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Carbon Sequestration in Fruit Crops

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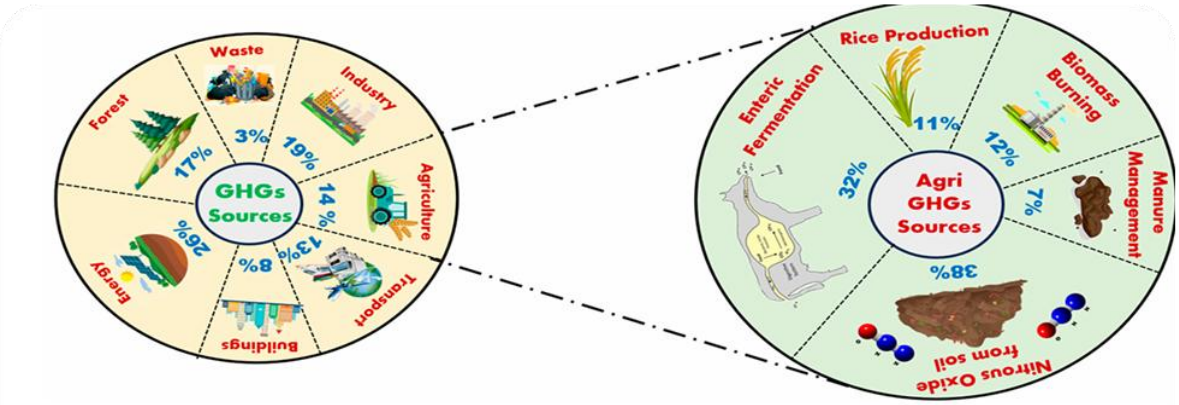
Carbon dioxide (CO_2) is one of the major greenhouse gases contributing to global warming and ongoing climate change. The rising concentration of CO_2 in the atmosphere has been largely driven by human activities, particularly the burning of fossil fuels and widespread deforestation. One strategy proposed to limit the buildup of atmospheric CO_2 is carbon sequestration. This process involves capturing carbon dioxide and storing it in a stable reservoir so that it does not return to the atmosphere. In simple terms, sequestration refers to securely locking something away. In environmental science, it describes the capture of CO_2 from the atmosphere and its long-term storage in natural or engineered systems where it can remain safely isolated.

Need to Capture?

Source of Greenhouse Gases emission



Ways that carbon can be sequestered

1. Geological sequestration: Underground
2. Ocean Sequestration: Deep in ocean
3. Terrestrial Sequestration: In plants and soil

Geological Sequestration

Geologic Storage involves capturing anthropogenic CO_2 before it enters the atmosphere and injecting it into underground formations. Once CO_2 is injected deep underground (typically more than 800 meters) it is trapped in minute pores or spaces in the rock structure. Impermeable cap rocks above the storage zones act as seals to ensure the safe storage of CO_2.

Ocean sequestration

Carbon is naturally stored in the ocean via two pumps, solubility and biological and there are analogous man made methods, direct injection and ocean fertilization, respectively.

At the present time, approximately one third of human generated emission are estimated to be entering the ocean.

Terrestrial Sequestration

The process through which CO_2 from the atmosphere is absorbed naturally through photosynthesis & stored as carbon in biomass & soils.

Carbon sources and carbon sink

Carbon source

Anthropogenic activities such as the burning of fossil fuels have released carbon from its long-term geological storage as coal, petroleum and natural gas and have delivered it to the atmosphere as carbon dioxide gas.

