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2. Conservation Agriculture and Carbon Sequestration

Shani Gulaiya, Abhishek Sharma, Priya Kochale

Ph.D. Scholar,
Department of Agronomy,
College of Agriculture,
Jabalpur, JNKVV,
Jabalpur (M.P.), India.

Parikha P. Singh

Ph.D. Scholar,
Department of Plant Physiology,
Jawaharlal Nehru Krishi Vishwa Vidyalaya,
Jabalpur (M.P.), India.

Abstract:

In order to increase productivity, technologies use, crop rotations, minimal soil disturbance, and cover crops or crop residue to provide permanent soil cover. Although there are various obstacles that prevent CA from being widely adopted, efforts to develop, improve, and disseminate conservation-based agricultural technology have been ongoing in India for about 20 years and have achieved significant progress since then.

Much work has been done, in particular, on no-till wheat in the Indo-Gangetic plains, where there is a rice-wheat rotation. Through the use of CA technology, it is possible to lower production costs, conserve water and nutrients, boost yields, diversify crops, optimize resource utilization, and protect the environment. However, there are still barriers to the promotion of CA technologies. These include the lack of suitable seeders, particularly for small and medium-sized farmers, the conflict between CA use and livestock feeding over crop residues, the burning of crop residues, the lack of skilled and scientific labour, and the need to change people's perceptions about tillage. When managed properly, soils have the capacity to absorb carbon from the atmosphere. Recent reports from the Intergovernmental Panel on Climate Change (IPCC 2019) indicate that even if significant cuts in human-caused carbon emissions are made in the near future, efforts to sequester previously emitted carbon will still be required to maintain safe levels of atmospheric carbon and to reduce climate change. (Smith et al. 2014).

By boosting soil carbon inputs and strengthening key soil mechanisms that guard carbon against microbial turnover, a number of agricultural management methods appear to store soil carbon.Other advantages of raising soil carbon include enhancements to soil fertility, structure, and water-holding capacity, which outweigh any potential drawbacks. We will go over the fundamentals of soil carbon, how it may be sequestered, promising management approaches, and the controversy around the idea that agricultural soils could act as a wedge for climatic stability.

Keywords:

Conservation agriculture, Conventional agriculture, Constraints, Resource use efficiency, Zero tillage, tillage, climate, carbon sequestration, soil carbon.

2.1 Introduction:

A farming method that keeps crop residue on the soil's surface while requiring the least amount of soil tillage. With the retention of crop residue in the soil cover, minimal tillage, and no tillage, CA is a management strategy that helps to maintain a soil cover. Despite the fact that the phrase "conservation agriculture" was first used in the 1990s, the concept of minimizing soil disturbance dates back to the 1930s, during the Dust Bowl in the United States of America. In the 1970s, no-till training programmes and experiments were pioneered by CIMMYT in South American maize and wheat systems. In South Asian agronomy projects in the 1980s, this technique was also applied. In the 1990s and the early 2000s, CIMMYT started collaborating with conservation agriculture throughout Latin America, South Asia, and Africa. According to FAO 2012, the term "conservation agriculture" (CA) describes a set of soil management techniques that aim to minimize disruption of the natural biodiversity, composition, and structure of the soil. The state of California has the potential to increase crop yields while enhancing farming's long-term financial and environmental sustainability.

The rice-wheat-dominant region is surrounded by rice/sugarcane-wheat growing regions, western Uttar Pradesh and Haryana, where a large amount of rice and wheat crop residues are generated but their disposal is a problem due to a low population of dairy/draught animals. As a result, framers burn the crop residues in-situ to clear the fields and prepare them for the next crop, which causes a very serious problem with atmospheric pollution, especially Stress from heat and moisture are two more significant problems in crop production. As a result, conservation agriculture has a lot of potential in this strategically significant area.

