Letter to World Resources Institute Regarding Soil Carbon Sequestration

August 20, 2020

In July 2019 the World Resources Institute (WRI) published a report entitled "*Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050.*" See https://files.wri.org/s3fs-public/wrr-food-full-report.pdf, and see https://wrr-food.wri.org for the Synthesis Report. One aspect addressed ways to decrease greenhouse gas (GHG) emissions in agriculture including a detailed discussion of sequestering carbon in soils. This was followed by a WRI blog on the subject: https://www.wri.org/blog/2020/05/regenerative-agriculture-climate-change, entitled "Regenerative agriculture: Good for Soil Health, but Limited Potential to Mitigate Climate Change."

Our understanding is that WRI felt it important to draw attention to the topic of carbon sequestration in agricultural soils to mitigate climate change because there has been intense interest in the subject, especially in the context of agricultural practices often grouped under headings such as "regenerative agriculture" or "conservation agriculture." Soil carbon sequestration has been the subject of numerous academic papers and popular articles and has been highlighted in several IPCC reports. The topic has generated considerable debate among scientists, with some strongly promoting the importance of soil carbon sequestration in mitigation of climate change, whereas others have argued its potential has been vastly overstated.

We write to state our general agreement with the arguments put forward by WRI in their communications. In summary, these are:

1. Increasing the organic carbon content of agricultural soils is almost always beneficial for the health and functioning of soils, leading to decreased risk of soil erosion, improved conditions for the growth of crop roots and to increased resilience of agricultural systems to adverse weather conditions, including the impacts of climate change. It is therefore appropriate to promote practices likely to increase soil carbon (or to slow the loss of soil carbon) wherever possible; such practices are expected to contribute to food security and environmental protection and can be regarded as an aspect of climate change adaptation.

2. There are several reasons why the quantity of carbon that can captured in this way in soils that continue to be used for productive agriculture is limited. On the basis of a strong body of evidence, we consider that there is a strong risk that the magnitude of what is practically achievable is overstated, which gives a misleading impression to decision-makers.

The WRI report and blog point out that the largest quantities of carbon are sequestered when cropland is either taken out of agriculture (e.g. returned to some form of natural vegetation) or converted to perennial cropping such as pasture for grazing. But there are major limitations to the areas where this type of change can be practiced. If one farm removes an area from producing crops, it is highly likely that land will be cleared elsewhere to make up the shortfall – concurrently causing release of carbon in addition to loss of habitat. Pursuing land use changes such as these may be valuable, where it is possible, but it would require combinations of moderation in demand for agricultural produce, increases in the yields of crops and pastures on land that continues to be used for agriculture, and governance to protect and restore forests and other native habitats.

We also note that a large factor in the potential for soil sequestration that is often stated is the avoidance of land clearance such as deforestation and drainage of wetlands and peat soils. These measures are clearly beneficial, but it is misleading to put them in the same category as the potential for carbon sequestration on existing farmland.

Meanwhile, emerging science has greatly reduced – or even eliminated – the expected carbon sequestration benefits from the two practices that are usually promoted and seem the most generalizable for this goal; namely reduced tillage and various forms of grazing management. Adding manure or compost increases soil carbon and is beneficial for soil health, but generally does not represent an additional transfer of carbon from atmosphere to soil, but rather a relocation from one landscape position to another. That leaves practices like cover crops, inter-cropping and a range of agroforestry practices as options to sequester C within agricultural soils. These are promising, have many other benefits, and should be strongly encouraged where appropriate. However, in most situations, it has yet to be shown how such practices can be scaled up to the degree necessary to achieve significant climate change mitigation whilst also achieving the economic imperatives of practical agriculture.

An additional point regarding sequestration of carbon in soil, regardless of practice, is that the quantity is finite: soil organic carbon stock does not increase indefinitely. Instead it moves asymptotically towards a new steady state value with declining rates of gain. Because the majority of experiments are relatively short-term, the annual values cited tend to be those made in the early years after a management change and thus are higher than the annual rate over a longer period. This phenomenon of declining rates of soil carbon accumulation can be easily overlooked by non-specialists when seeing a single annual rate of carbon sequestration. It may not be obvious that this differs from the annual CO_2 saving from replacing a fossil fuel power plant with solar or wind power where the annual saving continues indefinitely.

To summarize, many practices can be applied on working agricultural lands which will lead to increases in soil carbon, but according to the best scientific evidence available, the amount of soil carbon that can be sequestered is limited. It seems appropriate to regard the climate change benefits from soil carbon sequestration through achievement of these practices as a co-product of other goals, such as improving soil health and agricultural resilience.

David Powlson, Lawes Trust Senior Fellow, Rothamsted Research, U.K.

Robert Boddey, Researcher, Embrapa Agrobiology, Brazil

Kenneth G. Cassman, Emeritus Robert B. Daughtry Professor of Agronomy, University of Nebraska, U.S.A.

Pauline Chivenge, Senior Soil Scientist, International Rice Research Institute, Philippines

Ken Giller, Professor of Plant Production Systems, Wageningen University and Research, Netherlands

Keith Goulding, Sustainable Soils Research Fellow, Rothamsted Research, U.K.

Chris van Kessel, Professor Emeritus, University of California at Davis, U.S.A.

Cheryl Palm, Research Professor of Agricultural and Biological Engineering, University of Florida, U.S.A.

Jan Willem van Groenigen, Professor of Soil Biology, Wageningen University and Research, Netherlands