SINGLE-IMPACT FICHE
INTERCROPPING

IMPACT: PEST AND DISEASE CONTROL

Data extracted in May 2021

Note to the reader: This fiche summarises the impact of intercropping on PEST AND DISEASE CONTROL. It is based on 7 peer-reviewed synthesis research papers[1], each of them including from 11 to 180 individual studies.

1. WEIGHT OF THE EVIDENCE

- CONSISTENCY OF THE IMPACT:
  Intercropping of both multiple crop species (i.e., crop mixture cropping) or genotypes (i.e., cultivar mixture cropping), as compared to monoculture or pure stands, resulted in an overall positive effect on pest control (i.e., increase in pest control). For crop mixture cropping, from a total of 6 results, 5 were positive and 1 showed no-effect (see **Table 1**). For cultivar mixture cropping, from a total of 4 results, 3 were positive and 1 showed no-effect (see **Table 1**). The considered pests are insects, pathogens and weeds.

  Among the 7 reviewed synthesis papers, 4 include data collected in Europe (see **Table 2**).

Table 1. Summary of effects. The effect with the higher score is marked in bold and the cell coloured. The numbers between parenthesis 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.

		All studies				Only studies including EU			
Impact	**Intervention**	**Positive**	**Negative**	**No effect**	**Uncertain**	**Positive**	**Negative**	**No effect**	**Uncertain**
Increase Pest and disease control	Crop mixture	**5 (5)**	0	1 (1)	0	**1 (1)**	0	0	0
	Cultivar mixture	**3 (3)**	0	1 (1)	0	**3 (3)**	0	1 (1)	0

- 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* →.

As shown in the "Quality score" in **Table 2**, the quality level ranges from 62% to 94%. The least frequently satisfied quality criteria were "Number of studies at each step", "Individual_studies_weighted", "Dataset_available", "Publication_bias_analyzed" and "Search_string".

[1] Research synthesis papers include a formal meta-analysis or systematic reviews with some quantitative results

2. IMPACTS

The main characteristics and results of the synthesis papers are summarized in **Table 2**. Detailed results of each synthesis study are reported in the summary reports.

Table 2. Main characteristics of the synthesis papers reporting impacts of intercropping on pest control. The references are ordered chronologically with the most recent publication date first.

Reference	Population	Geographical scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Gibson, AK; Nguyen, AE 2021	Multiple crops	Global	55	Crop mixture cropping	Monoculture	Parasitism (bacteria, fungi or viruses)	Cultivar diversification is a sustainable solution for disease control and yield improvement.	94%
Daryanto, S; Fu, BJ; Zhao, WW; Wang, S; Jacinthe, PA; Wang, LX 2020	Grain legumes and cereals	Africa	180	Grain legume and cereal intercropping	Monoculture	Weed biomass, Striga hermonthica emergence, stemborer larvae abundance and stemborer parasitism	Intercropping grain legumes into cereals increased weed and pest control service.	62%
Zhang, CC; Dong, Y; Tang, L; Zheng, Y; Makowski, D; Yu, Y; Zhang, FS; van der Werf, W 2019	Cereals and faba bean	China	17	Crop mixture cropping	Monoculture	Disease incidence	Intercropping has a substantial and consistent effect on disease incidence in cereal/faba bean mixtures across studies, but is not sufficient to provide complete disease control. Intercropping is therefore best used as a component in an integrated approach for managing plant diseases.	69%
Koricheva, J; Hayes, D 2018	Multiple crops	Global	22	Cultivar mixtures	pure stand	Predator abundance, herbivore abundance and damage	The results of the study provide limited support for the suggestion that genotypically diverse cultivar mixtures can be used as an effective pest management tool.	75%
Iverson, AL; Marin, LE; Ennis, KK; Gonthier, DJ; Connor-Barrie, BT; Remfert, JL; Cardinale, BJ; Perfecto, I 2014	Multiple crops	Global	26	Crop mixture cropping	Monoculture	Plant damage, predator abundance and pest abundance	Intercropping had beneficial effects on biocontrol.	88%

Reference	Population	Geographical scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Huang, C; Sun, ZY; Wang, HG; Luo, Y; Ma, ZH 2012	Wheat	Global	11	Cultivar mixtures	pure stand	Wheat stripe rust intensity	Using cultivar mixture with different resistance backgrounds is effective in controlling wheat stripe rust.	75%
Letourneau, DK; Armbrecht, I; Rivera, BS; Lerma, JM; Carmona, EJ; Daza, MC; Escobar, S; Galindo, V; Gutierrez, C; Lopez, SD; Mejia, JL; Rangel, AMA; Rangel, JH; Rivera, L; Saavedra, CA; Torres, AM; Trujillo, AR 2011	Multiple crops	Global	45	Crop mixture cropping	Monoculture	Herbivore abundance, enemy abundance and crop damage	Overall, herbivore suppression, enemy enhancement, and crop damage suppression effects were significantly stronger on diversified crops than on crops with none or fewer associated plant species.	88%

3. KNOWLEDGE GAPS

Daryanto et al., 2020	Studies that focus on indigenous African grain legumes or cereals should be encouraged because, with the exception of cowpea and teff, most past studies have focused on non-native species.
Koricheva and Hayes2018	Future studies should 1) manipulate the amount of genetic variance in phenotypic traits, as opposed to just the number of genotypes, 2) explore the potential interactions between plant species and genetic diversity effects on arthropods and 3) focus on the consequences of losses of plant genetic diversity for pollination services, below-ground herbivory and nutrient cycling performed by the soil and litter arthropods.
Iverson et al., 2014	There is the need for a greater investment in researching the underlying relationships between multiple agroecosystem services so we can better achieve agroecosystem multifunctionality.
Letourneau et al., 2011	More research is needed to better discern which schemes deliver the desired results for herbivore suppression and biological control, and what underlying mechanisms can be used to predict the "right kind of diversity" for providing these ecosystem services for pest regulation while maintaining crop yield.

4. SYSTEMATIC REVIEW SEARCH STRATEGY

Keywords	TOPIC: (intercrop* OR "inter crop*" OR "mult* variet*" OR "mult* crop*" OR "Companion crop*" OR "Companion plant*" OR "polycultur*" OR "crop diversity" OR "mix* crop*" OR "crop* mix*" OR "cult* mix*"OR "variety mix*" OR "row crop*" OR "strip* crop*" OR "row crop*" OR "relay crop*") 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 in May 2021
Selection criteria	The main criteria that led to the exclusion of a synthesis paper were if the paper: (1) does not deal with intercropping; (2) does not include results for cropland (e.g. pastures, forests); (3) deals with agroforestry (e.g. alley cropping); (4) experimental treatment included other practices as well (e.g. crop rotation); (5) intercropping treatment included non-cash crops (e.g. companion plants that were not harvested, dual-purpose cropping); (6) presents the same dataset as previous studies and similar analyses; (7) is a simple review or a non-quantitative systematic review. Synthesis papers that passed the relevance criteria were subject to critical appraisal carried out on a paper-by-paper basis. The search returned 109 synthesis papers potentially relevant for the practice object of our fiche. Searches for other farming practices added another 2 potentially relevant synthesis papers. From the 111 potentially relevant synthesis papers, 54 were excluded after reading the title and abstract, and 32 after reading the full text according to the above-mentioned criteria. Finally, 25 synthesis papers were selected for intercropping, from which 7 were relevant for this impact.