SR4
A Systematic Map

MISTRA EviEM
EVIDENCE-BASED ENVIRONMENTAL MANAGEMENT

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Effects of agricultural management on soil organic carbon

Agricultural land has great potential to store carbon. With the right choice of cultivation methods and cropping systems, it can be transformed from a source of greenhouse gases into a sink for carbon dioxide. Mistra EviEM has assessed what evidence exists on the topic.

The carbon content of arable soil depends very much on the type of farming practices used. Photo: Jan Håkan Dahlström/ Bildhuset/ IT.

Carbon in soils is important for crop yields and climate

On farmland that is harvested annually, the carbon content of the soil declines as organic compounds are broken down, removed in the form of crops, leached out by run-off or lost by erosion. Globally, the top one metre of the soil contains roughly three times as much carbon as the above-ground biomass of plants, and twice as much as the atmosphere. Changes in the stock of soil carbon can therefore cause significant changes in the atmospheric concentration of carbon dioxide. On a global scale, the losses from agricultural soil is of the order of 100 to 1,000 million tonnes of carbon every year.

However, there are methods that can reduce carbon losses or even increase the sequestration (capture) of carbon in arable soils, even though the land continues to be farmed. Trials involving modified ploughing have led to higher carbon levels in certain areas, although the results in Sweden have been mixed.

Mapping the evidence

To date there has been no thorough investigation of the impacts of agricultural management on soil organic carbon. EviEM has therefore produced a systematic map which reviews and describes the existing evidence to better understand the state of current knowledge on the subject.

The searches for literature initially identified almost 25,000 articles as possibly relevant to the subject of the review. Through several stages of screening, most of these articles were subsequently excluded, but after close reading, 735 studies have been assessed as useful.

The map identified four broad categories of arable farmland practices, each having been investigated by between 238 and 307 studies: soil amendments (additions and modifications to the soil, for example the application of lime or crop residues), crop rotations (such as monocultures or complex rotations of different crops each year), use of fertiliser (inorganic and organic), and tillage (different depths of soil disturbance).

The review covered areas with a temperate or boreal climate. We found studies from the majority of these areas, as shown on the map overleaf, but there was a lack of studies from Russia, a sign of a knowledge gap in the literature.

The mapping process also identified several common problems with the research methods used in many studies. The majority of studies only sampled soil carbon at one point in time, whereas a few studies sampled the soil on a yearly basis to get a very accurate picture of change in carbon storage over time. Additionally, most studies only looked at a small number of replicate samples in each experiment, meaning that the averages calculated may not be as reliable as possible. One final problem was that over a quarter of studies did not provide enough detail regarding their methods.

Implications of the findings

The long-term study sites identified in this map provide a useful addition to existing databases of long-term experiments (LTEs). Furthermore, the review highlights 127 rele-

vant reviews and meta-analyses that have been conducted on the topic. Finally, a Geographical Information System (GIS) that displays the identified studies in detail allows users to interact with the evidence base, accessing detailed information about studies of greatest interest.

The identification of knowledge gaps, such as the lack of studies from Russia, shows that there is a need to better document the research that is being undertaken globally. The database of studies allows users, such as policymakers and farmers, to identify where research is lacking and where evidence exists that they can use in their decision-making. It is hoped that this map database will be regularly updated to provide a quick-to-use resource for those wanting to find evidence on how farmland management can affect carbon storage.

Free access to full report

The GIS application and a more detailed description of the project are available at the EviEM website (www.eviem.se/en/projects/Soil-organic-carbon-stocks/). The full report on the review can be downloaded there. The report has also been published in the *Environmental Evidence* journal.

What is a systematic map?

In this review we used a systematic approach to collate and catalogue available evidence on how farming practices affect soil organic carbon. A systematic map is characterised by meticulous planning, methodological procedures and a transparent, complete documentation of all assessments carried out in the course of the work. This approach is designed to avoid bias and increase reliability and repeatability.

How this review was conducted

This review was initiated and financed by the Mistra Council for Evidence-Based Environmental Management (EviEM). It was conducted as a project by a specially appointed team of researchers chaired by Katarina Hedlund, a Professor from Lund University. The project was managed by Neal Haddaway, EviEM.

EviEM

The Mistra Council for Evidence-Based Environmental Management (EviEM) strives to ensure that environmental management in Sweden is informed by the best possible scientific evidence. Through systematic reviews of relevant research, we aim to improve the basis for decisions in environmental policy. EviEM is funded by the Swedish Foundation for Strategic Environmental Research (Mistra) and hosted by the Royal Swedish Academy of Sciences. It is financially and politically independent.

Screenshot of the Geographical Information System that displays the content of the systematic map database on a map of the world. One entry (Hungria et al. 2009) is shown for demonstration purposes.

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