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Climate Change and Soil Carbon Sequestration

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Abstract—*Population growth and climate change are the challenges of the 21th Century. It is now widely accepted that the change in climate is unusual nature of environment. All quantitative assessments show that climate change will adversely affect food security. Analysis of the impact of climate change suggests that agro-ecological systems are the most vulnerable sectors. Agriculture in developing countries lying at low latitudes is expected to be especially more vulnerable, because climate of many of these countries is already too hot. Main climate change related drivers: temperature, precipitation, sea level rise, atmospheric carbon dioxide content and incidence of extreme events may affect the agriculture sectors in many ways like reduction in agricultural productivity, limitations on water resources, exacerbation of drought periods, reduction in soil health, pest and disease outbreak etc.*

Climate change is mainly caused by anthropogenic emissions of greenhouse gases (GHG: CO2, CH_4, N_2O, HFC, PFC and SF_6), which accumulate in the earth's atmosphere and trap heat. The concentration of atmospheric carbon dioxide, a leading cause of global warming, continues to increase with world population growth and economic development.

Table 1: Composition and changes in concentration of greenhouse gases in the atmosphere

Gas	Conc. in 1985	Annual increase since 1985 to present (%)	Contribution to global warming (%)
CO2	345 ppm	0.5	50
CH4	90 ppb	0.8	19
N2O	1.65 ppm	1.0	5
CFC	0.24 ppb	3.0	15
Other	---	---	11

[Source: Advances in Agronomy (2000). Vol. 70, pp. 1-7]

Soil Carbon Sequestration

Soil carbon sequestration is the process of transferring carbon dioxide from the atmosphere into the soil through crop residues and other organic solids, and in a form that is not immediately reemitted. This transfer or “sequestering” of carbon helps off-set emissions from

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fossil fuel combustion and other carbon-emitting activities while enhancing soil quality and long-term agronomic productivity.

Soil carbon sequestration can be accomplished by management systems that add high amounts of biomass to the soil, cause minimal soil disturbance, conserve soil and water, improve soil structure, and enhance soil fauna activity. Continuous no-till crop production is a prime example.

It has been estimated that 20 percent or more of targeted CO_2 emission reductions could be met by agriculture soil carbon sequestration.

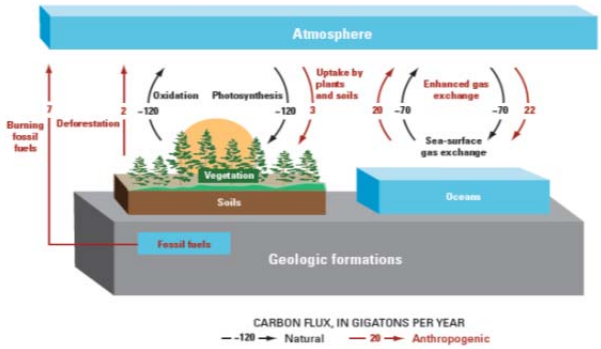

Fig. 1: The global carbon cycle

Types of Carbon sequestration

There are three main types of carbon sequestration:

Carbon sequestration in terrestrial ecosystems:- Increasing the amount of carbon stored in vegetation and soils.

Carbon Sequestration in the Oceans:- Enhancing the net uptake of carbon from the atmosphere by the oceans, through fertilization of phytoplankton with nutrients and injecting carbon dioxide to ocean depths great than 1000 meters.

The subsurface sequestration of carbon dioxide in underground geological repositories.

All of these options are commonly known as carbon "sinks". The first, increasing carbon storage in terrestrial ecosystems, is currently the focus of the most attention and is the easiest and most immediate option at the present time. The other options may become more important in the future, as the science and legal systems develop.

Soil carbon sequestration be improved

The following management practices can increase soil carbon sequestration and help to mitigate climate change:

- Add organic soil amendments i.e., compost, animal manure, biosolids, and organic mulch.

