Vol. 3 Issue-10, June 2023 (e-ISSN: 2582-8223)

Soil Carbon Sequestration and Climate Change

G. Sarvatha[1] and Elakiya, N. [2]
[1] III B.Sc., (Hons.) Agriculture,
JKK Munirajah College of Agricultural Sciences, Gobichettipalayam, Erode
[2]Assistant Professor (Soil Science & Agricultural Chemistry),
JKK Munirajah College of Agricultural Sciences, Gobichettipalayam, Erode

ARTICLE ID: 72

Introduction

There is a growing body of evidence supporting the hypothesis that the earth's climate is rapidly changing in response to continued inputs of CO_2 and other greenhouse gases (GHGs) to the atmosphere resulting from human activities. Currently CO_2 concentration is increasing at the rate of 3.3 Pg/ year. An option for reducing atmospheric CO2 concentration includes reducing future emission as well as sequestrating CO2that has already accumulated in the atmosphere. There is no strategy to reduce climate change without using the vast carbon sink's available in world's soils. Over the countries, human activities have degraded soil, resulting in the loss of nearly 70 percent of their organic carbon content in the soil. Soils hold more carbon than the atmosphere or plant and animal life combined. Thus the term carbon sequestration which alters the climate change finds importance now.

Soil Carbon Sequestration

Carbon sequestration is a process by which large amounts of CO_2 are captured, compressed, transported and stored by geological and biological means. Biological C sequestration is the long term storage in soils and vegetation. Soil carbon sequestration is when plants capture and store, or "sequester," atmospheric carbon dioxide (CO_2) in the soil, increasing the quantity of soil carbon stocks. It is dependent on intentional land management targeted at enhancing the storage of carbon as soil organic matter and in labile, inorganic forms.

It is one of the negative emission technology (NET) minimizing sinks re-emission and increases mean residence time (MRT).Being one of the three main approaches to CO_2 removal and storage through management of terrestrial ecosystems, SOC (Soil Organic Carbon) sequestration with adoption of recommended technologies depends on soil texture and structure, rainfall, temperature, farming system, and soil management. It relies on the adoption

JUST AGRICULTURE
multidisciplinary e-Newsletter

of improved management practices that increased the amount of carbon stored as soil organic matter, primarily in cropland (10% of the total land area) and grazing lands.

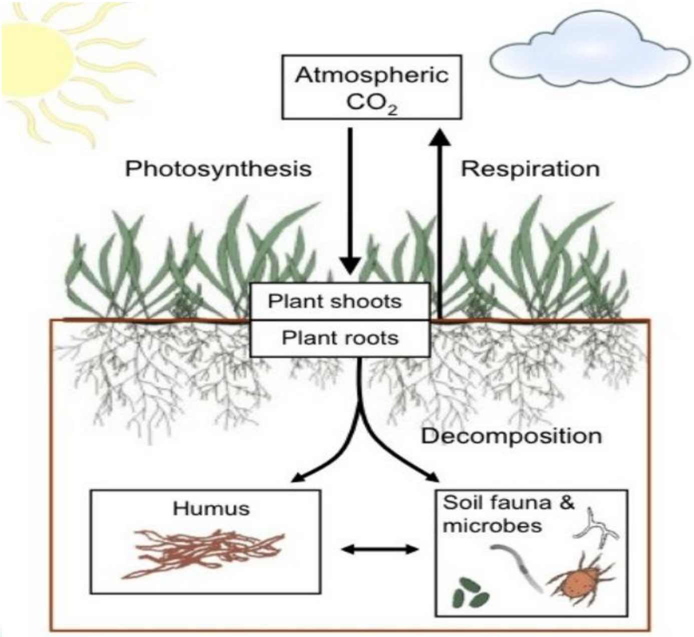

Fig. 1. Carbon balance within the soil controlled by carbon inputs from photosynthesis and carbon losses by respiration (Source : USDA Natural Resources Conservation Service)

Potential Scale

Soils hold three times the amount of carbon currently in the atmosphere or almost four times the amount held in living matter. But over the last 10,000 years, agriculture and land conversion has decreased soil carbon globally by 840 billion metric tons of carbon dioxide (GtCO2), and many cultivated soils have lost 50–70% of their original organic carbon. Because soils have such a large storage capacity, enhancing soil storage by even a few percentage points makes a big difference. A recent expert assessment estimates that soil carbon sequestration could be scaled up to sequester 2–5 $GtCO_2$ per year by 2050, with a cumulative potential of 104–130 $GtCO_2$ by the end of the century.

