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Direct seeded rice: A resource saving system for climate smart agriculture

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Being the staple food, rice is cultivated over an area of 42 million hectares in India. Compared to the traditional methods of rice cultivation, direct seeded rice serves as a climate smart strategy that contributes to the 2030 agenda for sustainable development through resource efficiency. As groundwater level is dropping in the Indo-Gangetic plains, this technique ensures stable production in water deficit areas by saving upto 25% water. As a low-carbon farming method, it reduces 30–40% methane emission and is vital for meeting the climate mitigation targets formulated under the sustainable development goals. It improves the economic viability of farming by reducing production costs. The collaboration of the International Rice Research Institute and the Department of Biotechnology in India resulted in improved varieties with dual adaptability. Its contribution towards SDG goals, benefits over traditional methods and the initiatives taken by government to encourage farmers to adapt the technology are discussed in this article.

Keywords: Environmental sustainability, Schemes for direct seeded rice, Sustainable development goals, Water conservation

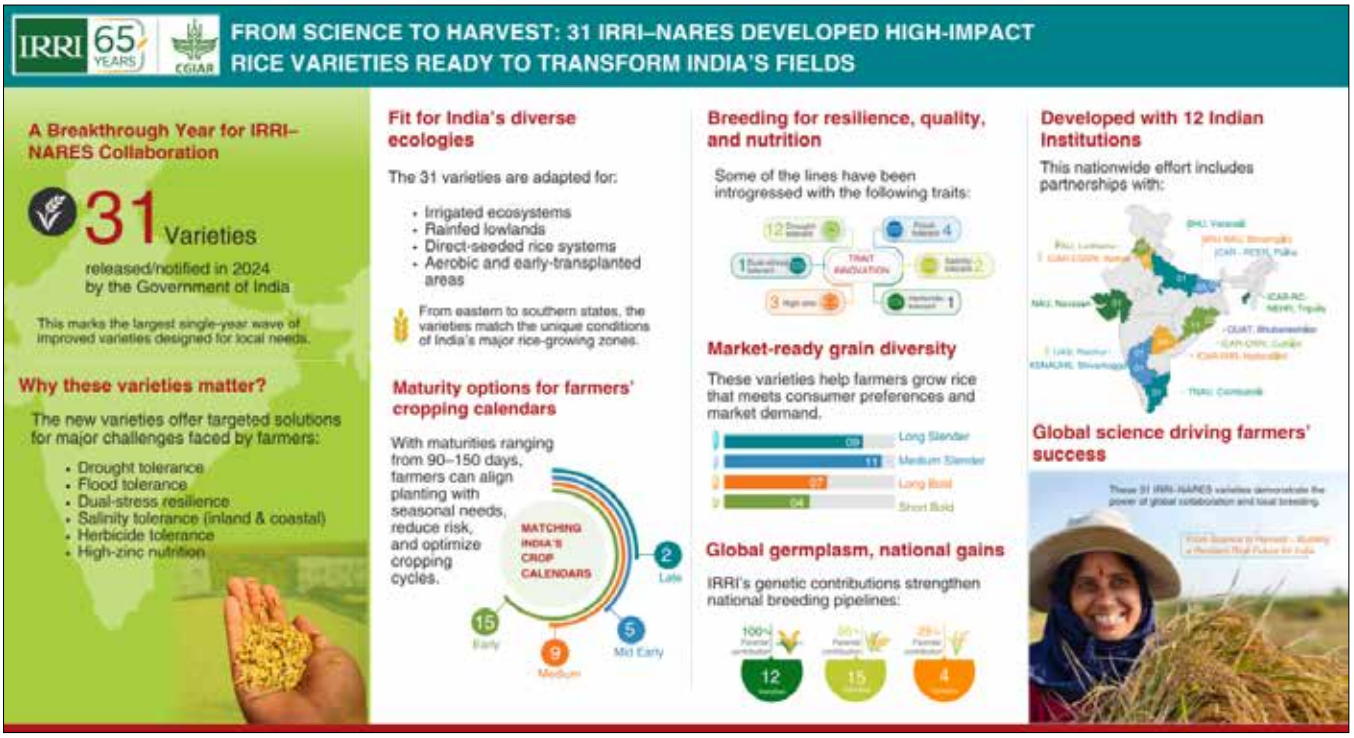
ORIGINATED in the Asian continent, rice (*Oryza sativa*) serves as the staple food for more than half of the world's population. Domesticated in China over thousands of years ago, it is one of the oldest cultivated cereals in the world. Over 90% of the world's rice is produced and consumed in Asia. More than being deeply ingrained in the Asian culture, it also acts as the symbol of wealth, fertility and prosperity. Serving as the premier food crop in Indian farming, the area of rice production covers roughly 42 million hectares, feeding over 60% of the world's population. Rice also serves as the cornerstone of India's economy contributing to approximately 10% of the country's GDP. India has not only achieved self sufficiency in production, but also produces surplus to export. When it has its own benefits, the rice crop is also known to have high water requirement. It is estimated that it alone could be consuming more than 50% of the irrigation water in agriculture. On an average, 2,500 L of water is essential to produce 1 kg of rice. Rice production primarily utilises groundwater, with the highest groundwater depletion being observed in the northern parts of the country. Flooded rice fields are also a source of methane emission contributing to climate change. Though major parts of the country are following puddled transplanting system, it is high time to recognise the need to shift to alternative agricultural techniques like Direct Seeded Rice (DSR) considering its environmental benefits and less production costs.