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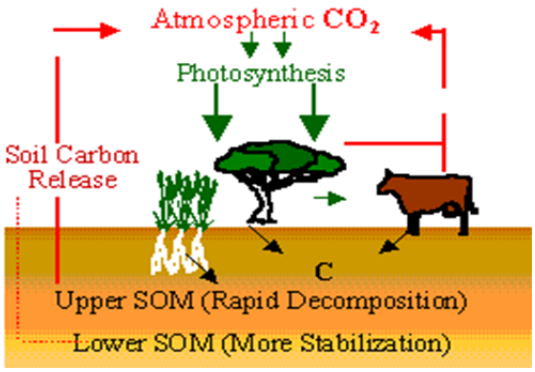
- Add biochar to the soil. Biochar is a microbially resistant carbon substance which is produced by heating organic wastes such as crop residues or wood chips in the absence of oxygen by a process called pyrolysis.
- Leave crop residues on the soil without open burning.
- Apply agronomic rates of nitrogen fertilizers to increase soil fertility and crop production.
- Adopt no-till or minimum till to avoid mechanical disturbance of the soil.
- Adopt crop rotations with cover crops in the rotation cycle.
- Switch from single crop farming to more diverse practices such as pasture, crop and pasture rotation, inter-cropping (growing two or more crops close to each other), pasture cropping (sowing crops such as cereals into pastures), and agroforestry (combining trees or shrubs with crops or pasture).
- Shorten or eliminate summer fallow periods.
- Practice organic, biological, or biodynamic farming or gardening methods (management practices that restore, maintain, and enhance ecological balance).
- Enhance biological nitrogen fixation through the use of legume crops such as alfalfa.
- Grow bioenergy crops which are grown specifically for their fuel value to make biofuel (e.g., switchgrass) on marginal lands.



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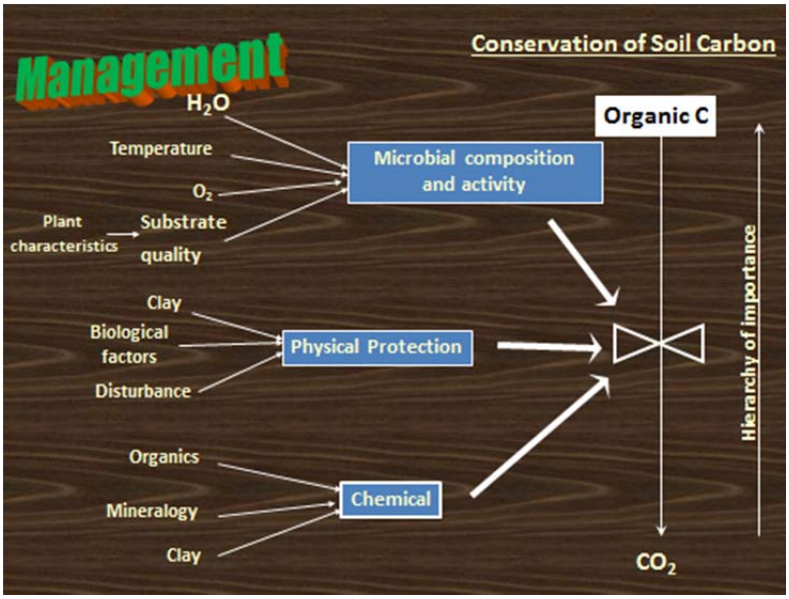

Fig. 2: Capture and sequestration of CO2 and management

1. BENEFITS OF SOIL CARBON SEQUESTRATION

In addition to reducing current atmospheric CO2 levels and green house effects, increasing soil carbon sequestration can provide other benefits for soil quality, the environment, and agricultural production.

- Increased agricultural productivity
- Improved soil structure
- Increased soil fertility
- Increased water holding capacity
- Increased infiltration capacity.
- Increased water use efficiency, due to reduced moisture loss from runoff, evaporation, deep drainage below the root zone.
- Improved soil health resulting in higher nutrient cycling and availability.
- Reduced fertilizer (N, P) needs over the longer term.

REFERENCE

[1] Steven A. Banwart, Elke Noellemeyer and Eleanor Milne (2015). Soil Carbon- Science, Management and Policy for Multiple Benefits, Scope Series Volume 71, CPI Group (UK) Ltd, Croydon.

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