



## Carbon Sequestration: Benefits and Impact on Environment

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Carbon is the fourth most prevalent element and is necessary for the synthesis of complex molecules like proteins and DNA that are necessary for life. One kind of carbon that is essential to control Earth's temperature is carbon dioxide (CO<sub>2</sub>). For the future of the planet, it is essential to understand the carbon cycle because carbon dioxide levels affect the climate. Excessive levels could cause the earth to become too warm, while insufficient levels could cause it to freeze. The movement of carbon between plants, animals, microorganisms, minerals, and the atmosphere is known as the carbon cycle. During photosynthesis, plants take up carbon dioxide, which they then store in their roots, permafrost, grasslands, and forests before releasing it through decomposition. Oceans and animals also play a role in the exchange of carbon. Burning fossil fuels is one human activity that releases stored carbon, raising the quantities of greenhouse gases that trap heat in the atmosphere. Carbon sequestration is the capture and secures storage of carbon that would otherwise be discharged into the atmosphere with the goal of preventing global climate change. It is one strategy to lower atmospheric carbon dioxide levels in an effort to slow down global warming. There are two main sources of atmospheric carbon dioxide: human activity and natural processes. The majority of animals are natural sources of carbon dioxide because they exhale it as waste. Human activities that lead to carbon dioxide emissions come primarily from energy production, including burning coal, oil, or natural gas.

### Difference Between Geologic and Biological Sequestration

Geologic carbon sequestration is the process of storing CO<sub>2</sub> in underground geologic formations. The CO<sub>2</sub> is usually pressurized until it becomes a liquid, and then it is injected into porous rock formations in geologic basins. This carbon storage technology is also frequently referred to as enhanced oil recovery, or tertiary recovery, because it is typically used later in the life of a producing oil well. Enhanced oil recovery involves injecting liquid CO<sub>2</sub> into an oil-bearing deposit to reduce the oil's viscosity and allow it to flow more freely to the oil well. The storage of atmospheric carbon in plants, soils, wood products, and aquatic environments is known as biologic carbon sequestration. For example, by encouraging the growth of plants—particularly larger plants like trees—advocates of biologic sequestration hope to help remove CO<sub>2</sub> from the atmosphere.

There are several strategies to achieve biological carbon sequestration:

- New forest and tree plantings that store CO<sub>2</sub> as biomass in the soil and trees after absorbing it through photosynthesis.
- Planting trees to improve soil and biomass carbon sequestration in agricultural landscapes.
- Using techniques like cover crops, conservation tillage, and the use of organic matter to increase the capacity of soils to store carbon.

## Technological Carbon Sequestration

Scientists are still investigating technological carbon sequestration, a relatively new technique for absorbing and storing carbon dioxide. It entails capturing, storing, or turning CO<sub>2</sub> into a resource utilizing technology. The following are some examples of how technology is applied to sequester carbon:

**Production of graphene:** Graphene may be made from CO<sub>2</sub> using technology. Manufacturers utilize graphene, a technical substance, to make screens for smartphones and other gadgets.

**Direct air capture:** With the use of cutting-edge technology, carbon dioxide may also be extracted straight from the atmosphere. Although direct air capture works well, it is highly costly to use.

**Engineered molecules:** Researchers are developing molecules with the ability to recognize and absorb CO<sub>2</sub> from the atmosphere. By acting as filters, the modified molecules only draw in and hold onto the element they are designed to trap.

## Agricultural Practices for enhanced carbon sequestration

Alternative agricultural and land use practices can reduce carbon emissions from soil and enhance carbon sequestration. Such practices include:

- Addition of organic amendments to the soil (compost)
- Implementing reduced or no-tillage methods
- Proper fertilizer management
- Planting cover crops
- Perennial Cropping Systems
- Implementing crop rotation, grazing management etc.
- Cropping intensification
- Liming, irrigation, and fertilizer management
- Management of microbe population

## Advantages of Carbon Sequestration

**Soil health:** By improving soil quality, retaining more water, and lowering nutrient loss, increasing the amount of carbon in soil is good for the ecosystem. In the end, this increases land productivity since more crops can be produced from healthier soils. Because healthier soils are less likely to have topsoil wash away during floods, it also increases resilience and reduces soil erosion.

**Revenue generation:** Carbon credits are a way for farms to make extra money. Farmers can offer credits to businesses wishing to offset their carbon footprint by using techniques that improve carbon sequestration. As a way to diversify a firm, carbon sequestration can generate revenue that is not entirely dependent on conventional agricultural markets.

