IEAGHG Information Paper: 2017-IP30; Soil Organic Carbon Sequestration

Breakthrough Strategies and Solutions recently organised a webinar on soil organic carbon sequestration (SOCS), with three leading experts on the topic: Keith Paustian (Colorado State University), Jean-Francois Soussana (INRA) and Eric Toensmeier (Yale University).

The organisers also provided a summary of the webinar's highlights, which are as follows:

- It is possible to remove significant amounts of CO_2 from the atmosphere and store it as organic carbon in soil. Much of the potential to increase carbon storage in soil is due to the large historic losses of soil carbon due to land use change, deforestation, tilling and other land disturbances.

- The range of technical potentials that have previously been estimated for agricultural lands (cropland and grassland) have been in the range of 3 - 8 $GtCO_2e$ annually (see Figure 1), but for a limited duration. In order to stay below 2°C of average global warming and strive to stay below the more ambitious target of 1.5°C, we must as a global community both reduce emissions from fossil fuels and other greenhouse gas sources and remove carbon dioxide from the atmosphere, through forestry, agriculture, land restoration, and possibly various industrial methods. By 2030, a gap of 12 $GtCO_2e$ will prevent the world from reaching the targeted 2°C maximum global warming threshold. Soils have a critical role to play in closing this gap.

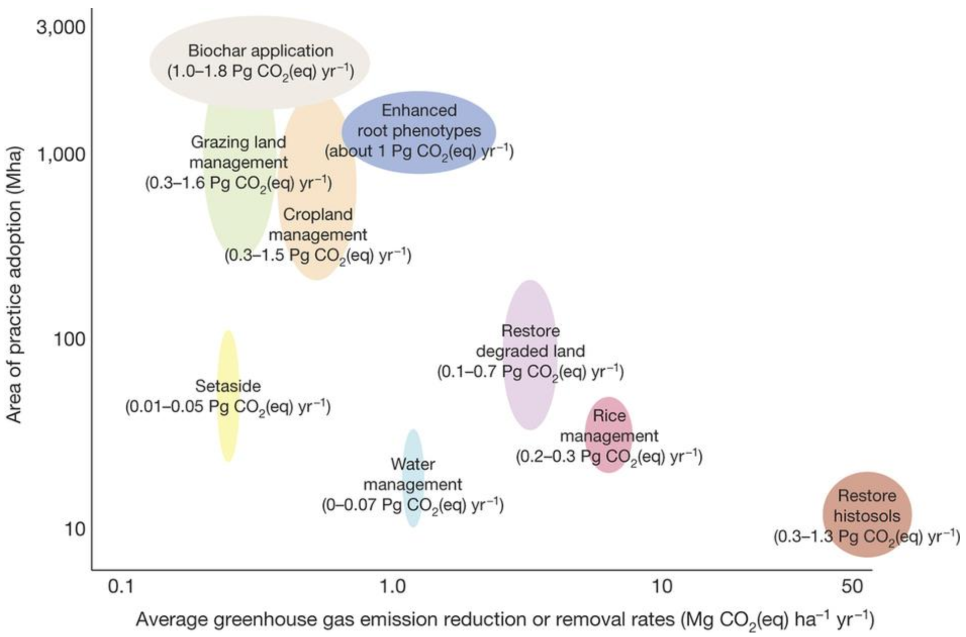

Figure 1 Global GHG mitigation potential of different agricultural practices[1]

- Carbon removal through SOCS has multiple co-benefits including improving soil health, thereby improving resilience and adaptation to climate change and strengthening food security.

- SOCS is not inherently permanent; in other words if the practices that led to the increase in soil carbon are not maintained, then the previously stored carbon can be emitted again as

[1] Paustian et al., 2016. Climate-smart soils. Nature, 532, 49–57 (07 April 2016)

CO_2. Also, increases following a management improvement are for limited duration, typically on the order of 20-30 years, as the soil approaches a new equilibrium level. New work on biochar amendments to soil, deeper-rooted crops, perennial crops and compost applications may add to the possibility of longer term sequestration. But in general, to keep the increase of soil C in the ground, the improved management practices that gave the increases must be maintained over time.

