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Management of Carbon Farming Systems and Factors Affecting Farmer Uptake

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Today, agriculture faces several difficulties, such as the degradation of soil health and major contributions to climate change through greenhouse gas emissions. Conventional farming lowers crop yields and increases the farming area's susceptibility to drought by eroding the soil's structure, reducing organic cover, and decreasing its ability to hold water. Studies on soil quality concentrate on how to manage soil to maximize its qualities, with particular focus on the organic matter component. To stop the subsequent rise in CO_2 levels in the environment, agricultural activities that produce organic residues are necessary. The amount of carbon that is accumulated by the rate of residues is influenced by various farming practices. Returned to the soil, the pace at which organic matter, including plant leftovers, breaks down. In the future, feeding and clothing the globe while simultaneously protecting and even improving soil capital would be the main obstacle facing Indian agriculture. Therefore, there is demand to cut greenhouse gas emissions in a number of ways that incorporate soil-based carbon farming techniques. Agroforestry systems and cover crops are examples of carbon farming techniques that improve the soil's capacity to retain carbon, which keeps the soil fruitful and healthy. Additionally, improving biomass, soil, and crop resistance, as well as reducing nitrous oxide relative emissions and nitrate leaching that affect nitrogen cycling and climate change, are also consequences of carbon farming.

Carbon Farming

Indian farmers, for example, may manage their grazing areas to retain and replenish the flora, including the tree cover that borders them, as part of a technique known as "carbon farming" that helps the soil store more carbon and emit fewer greenhouse gases into the atmosphere. Similarly, farmers should reduce the amount of greenhouse gasses linked to plants. by employing methods for reducing fertilizer, such as using biochar or compost. Carbon-neutral agriculture is rapidly becoming crucial for preserving environmental equilibrium, improving public health, and guaranteeing the security of food for future generations. During tillage operations, a soil with a greater potential to store carbon requires less energy and is more effective in using nutrients and water. After deducting the sink, the net reduction in CO_2 equivalent emissions must be properly priced and tracked to boost the C economy. By optimizing energy, implementing Best Management Practices (BMPs) can help Indian agriculture achieve carbon economy, using water, nutrients, and encouraging the soil's carbon accumulation.

Water management

Plant roots are directly irrigated by technologies such as solar-powered lifting devices, rainwater conservation techniques, and micro-irrigation. By the using sensors, overwatering can be avoided by optimizing irrigation schedules based on current soil moisture levels. Reliance on outside water sources is decreased by collecting rainwater from surfaces and rooftops for later usage. Rainwater can recharge groundwater instead of turning into runoff when absorbent materials are used for pathways and roadways. A sustainable method that minimizes operating costs and carbon footprints is to replace conventional irrigation pumps with solar-powered alternatives (Lancaster and Lipkis, 2010). India's Sustainable Development Goals and Carbon Farming (Wazed et al., 2018).

Live stock management

Effective livestock systems are crucial to carbon farming because they lower methane emissions, a potent greenhouse gas (Herrero et al., 2016). To increase livestock productivity, India developed a number of regulations and initiatives, sustainably. Notable initiatives include the Dairy Processing and Infrastructure Development Fund, the National Livestock Policy 2013, the Sub-Mission on Fodder and Feed, the Rashtriya Gokul Mission, the Livestock Health and Disease Control Scheme, and the Intensive Cattle Development Projects. These rules aim to improve health standards, increase cow productivity, and promote dairy development.

Nutrient Management

Enhancing agricultural nutrient usage efficiency (NUE) is crucial for sustainable food production and has a big impact on lowering greenhouse gas emissions (Hirel et al., 2011). The quantity of nutrients supplied to crops that are absorbed and used by the plants is referred to as NUE. By applying fertilizers precisely at predetermined times and locations, technology like sensors and GPS-guided equipment can reduce the needless use of nutrients. With GHG emission technology solutions such coated nutrients and slow-release nutrients, integrated nutrient management, alternative nutrient sources, and precision nutrient administration, there is more potential to increase the NUE in agriculture. Leguminous cover crops can help fix nitrogen from the environment, which lessens the demand for require artificial nitrogen fertilizers, as highlighted by Srinivasarao et al. (2012c) and Wittwer and van der Heijden (2020). Using controlled-release or slow-release fertilizers, which release nutrients gradually, gives plants a steady supply while lowering the chance of leaching (Vejan et al., 2021).

