

SINGLE-IMPACT FICHE

LANDSCAPE FEATURES



IMPACT: CARBON SEQUESTRATION

Data extracted in October 2021

Note to the reader: This fiche summarises the impact of four landscape features (field margins, hedgerows, isolated trees, and terraces¹) on CARBON SEQUESTRATION in soil as well as biomass. It is based on 4 peer-reviewed synthesis research papers², each of them including from 53 to 103 individual studies.

1. WEIGHT OF THE EVIDENCE

- CONSISTENCY OF THE IMPACT:

Landscape features have an overall positive effect on carbon sequestration (i.e. increase of carbon sequestration) compared to cropland or grassland without landscape features (see **Table 1**):

- Field margins have a positive effect on soil carbon sequestration compared to cropland and grassland without field margins, according to the only 1 synthesis paper reviewed.
- Hedgerows have a positive effect on carbon sequestration compared to cropland and grassland without hedgerows. 3 synthesis papers reported a positive effect on soil carbon sequestration, while 1 synthesis paper reported no effect. Another synthesis paper reported relevant results for carbon sequestration both in soil and in biomass, but without statistical test of the effects and it is labelled as uncertain. Details are provided below in Table 2 and in the summary reports.
- Isolated trees have an uncertain effect on carbon sequestration in biomass compared to cropland and grassland without isolated trees. One synthesis paper reported relevant results, but without statistical test of the effects and it is labelled as uncertain. Details are provided below in Table 2 and in the summary reports.
- Terraces have differing effects on soil carbon sequestration compared to cropland and grassland without terraces depending on the type of terrace (contour bound or stone terraces vegetated or not), according to the 1 synthesis paper reviewed.

Among the 5 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. One synthesis paper reported more than one effect for terraces and two synthesis papers reported effects for more than one landscape feature.

| Impact | Intervention | Positive | Negative | No effect | Uncertain* |
|-------------------------------|----------------|--------------|----------|-----------|--------------|
| Increase carbon sequestration | Field margins | 1 (1) | 0 | 0 | 0 |
| | Hedgerows | 3 (3) | 0 | 1 (0) | 1 (0) |
| | Isolated trees | 0 | 0 | 0 | 1 (0) |

¹ Described in the General Fiche.

² Research synthesis papers include a formal meta-analysis or systematic reviews with some quantitative results
[⇒](#).

| | | | | | |
|--|----------|-------|---|-------|---|
| | Terraces | 1 (1) | 0 | 1 (1) | 0 |
|--|----------|-------|---|-------|---|

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

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 38% to 100%. The least frequently satisfied quality criteria were “Number of studies at each step”, “Individual effect sizes”, “Dataset available” and “Publication bias analysed”.

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 landscape features on soil organic carbon. The references are ordered chronologically with the most recent publication date first.

| Reference | Population | Scale | Num. papers | Intervention | Comparator | Metric | Conclusion | Quality score |
|--|---|----------------------------|-------------|--|-------------------------------------|-----------------------------|--|---------------|
| Drexler, S; Gensior, A; Don, A 2021 | Croplands and grasslands | Global | 9 | Hedgerows | No hedgerows | Soil organic carbon stock | The establishment of hedgerows, especially on cropland, can be an effective option for C sequestration in agricultural landscapes. | 100% |
| Abera, W; Tamene, L; Tibebe, D; Adimassu, Z; Kassa, H; Hailu, H; Mekonnen, K; Desta, G; Sommer, R; Verchoť, L 2020 | Degraded landscape across several agroecology zones | Ethiopia | 103 | 1) Contour bunds; 2) Terraces; 3) Vegetated contour bunds (all classified as terraces) | No treatment, before treatment | Soil organic carbon | The mean effect of all land restoration interventions on soil organic carbon is positive, the highest effect being from “bunds + biological” (139%) followed by enclosure (90%). | 62% |
| England, JR; OGrady, AP; Fleming, A; Marais, Z; Mendham, D 2020 | Grazed dairy systems | Global | 83 | 1) Shelterbelts (hedgerows); 2) Pasture trees (isolated trees) | Grazed dairy pasture without trees | Carbon sequestration | Variable results with large increases in biomass C, but changes in soil C following reforestation of on-farm woody elements highly variable and uncertain. <i>Reviewers’ note: We labelled the results as uncertain due to the lack of statistical testing.</i> | 38% |
| Zheng, YL; Wang, HY; Qin, QQ; Wang, YG 2020 | Croplands | Global | 53 | Hedgerows | No hedgerows | Soil organic matter content | Plant hedgerows can effectively increase soil organic matter content. | 81% |
| Van Vooren, L; Reubens, B; Broekx, S; De Frenne, P; Nelissen, V; | Arable crops | Global (temperate climate) | 60 | 1) Grass strips (field margins); 2) Hedgerows | 1) No grass strips; 2) No hedgerows | Carbon stock | Grass strips and hedgerows showed positive effect on the increase of soil carbon stock. | 75% |