Direct seeded rice

DSR is a rice cultivation method where the seeds are directly sown onto the field rather than transplanting from nursery. This can be done either in puddled soil as wet direct seeding method or in unpuddled soil as dry direct seeding method. Dry DSR method is commonly used in rainfed lands. It is a sustainable, cost effective cultivation method. It saves 12–25% water, lowers labour costs and reduces methane emission (30–40%) making it a suitable climate resilient alternative. Weed growth, higher seed rates, seeds getting exposed to birds and pests, lodging risks and poor or non-uniform crop establishment are the major constraints in dry DSR but can be overcome by proper approach. According to International Rice Research Institute (IRRI), mechanised DSR creates opportunities for employment through new provisions. It is becoming popular among youth and women farmers as it is less labour intensive and free from drudgery.

Why choose DSR over puddling?

The traditionally followed system of puddling is a wet tillage process that improves crop yield by reducing leaching of nutrients. Anaerobic conditions can increase



Overview of 31 high-impact varieties (*Source*: IRRI)

the availability of nutrients like phosphorus. It controls weeds and also prevents water loss by deep percolation. Although it reduces percolation, the initial preparation of the puddle field requires enormous amount of water. The anaerobic conditions of the flooded field will contribute to high methane emissions, thereby resulting in global warming. Puddling breaks down soil aggregates and destroys microspores. In contrast, DSR lowers energy consumption for irrigation and land preparation. It reduces water usage upto 50% compared to puddle fields. DSR reduces labour demand by eliminating the need to raise nurseries and transplanting. This is crucial due to the increase in labour shortage in Indian farming. DSR crop varieties mature earlier than transplanted rice providing more time for soil management and preparation for subsequent crops. It also significantly lowers methane emissions leading to a 56–60% decrease in greenhouse emissions.

IRRI-DBT collaboration

The International Rice Research Institute and the Department of Biotechnology (DBT) in India are collaborating to advance direct seeded rice as environmentally sustainable, water efficient and climate resilient alternative to traditional transplanting.

***Targeted breeding*:** The research intends to make DSR a reliable, long term solution for farmers particularly in India. It is majorly focused on finding, developing, testing and improving the popular varieties to better drought tolerance, ensuring stability, early vigour and higher yields. These varieties are bred for 'dual adaptability' meaning they perform well under both direct seeding condition and conventional method if required. Recent developments have resulted in lines that perform 15% better under DSR conditions.

***Agronomic practices*:** The technique emphasises the use of precision machinery such as seed drills for dry DSR and drum seeders for wet DSR, which ensures uniform spacing (20–25 cm row to row spacing) and less seed rate (8 kg/acre) compared to traditional methods. It is better suited for medium to heavy textured soils due to better water retention. Laser land levelling could be done to ensure uniform water distribution and better drainage. Timely sowing of 7–10 days before onset of

CR Dhan 807

PR-126

Source: IRRI

Table 1. Varieties suitable for DSR

Variety	Suitable region	Characteristics
CR Dhan 108	Rainfed condition	• Early-maturing variety • Moderate drought tolerance, moderate resistance to leaf blast and sheath blight • Quick establishment in unpuddled fields
Swarna Purvi Dhan-5	Gujarat especially in dry areas	• Moderate resistance to pests such as stem borer, leaf folder and gall midge • Helps farmers in water-limited rainfed environments
CR Dhan 807	Suitable for dry direct seeded rice and zero tillage farming	• Herbicide tolerant variety • Strong early seedling vigour and better competitiveness against weeds • Drought tolerant • 4.2 t/ha yield under rainfed DSR
PR-126	Odisha	• Inbred variety that has higher yield potential compared to other test varieties
Malaviya Manila Sinchit Dhan-1	Rainfed condition	• Short maturity and water efficient variety

monsoon is considered. Sowing depth of 2.5–3.0 cm is considered. IRRI-DBT system advocates for stale seedbed techniques followed by timely application of pre and post emergence herbicides for weed management.

***Implementation strategy*:** IRRI engages farmers directly in the testing and selecting of most suitable varieties for local conditions through Participatory Varietal selection. The initiative is supported by public-private partnerships involving Direct Seeded Rice Consortium (DSRC) which brings together Government of Odisha, Non-Governmental Organisations (NGOs) and private partners to make DSR scalable.

