Proceedings of

Global Direct-Seeded Rice Conclave

ISARC, Varanasi, October 5-7, 2025

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Global Direct-Seeded Rice Conclave 2025

IRRI International Rice Research Institute

International Rice Research Institute
South Asia Regional Centre (ISARC), Varanasi

Foreword

The transformation of rice-based systems toward greater sustainability, resilience, and resource-use efficiency is central to achieving global food security and environmental stewardship. The conventional flooded, puddled transplanted rice (PTR) cultivation method is resource (labor, water, and energy) and capital-intensive and contributes significantly to methane emissions - a potent greenhouse gas responsible for climate change. Increasing climate variability, declining water resources, rising production costs, and changing labor dynamics demand a paradigm shift in the way rice is grown. In this context, Direct-Seeded Rice (DSR) has emerged as a scientifically and strategically important pathway for reimagining the future of rice cultivation within sustainable production systems.

The Global DSR Conclave 2025 provided a timely and impactful platform to deepen scientific dialogue, foster systems integration, and advance scalable solutions for DSR adoption. The conclave convened a diverse group of researchers, policymakers, development partners, private-sector actors, machine developers, service providers and farmer representatives to deliberate on technological advancements and institutional frameworks required for scaling of DSR. The discussions reflected significant progress in varietal development, precision weed, water and nutrient management, mechanization, and digital decision-support tools tailored to diverse agro-ecologies for adoption of DSR. Equally important were discussions on enabling policy environments, institutional convergence, and investment frameworks required to scale DSR responsibly and effectively. The commitment of the Uttar Pradesh Government to shift 2.5 million hectares from PTR to DSR over the next five years is commendable, and IRRI stands committed to providing technical support in advancing this transformative effort.

DSR is not merely an alternative rice establishment method. It represents a systems-level innovation that enables timely sowing, enhances water and nutrient use efficiency, strengthens climate resilience, reduces environmental footprint, and supports improved farmer profitability when implemented with appropriate management practices. The deliberations during the conclave emphasized the importance of embedding DSR within diversified and climate-smart rice-based systems to ensure long-term ecological and economic sustainability.

The proceedings of this conclave document the breadth of scientific insights, progress-made over time in addressing challenges faced by farmers in adopting DSR, field experiences, advancements in remote-sensing, data analytics and digital tools to support precision targeting and scaling DSR, and strategic perspectives shared during the sessions. It reflects the collective commitment of the research and development community to refine evidence-based recommendations and to strengthen institutional convergence for responsible scaling of DSR across regions.

I commend the organizers, contributors, and partners whose dedication and leadership made the Global DSR Conclave 2025 possible. I am confident that the knowledge compiled herein will inform future research agenda, guide policy reforms, catalyze investments, and contribute meaningfully to the sustainable transformation of rice-based systems worldwide.

Dr. Virender Kumar
ResearchDirector - Sustainable Impact through Rice-based Systems
International Rice Research Institute

Foreword

Ensuring the long-term sustainability, resilience, and competitiveness of rice-based production systems is no longer a matter of incremental improvement but a strategic global imperative. As water scarcity intensifies, input costs rise, labor availability declines, and climate variability increases. Conventional puddled transplanted rice systems are facing structural limitations across South Asia and other rice-growing regions. In this context, Direct-Seeded Rice (DSR) emerges not merely as a technological alternative, but as a transformative pathway aligned with national priorities on resource conservation, climate adaptation, productivity enhancement, and improved farmer incomes.

The Global Direct-Seeded Rice (DSR) Conclave 2025 marked a truly landmark event, one of its kind, bringing together the largest global congregation of leading scientists, policymakers, development partners, and practitioners focused on DSR. This unprecedented gathering created a high-level platform for evidence-based dialogue, strategic alignment, and cross-country learning on advancing DSR across diverse agro-ecological and socio-economic contexts. Deliberations moved beyond technical dimensions to address policy frameworks, institutional mechanisms, and scaling strategies necessary for mainstreaming DSR. Key discussions covered suitability mapping, varietal development and selection for direct-seeded systems, integrated weed and nutrient management, soil health implications, mechanization solutions suited to smallholders, risk mitigation strategies, and the growing role of digital advisory platforms in supporting informed decision-making.

