Rice, Resilience and Viksit Bharat: Telangana's Pathway to Climate-Smart and Nutrition-Sensitive Food Systems

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India's journey toward becoming a *Viksit Bharat* is not only about economic growth—it is also about building resilient livelihoods, ensuring nutritional security, and protecting natural resources for future generations. Agriculture lies at the heart of this transformation, and among all crops, rice occupies a special place in India's food systems (NITI Aayog, 2023).

For decades, rice has been the backbone of food security. High-yielding varieties, irrigation expansion, and policy support helped India achieve remarkable gains in food grain production. Yet, the challenges facing agriculture today are very different from those of the Green Revolution era. Climate change, groundwater depletion, rising cultivation costs, declining soil health, and persistent malnutrition are forcing policymakers and scientists to rethink the future of rice-based systems (Pingali et al., 2019).

The question is no longer simply "How much rice can we produce?" Instead, the focus is shifting toward a broader and more important question: "How can rice systems contribute to resilient, nutrition-sensitive, and climate-smart food systems?"

Why Rice Systems Need Transformation

Conventional rice cultivation is highly resource-intensive. Large quantities of water, fertilizers, and energy are required to sustain productivity. In many regions, excessive groundwater extraction for paddy cultivation is becoming unsustainable. Rice fields also contribute significantly to methane emissions, making them an important concern in climate change discussions (Rosegrant et al., 2022).

At the same time, farmers are increasingly vulnerable to climate shocks such as droughts, floods, and heat waves. These stresses threaten yields, increase risks, and affect rural livelihoods. While India produces enough food grains, nutritional challenges persist, particularly micronutrient deficiencies such as iron and zinc deficiency (FAO, 2023).Another concern is the growing dominance of paddy monocropping systems. Continuous rice cultivation reduces biodiversity, weakens ecological resilience, and limits opportunities for income diversification. Addressing these interconnected challenges requires a shift from production-centric agriculture to integrated food systems thinking.

Rice Science as a Driver of Policy Innovation

Rice research institutions today are no longer confined to developing varieties alone. They are increasingly contributing to evidence-based policy solutions that address sustainability, nutrition, climate resilience, and farmer welfare together.One major area of innovation is the development of climate-resilient rice varieties that can tolerate drought, floods, and heat stress. Such varieties are critical for stabilizing production under changing climatic conditions. Researchers are also promoting water-saving technologies such as Direct Seeded Rice (DSR) and Alternate Wetting and Drying (AWD). These approaches reduce water consumption, lower labor costs, and help cut greenhouse gas emissions while maintaining productivity (IRRI, 2024).

Another promising area is nutrition-sensitive agriculture. Biofortified rice varieties enriched with iron and zinc can help address hidden hunger and micronutrient deficiencies. Integrating these varieties into public distribution systems, school feeding programs, and nutrition initiatives could significantly improve dietary quality among vulnerable populations (ICAR, 2024). Scientists are also generating evidence on sustainable intensification practices, including reduced nitrogen application, improved nutrient-use efficiency, and regenerative soil management practices that protect long-term productivity.

Equally important is the growing recognition that technology adoption is not purely technical; it is also behavioral and institutional. Farmers' decisions are shaped by perceptions, social influences, risk attitudes, access to information, and economic constraints. Understanding these behavioral dimensions can help design more effective extension and policy interventions. Digital technologies are adding a new dimension to agricultural transformation. Remote sensing, AI-based advisories, mobile applications, and real-time crop monitoring systems are enabling data-driven agriculture and more responsive policymaking.

Telangana: A Living Laboratory for Food Systems Innovation

Among Indian states, Telangana offers a particularly important opportunity to demonstrate how rice systems can evolve toward sustainability and resilience.The state has witnessed rapid expansion in rice cultivation supported by strong public investment and farmer support programs. While this has boosted production, it has also raised concerns related to groundwater depletion, rising input use, and ecological sustainability. At the same time, Telangana possesses several advantages that make it an ideal "policy innovation laboratory."The state has invested significantly in

digital agriculture infrastructure, including land record digitization and crop monitoring systems. This creates opportunities for AI-enabled advisories and evidence-based agricultural planning.

Telangana is also promoting climate-smart agricultural practices such as DSR and AWD. These initiatives can generate valuable state-level evidence on water productivity, emission reduction, and resource-use efficiency. The state is equally well-positioned to integrate agriculture and nutrition agendas. Mainstreaming biofortified rice varieties into welfare schemes, school meals, and public distribution systems can strengthen nutrition security while supporting farmer adoption. Importantly, Telangana can use districts as pilot zones for co-created policy innovations involving researchers, extension agencies, policymakers, farmers, and development organizations. Such collaborative approaches can accelerate learning and scaling.