DSR contribution to SDG

DSR reduces greenhouse gas emissions by avoiding the traditional puddled method. It also reduces water, labour requirements significantly and decreases energy usage. DBT supports research to develop DSR specific, high yielding rice varieties that are suitable for direct sowing and thereby addressing the challenges in traditional method. DSR is the climate smart agricultural practice that contributes directly to the Sustainable Development Goals (SDGs) by improving resource

Table 2. Role of direct seeded rice in sustainable development goals

Sustainable Development Goal (SDG)	Role of DSR
SDG 2 - Zero Hunger	**Yield resilience:** Can improve rice productivity upto 10%. **Efficient cropping system:** Matures 7–10 days faster ensuring timely sowing of subsequent crops.
SDG 6 - Clean Water and Sanitation	**Water conservation:** Reduces irrigation water consumption. **Groundwater preservation:** By removing the need for constant flooding, it preserves groundwater table especially in Punjab and Haryana regions.
SDG 8 - Decent Work and Economic Growth	**Reduced production costs:** Farmers save between ₹6,000–10,000 per hectare due to reduced labour and energy costs. **Reduced drudgery:** It eliminates the drudgery of manual transplanting.
SDG 13 - Climate Action	**Methane mitigation:** Reduced methane emissions as the soil remain aerobic. **Low carbon footprint:** It reduces carbon by decrease in machinery requirement and energy consumption for irrigation.
SDG 15 - Life on Land	**Soil health:** Since the physical structure of soil is not disturbed as in case of puddle soil, its fertility is maintained for future.

Table 3. Government initiatives toward DSR in India

Scheme	Interventions
Major subsidies for machineries	
Sub Mission on Agricultural Mechanisation (SMAM) and Crop Residue Management Scheme	Small or marginal farmers, SC/ST and woman farmers are the priority group to obtain 40–50% subsidy on machineries like laser land leveller and DSR seed drill. Cooperative Societies, Farmer Producer Organisations (FPOs) and Self Help Groups can get upto 80% subsidy to establish custom hiring centre.
Training and awareness programme	
Krishi Vigyan Kendras (KVKs)	Act as frontline extension centres, providing field demonstrations and vocational training on techniques related to weed and water management on DSR crops.
Agricultural Technology Management Agency (ATMA)	Organises exposure visits and kisan melas where farmers can interact with researchers and see field use of DSR.
Financial Assistance for Training	Schemes like Seed Village Programme provide ₹15,000 to a group of farmers for seed technology training.
Specialized Institutes	Institutes like the ICAR-National Rice Research Institute (NRRI), Cuttack and Indian Institute of Rice Research (IIRR), Hyderabad provide three days to a week long vocational training programmes on high yielding DSR variety selection and seed technology.
State specific schemes	
Punjab (Laser Land Leveller Scheme 2026)	Offers upto ₹6,00,000 subsidy on 1,000 units, targeting a 25% reduction in water use.
Haryana (AgriHaryana Portal)	Provides 50% subsidy for individual Crop Residue Management machines in 2025-26 season.
Odisha	Provides an incentive of ₹7,000/ha to farmers to cover costs of land preparation and hiring DSR machinery.

efficiency and reducing the impact on environment.

Government Initiatives for DSR

Several schemes by Indian government provide financial support and awareness through training programmes to farmers that can help them adapt DSR technology. Some of the initiatives taken by the Indian Government that could facilitate the optimisation of DSR technique in Indian Farming are listed in the table.

Way forward

The initiative by IRRI and DBT greatly aligns with the global environmental practices and India's efforts to improve water use efficiency in agriculture. This partnership aims to facilitate the widespread adoption of DSR, offering the farmers a more profitable and environmental friendly alternative, effectively shifting from traditional methods. IRRI manages a DSR consortium (2018-2027) aimed at promoting sustainable rice production through DSR across Asia. The projections are anticipating a rise in rice production by 25% over the next 25 years in order to meet the global demand. The field trials indicated that optimised DSR lines perform well under direct seeding and also under traditional puddling, thus offering flexibility to farmers. The initiatives supported by DBT aim to address water scarcity and labour costs aligning with the sustainable development goals.

SUMMARY

Direct seeded rice (DSR) serves as a critical solution for managing global water scarcity in agriculture and to increase the food supply for the growing population. The transition to dry DSR from conventional puddling method presents a unique set of opportunity in water deficit parts of the country. The joint work of IRRI and DBT significantly improves the research and development of dry DSR crop and the dual adaptability of the improved crop would provide reliability for farmers. The substantial financial support and awareness through training programmes by the Indian government would enhance the adoption of the technology by small and marginal farmers. Thus, the DSR technology is indeed a decisive resource saving system that provides economic benefit to the farmers and simultaneously offers a strategic pivot towards environmental sustainability.

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