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11. Strategies to Boost Soil Carbon Sequestration in Agriculture

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Abstract:

Presently, climate change poses as an emerging global challenge to world's food security due to consistent increase in the concentration of green-house gases in atmosphere as a result of human induced activities. Soil carbon sequestration, i.e. the process of storing atmospheric CO2 as soil organic carbon, can be a potential strategy to avoid adverse consequences of climate change. Most of the soil carbon stock of agricultural lands worldwide has been depleted by continuous unsustainable farming practices under intensive farming.

There are many improved agronomic practices that sustainably helps to sequester atmospheric carbon and also improves soil productivity. Implementing various management practices like cover cropping with legumes, agro-forestry, conservation tillage, and long-term organic manure application contribute to enhancing soil organic carbon levels. These methods increase soil organic matter, facilitate carbon sequestration, improve soil aggregation, and enhance soil quality over time. Some novel technologies like bio-char application and microbial amendment application have the potential to be effective in SOC accumulation but lack of research work restricts the implementation extensively in agricultural system.

Breeding methods such as developing cereal varieties with perennial characteristics and annual varieties with deeper root system has also the possibility to restore carbon level. The goal of this book chapter is to describe different strategies of soil carbon sequestration and assert the significance of it

Keywords:

Soil carbon sequestration, SOC stock, Climate change mitigation, Conservation management practices, Biochar.

11.1 Introduction:

Carbon is the most important element to shape life on earth. Any organic compound isnot possible to form without carbon as it has the unique ability to construct bonds with other atoms as well as with other carbon atoms and produce complex organic compounds like long chain compounds (polymers), cyclic organic compounds etc. That leads to form complex biomolecules (like RNA, DNA etc.) which impart the defining characteristics of life.

Carbon pool is a part of the climate system with the ability to produce, store, or collect carbon. Oceanic pool (38,000 Pg) is the largest of the five major carbon pools. The other fourare soil carbon pool (2500 Pg), biotic pool (560 Pg), atmospheric pool (760 Pg), and geologicalpool (5000 Pg) (Pattnaik *et al*., 2020). The biggest carbon (C) reservoir in terrestrial ecosystemsis considered to be the soil. Climate change and the global C cycle are significantly influencedby dynamic variations in soil C (Lal, 2004b). Soil carbon can simply define as the carbon present in soil. Soil carbon can be of two types - soil organic carbon (SOC) and soil inorganiccarbon (SIC). Soil inorganic carbon has the greater stability and lower significance in the globalcarbon cycle than soil organic carbon (Serna-Pérez *et al.*, 2006). Whereas soil organic carbon is very much important in the carbon sequestration point of view. The estimated amounts of Soil Organic Carbon in India are 63 Pg (upper 150 cm) and 21 Pg (upper 30 cm) (Pattnaik *et al*., 2020). The carbon content in the seas is three times more than the carbon content in the soilwhich means 75% of carbon stored in seas. But a healthy global carbon cycle depends on healthy soils. Paustian *et al.* (2000) estimate that around 50 Pg C had been released into the atmosphere from soils worldwide as a result of natural land being converted to farmed agricultural land. In addition to benefiting in the mitigation of climate change, soil carbon is essential to land-based efforts to cut atmospheric carbon dioxide, halt carbon emissions, and offer ecosystem services. Soil organic carbon can regulate the atmosphere. The loss of carbonfrom this pool can result into the potential climate change and the global warming. So, the sequestration of carbon is very much needed to prevent the climate change.

Carbon sequestration is the process of storing carbon dioxide or other forms of carbonfor long-term in terrestrial and aquatic bodies. It is mostly needed to reduce the impact of greenhouse gases on the climate change which is an effect of anthropogenic activity (Majumder*et al*., 2008) and protect from the global warming. Soil carbon sequestration is simply the carbon storage of soil. In soil, carbon is stored into the organic matter and plant biomass.

Terrestrial ecosystems either actively remove carbon dioxide (CO_2) from the atmosphere or passively prevent CO_2 emissions from entering the atmosphere. Photosynthesis process of theplants is one of the removal processes of CO_2 from the atmosphere (Baldi *et al*., 2018).

This removed C from the atmosphere enters the soil system through plant biomass after the plants die and decay as this carbon source is used by different life forms or only provided to the soil as litter. Then it is formed soil organic matter (SOM). SOM is a complex combination of carbon-based substances that contains carbon bound to soil minerals, decaying plant and animaltissue, bacteria, fungus, protozoa, nematodes, and other carbon-containing materials(Komatsuzaki and Syuaib, 2010).

