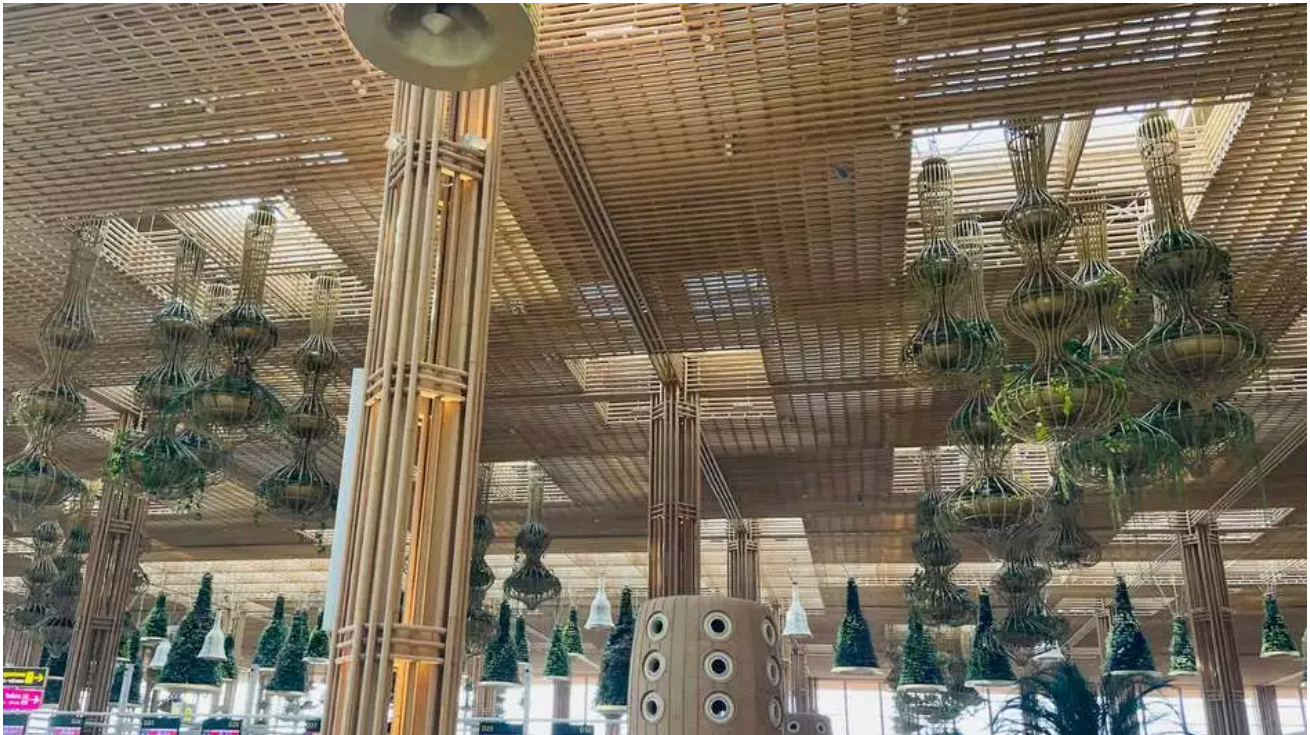


12/2024 | Taneja Anjali, Khushboo Garg

Focus Area

India Plans to Develop Top Grade Bioeconomy

Government is supporting the growth of bio-based manufacturing in sectors ranging from chemical to health and nutrition - generating both opportunities and risks.



The new airport of Bangalore, draped in lush green, is seen as a symbol of the political goal to foster a circular bioeconomy. © Anjali Taneja

DEUTSCHE VERSION

The bioeconomy sector is gaining significant momentum globally. The World Bioeconomy Forum (<https://www.naturefinance.net/resources-tools/global-bioeconomy-g20-stocktake/>) values the sector at approximately \$4 trillion with the potential to grow to \$30 trillion (https://birac.nic.in/webcontent/IBER_2024.pdf) by 2050. Several economies worldwide increasingly invest in bio-based innovations to address their energy, food

security, health, and climate mitigation and adaptation issues. India is one of the front runners in its global bioeconomy growth, with a projected bioeconomy worth \$300 billion by 2030.

Why Bioeconomy?

