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AEROBIC RICE SUSTAINABLE CULTIVATION FOR WATER-SCARCE REGIONS

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Introduction

Rice is the staple food for more than half of the world's population, yet traditional rice cultivation methods are increasingly unsustainable in the face of growing water scarcity. Aerobic rice cultivation has emerged as a promising alternative that addresses these challenges while maintaining productivity. This innovative farming system represents a paradigm shift from the conventional flooded rice fields to a more water-efficient approach that could revolutionize rice production in water-stressed regions.

What is Aerobic Rice?

Aerobic rice refers to rice varieties that are specifically developed and adapted to grow in non-flooded, well-drained soil conditions with adequate moisture but without standing water. Unlike traditional lowland rice that requires continuous flooding, aerobic rice is cultivated like other cereal crops such as wheat or maize, with periodic irrigation similar to upland farming systems.

The fundamental difference lies in the root system adaptation and plant physiology. Aerobic rice varieties have been bred to develop deeper, more extensive root systems that can efficiently extract water and nutrients from unsaturated soil, making them drought-tolerant while maintaining high yield potential.

India's State-Specific Initiatives Chhattisgarh's Leadership Role

Chhattisgarh has become a leader in aerobic rice research and adoption in India. The state government, together with IGKV Raipur, has set up demonstration plots in all districts, featuring aerobic rice varieties such as Sahbhagi Dhan and CR Dhan series. Chhattisgarh State Seed Corporation has been actively spreading certified seeds of aerobic rice varieties, while the state's Rajiv Gandhi Kisan Nyay Yojana offers input subsidy to farmers practicing water-saving technologies.

The success of the state lies in its integrated strategy that includes farmer training schemes, extension support in the form of Krishi Vigyan Kendras, and piggybacking over existing irrigation infrastructure. Raipur, Durg, and Bilaspur districts have indicated substantial adoption rates, with farmers obtaining similar yields as conventional methods but conserving 30-40% irrigation water.

Rice Varieties Under Trial and Research Major Varieties Being Tested in Research Programs

Drought-Tolerant and Aerobic Varieties:

- **Sahbhagi Dhan** - A drought-tolerant variety developed through collaboration with CRURRS-CRRI, BAU, IGKV, state seed corporations, and the National Seeds Corporation. This variety has shown excellent performance under aerobic conditions and is particularly suited for rainfed areas.

- **CR Dhan Series** - Four varieties from the Central Rice Research Institute, Cuttack: CR Dhan 200/Pyari (suitable for Odisha), CR Dhan 201 (suitable for Chhattisgarh and Bihar), CR Dhan 202 (suitable for Jharkhand and Odisha), and CR Dhan 204 (suitable for Jharkhand and Tamil Nadu) are suitable for aerobic rice cultivation.
- **Indira Barani Dhan-1** - This variety possesses medium slender grain with golden husk, high head rice recovery (65%) and intermediate amylase content (24.7%), maturing in 111-115 days.

Traditional Medicinal Varieties (IGKV Research)

Three medicinal varieties of rice - Gathwan, Maharaji and Laicha - have been found to have anti-cancer properties through research conducted by IGKV Raipur and BARC Mumbai.

Protein-Enhanced Varieties

IGKV researchers worked for seven years to develop a protein-enriched rice variety that is rich in protein along with high zinc content, specifically targeting nutritional deficiencies in tribal populations of Chhattisgarh.

Research Collaborations and Breeding Programs

IGKV Raipur has been actively involved in multi-institutional collaborations for developing and testing aerobic rice varieties. The intensive seed production programme involves collaboration with CRURRS-CRRI, BAU, IGKV, state seed corporations, the National Seeds Corporation, Ltd. (NSC) and various NGOs. These partnerships have accelerated the development and distribution of improved varieties suitable for local conditions.

Other Progressive States

Karnataka has implemented aerobic rice cultivation in its northern districts, particularly in areas affected by erratic monsoon patterns. The University of Agricultural Sciences, Dharwad, has developed region-specific packages of practices, with successful adoption in districts like Belgaum and Bagalkot.

Odisha, despite being a traditional rice-growing state, has begun promoting aerobic rice in upland areas through its Mission for Integrated Development of Horticulture program. The state focuses on tribal areas where water availability is limited.

Uttar Pradesh has integrated aerobic rice into its crop diversification schemes, particularly in western districts where groundwater depletion is a major concern. The state has established farmer producer organizations specifically for aerobic rice cultivation.

Bihar has piloted aerobic rice cultivation in drought-prone areas, with the Bihar Agricultural University conducting adaptive trials across different agro-climatic zones.

Future Prospects and Research Directions

Breeding Innovations

Advanced breeding techniques, including marker-assisted selection and genomic selection, are accelerating the development of improved aerobic rice varieties. Future varieties are expected to have enhanced drought tolerance, improved nutrient use efficiency, and better weed competitiveness.

Precision Agriculture

The integration of precision agriculture technologies, including soil moisture sensors, drone monitoring, and variable rate application systems, will optimize resource use efficiency

and improve the profitability of aerobic rice systems.

Climate Adaptation

As climate change intensifies, aerobic rice varieties are being developed with enhanced resilience to temperature extremes, drought stress, and other climate-related challenges. These climate-smart varieties will be crucial for maintaining rice production stability.

System Integration

Future research focuses on integrating aerobic rice with other sustainable agricultural practices, including conservation agriculture, integrated pest management, and agroforestry systems, to create more resilient and profitable farming systems.

Conclusion

Aerobic rice is a crucial breakthrough in sustainable agriculture, offering a significant solution to the mounting problems of water scarcity and environmental sustainability in rice production. Even though the challenges are still there, primarily related to weeds and yield optimization, the benefits of reduced water consumption, enhanced soil health, and economic gain make aerobic rice an attractive option for water-scarce region farmers. Sustained research into developing better varieties, along with enhanced management practices and new technologies, will also continue to augment the adoption and performance of aerobic rice systems. With growing water scarcity across the world and increased climate variability, aerobic rice farming will become more critical in maintaining food security while ensuring environmental stewardship. Realization of aerobic rice is in fact reliant on an inter-sectoral partnership among scientists, farmers, policymakers, and the agricultural sector. With ongoing investment in research and development, extension activities, and supportive policies, aerobic rice holds the potential to play an important role in developing stronger more sustainable rice farming systems for the future.