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DIRECT SEEDED RICE (DSR): A CLIMATE SMART AND WATER SAVING TECHNOLOGY FOR MODERN RICE CULTIVATION

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INTRODUCTION

Rice is the staple food crop for more than half of the world's population and plays a major role in food security, especially in Asian countries such as India, China, Bangladesh, and Vietnam. Traditionally, rice cultivation is carried out through the puddled transplanted rice system in which seedlings are first raised in nurseries and then transplanted manually into flooded fields. Although this method ensures good crop establishment, it consumes huge quantities of water, labor, energy, and time. In recent years, increasing labor shortages, groundwater depletion, climate change, delayed monsoon, and rising production costs have forced farmers and scientists to search for sustainable alternatives. As a result, Direct Seeded Rice (DSR) has emerged as an important modern technology in rice production.

Direct Seeded Rice is a method of rice cultivation in which seeds are sown directly into the field without raising nurseries or transplanting seedlings. Seeds are either drilled mechanically or broadcasted into dry or moist soil. DSR is considered a climate-smart agricultural practice because it reduces water consumption, lowers greenhouse gas emissions, saves labor, and decreases the overall cost of cultivation. The technology is rapidly expanding in states like Punjab, Haryana, Uttar Pradesh, and parts of eastern India where water scarcity and labor shortages are becoming serious concerns.

Concept and Principle of Direct Seeded Rice

The basic principle of DSR is to establish rice plants directly in the main field under proper moisture conditions without the traditional puddling and transplanting operations. In this system, rice plants develop stronger root systems because they are not subjected to transplanting shock. Proper field leveling, moisture management, and weed control are the key factors for successful DSR cultivation. Modern DSR systems mainly rely on mechanization, precision nutrient management, herbicide use, and improved varieties suited for direct seeding. Recent advancements in agriculture have made DSR more efficient and economically viable for farmers.

Types of Direct Seeded Rice

1. **Dry Direct Seeded Rice:** In dry DSR, dry seeds are sown directly into dry prepared soil using seed drills. Irrigation or rainfall is provided after sowing for germination. This method is highly suitable for areas facing water scarcity and is commonly practiced under mechanized farming systems.

2. **Wet Direct Seeded Rice:** In wet DSR, pre-germinated seeds are sown into moist or puddled soil. The field contains adequate moisture but not standing water. This method is useful in medium rainfall regions.

3. **Water Seeding:** This method involves broadcasting pre-germinated seeds into standing water. It is mostly adopted in lowland or flood-prone areas where water stagnation occurs frequently.

Latest Technologies Used in DSR

- **Laser Land Leveling:** Laser land leveling has become an important component of modern DSR cultivation. Uniform leveling ensures equal water distribution, better seed germination, and reduced water loss. Studies have shown that laser leveling can save up to

20–25% irrigation water.

- **Seed Drill and Happy Seeder Technology:** Modern seed drills help in precise sowing of seeds at uniform depth and spacing. In northwestern India, Happy Seeder technology is increasingly used for sowing rice directly into crop residues without burning stubble. This practice reduces environmental pollution and improves soil health.

- **Drone-Based Herbicide Spraying:** Recent advancements include the use of agricultural drones for herbicide and nutrient spraying. Drone technology improves spraying efficiency, reduces labor requirements, and minimizes chemical exposure to farmers.

- **Precision Nutrient Management:** Farmers are now using Leaf Color Charts (LCC), soil sensors, and digital advisory tools for accurate fertilizer application in DSR fields. Precision nutrient management increases fertilizer use efficiency and reduces unnecessary input costs.

Agronomic Practices in Direct Seeded Rice

- **Field Preparation:** A well-leveled field is essential for successful DSR cultivation. Uneven fields lead to poor germination and irregular crop growth. The field should be prepared with proper tillage to create a fine seedbed. Moisture should be maintained adequately before sowing.