2.2 Why We Need Conservation Agriculture?

There will be significant effects on natural resource bases, global climate change, and energy security for India, Asia, and the rest of the globe depending on how Asian nations choose to meet their food and energy needs over the coming decades. These difficulties highlight the urgent need for solutions to risks to Indian and Asian agriculture brought on by resource degradation, rising production costs, and climate change (Gupta and Jat 2010). No-till conservation agriculture is thought to be fundamentally important in addressing these issues. Asian farmers and academics will still require support as they refocus their agriculture and practices to produce more with fewer resources by adopting less vulnerable options and approaches (Pittelkow et al. 2014). Therefore, continuing with current practices in conventional agriculture does not appear to be a viable option for sustainable increases in the production of food-grains, and thus, in the majority of ecological and socioeconomic settings of Asian Agriculture, CA-based crop management solutions tailored to local needs will have to play a crucial role. The following opportunities exist for CA promotion in an Asian/Indian context:

A. **Lower production costs:** This is a significant component in the quick adoption of zero-till technologies. The majority of studies revealed that producing wheat costs Rs. 2,000 to 3,000 ($ 33 to $50) less per hectare. Savings on diesel, labour, and input expenses, particularly pesticides, are credited with the cost decrease (Malik *et al.*, 2005).
B. **Decreased occurrence of weeds:** When zero-tillage is used, which results in less pesticide use, most studies tend to show decreased occurrence of *Phalaris minor*, a significant weed in wheat.
C. **Nutrient and water savings:** Limited experimental findings and farmer experience suggest that zero-till planting, particularly in laser leveled and bed planted crops, can produce in significant fertiliser and water savings (up to 20 to 30%). According to De Vita *et al.*, (2007), lower water evaporation during the preceding time was suggested by the higher soil water content under no-till than under conventional tillage. Also, they discovered that throughout growing seasons, no-till had a 20% higher soil water content than conventional tillage.
D. **Increased yields**: Wheat yields were consistently higher in properly maintained zero-till planted fields than in traditionally prepared areas for comparable planting dates. Due to associated effects like the prevention of soil degradation, improved soil fertility, improved soil moisture regime (due to increased rain water infiltration, water holding capacity, and reduced evaporation loss), and the advantages of crop rotation, CA has been reported to increase the yield level of crops. In the Indo-Gangetic plains, no-till wheat yield increases of 200 to 500 kg ha^{-1} are observed when compared to conventional wheat in a rice–wheat system (Jat *et al.*, 2012).
E. **Environmental benefits**: Crop residue burning, which produces significant amounts of greenhouse gases including CO_2, CH_4, and N_2O, can be completely eliminated by conservation agricultural practices like zero-till and surface managed crop residue systems. Burning crop leftovers causes a significant loss of plant nutrients that, with good management, might be recycled. Burning crop leftovers on a large scale poses a severe health risk as well (Hobbs and Gupta, 2004).
F. **Crop diversification opportunities**: Conservation is adopted Crop diversification options are available in agricultural systems. Agro-forestry systems and crop rotations can improve natural ecological processes when used in the right geographical and temporal patterns.
G. **Resource improvement**: When no tillage is used in conjunction with surface management of crop residues, the gradual decomposition of residues starts a process that improves the structure of the soil and increases nutrient recycling and availability for plant growth. Remains on the earth's surface serve as mulch to lower soil temperatures, stop evaporation, and stimulate biological activity.

2.2.1 The Advantages of Conservation Agriculture (CA) Include:

- Maintaining permanent or semi-permanent soil cover
- Minimum soil disturbance
- Integrated disease and pest management
- Higher efficiency in the sense of more output for a lower input
- Regular crop rotation
- Improvement of air quality.
- Utilization of green manures/ cover crops

- Time saving and reduction in labour requirement
- Reduction of costs.
- Reduction in Green House Gas (GHG) emission and fuel uses
- No burning of crop residues
- Controlled/ limited human and mechanical
- Organic matter increase
- Carbon sequestration.
- In-soil water conservation
- Biodiversity increase.
- Improvement of soil structure
- Reduction in soil erosion.
- Improvement of water quality. (Behera et al. 2010)

2.3 Philosophy of Conservation Agriculture:

"*There is nothing wrong with our soils except our interference*". It can be said with considerable truth that the use of tillage actually destroyed the productivity of our soils (Abrol & Sangar 2006; Faulkner, 1942). Soil does not need tillage for effective crop production.

A. The Ca Philosophy Is Based on This:

- Crop residues are a very valuable part of farming system and must be retained in full and remain on the surface as a mulch.
- Permanent all year-round soil cover is essential.
- Control and promotion of natural biological soil process through rotation.
- Soil degradation and erosion is a symptom of an unsuitable farming system.