| Reference | Population | Scale | Num. papers | Intervention | Comparator | Metric | Conclusion | Quality score |
|--------------------------------|------------|-------|-------------|--------------|------------|--------|------------|---------------|
| Pardon, P; Verheyen, K 2017 | | | | | | | | |

3. KNOWLEDGE GAPS

- Drexler et al., 2021** With the current dataset, it was not possible to identify an influence of hedgerow age, soil texture or climate on the effect of hedgerow establishment on SOC storage due to the small dataset.
- England et al., 2020** The number of publications supporting a given relationship was often relatively low.

4. SYSTEMATIC REVIEW SEARCH STRATEGY

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|-----------------|---|
| Keywords | <p>Different searches were conducted with the following search strings:</p> <p>1) TS= ("terrac*" OR "contour bund*" OR "level bench*" OR "level ditch*" OR "fish-scale pit*" OR "dry-stone wall*" OR "dry stone wall*" OR "stone wall*" OR "earth wall*" OR "dry wall*" OR "dry-wall*" OR "rubble wall*") AND TS= ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= (agric* OR cultiv* OR crop* OR farm*)</p> <p>or</p> <p>TITLE-ABS-KEY: ("terrac*" OR "contour bund*" OR "level bench*" OR "level ditch*" OR "fish-scale pit*" OR "dry-stone wall*" OR "dry stone wall*" OR "stone wall*" OR "earth wall*" OR "dry wall*" OR "dry-wall*" OR "rubble wall*") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: (agric* OR cultiv* OR crop* OR farm*)</p> <p>2) TS= ("ditch*" OR "earth bund*" OR "open-channel" OR "intermittent W/4 stream" OR "small W/4 stream") AND TS= ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*")</p> <p>or</p> <p>TITLE-ABS-KEY: ("ditch*" OR "earth bund*" OR "open-channel" OR "intermittent near/4 stream" OR "small near/4 stream") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*")</p> |
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3) TS= ("pond*" OR "soda pan*" OR "reedbed*" OR "small W/4 lake*" OR "small W/4 wetland*") AND TS= ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*")

or

TITLE-ABS-KEY: ("pond*" OR "soda pan*" OR "reedbed*" OR "small near/4 lake*" OR "small near/4 wetland*") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*")

4) TS=(("strip*" OR "margin*" OR "hedge*" OR "edge*" OR "border*" OR "band*" OR "line*" OR "verge*" OR "row*") near/3 ("flower*" OR "vegetat*" OR "tree*" OR "shrub*" OR "plant*" OR "grass*" OR "filter*" OR "buffer*" OR "wooded" OR "riparian" OR "field*" OR "wildlife" OR "seminatural" OR "semi-natural" OR "semi natural")) AND TS= ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*")

