Journal of Agrometeorology

ISSN : 0972-1665 (print), 2583-2980 (online)
Vol. No. 24 (4) : 333-334 (December- 2022)

https://journal.agrimetassociation.org/index.php/jam

Editorial

Soil Carbon Sequestration Strategies for Climate Resilient Agriculture

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Increasing global population is driving up the food demand. The world will need 70 per cent more food to feed an estimated 9 billion people by the year 2050. The challenge is aggravated by threat of climate change and other natural calamities.The negative impacts of climate changeare already being felt, in the form of increased temperature, weather variability, shifting agroecosystem boundaries, invasive pest and diseases, and more frequent extreme weather events. On farms, climate change is reducing crop yields and the nutritional quality of major cereals, and lowering livestock productivity. In coming decades, climate risks to cropping, livestock, and fisheries are expected to be intensified, particularly in low-income countries where adaptive capacity is weaker. Impacts on agriculture threaten both food security and agriculture's pivotal role in rural livelihoods and broad-based development of the society.

In South Asia, the annual average maximum temperature is expected to rise by 1.4-1.8°C in 2030 and 2.1-2.6°C in 2050, resulting in a 12 per cent increase in heat-stressed areas in 2030 and a 21 per cent increase in 2050. According to projections, nearly half of the Indo-Gangetic Plains (IGP) will become unsuitable for wheat production by the year 2050 due to heat related stresses. A general thumb rule in the equatorial tropics is that every 1°C rise in mean temperature is associated with a 10 per cent decrease in crop yields. In India, a study showed that increasing the temperature by 1°C with no change in rainfall resulted in a decline of 10-15 per cent soybean yield and 10 and 8 per cent, in maize grain and biomass, respectively. This decrease in yield is usually attributed to a decrease in the crop duration. Other studies in India also revealed that an increase in temperature (<2°C) led to a 5.2 per cent decrease in wheat yield, 6 - 8 per cent decrease in rice yield and 10 - 30 per cent decrease in maize yield. Therefore, farmers need to adopt climate resilient agricultural practices to increase productivity, reduce greenhouse gas emissions and increase carbon sequestration, which in turns strengthen food security and deliver environmental benefits.

Carbon sequestration is the capacity of land and forests to remove carbon dioxide from the atmosphere. This carbon dioxide is absorbed by plants during photosynthesis and stored as carbon in tree trunks, roots, branches and soil. Forests and grasslands are referred to as carbon sinks because they store carbon for long periods of time. Employing farming practices with minimal disturbance can increase sequestration and reduce loss of carbon from fields. Agriculture contributes to 11 per cent of GHGs, mainly coming from agricultural soil, livestock, and rice production. Farming practices and technology can reduce greenhouse gas emissions and prevent climate change by carbon sequestration, preserving existing soil carbon and reducing carbon dioxide, nitrous oxide, and methane emissions.

The concept of climate resilient agriculture is gaining popularity at international and national levels to meet the challenges poses under climate change. The climate resilient agriculture is a concept that calls for integration of the need for adaptation and the possibility of mitigation in agriculture to support food security. Climate resilient agriculture integrates the three dimensions of sustainable development i.e. economic, social, and environmental by jointly addressing food security and climate challenges. It is composed of three main pillars:

a) Sustainably increasing agricultural productivity and incomes;

b) Adapting and building resilience to climate change and

c) Reducing and/or removing greenhouse gasesemissions.

Carbon sequestration is an important strategy for the mitigation of climate change effect by means of storing carbon in soils and biomass. Technological options for C-sequestration on agricultural soils include general strategies *viz*.,

- *Forestry*- Forests absorb and hold carbon dioxide emissions produced from other sources and help in sequestering carbon. Carbon offsets can be created through reforestation and improved forest management.

- *Grasslands conservation*- Grasslands provide a natural way of carbon sequestering emissions. Avoiding overgrazing of meadows.

- *Conservation tillage*- Dipping tillage reduces carbon disorder and mitigates the release of soil carbon. Conservation tillage improves the carbon sequestration capacity of the soil. It also helps in soil erosion and water conservation.

- *Renewable energy*- Substitute to fossil fuels for the production of electricity by wind or solar energy helps to generate carbon offsets. Farmers need to increase the energy efficiency and find alternatives for low-cost fuel which can be profitable.

- *Organic farming*- Organic systems with the use of compost manure and cover crops increase organic matter in soil and eliminate emissions from synthetic fertilizers. Usage of nitrogen fertilizers boosts production and reduces N_2O emissions.

Soils are a major part of the planetary carbon cycle, the second-largest pool after the oceans holding more carbon. When properly managed, farms are a powerful tool to fight against climate change. In view of this, Carbon markets are one of the necessary routes to building carbon storage in soil. Thus, adoption of conservation tillage, use of manures, and compost alone or in combination such as integrated nutrient management, crop residue management in fields, precision farming strategies, diversifying cropping systems, meadow-based rotations, winter cover crops, agro-forestrty and establishing perennial vegetation on contours and steep slopes. Proper soil and nutrient management may play key role for improving the C-sequestration in the soil. Further, depending on the processes and technological innovations, there are three main types of C-sequestration:

i) those based on the natural process of photosynthesis and conversion of atmospheric CO_2 into biomass, soil organic matter or humus and other components of the terrestrial biosphere;

ii) those involving engineering techniques and

iii) those involving chemical transformations.

The overall strategy of carbon sequestration is to increase the soil organic carbon (SOC) density, distribution of SOC in the subsoil, aggregation, and formation of secondary carbonates. The SOC density can be enhanced by increasing carbon input into the soil and decreasing losses by erosion, mineralization and leaching. The depth distribution of SOC can be achieved by planting deep-rooted species with high below- ground biomass production.

Thus, soil carbon sequestration can play a major role in climate smart agricultural practices and can be a solution for vagaries of climate change and variability. Growers can be encouraged to follow these smart agricultural practices to lower the environmental footprint and generate carbon credits for climate resilient agriculture.