Table 2.1: Global scenario of Conservation Agriculture FAO (2019)

Country	**Area (Mha)**	**Share (%)**
USA	35.61	22.70
BRAZIL	31.81	22.30
ARGENTINA	29.18	18.60
CANADA	18.13	11.70
AUSTRALIA	17.70	11.30
CHINA	6.70	4.30
RUSSIAN FEDERATION	4.50	3.90
INDIA	3.50	2.90
PARAGUAY	2.00	1.30
KAZAKHSTAN	1.50	1.10
OTHERS	6.68	4.10
TOTAL	**156.99**	**100**

B. Principles of Conservation Agriculture:

Conservation agriculture is a method of managing agro-ecosystems that aims to increase and sustain production boost earnings, and ensure food security while protecting and enhancing the environment and the natural resource base (Behera *et al*., 2010; Lal, 2013). It depends on the practical application of three interconnected principles, as well as other pertinent good agricultural practices (GAPs) of crop production, and therefore needs to be handled carefully with regard to appropriate design, planning, and execution procedures. These three principles are

2.3.1 CA Is Based on Three Principles Applied Simultaneously (FAO, 2012):

A. Minimum mechanical soil disturbance: The word "minimal mechanical soil disturbance" refers to no-till, permanent low soil disturbance, no-till weeding, and no-till direct sowing. The main goal of soil biological processes is to create extremely stable soil aggregates and pores with a range of sizes that allow for proper air and water infiltration. The biological processes that shape the soil cease to exist when the soil is mechanically disturbed by tillage or other farming techniques. Maintaining the ideal composition of respiration gases in the root zone, moderate soil organic matter oxidation, sufficient porosity for soil water transport, retention, and release, and preventing the re-exposure and germination of weed seeds all depend on minimal soil disturbance (Kassam and Friedrich, 2009).

B. Permanent organic soil cover: In conservation agriculture, a permanent soil cover is essential to prevent the soil from suffering negative effects from exposure to rain and sunlight, to maintain a constant food supply for soil micro and macro organisms, and to alter the soil microclimate for the growth of soil organisms and plant roots. This enhances soil aggregation, soil biological activity, soil carbon sequestration, and soil biodiversity (Ghosh *et al*., 2010). With the help of biomass produced by crop waste, cover crops, and stubble, soil can be covered. According to FAO (2014), crop residues must cover at least 30% of the total area that is cultivated.

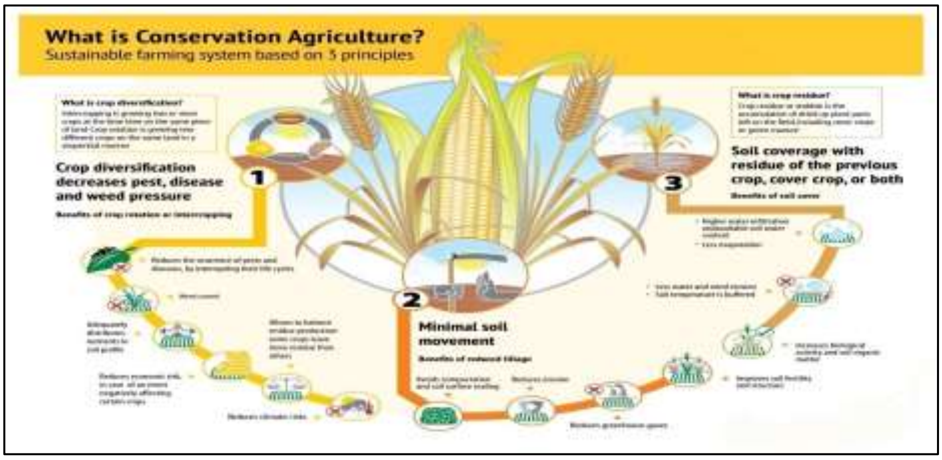

Figure 2.1: Conservation Agriculture

D. Diversified crop rotations:

The rotation of crops must be varied in order to feed the soil microorganisms and allow the crops to use the nutrients that have been leached into the various soil layers. To achieve this, alternate deep-rooted crops with shallow-rooted crops.

A variety of crops grown in succession also affect the flora and fauna of the soil negatively. Legumes play an important role in crop rotations because they help biological nitrogen fixation, disrupt the life cycles of pests to prevent pest infestations, and increase biodiversity (Kassam and Friedrich, 2009; Dumanski *et al*., 2006).

2.4 Conservation Agriculture Practices Includes:

A. Conservation Tillage
B. Mulching
C. Crop Residues Management
D. Crop Rotation

2.4.1 Conservation Tillage:

A technique for growing crops that uses other methods, like crop rotation and reintroducing organic matter to the soil, while minimizing mechanical disturbance to the soil. "Any tillage or planting system in which at least 30% of the soil surface is covered by plant residues after planting to decrease erosion" is the definition of conservation tillage (Sangar *et al*. 2005).