Carbon sink

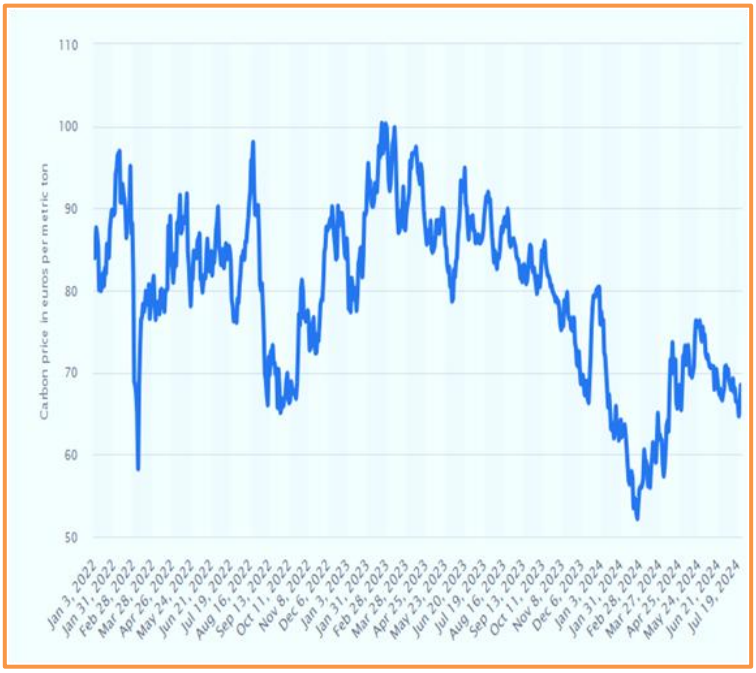
The main natural carbon sinks are plants, the ocean and soil. Plants grab carbon dioxide from the atmosphere to use in photosynthesis; some of this carbon is transferred to soil as plants die and decompose. The oceans are a major carbon storage system for carbon dioxide. Marine animals also take up the gas for photosynthesis, while some carbon dioxide simply dissolves in the seawater.

Carbon Credit

- A carbon credit represents a reduction or removal of one metric ton of CO_2 or its equivalent in GHG emissions.
- A carbon credit is a permit that allows a country or organization to produce a certain amount of carbon emissions which can be traded if the full quota is not used.
- One carbon credit is equal to one metric ton of carbon dioxide, or in some markets, carbon dioxide equivalent gases (CO_2-eq).
- It can be bought or sold after certification by a government or independent certification body.

Clean Air Act (Amended)	Acid Rain Trading Programme	Kyoto Protocol	COP 21, Paris
1970	1990	1997	2015
Allowing permitted facilities to increase emissions in exchange for paying another company to reduce its emissions of the same pollutant by a greater amount	Introduced the concept of a cap and trade system.	Established mechanism that enable countries or operators in developed countries to acquire offset credits	Allows countries to transfer carbon credits from reducing GHG emissions to help other countries meet their climate targets

