

A greener rice industry in India

Pooran Chand¹ and Tapas Ranjan Das²

¹*Professor, Genetics and Plant Breeding, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250110, UP-India. Email: pckardam@gmail.com*

²*Senior Scientist, Division of Genetics, Indian Agricultural Research Institute, New Delhi- 110012. Email: trdas.iari@gmail.com*

[DOI:10.5281/trendsinAgri.16932479](https://doi.org/10.5281/trendsinAgri.16932479)

Introduction

India, the world's second-largest rice producer, faces a paradox, while rice sustains over 65% of the population, its traditional cultivation practices threaten water security, soil health, and contribute significantly to greenhouse gas emissions. Rice is a staple crop in India, but its cultivation is resource-intensive and contributes significantly to greenhouse gas emissions, especially methane. A greener rice industry in India is emerging through the adoption of sustainable practices, technological innovations, climate-resilient varieties and environmentally friendly while still meeting the country's food security needs. These advancements aim to reduce the environmental impact of rice cultivation, improve farmers' livelihoods, and boost the overall sustainability of the rice value chain. This brief outline a green transformation plan leveraging sustainable techniques, tech adoption, and policy interventions.

a. Impact Goals by 2030

- Reduce water consumption by 30–40% in rice cultivation.
- Cut methane emissions from rice paddies by 30-50% by 2030.
- Increase adoption of sustainable rice practices by 50% of farmers by 2030.
- Strengthen livelihoods of rice farmers through green technology and climate resilience.
- Convert 20% of rice cultivation to sustainable methods.

b. Drawbacks in Traditional Rice Cultivation:

- **High Water Usage:** Traditional paddy farming requires flooding fields, consuming large volumes of water.
- **Methane Emissions:** Anaerobic decomposition in flooded fields releases significant methane, a potent greenhouse gas.
- **Chemical Dependency:** Overuse of fertilizers and pesticides leads to soil degradation and water pollution.

- Monoculture: Lack of crop diversity reduces resilience and depletes soil health.

Strategies for greener rice

a. Sustainable Rice Farming Practices:

- System of Rice Intensification (SRI): This method focuses on optimizing plant spacing, water management, and soil health to improve yields while reducing water and input requirements.
- Alternate Wetting and Drying (AWD): AWD involves controlling water levels in rice paddies to decrease methane emissions from flooded fields, a major source of greenhouse gases.
- Precision Agriculture: Technologies like drones, satellite imagery, and automated machinery are being used to optimize fertilizer and water application, minimizing waste and environmental impact.
- Climate-Resilient Varieties: Developing and promoting rice varieties that are more tolerant to drought, floods, and other climate-related stresses is crucial for ensuring long-term sustainability.
- Organic and Natural Farming: Use of biofertilizers, compost, and pest management through natural means. Promotes long-term soil health and biodiversity.

b. Technological Innovations greening rice industry:

- Genome Editing: Genome-editing technologies, like CRISPR-Cas, are being used to develop rice varieties with improved traits such as higher yields, drought resistance, and nutrient use efficiency.
- Mechanization: Implementing mechanization in rice farming can boost efficiency, cut labor costs, and potentially decrease the carbon footprint by optimizing resource use.
- Remote Sensing and Mobile Advisory Services: These technologies help farmers access real-time weather information, soil health data, and best practices, enabling them to make informed decisions and optimize their farming practices.
- Precision Agriculture Tools: Drones, satellite imaging, and IoT sensors for efficient irrigation and nutrient management.

c. Policy and Institutional Support:

- Government Initiatives: The Indian government is actively promoting sustainable rice farming through various schemes and programs, encouraging the adoption of best practices and technologies.
- Public-Private Partnerships: Collaboration between public research institutions, private companies, and NGOs is crucial for driving innovation and scaling up sustainable solutions.
- Financial Incentives: Providing financial support and subsidies to farmers adopting sustainable practices can incentivize wider adoption.
- Farmer Education & Incentives: Training in sustainable practices and access to subsidies for eco-friendly equipment.
- Carbon Credit Schemes: Farmers rewarded for reducing emissions through AWD or organic practices.

d. Benefits of a Greener Rice Industry:

- Reduced Environmental Impact: Lowering greenhouse gas emissions, conserving water resources, and minimizing the use of synthetic inputs.