**Reduced inputs:** To enhance soil quality, carbon sequestration can be combined with other regenerative agriculture techniques such as crop rotation, agroforestry, and managed grazing. Consequently, superior crops can be produced from healthier soils with less need on costly artificial inputs like fertilizers.

**Legal considerations:** By proactively putting eco-friendly procedures into place, we may guarantee adherence to new sustainability laws and prevent operating interruptions in the future.

**Other advantages:** Geothermal energy production can be made more sustainable by using geologically stored carbon dioxide to recover geothermal heat. Captured carbon dioxide is also added to concrete to increase its durability and helps make polymers and chemicals like polyurethanes. Additionally, carbon capture activities create opportunities for qualified technicians and engineers. Carbon sequestration has the potential to generate new job opportunities in fields including environmental monitoring, sustainable land management, and green technology development.

## Drawbacks of carbon sequestration

**Initial investment costs:** Early funding is necessary to encourage carbon sequestration on farms. Reforestation and no-till farming are two strategies that demand farmers to invest in new equipment and receive training in new practices. Smallholders must therefore balance the short-term financial strain against the long-term advantages.

**Land availability:** Techniques like cover crops and agroforestry may protect crops and lessen soil erosion, but they also lower total land availability and productivity. This may reduce immediate yields, necessitating a more calculated approach to land management. Adoption may be hampered by these limitations, particularly for smallholders and small-scale farms.

**Greenwashing:** Although carbon sequestration benefits the environment overall, it has come under fire for allowing polluting businesses to continue their destructive operations. In order to offset their emissions, many polluters can easily purchase carbon credits, which serves as a greenwashing approach and diverts attention from the crucial duties of preventing and lowering emissions at their source.

**Long-term viability:** An increasing amount of research indicates that carbon sequestration techniques lose their effectiveness over time. Sequestration rates tend to plateau after the soils are saturated with carbon, and they are maximum in severely degraded soils. Furthermore, there are questions about how long soil can store carbon and how soil bacteria affect soil carbon sequestration. This raises the likelihood that carbon sequestration's advantages will be more pronounced in the short to medium future.

**Other disadvantage:** Since carbon capture storage can only target emissions from fossil fuel-based heat and electricity generation, which account for around 25 per cent of total greenhouse gas (GHG) emissions, it is insufficient to combat climate change. Transportation, agriculture, and other industrial processes account for the other 60 per cent, none of which are presently controlled by carbon capture techniques.

## Impact of carbon sequestration on Environment

Carbon sequestration offers substantial environmental advantages, playing a crucial role in mitigating climate change and safeguarding ecosystems.

**Control of Global Warming:** Around 45 per cent of carbon dioxide is naturally absorbed by ecosystems, making carbon sequestration essential for reducing global warming. The greenhouse effect gets worse by the excess in the atmosphere, leading to a number of negative effects such as droughts, decreased rainfall, ice cap melting, sea level rise, increased flooding, decreased agricultural output, and possible food shortages.

**Encouragement to Grow Trees and Preserve Forests:** Trees and other vegetation are essential for storing and capturing carbon dioxide since they absorb around 25 per cent of carbon emissions. Realizing the importance of carbon dioxide in climate change, efforts to preserve current forests and encourage tree growth are probably going to continue. Carbon sequestration endures when forest cover is maintained and increased, resulting in both immediate and long-term environmental preservation.

**Reduced Rate of Ocean Acidification:** Approximately 30 per cent of the carbon dioxide released during fuel combustion is absorbed by the ocean's uppermost layer. Because of this absorption, ocean waters become more acidic, which makes it harder for marine organisms to survive and produce shells. Carbon sequestration benefits human populations that depend on seafood as well as the ecology by preventing disturbances to marine life.

**Reduction of Carbon Dioxide Emissions:** Carbon dioxide sequestration from coal-fired power plants and industrial smoke stacks is continuously improved by technological improvements. The environmental impact of carbon dioxide can be lessened by safely storing it in the oceans or deep underground.

**Improved health of the population:** After prolonged exposure to high CO<sub>2</sub> levels, some people experience symptoms like headache, dizziness, breathing difficulties, and a racing

heart. With correct implementation, carbon sequestration can significantly lessen all of these effects and eventually enhance people's health.

### **Conclusion**

Carbon sequestration, which can be accomplished through a variety of natural and man-made methods, is becoming recognized as a potential tool to mitigate the negative impacts of global warming. Policies should be put in place by the government to help industry absorb carbon and create new jobs for those with the necessary technological skills. Scientists and extension workers must work extremely hard to educate Indian farmers about the carbon sequestration process so they can employ agricultural modifications to reduce carbon emissions.