Bioeconomy complements the clean technology revolution and embraces the key tenets of a circular economy, i.e. reuse, repair, repurpose, refurbish, and recycle, to optimise resource use and minimise waste.

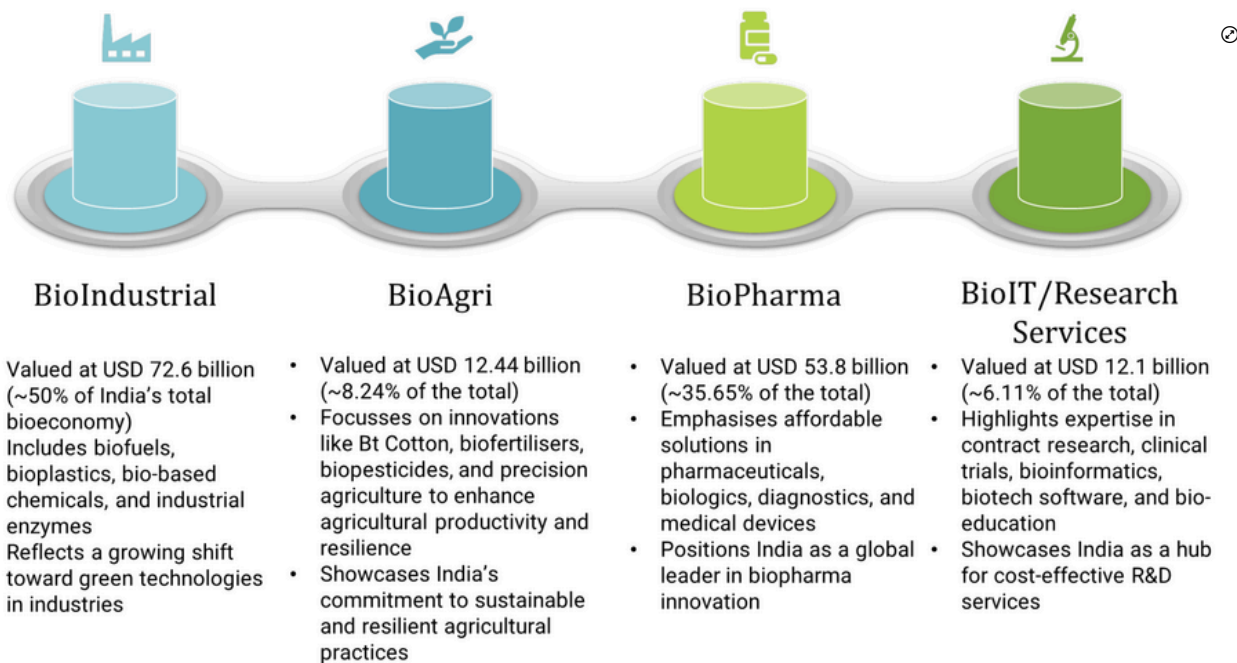
While recycling and repurposing biological resources lower the demand for virgin materials and thus reduce pressure on ecosystems and prevent habitat destruction, repairing and reusing cut down on emissions associated with production and disposal processes. A circular bioeconomy, (<https://cstep.in/publications-details.php?id=2763>) therefore, significantly contributes towards the reduction or efficient management of waste, air and water pollution mitigation, and biodiversity conservation. It is a cornerstone to achieving a low-carbon, climate-resilient, and nature-positive future.

Bioeconomy in India: Potential and Initiatives

India's bioeconomy (https://birac.nic.in/webcontent/IBER_2024.pdf) has grown remarkably, from \$10 billion in 2014 to \$151 billion in 2023, accounting for over 4% of the country's gross domestic product. Recognising its transformative potential, India introduced the first dedicated biotechnology policy in August 2024, the *Biotechnology for Economy, Environment and Employment Policy (BioE3)* (<https://pib.gov.in/PressReleasePage.aspx?PRID=2050369>). The policy aims to boost industrial output by fostering high-performance biomanufacturing in areas such as bio-based chemicals, smart proteins, precision biotherapeutics, and climate-resilient agriculture.