The soil carbon sequestration is depended upon the terrestrial ecosystem and different land use systems. Carbon can be trapped in soils for a very long time or be quickly released back into the atmosphere. Natural vegetation, soil texture, drainage, and climate all have an impact on the amount and duration of carbon storage in soil.

11.2 Importance of Soil Carbon Sequestration:

Soil can be considered as an integral component of the global carbon cycle (Dorrepaal*et al.,* 2009). Reduced SOC stock has long been a common issue as a result of intensive cultivation without consideration for the sustainability of the system. This reduction in SOC may have a detrimental effect on the structure of the soil, making it more erodible and vulnerable to problems including crust formation, compaction, erosion and surface runoff (Lal,2004a). Agricultural industry is more susceptible to climate change due to extreme weather sensitivity, which will have a significant economic impact. The amount of rainfall and temperature variations have a major impact on the yields of crops (Mendelsohn, 2009). One of the most important concepts for boosting agricultural productivity, preserving soil health, increasing agricultural resilience and reducing net GHG emissions from soil is soil carbon sequestration (Rodrigues *et al.,* 2023). This practice is important in agriculture in the followingways:

Climate change can be regarded as a main concern today as greenhouse gases (GHGs)are increasing in the atmosphere, thereby causing gradual increase in global temperature. The primary cause of the anthropogenic greenhouse gas effect is the growing concentration of greenhouse gases like carbon dioxide (CO_2), methane (CH_4) and nitrogen oxides (NO_X), which are released through the burning of fossil fuels and biomass, land use change, deforestation, and particularly through the decomposition of organic matter in the soil (Lehmann *et al.,* 2006).SOC is the result of plants removing CO_2 from the atmosphere through photosynthesis and storing fixed carbon as soil organic matter (Lal, 2004a). Small increases in soil organic carbon

Continuous increase in population has created tremendous pressure on agriculture to ensure food and nutritional security for the world’s population which is getting worse as a resultof climate change. Global warming may lead to increased incidence of extreme weather eventscausing decrease in crop yields (Malhi *et al.,* 2021). Plants are subjected to various abiotic stresses, including drought, salinity, heat stress etc.

Crops become more vulnerable to different diseases, pests and weeds due to change in weather pattern (Rosenzweig *et al.,* 2001). To maintain high SOC levels, soil organic matter management is most important. Implementing different soil and crop management practices such as cover cropping, minimum tillage, organic farming, agro-forestry, enhance carbon sequestration in soil and vegetation.

The addition of residues improves the status of soil organic matter (Naik *et al.,* 2019). SOC, especially humic substances, has the ability to detoxify monomeric Al in acid soils (Haynes and Mokolobate, 2001), bind toxic heavy metals strongly so that plant roots cannot access them, and bind a wide range of hazardous organic pollutants (Gerke, 2022). Lal (2004a) describes different purposes of soil organic carbon (SOC) reservoirs, such as supplying of major plant nutrients (e.g., N, P, S, Zn, Mo), a source of charge density, retaining water at low moisture potential, increasing the amount of plant available water, improving soil aggregation, increasing water infiltration capacity, minimizing surface runoff losses, increasing soil biodiversity by serving as a substrate for soil biota energy, lowering the susceptibility to erosion, serving as a buffer against abrupt changes in soil reaction (pH) due to the application of different agricultural amendments.

Carbon sequestration enhances soil fertility, improves soil quality, increases resilience to climate change and various physical degradation activities, helps to restore degraded soil, thereby improves soil health and ultimately ensures food security for human civilization (Lal *et al.,* 2011).

11.3 Management Strategies to Increase Soil Carbon Sequestration in Agricultural Soil:

Management practices for sequestration of soil carbon can be divided into two main categories (NASEM, 2019). Under the first group, there are established and tested conservation strategies that can raise soil C on fields that are currently under agriculture crop production practices, though they are not yet commonly used. These approaches are being adopted increasingly by environmentally responsible farmers and have the ability to extend significantly further. These are known as BMPs, or "Best Management Practices, which can be swiftly implemented to offer short term increases in soil C stock with the right incentives (Paustian *et al.,* 2019). The second group of approaches is known as "Frontier technologies," and it refers to systems or methods that face substantial economic and technological disadvantages and are still mostly in the experimental stage, having little to no presence in agriculture.