- **Seed Selection and Seed Treatment:** Good quality certified seeds with high germination percentage should be selected. Seed treatment with fungicides, biofertilizers, or biocontrol agents helps protect the crop from soil-borne diseases and improves seedling vigor. Recently developed short-duration and drought-tolerant rice varieties are becoming popular in DSR systems because they perform well under limited water conditions.

- **Sowing Time and Seed Rate:** Timely sowing is critical in DSR cultivation. Delayed sowing may expose the crop to weed infestation and terminal heat stress. Usually, a seed rate of 20–25 kg per hectare is recommended for line sowing. Mechanical sowing using zero-till drills ensures proper plant population and better crop stand establishment.

- **Water Management:** Water management is one of the greatest advantages of DSR. Unlike conventional flooded rice cultivation, continuous standing water is not required. Irrigation is provided only at critical growth stages such as germination, tillering, panicle initiation, flowering, and grain filling. Alternate Wetting and Drying (AWD) irrigation is now widely recommended in DSR systems because it saves water and reduces methane emissions.

- **Nutrient Management:** Nitrogen management is particularly important in DSR because nitrogen losses can occur through volatilization and leaching. Split application of nitrogen fertilizers improves nutrient uptake efficiency. Integrated Nutrient Management (INM), which combines chemical fertilizers, organic manures, green manures, and biofertilizers, is increasingly recommended for sustainable DSR cultivation.

Weed Management: The Major Challenge in DSR

Weed infestation is the most critical problem in Direct Seeded Rice because the absence of standing water favors rapid weed growth. Weeds compete with rice plants for nutrients, moisture, sunlight, and space, resulting in severe yield losses if not controlled timely.

Modern weed management in DSR involves an integrated approach including:

- Pre-emergence herbicides
- Post-emergence herbicides
- Mechanical weeding
- Crop rotation
- Mulching
- Stale seedbed technique

The first 30–45 days after sowing are considered the critical period for weed competition.

Advantages of Direct Seeded Rice

- **Water Saving Technology:** DSR can save approximately 15–35% irrigation water compared to transplanted rice. This is extremely important in regions facing groundwater depletion.

- **Reduction in Labor Requirement:** Since nursery preparation and manual transplanting are eliminated, labor requirement decreases significantly. This helps farmers overcome

labor shortages during peak planting seasons.

- **Lower Cost of Cultivation:** Reduced labor, fuel, irrigation, and energy requirements lower the overall cost of rice production. Farmers can obtain higher net profits under proper management.

- **Early Crop Maturity:** DSR crops generally mature 7–12 days earlier than transplanted rice. Early harvesting allows timely sowing of succeeding crops like wheat and mustard.

- **Environment Friendly Technology:** DSR reduces methane emission because fields are not continuously flooded. It also helps in reducing residue burning when combined with conservation agriculture practices.

- **Better Root Development:** Rice plants in DSR develop deeper and stronger root systems, making them comparatively more tolerant to drought stress.

- **Role of DSR in Climate Change Mitigation:** Climate change is becoming a major threat to global agriculture. Rice cultivation contributes significantly to methane emission under flooded conditions. DSR offers an important solution by reducing greenhouse gas emissions and conserving natural resources. The technology also improves water productivity, energy efficiency, and carbon sustainability. Because of these environmental benefits, DSR is increasingly promoted under climate-smart agriculture programs worldwide.

Government Initiatives and Future Prospects

The government and agricultural institutions are actively promoting DSR technology through subsidies, training programs, demonstrations, and machinery support. Several agricultural universities and research institutes are developing improved DSR-compatible rice varieties with better weed competitiveness and stress tolerance.

Future research is focusing on:

- Herbicide-resistant rice varieties
- Artificial intelligence-based weed detection
- Smart irrigation systems
- Precision farming technologies
- Climate-resilient rice production systems

With increasing mechanization and scientific management, DSR is expected to play a major role in sustainable rice cultivation in the future.

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