Carbon Pricing



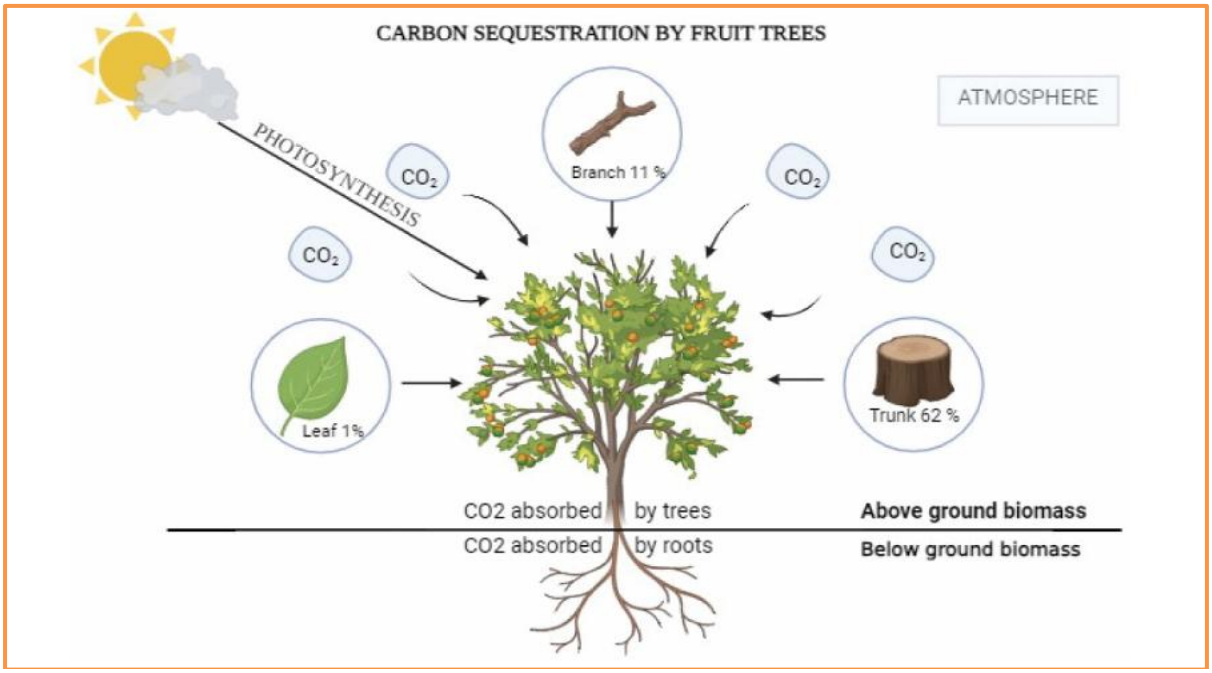
- As of 24th July 2024,

1 carbon credit =

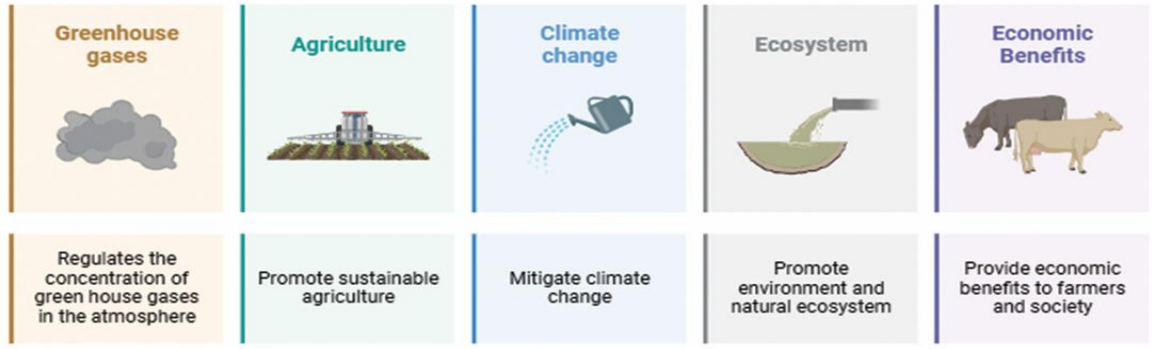
68. 41 euros

(As per EU-ETS)

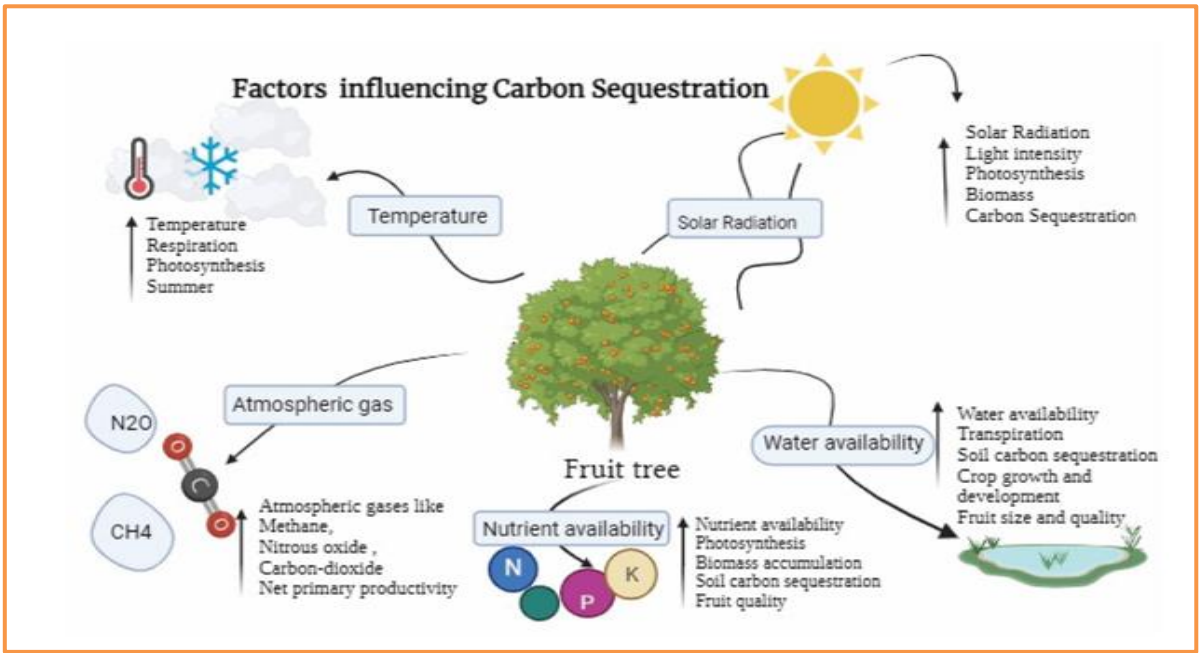
- 1 euros = 90.76 rupees
- 1 Carbon credit = 6209 rupees = $73.88