Specifically, the BioE3 Policy targets India's green growth by establishing biomanufacturing hubs and bio-artificial intelligence (bio-AI) centres, promoting regional development, leveraging local resources, integrating cutting-edge technologies, and generating employment. Furthermore, with a focus on regulatory reforms and international collaborations, the policy aims to reinforce the country's competitiveness in the global bioeconomy sector.

These are the sectors:



Biofuels are key

Increasing reliance on biofuels is key to India's bioeconomy strategy. In this regard, India launched the Global Biofuel Alliance (<https://pib.gov.in/PressReleasePage.aspx?PRID=2036867>), along with the USA, Brazil, Italy, Argentina, Singapore, Bangladesh, Mauritius, and UAE, at the G20 Summit in 2023. Driven by robust policy support and demand, bioethanol – a renewable energy source derived from biomass through the fermentation of sugarcane, sugar beet, plant-based starch, corn, barley, wheat and black liquor – has witnessed a growing trend over the years. It serves as a renewable fuel for vehicles and power generation on farms, fostering both environmental and economic sustainability.



Bioethanol production ensures an additional market for excess food grains and sugar, which directly benefits farmers. In case the sugarcane or food grain supply exceeds the demand, conversion to bioethanol provides an alternative route, therefore minimising waste and ensuring better returns for farmers. Where the demand for food grains exceeds the supply, acute food insecurity issues become imminent, with the rising population, thereby exacerbating the gap between haves and the have-nots. These could be mitigated by strengthening local value chains and encouraging the reuse and recycling of food resources.

Any discussion on India's food grains would be incomplete without a reference to rice or paddy. Rice accounts for over 23% of India's gross cropped area and produces almost 490 million tons of by-products annually with 38% being rice straw, 20% rice husk, and 8% rice bran. Valorising by-products of rice production offers a substantial opportunity for a bioeconomy, considering the scale at which it is produced in the country.

BioAgri centers on agricultural biotechnology

BioAgri is also slowly gaining momentum in the country. This subsector covers genetically modified (GM) crops, with *Bacillus thuringiensis* (Bt) cotton production being one of the most popular examples. Currently, it is the only GM crop approved for commercial production in India. In 2023–24, despite facing delayed monsoons and other climate adversities, Bt cotton (https://birac.nic.in/webcontent/IBER_2024.pdf) significantly enhanced cotton production. The GM crop offers better pest and climate resilience, contributing to better yield and reducing dependency on chemical fertilisers and pesticides. The production of cotton increased from 6.8 million tons in 2022 to 7.6 million tons in 2023.



Genetically modified BT-Cotton has been grown in India for more than 20 years. © ISAAA

These benefits led to increased productivity and profitability especially for small-scale farmers, decreased environmental damage, and reduced exposure of farmers to harmful chemicals. As a result, the BioAgri sector has not only bolstered farmers' income but also opened avenues for greater investments and profit generation in the biotechnology space.

At the same time, overall public perception also matters. Lack of awareness fuels scepticism among people. For instance, there is a lack of societal acceptance and limited use of GM crops, especially because of their associated risks and unclear environmental impact. Greater research is needed on how to prevent risks with biotechnology advancements. Moreover, carrying out focused sensitization drives to explain the pros and cons of such crops could be helpful. Further, robust safety measures and streamlined regulatory processes could ensure their timely adoption.

Challenges, Risks, and Potential Solutions

Although India's bioeconomy potential seems promising, some inherent challenges and risks need to be addressed to fully realise it.

India's bioeconomy sector is still at a nascent stage owing to fundamental challenges including skill gaps, inadequate funding, and lack of societal acceptance. For example, the lack of skilled professionals in different biotechnology fields, such as bioinformatics, synthetic biology, and biomanufacturing, hinders innovation. Therefore, education, training, and mentorship are important. Dedicated programmes

in higher education universities, industry-academia collaborative initiatives, and capacity-building sessions for students, researchers, and entrepreneurs could promote skill development.

A volatile sector exposed to financial risks

Furthermore, a flow of steady investments could significantly promote the growth of the bioeconomy. The sector, being volatile, is exposed to different kinds of financial risks, e.g. uncertain return on investments and indeterminate seed pricing. This makes the sector less attractive for investors and farmers. While innovation and research are being prioritised, translating lab-scale innovations into commercially viable products is challenging. Establishing biomanufacturing hubs, bio-foundries, or bio-AI centres requires infrastructure, funds, and expertise. This is where public-private partnerships can prove to be critical in providing the necessary support for seed procurement, sharing risks and pooling resources.

