Biochar: Environment

Biochar is a stable, carbon-rich product obtained by pyrolyzing biomass in limited oxygen, improving soil fertility, retaining water, and sequestering carbon, thus aiding climate change mitigation. It also reduces greenhouse gas emissions by locking carbon in soils for centuries.

Biochar – Carbon Removal Technology

1. Introduction

Charcoal-like material produced by pyrolyzing biomass (agricultural, forestry, or municipal waste) in an oxygen-limited environment. The purpose includes Long-term carbon sequestration, soil improvement, and generation of useful byproducts. Significance is seen as a scalable, sustainable negative emissions solution in the context of India's upcoming carbon market (2026).

2. Raw Material & Production Process

Feedstock Sources

1. Agricultural residues (crop waste, husks, straw).
2. Forestry waste (wood chips, sawdust).
3. Manure.
4. Municipal solid waste (biodegradable fraction).

Process, Pyrolysis – Thermal decomposition in limited oxygen.

Outputs, Biochar + Syngas + Bio-oil.

3. Physical Properties

1. Black, highly porous, lightweight, fine-grained.
2. Composition: ~70% stable carbon.
3. Longevity: Carbon stability for 100–1,000 years.

4. Biochar Production Potential in India

Waste Availability

1. 600+ million metric tonnes of agricultural residue/year.
2. 60 million metric tonnes of municipal solid waste/year.

Current Issue, Majority openly burned or dumped → pollution & GHG emissions.

5. Potential Yield

1. Using 30–50% waste → 15–26 million tonnes biochar/year.
2. Could remove ~0.1 GtCO_2e annually.

6. Byproducts & Energy Potential

Syngas

1. Annual production potential: 20–30 million tonnes.
2. Electricity generation: 8–13 TWh/year (~0.5–0.7% of India's electricity demand).
3. Coal replacement: 0.4–0.7 million tonnes/year.

Bio-oil

1. Production: 24–40 million tonnes/year.
2. Fossil fuel offset: 12–19 million tonnes of diesel/kerosene (~8% of national demand).
3. Import reduction: Cuts crude oil imports, lowers fossil-fuel emissions by >2%.

Applications Across Sectors

1. Agriculture

1. Improves soil fertility & water retention.
2. Reduces fertilizer need by 10–20%.
3. Increases crop yield by 10–25%.
4. Cuts nitrous oxide (N_2O) emissions by 30–50% (N_2O is 273× more potent than CO_2).

2.Carbon Capture

1. Modified biochar can capture CO_2 from industrial emissions.
2. Current efficiency < conventional methods but promising for future R&D.

3.Construction

1. Adding 2–5% biochar to concrete:
2. Increases compressive strength & heat resistance by ~20%.
3. Captures ~115 kg CO_2/m^3 of concrete.

4. Wastewater Treatment

1 kg biochar, treats 200–500 litres water. India's wastewater (~70 billion litres/day), requires 2.5–6.3 million tonnes biochar annually.

5. Co-Benefits

1. Acts as a long-term carbon sink (100–1,000 years).
2. Reduces open burning & landfill emissions → better air quality.
3. Byproducts contribute to energy security.
4. Generates rural employment (~5.2 lakh jobs possible).
5. Supports soil regeneration, water retention & climate resilience.

6. Challenges

1. No standardised feedstock protocols or carbon accounting frameworks.
2. Investor hesitancy over carbon credit eligibility.
3. Weak monitoring & verification mechanisms.
4. Low awareness among farmers, industries, and policymakers.
5. Policy silos between agriculture, energy, and climate change.
6. Lack of R&D for regional pyrolysis efficiency and adaptation.

7. Way Forward

1. Recognition in Carbon Markets: Officially include biochar as a verifiable carbon removal method.
2. Policy Integration: Link with crop residue management, bioenergy schemes, and State Action Plans on Climate Change.
3. Region-Specific R&D: Improve feedstock utilization and pyrolysis technology for local conditions.
4. Decentralised Production: Promote village-level pyrolysis units for local employment and circular economy benefits.
5. Co-Benefit Frameworks: Integrate soil health, water management, and emissions reduction benefits into incentive schemes.

Source: https://epaper.thehindu.com/ccidist-ws/th/th_international/issues/142917/OPS/GCCEMSOUG.1+GJDEO0RFE.1.html