Dhruva Space Successfully Launched its First Commercial Satellite Mission, LEAP-1

Reports and news articles from mid-2025 highlight that India's upcoming carbon market, set to launch in 2026, will create significant opportunities for biochar as a carbon removal technology. Biochar, a carbon-rich substance made from agricultural and organic waste, is positioned as a key tool for meeting India's climate goals and fostering a green economy.

India's carbon market and regulatory framework

- **Targeting hard-to-abate sectors:** The new Carbon Credit Trading Scheme (CCTS), expected to be fully operational by mid-2026, will initially focus on nine energy-intensive sectors, including steel, cement, and petrochemicals.
- **Shift to GHG-based trading:** The CCTS replaces the earlier Perform, Achieve, and Trade (PAT) scheme by shifting from energy efficiency to greenhouse gas (GHG)-based emissions trading.
- **Compliance mechanism:** Under the scheme, obligated entities that reduce their GHG emission intensity below prescribed targets will earn carbon credit certificates (CCCs). Entities that fail to meet their targets will need to purchase credits or pay a penalty.
- **Voluntary mechanism:** A parallel voluntary market is also being developed to include sectors like agriculture and afforestation, aiming to mobilize private capital for climate-positive projects.
- **First legally binding rules:** In October 2025, the Ministry of Environment, Forest and Climate Change notified the first legally binding GHG Emission Intensity Target Rules, 2025. These rules set emission reduction targets for four high-emission sectors, including aluminium, cement, pulp and paper, and chlor-alkali, for the compliance cycles of 2025–26 and 2026–27.

Biochar's potential in the Indian context

- **Waste-to-wealth opportunity:** By utilizing 30%–50% of the over 600 million tonnes of agricultural residue and 60 million tonnes of municipal solid waste generated annually, India could produce 15–26 million tonnes of biochar per year. This would offer a sustainable alternative to open burning and landfill dumping.
- **Significant CO_2 removal:** This level of biochar production has the potential to remove approximately 0.1 gigatonnes of CO_2-equivalent annually.

- **Extended carbon storage:** Biochar can lock carbon in the soil for hundreds to thousands of years due to its stable nature, providing a long-term carbon sink.
- **Diverse applications:** Beyond carbon sequestration, biochar offers applications in multiple sectors:
    - **Agriculture:** It can enhance soil fertility and water retention, boost crop yields by 10%–25%, reduce fertilizer use by 10%–20%, and cut nitrous oxide (a potent GHG) emissions by 30%–50%.
    - **Energy production:** The pyrolysis process for creating biochar produces valuable byproducts like syngas and bio-oil, which can be used to generate electricity and displace fossil fuels.
    - **Construction:** Adding biochar to concrete can improve its strength and thermal resistance while capturing CO_2.
    - **Wastewater treatment:** Biochar offers a cost-effective solution for treating polluted water.

Challenges and the path forward

Despite its potential, biochar faces several barriers that India's new carbon market framework aims to address:

- **Lack of standardization:** Inconsistent carbon accounting methods and the lack of a standardized feedstock market have lowered investor confidence.
- **Policy integration:** The need for biochar to be formally recognized in the CCTS and integrated into broader agricultural and energy policies.
- **Market incentives:** For large-scale adoption, incentives, technological standardization, and greater awareness among stakeholders are required.
- **Unlocking private investment:** News reports emphasize that formal recognition within the carbon market will be crucial for attracting private investment and generating income for farmers through carbon credits.
- **Rural job creation:** By deploying decentralized pyrolysis units, the biochar industry can create new rural jobs, linking climate action with economic growth.

Explanation of Exam Oriented Key Terms

01

Biochar

Biochar is a carbon-rich, charcoal-like substance produced by heating biomass in a low-oxygen environment, a process called pyrolysis. Its byproducts, syngas and bio-oil, can also generate energy and replace fossil fuels.

What is biochar?

- **Production:** Made from organic waste like agricultural residues, forestry waste, animal manure, and municipal solid waste through a process called pyrolysis.
- Pyrolysis: Involves heating biomass to high temperatures (typically 400–700°C) with minimal or no oxygen to prevent combustion.
- **Properties:**
  - Highly stable, porous, and lightweight material with a large surface area.
  - Rich in carbon (~70%), with other elements like nitrogen, hydrogen, and oxygen.
  - Most biochars are alkaline, which can neutralize acidic soils.
- **Terra Preta:** Modern biochar mimics the fertile "Terra Preta" or "Indian black earth" soils of ancient Amazonia, which were created by adding charcoal-rich waste to the soil.