A. The Systems Listed Below Can Be Used with Conservation Tillage:

- Strip tillage or zonal tillage
- Tined tillage or vertical tillage
- Ridge tillage

B. Type of Conservation Tillage System:

Zero tillage:

For pasture renovation, this method was initially used in the USA in 1950. The father of zero tillage is regarded as G.B. Triplet. An extreme form of minimum tillage is zero tillage. Secondary tillage is restricted to seedbed preparation in the row zone while primary tillage is completely avoided. In this system 50 to 100 % residue remaining in the field.

Due to its numerous advantages, zero tillage farming, commonly referred to as no till farming, and is getting popular among farmers in the United States and around the world. Approximately 47% of zero tillage Technology practice in South America, 39% in USA and Canada, 9% in Australia, 3.9% Europe, Africa and Asia (Gathala *et al*. 2011; Derpsch *et al*. 2010).

Figure 2.2: Type of Conservation Tillage System

Table 2.2: Advantages and disadvantages of Zero Tillage

Advantages	**Disadvantages**
Surface runoff is reducing due to presence of mulch.	Initial investment for zero-tillage machinery (the upfront costs can be high, but they should be recouped through higher crop yield and fuel and labour savings).
Organic matter content increases due to less mineralization.	Seedling establishment in zero tillage is 20% less than conventional method.
Less soil erosion from wind and water.	Higher dose of Nitrogen has to be applied due to slow mineralization of organic matter.
Less soil compaction.	Large population of population of perennial weed appear in zero tillage plots.
More fertile and resilient soils	Higher numbers of volunteer plants build up.
Less moisture evaporation.	Increased use of herbicides.

C. Minimum tillage: This idea was developed in the USA in 1974 as a result of the high cost of tillage brought on by sharp increases in oil prices. Like strip-till, minimum tillage is soil conservation technique that aims to manipulate the soil as minimum as possible while still producing a good crop. It is a form of tillage that does not disturb the soil, as opposed to intense tillage, which uses a plough to alter the soil's structure. Primary tillage is entirely avoided with minimum tillage, and only minor amounts of secondary tillage are used. The term "minimal tillage" refers to techniques like minimal furrowing, the use of organic fertilizer, the use of biological pest management methods, and the minimal use of pesticides (Sharma *et al.* 2012).

D. Tillage Can Be Reduced in Two Ways:

- By omitting operation which do not give much benefit when compared to the cost.
- By combining agricultural operations like seeding and fertilizer application.

Table 2.3: Advantages of Minimum Tillage

Advantages	Disadvantages
Improved soil conditions due to decomposition of plant residues *in situ.*	Seed germination is lower with minimum tillage.
More infiltration brought on by plants on the soil and channels created by dead root decay.	More nitrogen must be provided in minimum tillage because organic matter decomposition proceeds slowly.
A better structure results in fewer barriers to root growth.	Nodulation is affected in some leguminous crops like peas and broad beans.
Reduced soil erosion and less soil compaction compared to conventional tillage due to the decreased movement of large tillage vehicles	Sowing operations are difficult with ordinary equipment.

E. Different Methods of Minimum Tillage Practiced:

Row Zone Tillage: After first tillage with a mould board plough, disking and harrowing procedures are minimized. Only in the row zone is secondary tillage carried out.

Plough-plant Tillage: A specialized planter is used to pulverize the row zone and sow seeds in one pass across the field after the soil has been ploughed.

Wheel Track Planting: Ploughing is done as usual. Tractor is used for sowing and the wheels of the tractor pulverize the row zone.

2.4.2 Mulch Tillage:

Crop residues are left on the surface under a system called mulch tillage, whereas they are largely unaffected by subsurface tillage. In dry land regions, the mulch is mostly left on the surface; in more humid areas, some of the mulch is buried. Intercropping broadens the mulch-provided erosion protection in rainy areas. Intercrops are often small grains or sod crops, such as alfalfa or clover, grown between the rows of a field crop that mature quickly after the field crop has been established and provide mulch cover for a considerable amount of time.

