SR10
A Systematic Review

MISTRA EviEM
EVIDENCE-BASED ENVIRONMENTAL MANAGEMENT

EviEM Fact Sheet 2017

Impact of reduced tillage of arable land on soil organic carbon

There is a great potential for storing carbon in agricultural land and thus for mitigating climate change. EviEM has investigated what impact reduced tillage on arable land has on soil organic carbon (SOC).

Soil organic carbon in farmland important for climate and soil fertility

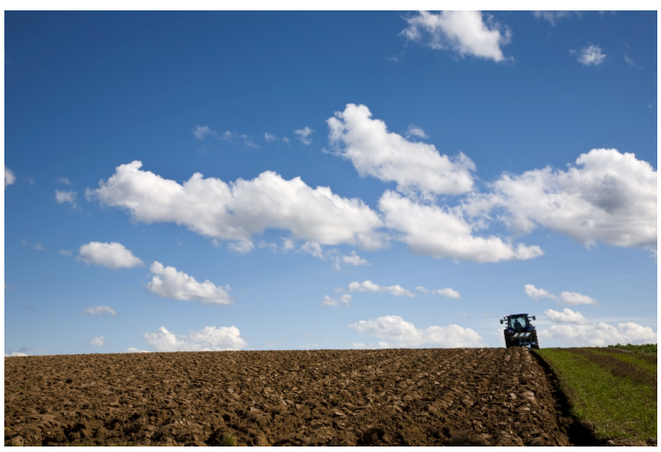
With the right farming methods and systems, agricultural land can be transformed from a source of greenhouse gases into a carbon dioxide sink. In addition to counteracting climate change, increased soil organic carbon in farmland contributes to increased diversity and activity of soil organisms, which in turn increases nutrient cycling and provides a favourable soil structure.

Tillage practices prepare the soil for cultivation and eliminate weeds that would otherwise compete with crops and reduce yield. Tillage has long been considered to improve soil structure and enable harvest residues to be incorporated into the soil. Nevertheless, there are indications that reduced tillage can minimise losses of soil organic carbon, especially if combined with methods for increasing the carbon content in the soil.

Several overviews have compared no-tillage management with intensive tillage. Some studies have found positive effects of no-tillage on the amounts of soil organic carbon, while others found no such effect. The results vary between different studies depending on whether the researchers measured the amount of carbon in the top soil layers only or in the entire soil profile. Here we have taken a broader approach by conducting a *systematic review*, quantitatively synthesising literature on how different intensities of tillage affect the amounts of soil organic carbon at different depths in arable land.

More carbon in arable soil with reduced-tillage and no-tillage practices

Overall, the studies analysed in this review show that soils with no-tillage practices have higher *concentrations* of organic carbon than soils with intensive tillage. Concentrations were significantly higher with no tillage than with intensive tillage (difference 2.09 g/kg) but also in comparison to reduced-tillage cultivation (difference 1.18 g/kg). Even reduced tillage led to significantly higher carbon concentrations than intensive tillage (difference 1.30 g/kg). When we analysed the *stocks* of carbon in the top soil layer (0 to 30 cm), we found that no-tillage soils stored significantly more soil carbon than soils under intensive tillage (difference 4.61 tonnes/ha) or reduced tillage (difference 3.85 tonnes/ha).