Innovation to foster self reliance

Moreover, the local supply and value chains also need to be strengthened to reduce stubble burning (i.e. setting fire to fields after harvesting) and India's dependency on global imports. For instance, India's rice value chain poses a few challenges to transition to a bioeconomy, partly because of the short period of time between the harvest of the monsoon and winter crops. Ploughing rice straw back into the land, as promoted under India's Happy Seeder (<https://iiss.icar.gov.in/eMagazine/v1i1/15.pdf>) programme, reinforces the idea of a bio-regenerative approach through which materials can help protect and enhance soil quality.



Rice straw is a byproduct that has great potential as a biological resource. © International Rice Research Institute (IRRI) via Flickr

Understanding intermediate technologies available for straw baling and systemic sharing of knowledge and research on mixed farming methods could also help enable change. At the same time, investments in the indigenous production of critical inputs and materials (e.g. enzymes and specialised equipment) must be encouraged to help foster self-reliance. Government support in the form of fiscal incentives, grants, and subsidies could further stimulate innovation.

Avoiding unintended ecological risks

Finally, it is crucial to ensure complete sustainability (i.e. preservation of land, water, and biodiversity) while promoting the bioeconomy. Although there is an emphasis on circular bioeconomy, some biotechnological processes might have unintended ecological consequences. For example, the large-scale production of bio-based materials could lead to deforestation, monoculture plantations, and excessive water usage.

The improper disposal of biowaste or by-products could also harm natural ecosystems. This could adversely affect the environment and the livelihoods of local communities. Careful planning and robust environmental regulations are needed to

mitigate these risks. Proactive governance and regular interactions with local communities and stakeholders could ensure that the bioeconomy strategy is inclusive and sustainable.

India is at a critical threshold

A smooth transition to bioeconomy necessitates a collaborative approach. Therefore, a unified framework based on consensus among various stakeholders (e.g. primary producers, logistic service providers, researchers, and policymakers) is critical. The framework could be governed by the following four pillars:

1. A clear, transparent, and *supportive policy environment* that encourages investments, streamlines regulations, and promotes inclusivity and sustainable practices.
2. Strong *alliances* among government, industry, academia, and consumers to drive innovation and ensure inclusive growth.
3. *Training programmes* to build a skilled workforce and awareness or sensitisation drives to shift societal perceptions toward bio-based products.
4. Continuous *research and development* to build cost-effective and scalable solutions.

India is at a critical threshold of its bioeconomy journey. By prioritising innovation, strengthening local capabilities, and embracing circular principles, the country could play a crucial role in the global transition towards a bio-based future. This transformation is not merely another opportunity for growth but a pathway to ensure a secure, inclusive, and sustainable future.



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Supplementary Literature:

1. CSTEP's White Paper on Circular Bioeconomy 2024 - **Growing the circular bioeconomy, with a focus on the Global South** (<https://cstep.in/publications-details.php?id=2763>)
2. India Bioeconomy Report 2024 by BIRAC - **IBER_2024.pdf**
(https://birac.nic.in/webcontent/IBER_2024.pdf)
3. Agricultural Bioeconomy 2023 (Innovation and Foresight in the post-COVID Era) -<https://www.sciencedirect.com/book/9780323905695/agricultural-bioeconomy>
(<https://www.sciencedirect.com/book/9780323905695/agricultural-bioeconomy>)
4. The Bioeconomy and Food System Transformation 2023 -
<https://www.ncbi.nlm.nih.gov/books/NBK599635/#:~:text=Bioeconomy%20offers%20support%20for%20the,and%20recycling%20>
(<https://www.ncbi.nlm.nih.gov/books/NBK599635/#:~:text=Bioeconomy%20offers%20support%20for%20the,and%20recycling%20>)
5. Changing Agricultural Stubble Burning Practices in the Indo-Gangetic Plains: is the Happy Seeder a Profitable Alternative 2020 -
<https://www.tandfonline.com/doi/full/10.1080/14735903.2020.1834277>
(<https://www.tandfonline.com/doi/full/10.1080/14735903.2020.1834277>)

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