- **Improved Farmer Livelihoods:** Increased yields, reduced input costs, and enhanced resilience to climate change can improve farmers' incomes and living standards.
- **Enhanced Food Security:** Sustainable rice production can help ensure food security for a growing population while minimizing the environmental burden.
- **Global Leadership:** India, as a major rice producer and exporter, can play a leading role in promoting sustainable rice farming globally.

e. Reviving Indigenous & Organic Rice Systems

- **Desi Rice Revival:** At Mysuru's Desi Rice Mela, stakeholders highlighted the value of traditional varieties—like red and black rice—for their nutritional, ecological, and cultural benefits.
- **Organic & GI-Tagged Systems:**
 - **Koraput Kalajeera rice:** Organic aromatic rice supplied to the Jagannath Temple, boosting tribal farmer livelihoods (1,900 quintals, covering 1,365 acres).
 - **Pokkali & Kaipad rice (Kerala):** Coastal, salinity-resilient, organic systems where rice and aquaculture coexist, requiring no synthetic inputs. These systems are GI-tagged, preserving agro-ecosystems and local livelihoods.
 - **Wayanad Jeerakasala & Gandhakasala rice:** GI-registered aromatic varieties cultivated traditionally by farming communities, safeguarding biodiversity and cultural heritage

f. Challenges of Greener Rice Industry:

By addressing challenges and embracing a holistic approach, India can pave the way for a greener, more resilient, and sustainable rice industry that benefits both farmers and the environment. The main challenges of greener rice are:

- **Initial Investment Costs:** Adopting new technologies and sustainable practices may require initial investments that can be a barrier for some farmers.
- **Lack of Awareness and Capacity Building:** Ensuring that farmers are aware of the benefits of sustainable practices and have the necessary skills to implement them is crucial.
- **Climate Change Impacts:** Extreme weather events and changing climatic conditions can pose significant challenges to rice production and sustainability efforts.

g. Circular Economy in Rice Industry

- **Rice Straw Management:** Instead of burning, use straw for bioenergy, compost, or biodegradable packaging.
- **Wastewater Recycling:** Treat and reuse irrigation water to conserve resources.

h. Region-Specific Action Plans for a Greener Rice Industry in India

1. Punjab: Water-Stressed, Mechanized Rice Belt

Key Issues

- Severe groundwater depletion due to puddling and flood irrigation.
- High residue burning causing air pollution (PM2.5, stubble smoke).
- Heavy use of fertilizers and chemicals.
- Mechanization is widespread.

Action Plan

Focus Area	Strategy
Water Management	Scale up Direct Seeded Rice (DSR) and AWD using laser land levellers and tensiometers.

Straw Management	Promote Happy Seeder, Super Straw Management System (SMS), bio-decomposers to prevent stubble burning.
Technology Adoption	Subsidize precision irrigation, sensor-based fertilization, drone spraying.
Policy Incentives	Link Minimum Support Price (MSP) to adoption of sustainable methods. Offer carbon credits for AWD.
Capacity Building	Partner with PAU and KVKs for large-scale farmer field schools (FFS).

2. West Bengal: High-Yield, High-Rainfall Eastern Delta

Key Issues

- High rainfall + lowland topography → methane emissions from flooded fields.
- Vulnerable to floods and cyclones.
- Predominantly small/marginal farmers.

Action Plan

Focus Area	Strategy
Climate-Resilient Varieties	Promote flood-tolerant rice (e.g., Swarna-Sub1, IR64-Sub1).
Methane Mitigation	Introduce Alternate Wetting and Drying (AWD) in boro season.
Diversification	Introduce short-duration rice followed by pulses/oilseeds in rabi.
Organic Push	Promote organic/natural rice farming in Sundarbans and tribal districts for eco-tourism and export.
Farmer Cooperatives	Strengthen FPOs for collective equipment use (e.g., mechanical weeders, water control tools).

3. Tamil Nadu: Multi-Crop, Irrigation-Dependent Southern Hub

Key Issues

- Dependent on seasonal northeast monsoon.
- Rice grown in delta zones with canal irrigation.
- Transition pressure toward water-saving crops like millets.

Action Plan

Focus Area	Strategy
Efficient Irrigation	Promote solar-powered drip/sprinkler systems and AWD in Cauvery delta.
SRI Expansion	Promote System of Rice Intensification with community nurseries and mechanized transplanters.
Climate Adaptation	Deploy salt-tolerant and drought-tolerant varieties in coastal and rainfed zones.
Digital Advisory	Scale up apps like Uzhavan and partner with TNAU for customized advisories.
Crop Rotation	Promote rice-fallow pulses and green manure to improve soil health.