Mulching: Mulching is the process of adding a layer of plant residue or other materials to the soil's surface, either naturally or artificially. In other words, it may be described as a protective layer placed on the ground around plants, such as bark chips, straw, or plastic sheeting, to control weed development, hold in moisture, or prevent the freezing of the roots (Sharma *et al.* 2005).

Figure 2.3: Mulch Tillage

- This technique improves soil structure, inhibits the growth of weeds, and helps to preserve soil moisture. Mulching improve soil structure due to decomposition of organic mulch materials.
- Mulching significantly minimizes soil loss by shielding the soil from the direct impact of raindrops, lowering the sediment carried by runoff, and reducing evaporation. In order to sustain soil biodiversity, organic wastes are also helpful (Sharma *et al.* 2005).

2.4.3 Crop Residue Management (CRM):

Figure 2.4: Crop Residue Management (CRM)

Soil and water are conserved by using crop residue management (CRM) techniques. CRM systems incorporate conservation tillage techniques like zero-till, reduced-till, bed planting, and other techniques that offer enough residue cover to shield the soil surface from the erosive effects of wind and rain (Singh *et al*. 2005).

A. Impact of Crop Residue Burning:

Effects of burning stubble in addition to having negative effects on the environment, human health, and soil quality, open-field residue burning also has a negative effect on the world economy. Below, in the following subheadings, are discussed these negative effects:

- Impact on air
- Impact on soil
- Impact on agricultural productivity
- Impact on the economic development
- Decline soil microbial biomass
- Loss soil biodiversity
- Loss of soil organic carbon
- Chronic heart and lungs disease
- Climate pollution
- Smog and haze
- Aerosols and particulate
- Atmospheric environment
- Soil environment
- Human environment

2.4.4 Crop Rotation:

Figure 2.5: Crop Rotation

Crop rotation, as opposed to a one-crop system or unplanned crop successions, is the cultivation of various crops in succession in a predetermined order on the same land.

Crop rotation is the process of planting various crops in succession on the same piece of land to enhance soil health, maximize nutrients in the soil, and reduce insect and weed burden. Take the case of a farmer who has a field of corn planted.

A. Advantages of Crop Rotation:

- Enhanced soil fertility and microbial activity
- Avoid accumulation of toxic substance
- Better utilization of nutrients and soil moisture
- Insurance against natural devastation
- Higher chances to provide diversified commodities
- Slow but steady income, which is beneficial to marginal and small farmers
- Deep rooted crops work the soil below plough layer

B. Limitations to The Use of Conservation Agriculture:

Hobbs and Govaerts (2010) pointed out that overcoming the bias or mindset about tillage is likely the most crucial element in the implementation of CA. It is considered that one of the biggest obstacles to adopting CA widely is encouraging farmers that effective agriculture is still achievable with minimal or no tillage (Hobbs & Govaerts 2010).

- Lack of appropriate seeders especially for small and medium scale farmers.
- The wide spread use of crop residues for livestock feed and fuel.
- Burning of crop residues.
- Lack of knowledge about the potential of CA to agriculture leaders, extension agents and farmers.

- Skilled and scientific manpower.

2.5 Carbon Sequestration:

The process of removing, securing, and storing carbon dioxide from the atmosphere is known as carbon sequestration (CS) (Lal, 2004). The goal is to prevent carbon from warming the atmosphere by stabilizing it in both solid and dissolved forms. CS is the provision of long-term carbon storage in the terrestrial biosphere, underground, or the oceans in order to slow or stop the increase of atmospheric carbon dioxide concentration (Lal, 1995). It reduces the amount of carbon dioxide that enters the atmosphere as a result of sources like deforestation, forest fires, and primarily emissions from burning fossil fuels. This process is also referred to as carbon capture. The act of diverting CO_2 away from emission sources and storing it in the ocean, terrestrial settings (vegetation, soils, and sediments), and geologic formations is referred to as "carbon sequestration."

This process can be either natural or intentional. Carbon dioxide levels in the atmosphere have significantly increased as a result of human activity, particularly the combustion of fossil fuels like coal, oil, and gas (Jenkinson and Rayners, 1977). Global warming is being observed as a result of the rise in atmospheric CO_2 during the past 250 years, from around 280 to more than 400 parts per million (ppm).