Rice Production in Telangana: Achievements and Emerging Challenges

Telangana has emerged as one of India's leading rice-producing states over the past decade. Supported by large-scale irrigation expansion, investment support schemes such as *Rythu Bandhu*, improved procurement systems, and expansion of irrigation infrastructure under projects like *Mission Kakatiya*, the state has witnessed a remarkable increase in paddy cultivation and production. Rice procurement by government agencies has also provided market assurance to farmers, encouraging large-scale adoption of paddy cultivation across districts. As a result, Telangana has transformed from a relatively moderate rice-producing state into a major contributor to the national food grain pool.

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Rice area and Production in Telangana during 2023–24

Indicator	Telangana
Rice area	46.85 lakh ha
Rice production	168.75 lakh tonnes
National rank	1st in India
Share in India's rice production	12.5%
Kharif production	93.44 lakh tonnes
Rabi production	75.30 lakh tonnes
Average yield	36.02 q/ha

Source: Reddy MN 2024

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Another critical challenge is balancing productivity goals with environmental sustainability. Rice cultivation contributes significantly to methane emissions and water consumption, making climate-smart interventions increasingly important. There is also growing recognition that future rice systems must move beyond quantity-focused production toward diversified, nutrition-sensitive, and

resource-efficient farming systems. Promoting technologies such as Direct Seeded Rice (DSR), Alternate Wetting and Drying (AWD), biofortified rice varieties, and rice-based diversified cropping systems will therefore be essential for ensuring long-term sustainability and resilience in Telangana's agricultural sector.

Farmer-Centric Welfare Schemes Strengthening Telangana's Agricultural Transformation

A major strength of Telangana's agricultural transformation has been its strong focus on farmer welfare and institutional support. Over the past decade, the state has introduced several pioneering schemes that have significantly influenced agricultural investment, farmer confidence, and rural livelihoods.

One of the most notable initiatives is the *Rythu Bandhu* scheme, India's first large-scale farmer investment support program. Introduced in 2018, the scheme provides direct financial assistance to farmers before each crop season to support the purchase of seeds, fertilizers, pesticides, and other essential inputs. The initiative was designed to reduce farmers' dependence on informal credit and prevent indebtedness (Government of Telangana, 2024a).

Complementing this is the *Rythu Bima* farmer insurance scheme, which provides financial security to farm families through life insurance coverage for farmers. The scheme acts as a social protection mechanism, helping vulnerable households cope with economic shocks arising from the sudden loss of earning members (Government of Telangana, 2024b).

The state has also invested in institutional platforms such as *Rythu Vedikas*, which function as village-level farmer coordination and knowledge-sharing centers. These spaces are increasingly being used for training programs, expert interactions, awareness campaigns, and dissemination of climate-smart agricultural practices. Such platforms can play an important role in scaling sustainable technologies and strengthening farmer collectives (The Times of India, 2025).

Another important reform has been the digitization of land records through the *Dharani* portal, which has improved land administration, facilitated direct benefit transfers, and strengthened transparency in agricultural governance. The availability of digital land records also creates opportunities for AI-enabled advisory services, crop monitoring, and evidence-based policymaking (Government of Telangana, 2024c).

In addition, Telangana has implemented crop loan waiver initiatives and investment support programs aimed at reducing agrarian distress and improving access to formal credit systems. While such schemes provide immediate relief to farmers, experts increasingly emphasize the importance of complementing welfare measures with long-term sustainability strategies such as crop diversification, efficient water management, and climate-resilient agriculture.

Large-scale irrigation initiatives like *Mission Kakatiya* and rural water supply programs such as *Mission Bhagiratha* have further strengthened the agricultural ecosystem by improving water access and rural infrastructure (Government of Telangana, 2024d). Together, these interventions position Telangana as an important laboratory for integrating welfare-oriented governance with sustainable agricultural transformation.

The next phase of Telangana's agricultural transition will require aligning these welfare schemes with broader goals of climate resilience, nutrition sensitivity, sustainable resource management, and diversified farming systems. By integrating farmer support programs with scientific innovation and evidence-based policy design, Telangana can continue to lead India's efforts toward resilient and inclusive agri-food systems.

Building Resilient and Nutrition-Sensitive Food Systems

Moving toward sustainable food systems requires coordinated policy action across multiple dimensions.