Scaling DSR requires coordinated action across research institutions, extension systems, governments, private-sector actors, and service providers. The Conclave emphasized adaptive research across agro-ecologies, strengthening capacity of stakeholders, and farmer-centric validation to ensure reliable performance, reduced risk, and inclusive adoption. Institutional collaboration, innovation platforms, and enabling policy environments will be critical to accelerate uptake while safeguarding environmental sustainability.

The proceedings presented in this volume synthesize the scientific evidence, practical experiences, and strategic insights shared during this historic global gathering. They serve as an important reference for policymakers, researchers, and development partners committed to transforming rice systems through resource-efficient and climate-resilient approaches. By embedding DSR within broader agricultural transformation strategies, we strengthen collective efforts toward food security, environmental sustainability, and long-term rural prosperity.

I extend my sincere appreciation to all contributors, partners, and members of the organizing team whose commitment made this exceptional global platform possible. I am confident that this publication will inform policy, inspire innovation, and catalyze sustained collaboration in advancing resilient and sustainable rice systems worldwide.

Dr. SudhanshuSingh
Director,
IRRI South Asia Regional Centre (ISARC)

Table of Contents

Executive Summary:

The Global DSR Conclave 2025, organized by the International Rice Research Institute (IRRI) South Asia Regional Centre in Varanasi, convened policymakers, researchers, private sector leaders, CGIAR institutes, and farmers to explore pathways for scaling Direct-Seeded Rice (DSR). Since its establishment in 2018, the DSR Consortium (DSRC) has advanced DSR research and adoption through its first two phases, which concentrated on mechanization, weed management, and agronomic optimization. As it enters Phase III (2025–2027), the focus shifts to large-scale adoption through innovation, partnerships, business models, and digital technologies.

The inaugural session emphasized the transformative potential of Direct-Seeded Rice (DSR) in enhancing the sustainability of rice-based systems by significantly reducing water use, labor requirements, and methane emissions. DSR offers numerous economic and environmental benefits, including 25-30% water savings, yield improvements in succeeding/sequential crops, and enhanced soil health. However, challenges such as weed pressure, uneven crop establishment, and limited mechanization hinder large-scale adoption.

India aims to expand DSR to 16 million hectares by 2030, focusing on improving water productivity, mitigating carbon emissions, and advancing precision agronomy. Uttar Pradesh has set a target of 2 million hectares under DSR by 2030, driven by labor shortages and profitability, in the suitable blocks identified under the Samriddh Dhan program. Institutional and state representatives emphasized the importance of integrating DSR with national schemes such as PM-KUSUM and NFSM, alongside farmer training through KVKs and varietal innovations.

The private sector proposed farmer-centric mechanization models and the promotion of hybrid rice to scale DSR adoption to 1.5 million hectares by 2032. Overall, DSR is recognized as a strategic tool for building climate resilience, offering up to 50% labor savings and a 45% reduction in global warming potential. Key policy priorities include providing subsidies for seed drills and machinery, integrating DSR into national agricultural missions, and reforming seed systems through the SATHI portal and updated Seed Bill.