Direct seeded Rate

A 2022 Government of India study (GOI) states that during India's Kharif season, around 55% of the nation's total cultivated Paddy is grown on 39.54 million hectares of land. Furthermore, according to the GOI in 2020, paddy production directly employs 57.5% of the country's farming labor force and significantly boosts the agricultural GDP. Due to urbanization, industrialization, and crop diversification, paddy cultivation has lost land worldwide. By 2035, an additional 114 million tonnes of milled rice would be required to provide food security, but there isn't enough land or water to support paddy farming. The DSR technique is mostly used by farmers with limited resources who struggle with extreme weather circumstances such low water tables, irregular rainfall, and long dry periods that prevent the deployment of rice-intensification systems. However, other paddy farmers in India and other developing nations are also trying to switch from the more costly PTR method to the less costly DSR methodology. In order to assess the potential of DSR with TPR for labor, water, and greenhouse gas reduction, Pathak [26] conducted a two-year field experiment in the Punjab region of Jalandhar, India. In the absence of efficient weed control, prior research has shown that yield loss in DSR is greater than in transplanted rice options. Since poorly managed weeds provide little to no yield, effective weed management in DSR is exceedingly challenging.

Conservation tiilage practises

Frequent and extensive soil tillage significantly disrupts the equilibrium of the carbon cycle between agricultural soils and the environment which decreases soil organic carbon storage and increases greenhouse gas emissions. Conversely, conservation tillage may drastically change the size and distribution of soil aggregates, which in turn affects the accumulation of organic carbon, according to Liu et al. Conservation tillage increases the soil's capacity to absorb organic carbon while concurrently reducing soil carbon emission rates, according to Uri et al. and Bayer et al. However, it also has an impact on agricultural development, which increases atmospheric CO_2 fixation. According to research, farmers with higher levels of knowledge are more likely to implement no-till California since these farmers are more likely to understand new concepts and technology more easily. There were significant disparities in land, income, group involvement, financial accessibility, and CA training. Farmers who did not use no-till CA farmed greater mean land areas than adopters. differences in income between adopters who wait till California and those who don't. Income levels and adoption rates are favourably connected. Adopters of no-till farming practices earned an average of Rs 1746, whereas non-adopters earned an average of Rs 1271.

Food Systems Management

Carbon reduction can be positively impacted by strengthening food systems and lowering food loss. The food supply chain plays a major role in Climate change can be lessened by reducing greenhouse gas emissions and fixing systemic inefficiencies (Porter et al., 2016). The 2.1 lakh hectare National Mission for a Green India (Economic Survey, 2022–2023) focuses on preserving, replenishing, and improving India's diminishing forest cover while utilizing mitigation and adaptation techniques to deal with climate change (MOEF&CC, 2021). In order to support climate science research, knowledge creation, and capacity building, the National Mission on Strategic Knowledge for Climate Change (NMSKCC) established 12 Centres of Excellence for climate change as of June 2021.

Organic farming

The demographic and other social characteristics of farmers, such as their professional abilities, have been the subject of several studies. concluded that farmers' decisions to proceed with the transition to carbon-neutral farming practices are influenced by these attributes. More specifically, farmers made important decisions based on criteria like gender and off-farm activities, household wealth, age and experience (measured in years of farming), and household size (related to the available workforce). Younger farmers, those with better levels of education, and/or ICT use and specialized agriculture training. However, home labor constraints limit the implementation of this method. Lack of knowledge and comprehension of climate smart technologies may hinder their adoption because knowledge and experience are crucial in helping organic farmers replace synthetic agrochemicals.

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