Since over one third of arable land is in agriculture globally (World Bank, 2015a), finding ways to increase soil carbon in agricultural systems will be a major component of using soils as a sink. There is a strong scientific basis for managing agricultural soils to act as a significant carbon (C) sinks over next several decades. French government proposed COP 21

JUST AGRICULTURE
multidisciplinary e-Newsletter

– UNFCC in Paris in Dec 2015 that SOC concentration to be increased globally at the rate of '4 per 1000' to offset anthropogenic emissions.

Process of carbon sequestration in soil

Processes behind sequestration are photosynthesis, decomposition , respiration. Primarily mediated by plants through photosynthesis. Through the process of photosynthesis, plants assimilate carbon and return some of it to the atmosphere through respiration. The carbon that remains as plant tissue is then consumed by animals or added to the soil as litter when plants die and decompose. The primary way that carbon is stored in the soil is as soil organic matter (SOM).

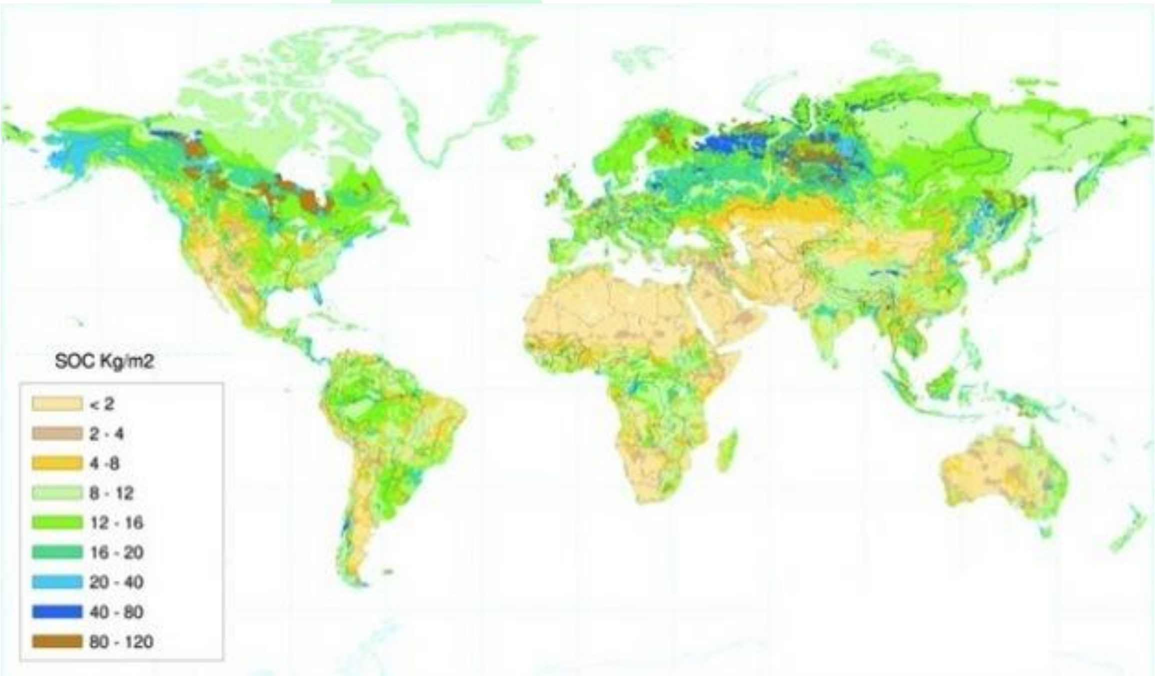

Fig. 2.

World map showing the quantity of SOC to 1 m depth

(Source : USDA Natural Resources Conservation Service)

SOM is a complex mixture of carbon compounds, consisting of decomposing plant and animal tissue, microbes (protozoa, nematodes, fungi, and bacteria), and carbon associated with soil minerals. Carbon can remain stored in soils for millennia, or be quickly released back into the atmosphere. Climatic conditions, natural vegetation, soil texture, and drainage all affect the amount and length of time carbon is stored. In arid and semi-arid climates soil C sequestration also occur from conversion of CO_2 from air into inorganic forms such as carbonates , however the rate of inorganic C formation is comparatively low.