The session on Agronomy and Mechanization for DSR Systems highlighted the vital role of precision agronomy and mechanization in the success of DSR. Experiences from various regions demonstrated that innovative agronomic practices, such as tar-vattar DSR, have achieved yields comparable to traditional puddled transplanted rice while conserving water and reducing labor requirement, leading to significant adoption in key states. Evidence from DSR based systems showed improvements in soil health and climate resilience. Additionally, regional case studies from Asia and Africa illustrated that mechanized DSR can substantially enhance productivity, provided the service-provider networks are strengthened. Technological innovations, such as inclined-plate seeders, urea briquette machines, and laser land levellers, are enhancing precision and efficiency. Overall, discussions emphasized the need to promote DSR as an integrated technology package that includes quality seed, precise sowing, effective water and weed management, and mechanization. Strengthening Custom Hiring Centres (CHCs) and expanding capacity building are essential, along with policy support and subsidies to encourage adoption, particularly among smallholders.

The session on Geospatial Intelligence and Digital Innovation explored the transformative potential of artificial intelligence, remote sensing, and GIS in scaling DSR. Digital platforms are enabling real-time DSR suitability mapping, while satellite-based detection using SAR data and machine learning offers advanced tools for monitoring and planning. Upcoming satellite missions will provide high-resolution soil moisture data to support precise irrigation scheduling, and drone-based multispectral sensing is helping automate crop advisories at the field level. The session concluded that digital agriculture frameworks must institutionalize geospatial and AI tools for monitoring, yield forecasting, and improving water-use efficiency. Collaboration among national and international research institutions can establish MRV systems to underpin carbon credit initiatives, and user-friendly digital tools such as chatbots can effectively bridge the gap between scientific knowledge and on-farm practice.

The session on Varietal Development and Seed Systems highlighted that varietal improvement is central to scaling DSR sustainably. Advances in genomic breeding are accelerating the development of rice varieties with traits such as anaerobic germination, early vigor, weed competitiveness, and nutrient-use efficiency. Evidence from hybrid rice trials demonstrated substantial yield gains under DSR conditions. Decentralized seed systems and cluster-based demonstrations were identified as vital for ensuring timely access to quality seed. The session recommended fast-tracking the release and multiplication of DSR-suitable varieties, including premium types like Basmati, and establishing stewardship frameworks for herbicide-tolerant rice. Strengthening public–private partnerships for seed production and mechanization will be key to widespread adoption.

The session on Carbon Market Potential examined how DSR can be integrated into carbon credit mechanisms to promote climate-smart rice cultivation. Scientific studies indicate that DSR can reduce greenhouse gas emissions by 35–50% and save up to 1,850 cubic meters of water per hectare. Emerging digital MRV tools and farmer-centric carbon finance models are creating opportunities for producers to capture a significant share of carbon revenue. Experts emphasized the importance of farmer aggregation, farmer centric carbon credit models, private sector investment, and robust, science-based MRV systems to ensure credibility and scalability. The policy directions outlined include aligning DSR adoption with India's national carbon market strategy, strengthening institutional capacity for MRV and carbon registry participation, and promoting residue management and regenerative practices as integral components of the DSR technology package.

The session on 150th Anniversary of Department of Agriculture highlighted the state's vision to become a global food hub by 2030. Plans include a 250-acre Seed Park in Lucknow and collaborative initiatives driving innovation in low-GI and climate-resilient crops such as rice and potatoes through integrated systems. Partnerships under the Samriddh Dhan Network aim to expand DSR to 2 million hectares, generating significant cost savings. Strategic recommendations focus on scaling DSR and zero-tillage practices to 2 million hectares by 2030, leveraging digital tools, carbon credits, and premium "low-carbon rice" branding, and strengthening farmer producer organization (FPO)-led adoption alongside women and youth entrepreneurship.

The DSRC stakeholder workshop consolidated lessons from regional experiences in Vietnam, Cambodia, and India. In Vietnam, DSR adoption reached 60–65% in the Mekong Delta, though challenges remain with high seed and fertilizer usage. Cambodia has seen expansion of mechanized DSR supported by digital dashboards and private-sector models, while India's initiatives, including cluster-based platforms, are scaling adoption effectively. Key outcomes emphasized the need for supportive policies, business models, and farmer incentives to sustain mechanized DSR. The development of DSR-suited varieties, integrated weed management, and linkages to carbon markets and financial instruments were identified as essential for long-term scaling.