11.3.1 BMPs for Soil C Sequestration (Conventional Conservation Practices):

Conventional methods for conserving soil carbon involve enhancing crop rotation and cover cropping, adding manure and compost, refining tillage practices, introducing agroforestry, transitioning to perennial grasses and legumes, and improving nutrient management. These practices aim to boost the accumulation of organic matter in soils, thereby facilitating carbon sequestration. The effectiveness of these carbon-sequestering operations lies in the ability to elevate the input of agricultural residues into soils and/or decrease the decomposition rates of existing organic carbon stocks in the soil.

A. Crop Rotation and Cover Cropping:

Crop production strategies that improve soil structure and enrich the soil with organic matter, like crop rotation instead of monocropping and introducing cover crops into the production system, aid in carbon sequestration. Planting high biomass producing crops, covercropping in off season, green manuring, continuous cropping (lower frequency of fallow periods), and permanent or rotating perennial grasses are some cropping strategies that can bepracticed for boosting C inputs into soils (CAST, 2004). For instance, an average annual sequestration rate of 0.32 tC/ha/y was reported in a recent global evaluation of cover crops, with numerous findings with rates higher than 1 tC/ha/y (Poeplau and Don, 2015). Legume crops are effective cover crops that enhance biodiversity, residual input quality, and eventuallythe SOC pool. Ecosystems with more biodiversity can absorb and sequester higher carbon than ecosystems with lower biodiversity. According to Ganeshamurthy (2009), pulses have the potential to boost belowground biomass, leaf shedding ability, nitrogen fixation and add a substantial number of organic residues to the soil.

Crop rotation is the practice of growing crops on the same piece of land in a recurring succession. It improves soil structure and fertility by producing both shallow and deep roots and In the next season, a deeply rooted crop replenishes the nutrients that the previous crop leached out in the soil. Plants with different physiological patterns can be cultivated for increasing the soil's organic matter content.

However, harvesting the benefits of crop rotation depends on the kind and frequency of the rotation. In order to replenish nitrogen by fixing it from the atmosphere, legume crops or green manure crops are often grown alongside cereals in crop rotation practices. Raising the SO/c content in the deeper soil layers is achieved by growing deep-rooted legumes as part of an organic crop rotation approach. In dry climates, where fallow crops are used in alternate years to retain soil moisture and maintenance of crop yields, crop rotations that are more intense and diverse can raise annual carbon inputs, resultingin higher soil carbon stocks than systems with higher fallowing practices (Sherrod *et al.*, 2005).

B. Conservation Tillage:

Conservation tillage (CT) is characterized by three fundamental principles: crop rotation, maintenance of permanent soil cover through mulching, and minimizing soil disturbance, often referred to as no-till. This includes reduced ploughing frequency and intensity and leaving agricultural waste on the soil surface to act as mulch. Studies indicate thatzero tillage systems tend to exhibit lower CO2 evolution compared to traditional tillage methods. Additionally, the reduced loss of labile carbon in a zero-tillage environment leads to increased carbon sequestration.

Worldwide, reduced tillage or no-till farming methods are employed to manage soil erosion and enhance soil structure, water retention ability, and soil macrofauna throughelevated soil cover and less soil disturbance. Furthermore, it is usually assumed that conventional tillage disrupts macroaggregates and increases OM mineralization, whereas reduced tillage/no-till systems improve soil aggregation and, thus, the physical protection of OM.

On sandy and non-sandy soils, the increase in SOC content by using the no-till approachhas been found to be approximately 0.25 tC/ha/y and 0.29 tC/ha/y, respectively (Ogle *et al.*, 2005). According to a recent assessment of NT's net atmospheric impact, NT systems have a 71% lower greenhouse gas intensity (GHG emissions per unit of production) and a 66% lowerglobal warming potential (GWP) than conventionally farmed systems (Sainju, 2016).

A single deep inversion tillage once in a several decades, may be extremely beneficial in humid and subhumid croplands for encouraging a significant increase in soil C stores. This method involves transferring low-C subsurface material to the surface and burying C-rich surface horizons between 60 and 80 cm below the surface. Surface soil that is high in C can beburied to significantly slow down its breakdown and encourage deeper root penetration. In comparison to similar soils that were not deep-tilled, Alcantara *et al.* (2016) discovered that the deep-tilled sites had an average of 42 t/ha higher SOC stocks down to 1.5 m depth.

C. Application of Soil Amendments:

Soil amendments encompass both inorganic and organic substances that improve the physiochemical properties of soil and enhance its fertility. Beyond introducing carbon directlyinto the soil through the amendment itself, the incorporation of organic materials such as compost and manures can also enhance the soil's physical characteristics and increase nutrientavailability.

