6. Biostimulants- Environment

Biostimulants offer promising, sustainable alternative chemical fertilisers to secure the future of Indian agriculture

Biostimulants

Biostimulants are substances or living microorganisms that enhance plant growth and productivity by stimulating natural physiological processes, independent of their direct nutrient content. Unlike conventional fertilisers, biostimulants do not primarily supply nutrients; instead, they improve the plant's ability to use available nutrients more efficiently. Core functional objectives include-

1. Enhancing nutrient uptake and assimilation
2. Improving tolerance to abiotic stresses such as drought, salinity, heat, and cold
3. Improving crop quality parameters (yield stability, nutritional quality, shelf life)
4. Building long-term climate resilience in farming systems

Types of Biostimulants

Botanical Extracts- Derived from seaweed, kelp, or terrestrial plants. Rich in natural phytohormones (auxins, cytokinins, gibberellins), polysaccharides, and micronutrients. Promote root development, flowering, and stress tolerance

Microbial Products- Include Plant Growth-Promoting Rhizobacteria (PGPRs) and beneficial fungi (e.g., mycorrhizae) Functions

1. Biological nitrogen fixation
2. Phosphorus and micronutrient solubilisation
3. Production of growth-promoting substances
4. Improve rhizosphere health and nutrient cycling

Amino Acids and Protein Hydrolysates

1. Act as precursors for enzymes, proteins, and stress-related metabolites
2. Help plants recover rapidly from biotic and abiotic stress
3. Enhance photosynthesis and metabolic efficiency

Humic and Fulvic Acids

1. Derived from decomposed organic matter
2. Improve soil structure, water retention, and cation exchange capacity
3. Chelate nutrients, making them more bioavailable to plants
4. **Inorganic Compounds**
5. Beneficial (non-essential) elements such as silicon, cobalt, and selenium
6. Enhance structural strength, disease resistance, and stress tolerance

Chitosan

1. A biopolymer obtained from chitin (shellfish waste)
2. Induces plant defence mechanisms and enhances resistance to pathogens and environmental stress

Key Benefits of Biostimulants (Ecosystem Services Perspective)

Input Efficiency- Improve Nutrient Use Efficiency (NUE), reducing fertiliser requirement and input costs

Soil Health and Carbon Sequestration- Enhance soil organic matter and microbial activity. Contribute to long-term soil carbon storage

Climate Resilience- Enable crops to withstand droughts, salinity intrusion, heat waves, and erratic rainfall

Biodiversity Enhancement- Promote soil microbial diversity and ecological balance in agro-ecosystems

Circular Economy Linkages- Many biostimulants are produced from agricultural residues, seaweed, and food-processing waste. Convert waste streams into high-value agricultural inputs

Sustainable Development Alignment- Strongly aligned with United Nations Sustainable Development Goals, especially

1. SDG 2 (Zero Hunger)
2. SDG 12 (Responsible Consumption and Production)
3. SDG 13 (Climate Action)
4. Position biostimulants as a core pillar of green and regenerative agriculture

The Chemical Fertiliser Crisis in India- Chemical fertilisers and pesticides played a decisive role in India's Green Revolution and food security. However, excessive and imbalanced use has generated structural vulnerabilities.

Overuse and Regional Imbalance

1. National average fertiliser consumption- ~139.8 kg/ha (2023–24)
2. States like Punjab exceed 240 kg/ha, indicating unsustainable intensification

Major Consequences

1. Declining soil fertility and micronutrient depletion
2. Water and air pollution (nitrates, eutrophication, ammonia volatilisation)
3. Increased farmer dependence on costly external inputs
4. Health risks for rural populations due to chemical exposure
5. Agriculture contributes roughly 19% of India's GHG emissions
6. Heightened vulnerability to climate-induced yield shocks

These trends underscore the need for input diversification, where biostimulants complement fertilisers rather than replace them entirely.

Challenges to Widespread Adoption of Biostimulants

Farmer Skepticism

1. Perceived uncertainty regarding effectiveness compared to chemical fertilisers
2. Lack of visible, immediate yield response in some cases

Scientific and Knowledge Gaps

1. Limited understanding of plant–biostimulant interactions at the molecular and physiological level
2. Insufficient crop- and region-specific recommendations

Variable Field Performance

1. Effectiveness varies across soil types, climates, and cropping systems
2. Requires context-specific application strategies

Market and Quality Issues

1. Proliferation of unregulated or substandard products
2. Weak quality assurance erodes farmer confidence

Regulation of Biostimulants in India

The Fertiliser Control Order, 1985 was amended in February 2021 to formally bring biostimulants under regulatory oversight.

Key regulatory features-

1. Mandatory registration and standardisation
2. Quality control and labelling norms

Biostimulants are currently classified into nine categories, including-

1. Botanical extracts
2. Humic and fulvic acids
3. Protein hydrolysates
4. Vitamins and antioxidants
5. Live microorganisms

This move marked a shift from regulatory ambiguity to structured governance, improving market

credibility.

The Way Forward

Farmer Empowerment

1. Awareness campaigns, on-field demonstrations, and digital extension services
2. Integration into Krishi Vigyan Kendras (KVKs) and FPO-led advisory models

Research and Development

1. Investment in molecular biology and plant physiology research
2. Development of crop-specific and region-specific formulations
3. Synergistic use with biofertilisers and organic inputs

Policy and Regulatory Strengthening

1. Streamlined approval processes without compromising safety
2. Strict enforcement against spurious products
3. Incentives for R&D, startups, and indigenous innovation

Infrastructure and Supply Chain Support

1. Establish processing units for seaweed, crop residues, and agro-waste
2. Promote decentralised production models in coastal and rural areas

Financial Access

1. Credit support, targeted subsidies, and tax incentives for early adopters
2. Inclusion under sustainable agriculture and climate-resilient farming schemes

Collaborative Models

1. Encourage Public–Private Partnerships
2. Support agri-biotech startups, cooperatives, and global research collaborations

Concluding Perspective

Biostimulants represent a strategic transition tool in Indian agriculture—bridging productivity goals with ecological sustainability.

While not a silver bullet, their responsible integration can-

1. Reduce chemical dependency
2. Restore soil health
3. Enhance climate resilience

The success of biostimulants will ultimately depend on science-led policy, farmer trust, and robust regulation, making them a cornerstone of India's sustainable and climate-smart agriculture pathway.

Source- https-//www.downtoearth.org.in/agriculture/biostimulants-the-green-solution-for-sustainable-indian-agriculture