Potential negative impacts include an increase in sea level, a rise in the frequency and intensity of wildfires, floods, droughts, and tropical storms, changes in the quantity, timing, and distribution of rain, snow, and runoff, and the disruption of coastal marine and other ecosystems. A more acidic ocean could have negative impacts on marine plankton and coral reefs due to rising oceanic CO_2 levels and increased CO_2 absorption by seawater. To lessen the effects of rising atmospheric CO_2, technically sound and economically viable measures are required. In order to minimize human caused CO_2 emissions and remove CO_2 from the atmosphere (Wilson *et al.*, 2009).

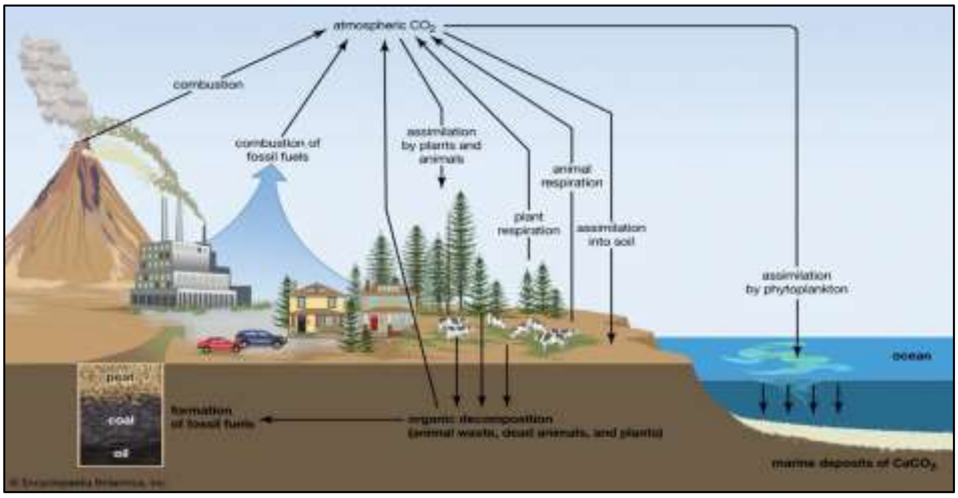

Figure 2.6: The process of Carbon sequestration

A. In What Ways Do Soils Sequester Carbon?

Soil carbon is successfully enhanced in the labile and slow pools by increasing the net balance of carbon that enters the soil each year relative to what is lost because the stable pool's size is typically unchanged. Govindarajulu *et al.,* (2005) this dynamic is significantly influenced by agricultural managers in four ways:

- Reducing soil disturbance (i.e., tillage) levels to improve the soil carbon's physical protection in aggregates.
- Enhancing soil inputs of plants and animals in quantity and quality.
- Increasing the diversity and richness of soil microbes.
- Ensuring that soils always have a living plant cover.

B. Why Now the Time to Act Is:

The overall quantity of carbon stored in American forests is greater than the cumulative historical CO_2 emissions from fossil fuels in the US. According to projections, total U.S. emissions will double by 2050 and rise by a factor of three to four by 2100 if current trends continue.

Sequestration and emission reduction over the next two to three decades could potentially have a significant impact on long-term opportunities to stabilize atmospheric CO_2 levels and mitigate the effects of climate change, according to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change from 2007.

C. Why C-Sequestration Is Required:

- To improve soil fertility status
- To improve soil quality
- Improve crop yields
- To improve farmer’s income
- Improve Rehabilitation of degraded land
- In climate change mitigation
- Enhancing carbon removal.

2.5.1 Carbon Sequestration Methods:

A. Natural Processes

a. Terrestrial Sequestration
b. Ocean Sequestration

B. Human Techniques:

a. Carbon Capture and Storage (Geologic Sequestration)

a. Terrestrial Sequestration:

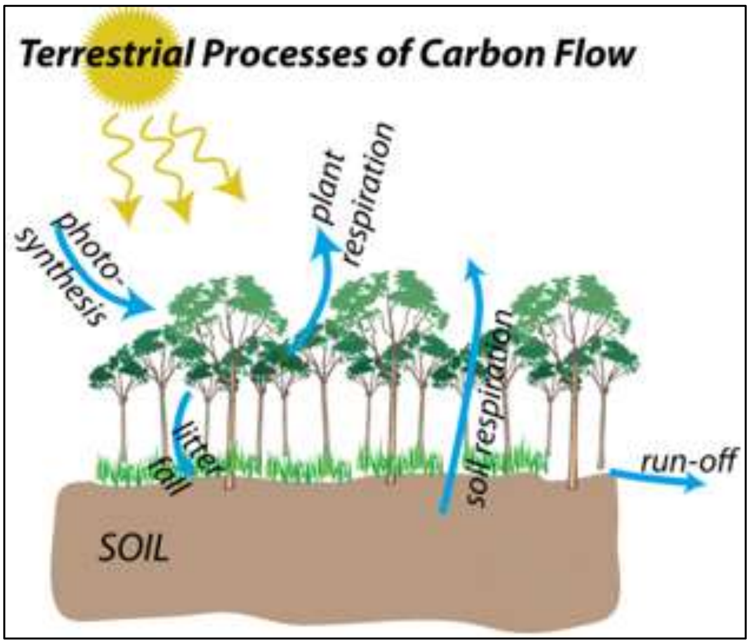

Figure 2.7: Terrestrial Sequestration

Terrestrial sequestration, also known as "biological sequestration," is primarily achieved by soil and forest conservation techniques that improve carbon storage (by building and regenerating forests, wetlands, and grasslands, for example) or lower CO_2 emissions (such as reducing agricultural tillage and suppressing wildfires). When dead roots and leaves decay, some of that CO_2 is released into the soil (Jandl *et al*. 2007; Batjes, 1996).

Uptake Saturation: Beyond a certain point, increased sequestration of carbon is no longer possible in plants due to saturation. When a tree reaches maturity or the amount of organic carbon in the soil becomes a constraint, this happens (Six et *al.*, 2002).

i. Enhancing Terrestrial Sequestration:

- **Agricultural Practices:** A lot of agricultural land is bare between planting seasons. Increase biomass sequestration by providing temporary cover with cover crops like grasses and weeds.
- **Sequester livestock:** To promote light, even grazing and thorough soil tilling, grazing should be restricted to shorter grassland for a brief period of time. Deeper root insertion into the soil is encouraged as a result.
- **Cover bare paddocks** with hay or dead vegetation to protect soil from the sun and to allow a higher water content, making the soil more appealing to carbon-capturing microbes.
- **Reforestation:** is the process of replanting trees in arid and marginal agricultural and grazing lands.

- **Afforestation:** is the process of establishing a forest in a place where none previously existed. This is done to increase biomass for the purpose of absorbing carbon dioxide.
- **Wetland Restoration:** Re-establishing or rehabilitating a wetland in order to return its original biological, geological, and chemical processes. This encourages carbon to be trapped in the sediments below. Wetlands make up only 5 to 8% of the planet's land, yet they hold 20 to 30% of its soil carbon, especially in coastal wetlands like mangroves, sea grasses, and salt marshes (Schnitzer *et al.* 2011)**.**

b. Ocean Sequestration:

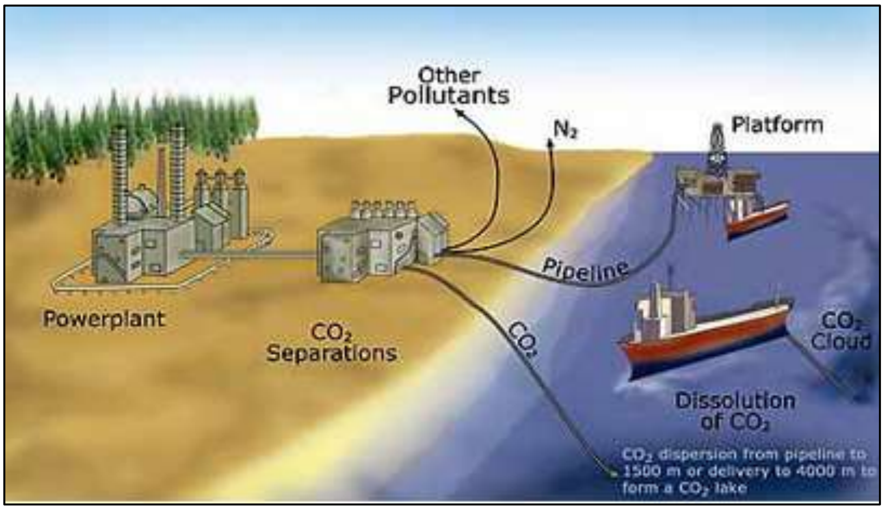

Figure 2.8: Ocean Sequestration

The largest long-term sink for CO_2 emissions from human activity is the ocean, which now absorbs around 2 gigatonnes of carbon yearly. The seas, which now absorb a third of the carbon produced by human activity, or about two billion metric tonnes annually, are one of the most promising areas to sequester carbon (Lal, 2004).