Biochar's role in climate change mitigation

- **Carbon sequestration:** Biochar's stable structure resists decomposition and can store carbon in the soil for hundreds to thousands of years, acting as a long-term carbon sink.
- **Reduced greenhouse gas emissions:**
  - Sequesters carbon that would otherwise be released into the atmosphere from biomass decomposition or burning.
  - Can reduce nitrous oxide emissions from agricultural soils, a potent greenhouse gas.

Benefits in agriculture

- **Soil health:** Improves overall soil quality and helps restore degraded land.
- **Fertilizer efficiency:** Enhances nutrient retention in the soil, reducing the need for chemical fertilizers.
- **Water retention:** Its porous, sponge-like structure improves the soil's water-holding capacity, making crops more resilient to drought.
- **Microbial activity:** Provides a habitat for beneficial soil microbes, promoting healthy soil ecosystems.
- **Increased crop yield:** Can increase agricultural productivity, especially in nutrient-poor or semi-arid regions.

Applications in other sectors

- **Renewable energy:** Pyrolysis produces valuable byproducts like syngas and bio-oil, which can be used to generate electricity and replace fossil fuels.
- **Waste management:** Provides a sustainable alternative for managing large quantities of agricultural residue and municipal solid waste.
- **Construction:** When added to concrete, it can improve mechanical strength, increase heat resistance, and sequester carbon in building materials.
- **Wastewater treatment:** Its adsorbent properties allow it to filter and remove pollutants from wastewater.
- **Land reclamation:** Can be used to reclaim degraded land by neutralizing soil acidity and immobilizing heavy metals.

Relevance for India

- **Carbon market:** Biochar is a promising carbon dioxide removal (CDR) technology for India's carbon market, set to launch in 2026.
- **Addressing stubble burning:** Offers a sustainable method to manage vast amounts of agricultural residue, providing an alternative to harmful stubble burning.
- **Rural development:** Decentralized production of biochar can create rural jobs and generate rural income.
- **Sustainable development goals (SDGs):** Supports multiple SDGs, including Climate Action, Zero Hunger, and Clean Water.

Practice Questions:

1. **With reference to Dhruva Space's LEAP-1 mission, consider the following statements:**

   I. It was the first satellite launch by Dhruva Space, placing it in a low-earth orbit using ISRO's PSLV

   II. The mission is an example of international collaboration, carrying payloads for Australian firms

   III. The satellite platform used for LEAP-1 was previously space-qualified during a technology demonstrator mission

   IV. The mission's primary objective was to demonstrate the effectiveness of onboard AI processing and hyperspectral imaging

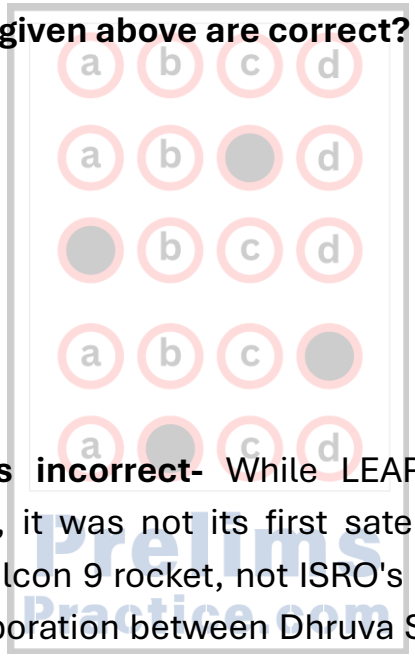
   Which of the statements given above are correct?

   a) I and II only

   b) II, III, and IV only

   c) I, III, and IV only

   d) I, II, III, and IV



Answer: b

Explanation: Statement I is incorrect- While LEAP-1 was Dhruva Space's first commercial satellite mission, it was not its first satellite launch. The mission was launched aboard a SpaceX Falcon 9 rocket, not ISRO's PSLV. **Statement II is correct-** The LEAP-1 mission is a collaboration between Dhruva Space and two Australia-based companies, Akula Tech and Esper Satellites. It carried their payloads, Nexus-01 (an AI module) and OTR-2 (a hyperspectral imager), respectively. **Statement III is correct-** The mission used Dhruva Space's indigenously developed P-30 nanosatellite platform. This platform was successfully space-qualified during the earlier LEAP-TD technology demonstrator mission, which was launched on ISRO's PSLV-C58 in January 2024. **Statement IV is correct-** The mission was specifically designed to demonstrate onboard AI capabilities and hyperspectral imaging. The Nexus-01 payload performs AI/ML data processing in orbit, while the OTR-2 payload is a hyperspectral image.

Class Discussion Space