- First, climate-smart rice systems must be promoted through targeted incentives, training, and extension support. Farmers need practical and economically viable solutions that reduce risks while maintaining profitability.
- Second, nutrition objectives should become an integral part of agricultural policy. Agriculture should not only produce calories but also support healthier diets and improved nutrition outcomes.
- Third, diversification of rice-based systems must be encouraged. Integrating pulses, vegetables, and other crops into rice systems can improve resilience, increase farm income, enhance soil health, and strengthen household nutrition.
- Fourth, stronger linkages between research and policy are essential. Continuous engagement between scientists, policymakers, and field practitioners can ensure that decisions are grounded in evidence and local realities.
- Fifth, digital agriculture and data-driven governance should be expanded to support real-time decision-making and precision advisory systems.
- Finally, policies must recognize the human side of agricultural transformation. Behavioral approaches

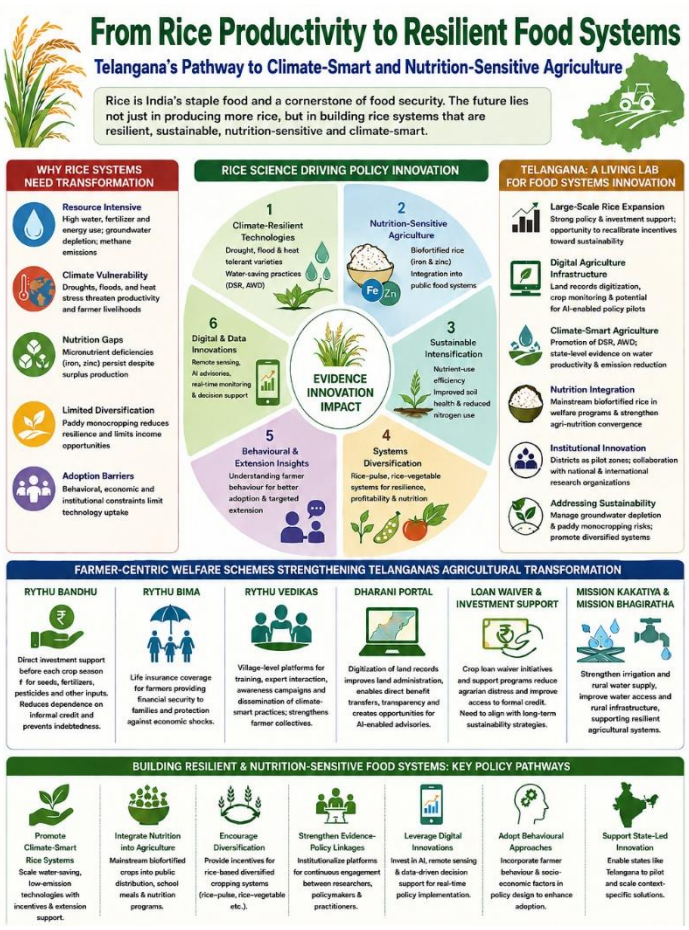
that consider farmers' perceptions, motivations, and constraints can significantly improve adoption of sustainable technologies.

- India's journey toward Viksit Bharat requires a paradigm shift from a narrow focus on crop productivity to a broader vision of resilient, sustainable, nutrition-sensitive, and farmer-centric food systems. Future agricultural development must simultaneously address the interconnected challenges of climate change, natural resource degradation, malnutrition, rural livelihood insecurity, and market volatility. Achieving these multiple goals will require integrated approaches that combine technological innovation, ecological sustainability, social inclusion, and evidence-based policymaking.
- Rice-based production systems, which support millions of farmers and provide food security for a large proportion of the population, offer a strategic entry point for this transformation. Innovations such as climate-smart rice cultivation, direct-seeded rice, precision nutrient and water management, ecological engineering, digital advisory services, biofortified varieties, and diversified rice-based farming systems can contribute to reducing environmental footprints while enhancing productivity, profitability, and nutritional outcomes. Equally important is the incorporation of behavioral and institutional approaches that encourage farmer adoption of sustainable practices and strengthen resilience at the household and community levels.

The Road Ahead

Telangana has emerged as an important laboratory for agricultural innovation, demonstrating how state-led initiatives can accelerate the transition toward sustainable food systems. The promotion of climate-smart technologies, digital agriculture platforms, mechanization, farmer producer organizations, and nutrition-sensitive interventions provides valuable lessons for the rest of the country. At the same time, challenges such as groundwater depletion, rising production costs, labor shortages, climate variability, and declining dietary diversity underscore the need for continuous innovation and adaptive policy support.

Looking ahead, the transformation of rice systems must move beyond the objective of producing more grain to creating more value per unit of land, water, labor, and energy. Investments in research, extension, digital infrastructure, climate services, value chains, and nutrition-sensitive agriculture will be critical. Strong partnerships among



research institutions, government agencies, the private sector, civil society organizations, and farming communities can accelerate the scaling of proven solutions.

If supported by enabling policies, robust evidence, and inclusive governance, rice can evolve from being merely a staple crop to becoming a cornerstone of resilient food systems that deliver environmental sustainability, improved nutrition, economic prosperity, and climate resilience. In doing so, Telangana and India can demonstrate how agricultural transformation can contribute meaningfully to the broader national vision of a prosperous, sustainable, and inclusive Viksit Bharat by 2047.

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