). In this analysis, the Energy Analysis Method (EAM), Life Cycle Assessment (LCA), Emergy, and other methods, including Life Cycle Climate Impact (LCCI), are compared.	Organic livestock products, as compared to conventional, showed significantly higher GHG emissions. Dairy products, fruits, vegetables and crops showed non-significant differences.	44%
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 production of milk, beef, pork, olives, cereals	Conventional production of milk, beef, pork	GHG emissions (LCA approach) per unit of product	Aggregated greenhouse gas emissions per unit of product were not significantly different for organic (all production systems) vs conventional systems. For single categories of products, olives, organic milk, beef and pork, results were rated as uncertain, due to the lack of statistical analysis and few data available.	69%
Ref30	Studies assessing the performance of organic systems (crops + livestock) in comparison to conventional systems.	Global	9	Organic mixed farming: with animal and plant production on the same farm.	Conventional mixed farming	GHG emissions (total, N_2O, CH_4)	Organic mixed farming (crops + livestock) scores equal (per unit product no general direction is noticeable) or better (per unit of agricultural area. For CH_4, N_2O and aggregated GHG emissions) than conventional farming.	50%

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	
Decrease global warming potential (lca)	GWP area based	Organic mixed farming systems	Conventional	Ref30			
Decrease global warming potential (lca)	GWP CH_4 emission area based	Organic mixed farming systems	Conventional	Ref30			
Decrease global warming potential (lca)	GWP N_2O emission area based	Organic mixed farming systems	Conventional	Ref30			
Decrease global warming potential (lca)	GWP product based	Organic cropping systems	Conventional	Ref11		Ref11 and Ref15	Ref27
		Organic livestock products	Conventional		Ref15	Ref11 and Ref15	Ref27
		Organic mixed farming systems	Conventional			Ref30	
		Organic systems	Conventional			Ref11 and Ref27	

3. FACTORS INFLUENCING THE EFFECTS ON GLOBAL WARMING POTENTIAL (LCA)

Table 4: List of factors reported to significantly affect the size and/or direction of the effects on Global warming potential (LCA), according to the synthesis papers reviewed.

Factor	Reference number
Product/area unit	Ref15

4. KNOWLEDGE GAPS

The authors did not report knowledge gaps in the reviewed synthesis papers.

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
Ref11	Clark, M; Tilman, D.	2017	Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice.	ENVIRONMENTAL RESEARCH LETTERS 12 6	10.1088/1748-9326/aa6cd5
Ref15	Lee K.S., Choe Y.C., Park S.H.	2015	Measuring the environmental effects of organic farming: A meta-analysis of structural variables in empirical research	JOURNAL OF ENVIRONMENTAL MANAGEMENT 162, 263-274.	10.1016/j.jenvman.2015.07.021
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
Ref30	Mondelaers, K; Aertsens, J; Van Huylenbroeck, G.	2009	A meta-analysis of the differences in environmental impacts between organic and conventional farming	BRITISH FOOD JOURNAL 111 10, 1098-1119	10.1108/00070700910992925

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