The amount of carbon that would cause the load in the atmosphere to double would only result in a 2% increase in the concentration in the deep ocean. 38,000 gigatonnes (Gt) of carbon are sequestered by the ocean each year (1 gigaton = 1 billion tonnes). This is sixteen times more carbon than the terrestrial biosphere is capable of storing (Macias and Arbestain 2010).

Process of Ocean Sequestration: Plankton at the ocean's surface employ photosynthesis to transform carbon dioxide into sugars, which is a process known as ocean sequestration. Plankton is eaten by sea life, which contributes carbon to the marine ecology.

Marine life eventually perishes and sinks to the ocean floor, where it accumulates in sedimentary layers and is stored as carbon. In order to keep it from exchanging with the atmosphere over millennia, the residence period of carbon molecules in deep ocean sediment is expected to be at least 3,800 years (Kell 2012; Robertson and Grandy 2006).

i. Physical Sequestration: Carbon Capture and Storage (CCS):

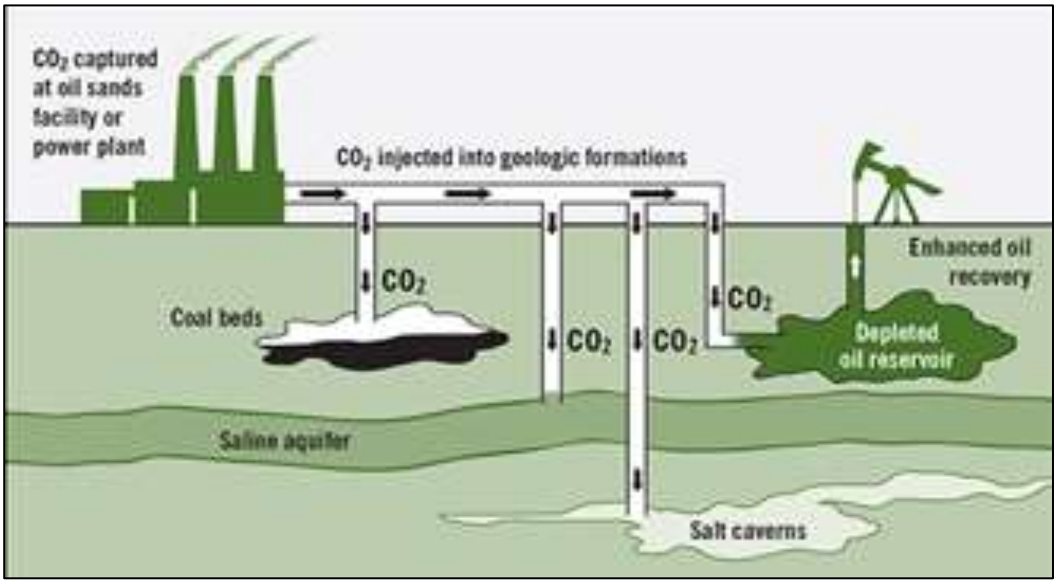

Figure 2.9: Physical Sequestration: Carbon Capture and Storage (CCS)

A geo-engineering technique called carbon capture and storage is used to physically stop significant amounts of CO_2 from being emitted into the atmosphere. It is being used as a promising complement to natural sequestration techniques all around the world.

CCS has the capacity to collect up to 90% of the carbon dioxide emissions produced when fossil fuels are burned to produce electricity and in industrial processes (Duke and Powles, 2008).

2.6 Conclusion:

- Food security depends on healthy soils, and climate change has jeopardised it by changing the soil's properties. In such circumstances, conservation agriculture is a suitable strategy to maintain soil fertility and improve the sustainability of agriculture.
- Numerous advantages of conservation agriculture include improved soil physical, chemical, and biological health; sustaining crop production through resource conservation and soil quality; cost, energy, and labour savings; improved water and nutrient use efficiency; reduced greenhouse gas emissions by carbon sequestration; reduced soil erosion and environmental pollution due to the elimination of the need to burn crop residues; and climate change mitigation.
- No tillage, crop residue, judicious use of fertilizer & INM, cropping system and biochar application can easily be adopted and these practices have positive impact on soil carbon sequestration and crop productivity.
- Crop diversification and intercropping could be viable options for enhancing carbon sequestration in changing climatic scenario. For sequestering the atmospheric carbon and for maintaining sustainability, integrated nutrient management has a pivotal role.

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