Importance of Carbon Sequestration Potential of Fruit Trees



Factor Affecting Carbon Sequestration in Fruit Crops



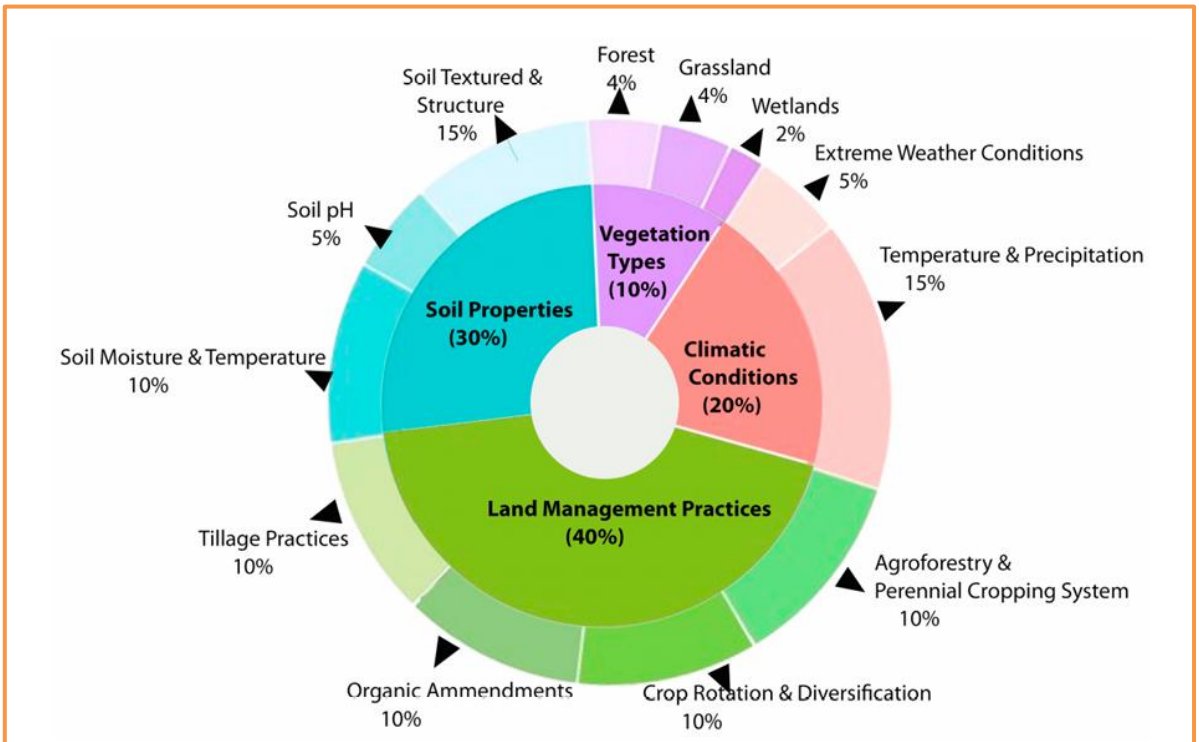


Figure 6. Percentage share of factors affecting carbon sequestration.

Challenges in Measuring Carbon Sequestration in Horticultural Crops

Fruit Trees (High Difficulty)

- Above-ground: Difficult (varied size/shape)
- Below-ground: Hard (deep roots)
- Soil C: Affected by soil & climate

Plantation Crops (High Difficulty)

- Above-ground: Challenging (woody, tall)
- Below-ground: Very hard (deep root systems)
- Soil C: Variable with soil & management practices

Vegetable Crops (Moderate Difficulty)

- Above-ground: Easier (small plants, short life)
- Below-ground: Simpler (shallow roots)
- Soil C: Still influenced by soil/weather

Conclusion

Fruit crops play an important role as carbon sinks by contributing to both biomass accumulation and soil carbon storage. The capacity for carbon sequestration varies among species, management practices, and soil depths, with systems based on mango, citrus, and coconut demonstrating particularly strong potential. Practices such as intercropping and integrated nutrient management further enhance soil organic carbon and increase the overall carbon stock in these systems. Although the upper soil layers contain the highest proportion of stored carbon, deeper soil horizons also contribute significantly to long-term carbon storage. Regional research indicates that climate, soil characteristics, and cultivation methods strongly influence the effectiveness of carbon sequestration. Therefore, fruit-based production systems not only contribute to climate change mitigation but also promote improved soil health and long-term sustainability in horticulture.