BIOECONOMY FINANCING

IMPACT ON INDIA'S SUSTAINABLE AGRICULTURE INITIATIVES

India's economic reliance on agriculture and the sector's high climate sensitivity, puts the country in a perilous situation. The costs of extreme weather events such as floods, heatwaves, and landslides, among others, which were witnessed on 93% of the days between January – September of 2024, are becoming steep with 3.2 million hectares of crop land being affected in the period. With there being an increase in the likelihood of such extreme weather events, the need to climate-proof the sector is evident.

India's agriculture sector remains climate vulnerable despite it contributing around 17-18% to India's GDP, and employing over 50% of the population.

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A study from the National Innovations in Climate Resilient Agriculture (NICRA) indicates that India could experience a 6-10% decline in key crop yields that include staples such as rice and wheat by 2050-2080 due to changing weather patterns. Over 30% of India's agricultural land is affected by soil degradation, leading to decreased soil fertility, crop yields and overall agricultural productivity, further exacerbated by unsustainable farming practices, such as the overuse of chemical fertilisers. In addition to this, the looming threat of water stress is escalated by unfavourable agricultural practices, since the sector consumes 90% of India's water resources. The sector is also a significant contributor to greenhouse gas emissions (carbon dioxide, methane and nitrous oxide), contributing to 13.72% of GHG emissions in 2020 in India.

In this context, the bioeconomy—an economic model built on the sustainable use of biological resources—offers transformative potential for enhancing

agricultural resilience and driving sustainability in India. With its focus on leveraging renewable biological resources, the bioeconomy intersects closely with agriculture, creating opportunities for innovation in sustainable farming, reducing environmental degradation, and addressing the growing challenges posed by climate change. By converting crop residues into bioenergy or compost and recycling agricultural by-products into bioplastics and biofuels, the transition to a circular bioeconomy enhances resource efficiency, reduces waste, and lowers carbon footprints. For instance, Brazil's use of sugarcane to produce ethanol showcases how agriculture can drive sustainability while reducing fossil fuel dependence.

India's Efforts Towards Fostering a Bioeconomy

India's bioeconomy sector has been booming, standing at a valuation of US $92 billion in 2022 and swiftly increasing to US $130 billion in 2024, further projected to reach US $300 billion by 2030. The country has undertaken significant measures to make its agriculture climate resilient. For example, in Rayanpet, Telangana, scientists have developed drought-tolerant rice varieties, helping farmers secure yields despite erratic weather. Government initiatives like the Galvanising Organic Bio-Agro Resources Dhan (GOBARdhan) scheme and the Godhan Nyay Yojana go beyond waste management to create value chains around organic waste. These initiatives stimulate rural employment, generate income for farmers, and foster a circular economy. Holistic policies like the National Mission for Sustainable Agriculture (NMSA), operationalised under the National Action Plan for Climate Change (NAPCC), and programs like NICRA focus on adaptive farming, water management, and soil health to climate-proof agriculture.

Efforts such as Paramparagat Krishi Vikas Yojana (PKVY) demonstrate how incentivising organic farming can shift agricultural practices toward sustainability. Meanwhile, crop insurance schemes like Pradhan Mantri Fasal Bima Yojana (PMFBY) protect farmers from climate-induced losses, acting as safety nets for vulnerable rural communities. Additional announcements on incentives on climate smart agriculture and climate-resilient seed varieties in cereals, pulses and oilseeds are expected in the upcoming Union Budget 2025-26, offering potential avenues for enhancing bioeconomy.

Despite these efforts, challenges persists such as Limited awareness of climate-resilient practices, inadequate infrastructure for irrigation and storage, scarcity of comprehensive and accurate data, and fragmented landholdings hinder large-scale adoption of sustainable techniques. Moreover, farmers often lack access to affordable financing to invest in bioeconomy-based innovations, such as biogas plants, biofertiliser production units, and precision agriculture technologies. As a result, adequate and targeted financing to the sector is critical to leveraging its full potential in transforming Indian agriculture. The sector heavily depends on public funding, such as subsidies and grants, but lacks a steady flow of capital, specifically private capital. Given the valuation and the massive economic potential of bioeconomy, private capital investments need to be tapped to unleash the true scope of the sector.