4. Cross-Regional Support Mechanisms

- Green Rice Certification: Create a national label for sustainably grown rice with region-specific protocols.
- Real-Time Monitoring: Use satellite data and AI dashboards for crop water use and GHG emissions.

- Eco-Markets & Procurement: Encourage eco-labelled rice in government procurement and exports.
- State-Specific Curriculum: Develop multilingual sustainability modules for farmer training institutes.

India boasts a rich diversity of rice varieties, with estimates ranging from 6,000 to over 100,000 (Figure 1). This vast genetic pool is a result of India's diverse agro-climatic zones and cultural practices, with each variety adapted to specific local conditions and culinary preferences. While the number of cultivated varieties is estimated at around 6,000, each representing unique agroecological zones, challenges, and priorities in India's rice cultivation, and scientists believe there were once significantly more.

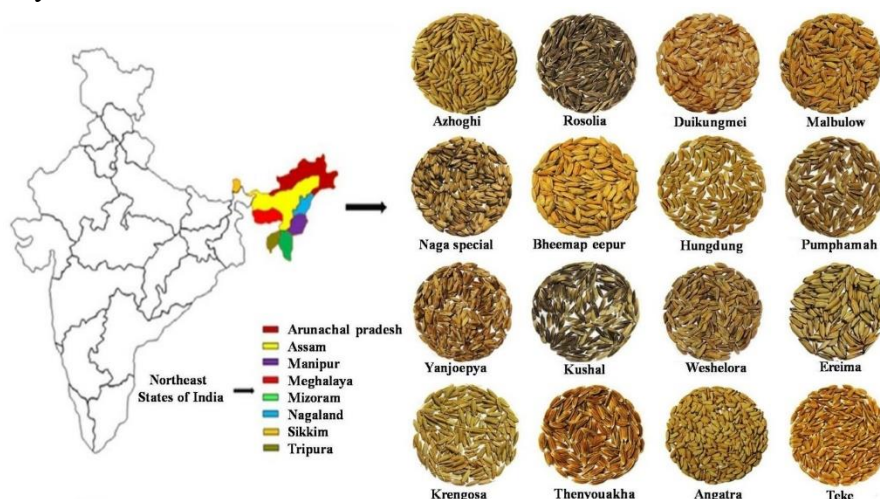


Fig.1. Geographical distribution of diverse rice landraces across North Eastern states of India.

The more detailed are:

1. Estimated Varieties: While some sources cite 6,000, others suggest over 100,000 rice varieties were once grown in India, highlighting the significant loss of diversity.
2. Adaptation: Rice varieties in India are uniquely adapted to local climates, soils, and water availability, reflecting centuries of cultivation and selection.
3. Cultural Significance: Rice is a staple food for a large part of the Indian population, and traditional varieties are deeply rooted in cultural practices and traditions.
4. Loss of Diversity: The Green Revolution, while increasing rice production, led to a decline in the cultivation of traditional varieties, favoring high-yielding, but potentially less diverse, types.
5. Conservation Efforts: Organizations and communities are working to conserve and promote traditional rice varieties, recognizing their importance for food security, biodiversity, and cultural heritage.

Examples: Aromatic varieties like Basmati and Kalanamak, along with other regional specialties, showcase the diversity of rice found in India.

Conclusion

The transformation of India's rice sector towards sustainability is both an environmental necessity and an economic opportunity. By adopting water-efficient methods like Direct-Seeded Rice and Alternate Wetting and Drying, promoting climate-resilient and nutrient-efficient varieties, integrating precision agriculture, and reviving traditional and organic rice systems, India can significantly cut water use, lower methane emissions, enhance soil health, and boost farmer incomes.

Public–private partnerships, climate-tech innovations, and farmer-centric training programs are accelerating this shift, while GI-tagged and indigenous varieties help preserve biodiversity and cultural heritage. Achieving a greener rice industry will require scaling proven technologies, incentivizing sustainable practices through policy and carbon markets, and ensuring inclusive benefits for smallholders. If implemented at scale, these efforts can position India as a global leader in climate-smart rice production, securing food security while meeting climate goals.