CARBON SEQUESTRATION IN AGRICULTURE

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INTRODUCTION

Carbon dioxide is a trace gas in the Earth's atmosphere that plays a constitutive part in the greenhouse effect, photosynthesis, carbon cycle, and oceanic carbon cycle The concentration of CO_2 increases in the atmosphere due to increases in human activities like the burning of fossil fuels (coal and oil), deforestation, biomass burning and industrial revolutionization. The current global average concentration of CO_2 in the atmosphere is 421 ppm as of May 2022. Among all the greenhouse gases like methane, CO_2, nitrous oxide and O_3, carbon dioxide contributes more towards climate change and the rise in average global temperature. The effects of climate change directly affect the physical environment, ecosystems as well as human societies. Carbon dioxide exerts a larger overall warming influence than all of the other greenhouse gases combined. Carbon sequestration is the process of capturing and long-term storing of atmospheric carbon dioxide in plants, soil, geologic formations, and the ocean. It is one of the methods that reduce the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change. It is naturally captured from the atmosphere through biological, chemical or physical processes.it is part of the natural carboncycle by which carbon is exchanged among the biosphere, pedosphere, geosphere, hydrosphere, and atmosphere of Earth

ROLE OF CARBON SEQUENSTRATION

- It acts as a carbon sink which helps to mitigate climate change and thus reduce the harmful effects of climatic hazards.
- It helps in reducing the concentration of greenhouse gases in the Earth's atmosphere, which is released by burning fossil fuels and industrial livestock production.
- It makes the degraded soil healthy soil through carbon restoration, which can improve agricultural productivity as well as make the farms more resilient against both drought and heavy rainfall.
- For carbon to be sequestered artificially (i.e., not using the natural processes of the carbon cycle) it must first be captured, or it must be significantly delayed or prevented from being re-released into the atmosphere.

BIOLOGICAL CARBON SEQUESTRATION

Biological carbon sequestration is also called *biosequestration*. It is the capture and storage of the atmospheric greenhouse gas carbon dioxide by continual or enhanced

biological processes. This form of carbon sequestration occurs through increased rates of photosynthesis via land use practices such as reforestation and sustainable forest management. It includes the conservation, management, and restoration of ecosystems such as forests, peatlands, wetlands, and grasslands, in addition to carbon sequestration methods in agriculture.

Biological Methods of Carbon Sequestration-The methods and practices exist to enhance soil carbon sequestration in both sectors of agriculture and forestry

Role of Carbon Sequestration in Agriculture

The soil organic carbon (SOC) is depleted by around 30-40%, when the soil is converted from natural land or semi-natural land, such as forests, woodlands, grasslands, steppes and savannas to cultivated land. The SOC losses are due to the removal of plant material that contains carbon. When the land use changes, the carbon in the soil will either increase or decrease, and this change will continue until the soil reaches a new equilibrium. Modification of agricultural practices is a recognized method of carbon sequestration as the soil can act as an effective carbon sink. The agricultural practices that help in carbon sequestration are as follows

Carbon Farming-

Carbon farming is an agricultural method aimed at sequestering atmospheric carbon into the soil and in crop roots, wood and leaves. The aim of carbon farming is to increase the rate at which carbon is sequestered into soil and plant material with the goal of creating a net loss of carbon from the atmosphere. Increasing a soil's organic matter content can aid plant growth, increase total carbon content, improve soil water retention capacity and reduce fertilizer use. The benefits of carbon farming include Lower greenhouse gas emissions associated with clearing vegetation, storing carbon in vegetation, Increased biodiversity, Improved air quality, Mitigating the risk of soil erosion, Increased soil fertility, reduced soil salinity & buffering against drought

Bamboo farming

Although a bamboo forest stores less total carbon than a mature forest of trees, a bamboo plantation sequesters carbon at a much faster rate than a mature forest or a tree plantation. Therefore, the farming of bamboo timber may have significant carbon sequestration potential.

Deep soil

On a global basis, it is estimated that soil contains about 2,500 gigatons of carbon. This is greater than 3-fold the carbon found in the atmosphere and 4-fold of that found in living plants and animals. About 70% of the global soil organic carbon in non-permafrost areas is found in the deeper soil within the upper 1 meter and stabilized by mineral-organic associations.

Biochar :

Biochar is charcoal created by the pyrolysis of biomass waste. Biochar production is a technique through which carbon from certain biomasses is transformed into stable carbon that can be captured in the soil. In addition to this long-term carbon sequestration role, it is also beneficial to soil performance as it improves the retention and diffusion of water and nutrients.

Terra Preta :

Terra preta, an anthropogenic, high-carbon soil, is also being investigated as a sequestration mechanism. It is characterized by the presence of low-temperature charcoal residues in high concentrations, high quantities of tiny pottery shards, of organic

matter such as plant residues, animal faeces, fish and animal bones, and other material and nutrients such as nitrogen, phosphorus, calcium, zinc and manganese. Fertile soils such as terra preta show high levels of microorganic activities and other specific characteristics within particular ecosystems. it is less prone to nutrient leaching because of its high concentration of charcoal, microbial life and organic matter.

Urban lawns:

Urban lawns can store significant amounts of carbon. The amount stored increases over time from the most recent disturbance (e.g., house construction).