This, in turn, promotes heightened plant productivity and contributes to additionalcarbon inputs from residues (Paustian *et al.*, 1997). Agricultural residues, when integrated intothe soil, serve as amendments, enhancing soil fertility during their decomposition.

Commonly used organic supplements include animal manures, composted biosolids, municipal biosolids,wood ash, and other agricultural byproducts after composting. Since organic amendments typically originate from external sources, they do not directly account for on-farm CO2 intake from the atmosphere, making it challenging to assess their overall impact on net CO2 removal.

D. Introduction of Agroforestry:

Agroforestry, the practice of cultivating versatile trees alongside agricultural crops, has demonstrated significant benefits such as enhancing soil organic carbon (SOC) levels, mitigating soil erosion, improving land quality, boosting productivity, and diversifying farm income (Escobar *et al.*, 2002).

Agroforestry systems function as effective carbon sinks by sequestering carbon in both above- and below-ground areas, contributing to the absorption of CO2 from the environment and the mitigation of global warming (Albrecht and Kandji, 2003).

A recent investigation on soil organic carbon stocks in agroforestry systems revealed that teak,arjun, and ber plantations exhibited 36.8%, 29.6%, and 22.8% higher total SOC, respectively,across soil depths ranging from 0 to 60 cm (Naik *et al.*, 2021).

E. Nutrient Management:

Securing Soil Organic Carbon (SOC) involves precise application of nutrients, as the addition of appropriate quantities of nitrogen and phosphorus to the soil enhances its organic matter content.

The augmentation of SOC with prolonged nitrogen (N) supplementation is correlated with heightened input of plant carbon (C) into the soil, coupled with a reduction in carbon loss through decomposition. Consequently, N addition is expected to ultimately enhance SOC sequestration, offering potential climate change mitigation in the future (Xu *et al.* 2021).

Intensified agriculture over several decades has resulted in the export of significant amounts of macro, micro, and secondary nutrients from the soil. Any nutrient deficiency in thesoil is likely to prompt plants to extract nutrients from organic matter of the soil, leading to the subsequent loss of SOC. Integrated nutrient management, involving the judicious application of both chemical fertilizers and organic manures at optimal doses, proves beneficial in both increasing SOC stocks and enhancing soil productivity (Chaplot 2021).

F. Rewetting of Organic Soils:

Soils with higher amount of organic matter such as peat and muck, the predominant mass comprises organic matter. These soils develop in waterlogged conditions, impeding decomposition rate and resulting in the accumulation of substantial layers of partially decomposed plant residues. Organic soils are usually fertilized, limed, and drained before beingused for agricultural purposes. They can be very productive for annual cropping, but when theyare converted to agriculture, the soil mass is being oxidized, which can continue as long as organic layers remain exposed to aerobic (i.e., ambient O_2) conditions.

This results in extremelyhigh rates of CO_2 emissions, as much as 40–80 tCO_2/ha/y (as well as substantial N_2O emissions; Eggleston *et al.,* 2006). The extremely high CO_2 and N_2O emissions can be reduced,and soil C buildup can continue when organic soils are removed from production and hydrological conditions are restored, a process known as "rewetting" (Wilson *et al.,* 2016).

11.3.2 Frontier Technologies for Soil C Sequestration:

Frontier technologies are methods or systems that face substantial financialand technical obstacles and as a result, they represent methods and technologies that are still mostly in the experimental stage, having little to no presence in agricultural production systems. Therefore, they are not yet developed enough to be implemented widely. These cutting-edge technologies may eventually provide the possibility of higher soil C increases with more research and development as well as adequate financial incentives. The technical potential of these frontier technologies, however, is far less certain. This is either because thereis a lack of empirical data on how well these technologies perform in the field, or because the technologies themselves are still in the early stages of development.

A. Application of Biochar:

The residual biomass from agriculture can be converted into biochar which has major potential benefits in relation to carbon sequestration, greenhouse gas mitigation, increasing soilfertility, organic waste management and pollution control. Biochar is a fine-grained, highly carbonaceous substance that is produced by pyrolyzing biomass, a thermochemical reaction carried out at temperatures between 450 to 700 ° C at oxygen-deficit condition. As biochar is derived from residual biomass, its stabilized form of carbon can persist for decades or even longer in soil environments, simultaneously significantly reducing and delaying the emission of carbon from biomass (Lee *et al*., 2010).