Practices to Sequestrate C in Soil

- → Reducing soil disturbance by switching to low till or no – till practice or perennial crops (reduced c loss)
- → Changing planting schedules or relations such as planting cover crop / double crop , instead of leaving fields fallow
- → Managed grazing of livestocks
- → Applying compost or crop residue to fields

Practice	Soil carbon sequestration potential (Mg C ha^{-1} y^{-1})	Estimated uncertainty
Zero tillage	0.38 (0.29)*	>50%
Set-aside	<0.38	>>50%
Permanent crops	0.62	>>50%
Cereal straw	0.69 (0.21)*	>>50%
Conversion of cropland into grassland	1.2-1.69 (1.92)*	>>50%
Conversion of cropland into woodland	0.62	>>50%

Fig. 3. Practices influencing soil carbon sequestration potential

Soil potential to sequester C

According to Intergovernmental Panel on Climate Change (IPCC,2000), one of the best reservoirs of carbon is soil. Uplands hold upto 300-500 kg/ha (0.01%-0.02%) while wetlands hold upto 800-1000kg /ha (0.04%-0.05%). California adopted Marin carbon project i.e., applications of large quantities of compost and mulch to forestland which is a comprehensive carbon farm plan to sequestrate carbon in soils which significantly resulted in C sequestration in soil.

JUST AGRICULTURE
multidisciplinary e-Newsletter

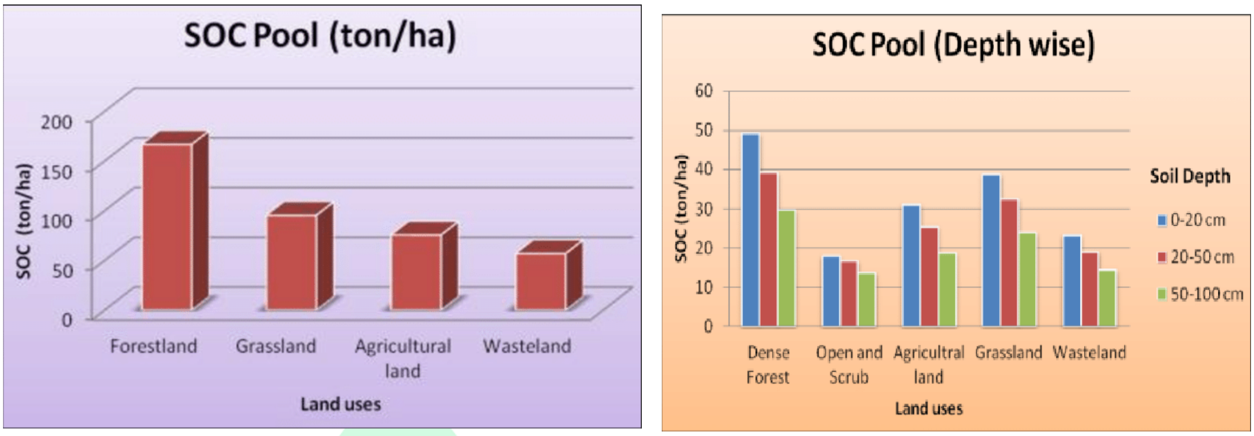

Fig. 4. SOC pool in different agri-ecosystems & depth

Agricultural soils sequestrate around 20 Pg C in 25 years, more than 10% of the anthropogenic emissions. However, modern agricultural practices and land conversion decreased soil C by 840 billion Mt of CO_2 ($GtCO_2$) and cultivated soils lost 50-70% of the original organic carbon. Hence, by adoption of restorative land use and recommended management practices on agricultural soils would reduce rate of atmospheric CO_2 concentration enrichment. Measured rate of sequestration ranges from 50 to 1000kg/ha/year. Enhancing soil storage by even a few percentages could make a big difference.

Co-benefits

- → Improved soil health : restores degraded soils , improve agricultural productivity
- → Improving soil organic carbon concentration to above the threshold level 1.5-2.0%
- → Restoring soil quality and its ecosystem functions and services
- → Requires less fertilizer for cropland

Challenges

- → Soils can hold only a finite amount. Once they are saturated ,societies will no longer able to capture more C using soil C sequestration
- → Reversibility:Captured C soil via soil C sequestration released if soils are disturbed. So societies would need to maintain appropriate soil management practices indefinitely
- → Monitoring ,verifying C removal via C sequestration is difficult and costly

Conclusion

Soil carbon sequestration involves transferring atmospheric carbon into the soil via plant photosynthesis and keeping those soil-based carbon pools protected as effectively as possible from microbial activity that will release the carbon back to the air. Nevertheless, incorporating carbon into soils by improving management practice should still be a priority to ensure food security. Ultimately, the need for drawdown strategies is increasingly urgent and soil carbon sequestration through agriculture warrants far greater attention from policymakers, climate negotiators, farmers, ranchers, and scientists.