Role of Carbon Sequestration in Forestry

Forests play a major role in the natural global carbon cycle by capturing Carbon from the atmosphere through photosynthesis, converting those photosynthates to forest biomass, and emitting Carbon bank into the atmosphere during respiration and decomposition. In terms of carbon retention on forest land, it is better to avoid deforestation. There are four primary ways in which reforestation and reducing deforestation can increase carbon sequestration. First, by increasing the volume of the existing forest. Second, by increasing the carbon density of existing forests at a stand and landscape scale. Third, by expanding the use of forest products that will sustainably replace fossil-fuel emissions. Fourth, by reducing carbon emissions that are caused by deforestation and degradation.

Reforestation is the replanting of trees on marginal crop and pasture lands to incorporate carbon from atmospheric CO2 into biomass.

Afforestation is the establishment of a forest in an area where there was no previous tree cover.

Proforestation is the practice of growing an existing forest intact toward its full ecological potential. For this carbon sequestration process to succeed the carbon must not return to the atmosphere from mass burning or rotting when the trees die.

Urban forestry

Urban forestry increases the amount of carbon taken up in cities by adding new tree sites and the sequestration of carbon occurs over the lifetime of the tree. It is generally practiced and maintained on smaller scales, like in cities. The results of urban forestry can have different results depending on the type of vegetation that is being used, so it can function as a sink but can also function as a source of emissions. In hot areas of the world, trees have an important cooling effect through shade and transpiration. This can save on the need for air conditioning which in turn can reduce GHG emissions.

Role of Wetlands

Wetland restoration involves restoring a wetland's natural biological, geological, and chemical functions through re-establishment or rehabilitation. It has also been proposed as a potential climate change mitigation strategy. 20–30% of the world's soil carbon is found in wetlands, while only 5–8% of the world's land is composed of wetlands. Studies have shown that restored wetlands can become productive CO2 sinks and many restoration projects have been enacted in the US and around the world. Aside from climate benefits, wetland restoration and conservation can help preserve biodiversity, improve water quality, and aid with flood control.

Peatlands and peat bogs

Peatlands are a type of wetland that is critical for preventing and mitigating the effects of climate change, preserving

biodiversity, minimizing flood risk, and ensuring safe drinking water. it is damaged peat lands are a major source of greenhouse gas emissions, responsible for almost 5% of global anthropogenic CO2 emissions. Peatland restoration can reduce emissions significantly. Countries should include peatland conservation and restoration in their commitments to international agreements, including the Paris Agreement on climate change.

Peat bogs store vast amounts of carbon, which must keep in the ground to avoid contributing to climate change. It also acts like a sponge, soaking up rainwater, and can help to reduce flood risk. It acts as a sink for carbon because they accumulate partially decayed biomass that would otherwise continue to decay completely. There is a variance in how much the peatlands act as a carbon sink or carbon source that can be linked to varying climates in different areas of the world and different times of the year. Not only wetlands are a great carbon sink, but they also have many other benefits like collecting floodwater, filtering air and water pollutants, and creating a home for numerous birds, fish, insects and plants.

Climate change could alter soil carbon storage changing it from a sink to a source. With rising temperatures comes an increase in greenhouse gasses from wetlands especially in locations with permafrost. When this permafrost melts it increases the available oxygen and water in the soil. Because of this, bacteria in the soil would create large amounts of carbon dioxide and methane to be released into the atmosphere.

How to Enhancing carbon removal:

The goal of agricultural carbon removal is to use the crop and its relation to the carbon cycle to permanently sequester carbon within the soil. This is done by selecting farming methods that return biomass to the soil and enhance the conditions in which the carbon within the plants will be reduced to its elemental nature and stored in a stable state. Methods for accomplishing this include:

•Use cover crops such as grasses and weeds as a temporary cover between planting seasons.

•Concentrate livestock in small paddocks for days at a time so they graze lightly but evenly. This encourages roots to grow deeper into the soil. The stock also till the soil with their hooves, grinding old grass and manures into the soil.

•Cover bare paddocks with hay or dead vegetation. This protects soil from the sun and allows the soil to hold more water and be more attractive to carbon-capturing microbes.

•Restore degraded, marginal, and abandoned land, which slows carbon release while returning the land to agriculture or other use. Degraded land with low soil carbon pool has particularly high potential to store soil C which can be further enhanced by proper selection of vegetation.

Conclusion

Agricultural sequestration practices may have positive effects on soil, air, and water quality, be beneficial to wildlife, and expand food production. On degraded croplands, an increase of 1 ton of soil carbon pool may increase crop yield by 20 to 40 kilograms per hectare of wheat, 10 to 20 kg/ ha for maize, and 0.5 to 1 kg/ha for cowpeas.

Many factors affect the costs of carbon sequestration including soil quality, transaction costs and various externalities such as leakage and unforeseen

environmental damage. Because the reduction of atmospheric CO2 is a long-term concern, farmers can be reluctant to adopt more expensive agricultural techniques when there is not a clear crop, soil, or economic benefit. Governments such as Australia and New Zealand are considering allowing farmers to sell carbon credits once they document that they have sufficiently increased soil carbon content.

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