merged with

TS= ("margin strip*" OR "windbreak*" OR "shelterbelt*" OR "hedgerow*" OR "road verge*" OR "riparian buffer*" OR "riparian vegetation" OR "riparian woodland*" OR "buffer zone*" OR "riparian zone*" "vegetated filter strip*") AND TS= ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*")

or

TITLE-ABS-KEY: (("strip*" OR "margin*" OR "hedge*" OR "edge*" OR "border*" OR "band*" OR "line*" OR "verge*" OR "row*") W/3 ("flower*" OR "vegetat*" OR "tree*" OR "shrub*" OR "plant*" OR "grass*" OR "filter*" OR "buffer*" OR "wooded" OR "riparian" OR "field*" OR "wildlife" OR "seminatural" OR "semi-natural" OR "semi natural")) AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*")

merged with

TITLE-ABS-KEY: ("margin strip*" OR "windbreak*" OR "shelterbelt*" OR "hedgerow*" OR "road verge*" OR "riparian buffer*" OR "riparian vegetation" OR "riparian woodland*" OR "buffer zone*" OR "riparian zone*" "vegetated filter strip*") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*")

5) TS=(("patch*" OR "islet*" OR "island*" OR "remnant*" OR "group*" OR "copse*" OR "coppice*") near/3 ("flower*" OR "vegetat*" OR "tree*" OR "shrub*" OR "grass*" OR "forest*" OR "wooded" OR "field*" OR "wildlife" OR "seminatural" OR "semi-natural" OR "semi natural")) AND TS= ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR

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| | <p>"evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*")</p> <p>merged with</p> <p>TS=("woodland creation*" OR "mid-field islet*" OR "environmental island*" OR "refuge*" OR "scattered tree*" OR "shading tree*") AND TS=("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*")</p> <p>or</p> <p>TITLE-ABS-KEY: (("patch*" OR "islet*" OR "island*" OR "remnant*" OR "group*" OR "copse*" OR "coppice*") W/3 ("flower*" OR "vegetat*" OR "tree*" OR "shrub*" OR "grass*" OR "forest*" OR "wooded" OR "field*" OR "wildlife" OR "seminatural" OR "semi-natural" OR "semi natural")) AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*")</p> <p>merged with</p> <p>TITLE-ABS-KEY: ("woodland creation*" OR "mid-field islet*" OR "environmental island*" OR "refuge*" OR "scattered tree*" OR "shading tree*") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*")</p> <p>6) TS= ("landscape feature*" OR "landscape characteristic*" OR "green infrastructure*" OR "landscape connectivity" OR "landscape diversity" OR "landscape element*" OR "landscape fragment*" OR "landscape mosaic*" OR "landscape structure*" OR "nature-based feature*" OR "linear feature*") AND TS= ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*")</p> <p>or</p> <p>TITLE-ABS-KEY: ("landscape feature*" OR "landscape characteristic*" OR "green infrastructure*" OR "landscape connectivity" OR "landscape diversity" OR "landscape element*" OR "landscape fragment*" OR "landscape mosaic*" OR "landscape structure*" OR "nature-based feature*" OR "linear feature*") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*")</p> |
| Search dates | No time restrictions |
| Databases | Web of Science and Scopus, run in October 2021 |
| Selection criteria | The main criteria that led to the exclusion of a synthesis paper were when the paper: 1) does not deal with any landscape feature; 2) does not synthesise pairwise comparisons on the effect of landscape features; 3) does not include results for cropland or grassland; 4) deals with agroforestry; 5) is either a non-systematic review, a non-quantitative systematic review, or a meta-regression |

without mean effect sizes; 6) is not written in English. Synthesis papers that passed the relevance criteria were subject to critical appraisal carried out on paper-by-paper basis.

The search returned 244 synthesis papers potentially relevant for the practice object of our fiche. From the 244 potentially relevant synthesis papers, 136 were excluded after reading the title and abstract, and 74 after reading the full text according to the above-mentioned criteria. Finally, 34 synthesis papers were selected for landscape features, from which 5 were relevant for this impact.