As a result, the produced biochar is known as "C negative" as it has the ability to stabilize the CO_2 fixed by raw biomass during photosynthesis(Nan *et al.*, 2022). A common biochar consists primarily of recalcitrant organic carbon (ROC),with labile OC making up a smaller portion, which includes water-dissolved OC, DOC, and easily decomposable OC. The labile and recalcitrant pools of organic carbons are distinguishedfrom one another based on their degree of resistance to degradation, rather than being particularforms or species of C (Wang *et al*., 2020). The structure and stability of biochar formed from various feedstocks and at various pyrolysis temperature differ significantly from one another.

The main factors influencing biochar's aromaticity are thermochemical conditions, which increases sharply with reaction temperature and temperature retention duration (Luo *et al.*, 2015). Due to its condensed aromatic structure, biochar withstands both biotic and abiotic degradation and last for several decades in the environment (Cheng *et al*, 2006).

Carbon sequestration potential of biochar in soil has been reported in both incubation (Maucieri *et al*. 2017; Walkiewicz *et al*. 2020; Wang *et al*. 2020) and field studies (Purakayastha *et. al*. 2015; Abagandura *et al*. 2019; Wang *et al*., 2019; Fan *et al*. 2020; Yang *et al.*, 2020). Biochar application at the rate of 4% w/w soil in laboratory reduced CO_2 emissionby 9.31% (Wang et al., 2020). After addition of rice straw biochar and rice straw in a soil witha rice–wheat cropping system, biochar application resulted in more carbon sequestration and reduced annual CO_2 emission by 17.27% over rice straw application (Fan *et al.*, 2020). The application of optimum dose (up to 20 Mg ha^{-1}) of biochar in soil results in carbon sequestration, while excessive application of biochar (=40 Mg ha^{-1}) in soil does not show any positive correlation with carbon sequestration (Zhang *et al.*, 2012; Horák *et al.*, 2020).

Despite the advantages of using biochar for carbon sequestration, actual application of biochar for C sequestration is not keeping up with its potential. The primary obstacles to widespread adoption of biochar for carbon sequestration include apprehensions regarding soilquality and health, uncertain economic advantages, and inconsistent soil responses attributed to inadequate implementation of biochar standards. If overapplied, biochar can reduce nutrientavailability to plants, destroy soil structure and disrupt microbial community (Kim *et al.*, 2015, Mukherjee and Lal, 2014). Due to the high costs associated with collection, transportation, andpretreatment, applying biochar to sequester C is still a costly endeavor, severely limiting its useat the field scale (Han *et al*., 2022

B. Application of Microbial Amendments:

Another strategy to "supercharge" the sequestration capability of microbial products and increase the residance time of organic carbon in soil is to apply soil amendments in conjunction with particular microbial groups. Soil microbes assimilate carbon from residual plant and animal biomass for growth (anabolism) and release it as CO_2 and extracellular products (catabolism) through the process of microbial decomposition. The equilibrium between these metabolic processes is known as microbial carbon use efficiency (CUE), and itplays a role in determining how much carbon that enters the system and stays there (Kallenbach*et al*., 2019). Considering that microorganisms with higher CUE might potentially transfer more carbon from labile to recalcitrant pools through more effective biomass production, theymay be helpful in the sequestration and stabilization of soil carbon. (Tao *et al*., 2023). Throughthe promotion of practices that result in higher fungal activity and fungal-to-bacterial ratios (F: B), such as no-till farming (Bailey *et al*., 2002), the promotion and preservation of microbialbiomass and necromass has in fact been identified as a strategy to build stabile pools of soil C(Liang *et al.,* 2019). Since fungal groups have been found to contribute more carbon to biomass per unit ofsubstrate utilized than other significant decomposers (bacteria), it is expected that a fungal- dominated soil system would have a higher C ratio (Soares and Rousk, 2019).

Numerous fungaltaxa generate vast networks of vegetative mycelium, made up of hyphae that resemble interwoven threads and contain C compounds, which can eventually decompose into resistantC pools. Arbuscular mycorrhizal fungi (AMF) are particularly important for cycling of soil C and regenerative agriculture (Hawkins *et al.*, 2023). Mycorrhizal fungi also indirectly contribute to the cycling of carbon in the soil by improving plant uptake and availability of nutrients, which increases plant biomass production (Hakim *et al*., 2021).