The overarching conclusions highlighted that DSR is a proven climate-smart technology, capable of reducing methane emissions by 50%, water use by 30–40%, and labor requirements by 25–30%. Successful scaling requires the integration of scientific research, policy frameworks, mechanization, and carbon finance. Policy and institutional priorities include subsidizing mechanization and seed drills, building digital MRV and geospatial monitoring systems, and promoting public–private partnerships and FPO networks. Research focus should continue on DSR-adapted varieties, precision agronomy, low-emission cropping systems, and socio-economic studies. Collectively, India and Southeast Asia are positioned to lead the transition toward sustainable, low-carbon, and profitable rice ecosystems.

Session Proceedings:

Session Title: *Direct-Seeded Rice: Progress, Vision, and Policy Pathways for Large-scale Adoption*

1. Overview / Objective of the Session

Rice sustains millions across Asia, yet traditional puddled transplantation is becoming increasingly unsustainable due to water scarcity, labor shortages, rising input costs, and the growing impacts of climate change. Direct-Seeded Rice (DSR) presents a transformative alternative, reducing water and labor requirements, lowering greenhouse gas emissions, and enhancing farm profitability.

The DSR Conclave 2025 served as a pivotal platform to advance this agenda, bringing together scientists, policymakers, private sector representatives, NGOs, and farmer organizations to exchange knowledge, shape enabling policies, explore business opportunities, and develop a collaborative roadmap for scaling DSR.

2. Summary of Presentations and Discussions

Opening Address – Dr. Yvonne Pinto, Director General, IRRI

- Highlighted DSRC as a critical platform for advancing dry DSR and climate-smart rice systems.
- Reported evidence of 25–30% labor and water savings, and ~50% methane reduction under DSR.
- Emphasized the need for tailored agronomy and mechanization, use of IRRI's Rice-Based Innovations (RBI) platforms, and NARES partnerships for developing DSR-fit varieties.
- Outlined Phase II to Phase III transition goals: scaling from 1,000 ha to million-ha coverage, promoting business models, digital technologies, and robust M&E systems.

Keynote – Dr. Virender Kumar, IRRI

Topic: "DSR for Economic and Environmental Sustainability: Global Achievements and Progress of DSRC"

- Identified key challenges in the rice sector: GHG emissions, climate impacts, and commitments toward Net Zero 2050.
- Reported >30% methane reduction, 20–50% water savings, and a 9% rotational yield benefit for wheat under DSR.
- Highlighted adoption challenges: uniform crop establishment, weed pressure (including weedy rice), N_2O emissions, limited mechanization, and lack of DSR-fit varieties.

- Shared regional insights:
  - Cambodia, Sri Lanka, Malaysia – high adoption but limited mechanization.
  - India (Punjab) – success with no yield penalty and 45% GWP reduction.
  - Assam – income gains of USD 150–350/ha.
- Proposed solutions: precision seeding (drones), vattar DSR, seed priming, integrated weed management, HT rice stewardship, and water management at 10–20 kPa tension.

Keynote – Dr. A.K. Nayak, ICAR
Topic: "Rice@2030: India's Vision in Research for Development"

- India's rice area: ~50 million ha with significant export potential and ecosystem service valuation (~USD 1,473/ha/year).
- Highlighted low water-use efficiency (beneficial irrigation efficiency <30%).
- Reported 26% higher water productivity under dry DSR + AWD systems.
- Identified carbon crediting challenges due to small landholdings; emphasized role of methanotrophs and water management in emission reduction.
- Set target of 16 million ha under DSR by 2030.
- Recommended science-driven interventions using CRISPR, genome editing, and HT rice.

