

# What is the evidence that public money leads to public goods delivery from agri-environment schemes?



## Key messages

- There is strong evidence that public goods including climate change mitigation, improved water quality and soil health can be provided by several on-farm interventions, such as watercourse fencing to exclude livestock, conservation tillage and planting hedges in arable land
- However, for the majority of options and public goods investigated, evidence was mixed or weak, and it was not possible to assess the magnitude or rate of change, requiring more research
- There are policy options that could prioritise public money for public goods that can most reliably be delivered, while developing the evidence-base for interventions that are feasible on-farm via Environmental Land Management Scheme (ELMS) pilot trials

# The Research

Researchers have assessed the evidence base for a number of agri-environment options, asking whether they deliver on ‘public money for public goods’. Two teams of researchers completed reviews of 13 options, considering evidence from over 250 peer-reviewed papers:

- Options considered included: fencing waterways from livestock, soil loosening, tree planting on floodplains, conversion of grass to woodland or arable to woodland, buffer strips, agroforestry, conservation tillage, organic amendments to arable land, hedges, cover crops, over-winter stubble and leys in arable rotations

- Public goods evaluated were: water quality (including N and P concentrations, suspended sediment, *E. coli*), flood risk alleviation (based on changes in channel discharge, soil bulk density, aggregate stability, porosity, infiltration rate and hydraulic conductivity), climate change mitigation (carbon stocks) and soil health (based on eight soil health indicators)

The research was conducted by the Resilient Dairy Landscapes project and Yorkshire Integrated Catchment Solutions Programme (see further information

# Key Findings

The following table lists agri-environment options for which there was robust evidence for specific public goods, based on certain well-studied indicators.

For other options and public goods, evidence was mixed or weak and it was not possible to assess the magnitude or rate of change, requiring more research. For

example, planting trees on floodplains reduces channel discharge<sup>1</sup>, but the effect was variable<sup>2</sup>, the potential for confounding was high, and publication bias is strongly suspected<sup>3</sup>. Due to the lack of direct evidence the overall strength of evidence is low, indicating high uncertainty.

Scheme option	Public good (indicator used in brackets)
Watercourse fencing to exclude livestock	Water quality (led to a reduction in P and <i>E. Coli</i> )
Converting arable land to woodland	Climate change mitigation (soil carbon stock increases)
Grass-clover leys in arable rotation	Climate change mitigation (soil carbon increases)
Conservation tillage	Soil health (soil carbon, aggregate stability, infiltration all increase)
Hedges in arable land	Climate change mitigation (soil carbon increases)
Organic amendments	Climate (soil carbon increases) and soil health (aggregate stability, earthworms) BUT could lead to reductions in water quality if the amendment contains high concentrations of nutrients, heavy metals, pathogens and emerging contaminants

<sup>1</sup> Standardised mean difference -0.35, 95%CI, -0.71 to 0.00

<sup>2</sup> I<sup>2</sup> = 81.91%

<sup>3</sup> Egger Test z = 3.0568, p = 0.002

## Evidence gaps

- Few studies compared soil health indicators of buffer strips in and around grass fields
- Agroforestry may improve soil health but more data is urgently needed from temperate agroforestry systems to draw reliable conclusions, as most studies are from tropical and sub-tropical areas
- There is limited evidence on impacts on soil health of planting agricultural land with deciduous trees (66% of studies were related to coniferous afforestation)
- In contrast to our understanding of above-ground hedgerow function, little is known about how hedgerows affect the below-ground soil systems and health
- There is limited research on the effects of introducing grass leys into arable rotation, cover crops, organic amendments or woodland conversion on soil aggregate stability, bulk density and infiltration and thus how they mitigate flooding
- Very few studies reported the impact of the land management activity on crop yield as well as soil health indicators, making it difficult to evaluate how best to develop agricultural systems which are able to balance productivity with protecting and enhancing the environment. For soil loosening, where yield data were available there was not a statistically significant impact on pasture yield<sup>4</sup>
- Most studies are conducted at plot level and few are at catchment scales

## Limitations

- There is a high degree of uncertainty over the effect of some interventions on the specific public benefits for which we assessed evidence. As a result, for some interventions there is not sufficient evidence to determine whether or not these options deliver the assessed public goods at present, pending further research and trials
- There are a number of sources of uncertainty, for example soil depth sampled, choice of species/combination of species, the time taken for many public goods to arise from changes in land management, the different ways in which options are implemented in very different biophysical contexts
- A lack of standardised methodologies for collecting or reporting data makes it difficult to create robust syntheses for decision-makers in policy and practice

<sup>4</sup> 12 studies, pooled effect size -0.35; 95% CI from 1.02 to 0.31

# Policy Options

## 1. Using public money for public goods

- Address the evidence gaps above through Environmental Land Management Scheme (ELMS) pilot trials involving farmers and other land managers to develop the evidence-base for interventions that are feasible on-farm
- Builds flexibility into the ELMS so that activities can be reviewed/added/removed as more robust evidence becomes available
- Funding could be prioritised towards scheme options with the best evidence for delivering public goods via an 'evidence-based premium' for the options we know are most likely to deliver multiple public goods
- Code of good practices could be made part of a future scheme, such as the recent Defra Code of Good Agricultural Practice (COGAP) for reducing ammonia emissions, providing simple, evidence-based ways to reduce NH3 emissions

## 2. Generating better evidence to inform post-Brexit policy

- Government, researchers, farmers and other stakeholders should agree on core common outcomes (effects of interventions) for which data should be collected and reporting standards for environmental research in the UK, and assess the potential for developing international standards for environmental research more broadly
- The International Union for Conservation of Nature are planning to attempt this for peatland research in 2019 as a test case and, if successful, the approach could be widened
- There should be a call for rapid evidence syntheses from the research community to cover a targeted range of interventions/options that farmers are likely to take up, to assess their ability to deliver multiple public goods
- Evidence gaps highlighted in this policy brief may provide a focus for current/future research, including Defra-funded trials/tests and use of transition period funding
- Identified gaps should be targeted by UKRI's existing or new research funding mechanisms, with an aim to significantly improve the evidence base

## Further Information

The Resilient Dairy Landscape project is funded by Global Food Security's 'Resilience of the UK Food System in a Global Context' programme with BBSRC, ESRC, NERC and Scottish Government. Find out more at [www.resilientdairylandscapes.com](http://www.resilientdairylandscapes.com) or contact Mark Reed ([mark.reed@newcastle.ac.uk](mailto:mark.reed@newcastle.ac.uk)) or Jenny Gilroy ([jenny.gilroy@newcastle.ac.uk](mailto:jenny.gilroy@newcastle.ac.uk))

The Yorkshire Integrated Catchment Solutions Programme (iCASP) is funded by NERC. The full report and policy brief is available here: <https://icasp.org.uk/resources/public-goods/>. Contact Finn Barlow-Duncan ([F.Barlow-Duncan@leeds.ac.uk](mailto:F.Barlow-Duncan@leeds.ac.uk)) or Pippa Chapman ([P.J.Chapman@leeds.ac.uk](mailto:P.J.Chapman@leeds.ac.uk)).