- There are limits to the total amount of sequestration that might be achieved through agricultural soils. Soils can reach a saturation point (see Figure 2). Further, adequate N and P supplies are needed to form the stabilized soil organic matter that contains the bulk of soil carbon. There is not yet adequate data on this but it is important to note this emerging analysis.

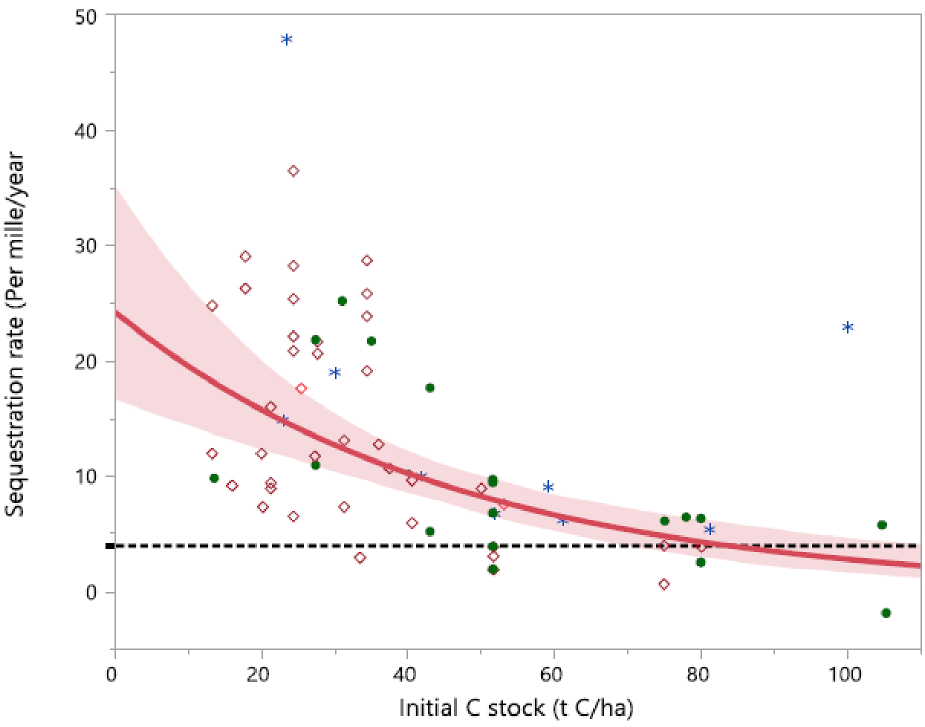

Figure 2 Saturation effect of SOCS rate[2]

- The potential for agroforestry for small land holders in particular holds more promise than is currently reflected in some of the Intergovernmental Panel on Climate Change (IPCC) estimates for SOCS.

- The “4 per 1000” initiative has a target of 3.4 GtC/yr of SOCS, which is the sum of agricultural soils (1.4 GtC/yr), desertified/salinized soils (0.9 GtC/yr), and forest soils (1.1 GtC/yr).

In addition to the highlights summarised by Breakthrough Strategies and Solutions, I would like to add the following points:

[2] Minasny et al., 2017. Soil carbon 4 per mille. Geoderma, Volume 292, Pages 59–86 (15 April 2017)

- Carbon depleted soils usually have the highest potential SOCS capacity gain but the least propensity to do so. Currently, about half of all agricultural soils are considered degraded/depleted.

- There seems to be a reasonably good knowledge today of how soils respond to management practices.

- Similar to other carbon removal approaches, the challenge is how to realise the technical potential, i.e. in a politically and economically feasible way. Estimates point to 80% of the technical potential being realisable for 100$/t$CO_2$.

- Storing 1.4 GtC/yr in soil, i.e. a rate of 0.4%/yr, can have the additional benefit of increasing crop yields by up to 1.3%/yr. This is why several researcher highlight SOCS potential to prevent calorie losses in climate change scenarios and to help with food security.

- Several practices are already in place or planned in the near future. However, the ones in focus are not necessarily the ones with the highest GHG mitigation impact (see Figure 3).