Q&A Highlights

- Dr. Y. Pinto: Need for standardized MRV tools and baseline data for carbon credits; analysis of hidden costs and ecosystem services.
- Dr. M. Chakravorty (NRRI): Raised concerns over weedy rice issues (e.g., Bihar).
- Dr. V. Kumar: Reiterated stewardship for HT rice and private sector engagement under DSRC.

Presentation – Dr. Rica Joy Flor, IRRI
Topic: "DSR Vision – Achievements and Scaling in Cambodia and Vietnam"

- Vietnam: National climate-smart rice program targeting 1 million ha and 1.5 million farmers; mechanization and efficient input use improved profitability.
- **Cambodia:** Mechanized DSR + AWD improved IRR (USD 114–116/ha).
- Emphasized gender-inclusive capacity building and context-specific adoption drivers.

Presentation – Dr. P.S. Birthal, ICAR-NIAP
Topic: "Enabling Policies and Incentives for Large-scale Adoption of DSR"

- Stressed DSR as primarily a water management intervention; urgent need to address IGP groundwater depletion.
- Highlighted policy challenges: politically sensitive water pricing and subsidy reform.
- Recommended: water sector reform, market regulation, financial incentives, crop diversification, and micro-irrigation.

Closing Remarks – Shri D. P. Wickramasinghe

- Emphasized mainstreaming mechanized DSR in Sri Lanka for water saving, emission reduction, and cost efficiency.
- Encouraged country-specific scaling pathways based on scientific evidence and stakeholder partnerships.

3. Key Discussion Points

- DSR delivers 20–50% water and 25–30% labor savings and reduces methane emissions by 30–50%.
- Key barriers: uneven establishment, weeds/weedy rice, N_2O emissions, limited mechanization, few DSR-fit varieties, and soil/nutrient issues.
- Mechanization (e.g., APV seeder, drones) and precision agronomy are essential for scaling.
- Stewardship frameworks required for HT rice and herbicide management.
- Water policy reform is the most critical lever but politically sensitive; differentiated regional approaches are needed.
- MRV systems and baseline data are vital for accessing carbon finance and valuing ecosystem services.
- Gender-responsive capacity development and context-specific scaling strategies are essential.

4. Major Outcomes / Conclusions

- Consensus that DSR is a priority climate-smart practice offering tangible environmental and economic benefits.
- DSRC Phase III (2025–2027) to focus on large-scale adoption through partnerships, digital tools, business models, and enhanced M&E.
- Country experiences (Punjab, Assam, Vietnam, Cambodia) validate scaling potential but underscore contextual challenges.
- Need for integrated technology packages combining DSR-fit varieties, mechanization, weed management, precision agronomy, and MRV systems.

5. Policy and Institutional Recommendations

- Water Policy Reform: Regional differentiation in subsidy and pricing structures; promote efficient irrigation and diversification.
- Financial Incentives: Targeted schemes to support mechanization and eco-service payments.
- MRV and Carbon Finance: Develop baselines and tools to enable carbon market access and ecosystem service valuation.
- Regulatory Stewardship: Establish frameworks for safe and responsible HT rice and herbicide use.
- Targeting Strategies: Identify agro-ecologies and farmer segments with highest adoption potential.

6. Research and Innovation Priorities

- Breeding DSR-fit and long-grain/Basmati varieties; use of HT traits and CRISPR/genome editing.
- Studies on N_2O mitigation, soil health, micronutrients, and nematodes under DSR.
- Integrated weed and weedy rice management, including HT rice stewardship.
- Mechanization innovations: low-cost seeders (APV, Vattar), drone-assisted precision seeding, and service-provider models.
- Development of MRV tools, datasets, and WTP/market uptake studies.
- Socio-economic research on gender inclusion, business models, and adoption segmentation.

7. Reflections / Participant Feedback

- Participants appreciated the balance between science, scaling, and business model discussions.
- Emphasized harmonizing diverse scaling approaches for aggregating global benefits.
- Farmers and researchers urged focused interventions for weedy rice management and HT rice stewardship.