The Financing Angle: Opportunities to Unlock the Potential of Bioeconomy

There are several innovative financing mechanisms that can scale capital flows to this sector. Blended finance models—combining private, concessional and philanthropic capital—can play a pivotal role in supporting bioeconomy ventures by providing small-scale projects a bankable pipeline.

Thematic bonds have emerged as powerful tools for mobilising capital. Green bonds, for instance, can be directed toward funding large-scale biogas plants, bio-refinery projects, and renewable energy initiatives in rural areas. India's sovereign green bond framework, launched in 2023, also presents an opportunity to integrate bioeconomy initiatives within its scope. Expanding this framework to include agricultural bioeconomy projects can provide farmers and entrepreneurs with access to low-cost financing while attracting global

investors seeking sustainable opportunities.

Public-private partnerships (PPPs) are another vital mechanism for scaling bioeconomy projects and improving the delivery of existing schemes. By combining the resources and expertise of the private sector with public funding and infrastructure, PPPs can drive innovation in bio-based technologies while ensuring accessibility for smallholder farmers. For example, partnerships could focus on building decentralised biomass processing units, facilitating farmer collectives to monetise agricultural waste.

Outcome-based instruments, such as pay-for-performance models and sustainability-linked instruments, are gaining traction as a way to ensure accountability and impact. These models provide financial incentives for achieving predefined sustainability goals, such as improved crop yields through biofertilizers or reductions in water usage via precision agriculture. Sustainability-linked bonds (SLBs), for instance, tie funding outcomes to measurable sustainability performance, such as reductions in agricultural emissions or increases in soil carbon sequestration, thereby reducing greenwashing concerns in fighting climate change. Such approaches can align the interests of investors, governments, and farmers, ensuring that financing translates into tangible benefits.

Furthermore, technological innovations are enhancing India's capacity for climate adaptation. AI-driven weather forecasting tools are helping farmers make informed decisions, reducing debt and improving savings. These tools

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are part of a broader push to integrate climate-resilient technologies in agriculture, with the potential to transform food security across Asia, Africa, and Latin America. Additionally, bio-based practices, such as agroecology and biofertilisers, can significantly improve soil health, sequester carbon, and reduce the sector's carbon footprint, aligning with India's climate goals.

Lessons from Global Success Stories

Several developed and emerging economies provide valuable lessons in bioeconomy financing. The European Union's Bioeconomy Strategy has mobilised significant funding under Horizon Europe, supporting innovations in bio-based industries, including sustainable agriculture. Brazil's RenovaBio program has successfully financed biofuel production, benefiting its agricultural sector by creating demand for sugarcane and soybean-based biofuels. South Africa's bioeconomy strategy, supported by government grants and international aid, emphasises biotechnological innovations in agriculture and industry.

These examples demonstrate how tailored financing mechanisms can drive bioeconomy growth while addressing country-specific challenges. For India, adopting similar approaches and fostering international collaboration can unlock its agricultural potential while ensuring environmental sustainability.

India's bioeconomy, therefore, presents an immense opportunity to make agriculture more sustainable, resilient, and profitable. Expanding infrastructure for biogas and biomass energy generation, promoting public-private partnerships for bio-based research, and incentivising farmers to adopt bio-based technologies can catalyse this transformation. Creating farmer cooperatives and microfinance programs specifically targeting bioeconomy ventures can address funding gaps and enhance grassroots adoption.

Additionally, fostering international collaboration is essential. Partnerships with countries that have advanced bioeconomy strategies can bring technical expertise, best practices, and funding opportunities to India. For example, India can learn from the EU's approach to integrating bioeconomy goals into broader policy frameworks, ensuring alignment with climate and sustainability targets.