

7. Bioeconomy – Science & Technology

India is rapidly positioning itself as a global biotechnology powerhouse, leveraging biological resources to drive sustainable economic growth. The transition toward a "Bioeconomy" represents a systemic shift where the country uses renewable biological agents to solve pressing challenges in food security, healthcare, and environmental sustainability.

Background

Bioeconomy- An economic model based on the consumption and production of goods and services derived from direct biological activity or the use of biological resources (plants, animals, microorganisms, and residual biomass).

Biotechnology- The technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.

Circular Economy Principles- A model of production and consumption which involves sharing, leasing, reusing, repairing, refurbishing, and recycling existing materials and products as long as possible.

Gene Editing- A group of technologies that give scientists the ability to change an organism's DNA, allowing genetic material to be added, removed, or altered at particular locations in the genome.

Status of India's Bioeconomy

India has witnessed an extraordinary trajectory in this sector over the last decade, transitioning from a nascent industry to a core pillar of the national GDP.

Global Standing- India is ranked among the Top 12 biotechnology destinations globally and holds the 3rd spot in the Asia-Pacific region.

Economic Growth- The sector grew from \$10 billion in 2014 to \$165.7 billion in 2024—a sixteen-fold increase.

GDP Contribution- It currently contributes 4.25% to the national GDP, maintaining a Compound Annual Growth Rate (CAGR) of 17.9%.

2030 Vision- The government aims to achieve a \$300 billion bioeconomy by the end of the decade.

Sectoral Categorization

The Indian biotech landscape is organized into four primary verticals-

Biopharmaceuticals- Vaccines, diagnostics, and therapeutics.

Bio-agriculture- Genetically modified and genome-edited crops, bio-fertilizers.

Bio-IT- Bioinformatics and computational biology.

Bio-services- Clinical trials, research and development (R&D) outsourcing.

Biotechnology in Agriculture- Key Achievements

The Department of Biotechnology (DBT) focuses on "Climate-Smart" and "Nutri-Rich" agricultural solutions through its Agriculture Biotechnology programme.

Climate-Smart Crops- Development of "SAATVIK (NC 9)", a superior, high-yielding, and drought-tolerant chickpea variety.

Genome-Edited Rice- Scientists have utilized genome editing to disable specific genes that negatively regulate productivity, leading to enhanced rice yields.

Amaranth Genetic Research- * Development of the Amaranth Genomic Resource Database.

1. Creation of a 64K SNP chip and Near Infrared Spectroscopy (NIRS) for nutritional screening.
2. Research indicates these amaranth accessions can help counteract obesity induced by high-fat diets.

Eco-friendly Biocontrol- A nano-formulation derived from the fungus *Myrothecium verrucaria* acts as a stable enzyme-based control for powdery mildew in tomatoes and grapes.

Kisan-Kavach- A specialized anti-pesticide suit designed to protect farmers from the toxic effects of chemical pesticide exposure

Aquaculture and Marine Biotechnology

With a focus on enhancing productivity and lowering costs, recent innovations have targeted fish health and nutrition.

CIFA-Brood-Vac- A novel vaccine developed to prevent mass mortality in fish spawn, ensuring the survival of aquaculture stocks.

Sustainable Feed- Research is focused on replacing expensive and unsustainable fish meal with alternative protein sources.

Interactive Fish Feed Designer (IFFD) v2- A user-friendly software that allows farmers to formulate cost-effective fish feed using non-conventional ingredients.

Animal Biotechnology and Livestock

India manages the world's largest livestock population, which supports the livelihoods of over two-thirds of the rural population. Biotechnology in this sector focuses on-

1. Improving breed quality and disease resistance.
2. Enhancing milk and meat productivity through genomic selection.
3. Developing indigenous vaccines for livestock diseases.

Infrastructure and Regulatory Challenges

Despite robust growth, several structural bottlenecks remain that could hinder the \$300 billion goal.

Conclusion

The integration of biotechnology with digital tools is creating a resilient agricultural and industrial ecosystem. By addressing infrastructure fragmentation and modernizing regulatory frameworks, India can transition from being a "pharmacy of the world" to a "biotech laboratory of the world," ensuring both food security and economic prosperity.

Source- <https://www.thehindu.com/sci-tech/science/biotech-industry-driving-both-human-and-animal-nutrition-experts/article70775766.ece#~~~>

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