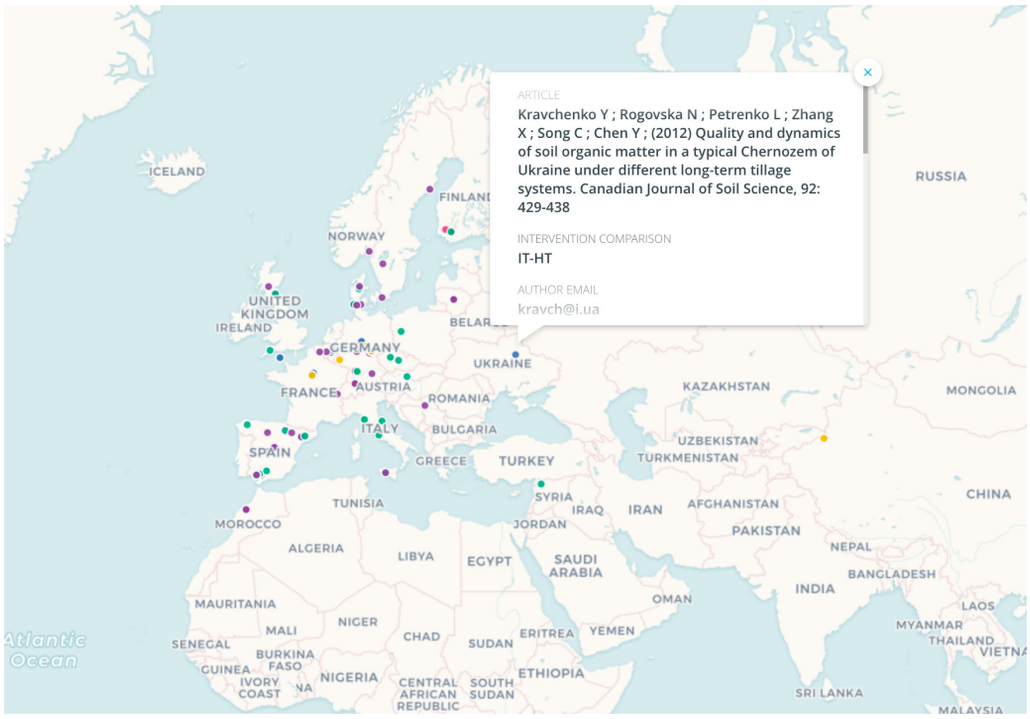


Agricultural field. Photo: iStock.

Most studies only reported on carbon in the upper soil layer, and only a third of all studies attempted to estimate concentrations or stocks of carbon deeper than 15 cm from the surface. However, our analyses show that it is primarily in the top soil layer that more carbon is accumulated under reduced or no tillage.

Carbon stocks in arable soil change only slowly when agricultural practices have been altered. In the systematic review, therefore, only studies that had lasted longer than ten years were included. The longer the studies, the more carbon was found to be stored in the top soil layer (0 to 15 cm depth). On the other hand, we found no clear increase in carbon storage over time in deeper soil layers. This is likely due to the large variation between different studies or to carbon being stored at a lower rate further down into the soil profile.

Tillage practices do not only affect carbon storage in the soil. Assessments of whether a certain practice is useful or not also have to account for its effects on crop yields, risk of soil erosion and emissions of nitrous oxide, which is an important greenhouse gas.



A screenshot of the map database for our review, which presents all of the studies found in an interactive atlas.

Implications of the findings

Our review and meta-analyses have shown that reduced tillage practices lead to more carbon being stored in the upper soil layer than with intensive tillage. Our analyses also show that we still cannot detect changes in the carbon stock throughout the soil profile, but this could be due to a lack of data.

Most studies in our review included only a small number of replicates of each trial, which means that calculated mean values are not as reliable as they might otherwise have been. Furthermore, the review provides quantitative support to the claim that changes in soil organic carbon in arable land cannot be observed over shorter times than ten years. It is thus crucial for research funding to support longer-term experiments.

It is clear that there is a strong interest among farmers to find ways to use their land more sustainably, both from economic and environmental perspectives. The United Nations Food and Agriculture Organization (FAO) has launched the Global Soil Partnership, which could raise the need for such activities to an intergovernmental level.

Free access to full report

A more detailed summary of this review is available at the EviEM website (www.eviem.se/en). The full report on the review can also be downloaded there. The report has been published in the journal *Environmental Evidence* (www.environmentalevidencejournal.org).

What is a systematic review?

A systematic review is characterized by meticulous planning, methodical 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 systematic review was initiated and financed by the Mistra Council for Evidence-Based Environmental Management (EviEM). The review was conducted as a project by a specially appointed team of researchers chaired by Katarina Hedlund, professor at the Centre for Environmental and Climate Research (CEC), Lund University, Sweden. 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 Stockholm Environment Institute (SEI). It is financially and politically independent.

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