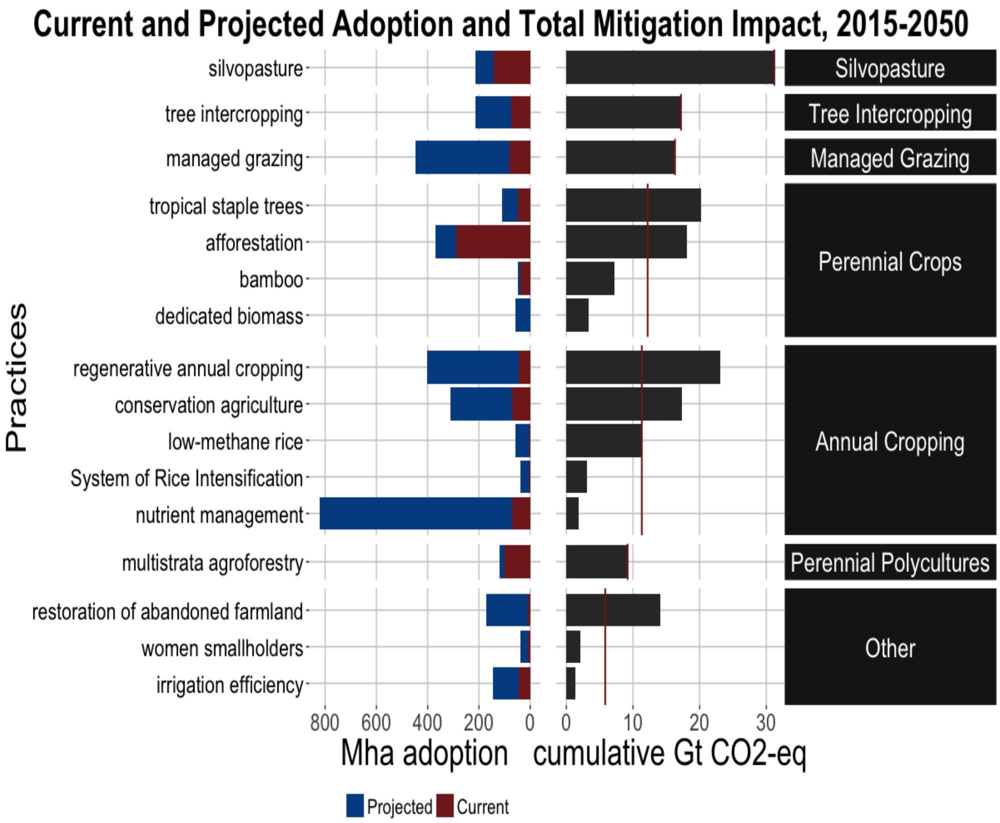

Figure 3 Estimated mitigation impact of different agricultural practices[3]

The SOCS webinar and related materials are available on the following website:

https://www.breakthroughstrategiesandsolutions.com/resources

[3] Hawken, 2017. Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming. Penguin Books, New York.

In addition, German researchers recently published an interesting study looking at the trade-offs for food production, nature conservation and climate related to terrestrial carbon dioxide removal (tCDR)[4] using large-scale biomass plantations. tCDR potentials of these systems depend on factors such as land availability, carbon capture efficiency and timing (i.e. carbon debts). The researchers found that, under their assumptions for future nature protection and food production, tCDR potentials are limited. Bioenergy plantations on abandoned cropland and pasture could potentially store 100 GtC by 2100, using 1,300 Mha. However, the authors point out that this potential would be 80% lower if only cropland was available and 50% lower if albedo changes were considered. Using natural forests, shrublands or grasslands results in a large tCDR potential but would come at high environmental costs, such as loss of biodiversity.

In conclusion, SOCS and tCDR have significant technical GHG mitigation potentials but the realisable potentials are much smaller, due to several limitation. The best bet would thus be a balanced portfolio of mitigation options.

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[4] Boysen et al., 2017. Trade-offs for food production, nature conservation and climate limit the terrestrial carbon dioxide removal potential. Global Change Biology. 1365-2486 (29 May 2017)