Nevertheless, it remains to be verified whether microbial amendments can effectively utilize these characteristics and impact soil carbon cycling in practical, real-world scenarios. Itis significantly more difficult to identify and use specific taxa with beneficial traits since thesequalities are more directly related to environmental factors (such as soil type, temperature, nutrient concentrations, and stoichiometry) than they are to any one type of microbial community. In addition to a deeper comprehension of the fundamental mechanisms through which soil microorganisms affect soil C stabilization in field settings, more investigation is necessary to evaluate potential choices for inoculation development in the framework of soil Csequestration.

C. SIC Sequestration Through Addition of Rock Powder:

Though generally thought to be stable for millennia, SIC reserves (up to 7 m belowground) are susceptible to losses from agricultural activities (Raza *et al*., 2021) and are typically lost to the atmosphere as CO_2 emissions, primarily through N-fertilization-induced acidity that causes $CaCO_3$ dissolution (Zamanian *et al.,* 2018). The process of forming pedogenic carbonates when atmospheric CO_2 reacts with silicate minerals that have greater Ca^{2+}/Mg^{2+} concentrations is known as mineral carbonation, and it is thought to be the most stable way of sequestering CO_2 (Snæbjörnsdóttir *et al*., 2020).

The addition of finely broken or powdered silicate pebbles to soil can raise pH and buffering capacity by releasing alkaline metal cations during weathering (Ng *et al.,* 2022). These cations can eventually react with carbonate anions to generate pedogenic carbonates withtime and the influence of biotic and abiotic factors. Silicates containing Ca^{2+} and Mg^{2+}, such as olivine, serpentine, and pyroxene minerals, are examples of potential inorganic rockmaterials for increased biological weathering (Haque *et al.,* 2019). The significance of rock powders in the development of related carbonates is rarely explored, despite the fact that theyare primarily investigated as possible rock fertilizers (Jones *et al.,* 2020).

D. Development of Perennial Grain Crops:

Over the previous three decades, breeding attempts have been made to produce cereal grains (as well as other annual crops) with a perpetual growth habit. Compared to traditional annual crops, the perennial grasses chosen for breeding stocks have deeper, more expansive root systems that allocate a larger percentage of dry matter underground. Because of this, soil receives far more C inputs than do annual crops, which will increase SOC stores. Additionally, the necessity for tillage and its detrimental impacts on soil erosion and SOC stocks would be significantly reduced by using perennial crops (Glover *et al.,* 2010; Pimentel *et al.,* 2012).

Perennial grain adoption is now confronting a number of obstacles because of their poor yields and uncertain economic feasibility if scaled up. Adopting lower yielding perennials could reduce the supply of food and feed, which could put pressure on landowners to restore lost production by converting new land to agriculture elsewhere, resulting in significant increases in greenhouse gas emissions from changing land uses.

E. Annual Crops with Deeper Root System:

Another potential approach for future development could involve modifying current annual crop plants via selective breeding and plant selection to generate extensive roots that extend deeper into the soil. As a result, deeper root distributions, where breakdown rates are slower than in surface strata, would act to improve soil C storage even if crops would still havean annual life cycle. On current US agriculture, it has been estimated that widespread adoptionof annual crop genotypes with larger and deeper root systems might result in increases in soil C stock of 0.5 Gt CO_2/ha/y (Paustian *et al.,* 2016).

11.4 Conclusion:

It can be concluded that in 21st century, soil carbon sequestration is a very much desirable practice due to its positive impacts on greenhouse gas reduction and climate change.It also plays a pivotal role in improving soil fertility, soil structure, supporting microbial life and enhancing agricultural output. There are different strategists that help to increase the soil organic matter level and boosting soil organic carbon stock. Conventional conservation practices are the best to enhance soil carbon sequestration. Agronomic practices such as crop rotation, cover cropping, application of manures, conservation tillage etc. could be employed to raise the soil organic matter content. These are the most used practices to improve soil carboncontent.

There are some other practices which is known as frontier technologies, can also be used. But those technologies are very much novel and very little research knowledge make these of little use in Indian agriculture. Application of bio-char and microbial amendments, application of rock powder, development of perennial grain crops and development of annual crops with deeper root system are some frontier technologies which have a great potential to become a useful way to enhance soil carbon sequestration. The advantages of reducing climate change depend on the continuous use of sustainable management techniques, and it is crucial to remember that the soil's ability to absorb carbon is limited. That being said, in our attempt to increase soil carbon content, we should remain consistent in our dedication to create new and unique strategies and breaking new ground in technology applications.

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