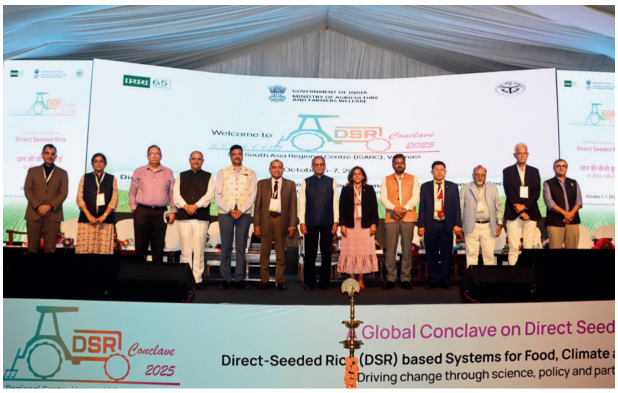
Session Title: Inaugural Session – Direct Seeded Rice (DSR) Scaling and Adoption

1. Welcome Remarks
Dr. Virender Kumar, Research Director, SIRS, IRRI

- Highlighted challenges in current rice cultivation, emphasizing that Puddled Transplanted Rice (PTR) is highly resource-intensive (water, labour, costs) and contributes significantly to greenhouse gas emissions.
- Questioned the sustainability of PTR and emphasized the need for viable alternatives.
- Presented Direct Seeded Rice (DSR) as a transformative option that saves water and labour, reduces emissions, and improves profitability.
- Noted low farmer adoption due to challenges in crop establishment and weed management, citing Haryana as an example where incentives of ₹10,000/ha did not drive widespread adoption.
- Highlighted IRRI's DSR Consortium (DSRC) efforts to overcome these barriers and urged stakeholders to "take the risk out of technology" by providing farmer-ready solutions.
- Concluded by urging that DSRC Phase 3 and 4 focus on innovation, partnerships, investment, and shared vision to effectively scale DSR.
- Called upon policymakers, private sector partners, and researchers to collaborate for global DSR adoption.

2. Key Reflections & Recommendations on DSR Scaling in Uttar Pradesh
Shri Ravinder, Principal Secretary, Agriculture and Agriculture Education, Govt. of Uttar Pradesh

- UP cultivates 7.2 million ha of paddy annually.
- Water is less critical than in Punjab/Haryana; labour shortages are the primary driver for DSR adoption.
- Emphasized income improvement and economic incentives; any yield reduction must be offset with subsidies.
- Identified 2.5 million ha as suitable for DSR; comprehensive surveys under Samriddhi Dhan are ongoing to prioritize blocks for adoption.
- The Conclave's recommendations will guide scaling and farmer motivation strategies ahead of the next paddy season.



3. Private Sector Vision for Scaling DSR
Dr. Sangeeta Mendiratta, Bayer Crop Science

- Outlined Bayer's structured approach to promote climate-resilient DSR in India, initiated in 2021 during labour shortages.
- Pilot programs expanded from 800 acres in Punjab to 100,000 acres nationwide, in collaboration with ICAR, SAUs, IRRI, NGOs, and State Governments.

- Focused on farmer-centric scaling to increase incomes by 10–15% through mechanization and precision farming.
- Highlighted support during first 30 days of crop establishment, emphasizing weed management.
- Reaffirmed goal to scale DSR to 1.5 million ha by 2032, with a strong focus on UP.
- Emphasized water saving (~25%), carbon reduction, cluster-based approaches, and R&D for germplasm and next-generation weed management.
- Highlighted ecosystem support, farmer training, and private–public partnerships as critical enablers.

4. Seed Industry Vision for DSR Research and Scaling
Mr. Ajai Rana, Chairman, Federation of Seed Industry of India

- Indian seed sector has 25 years of DSR experience, aligned with UP's vision and national targets for DSR adoption.
- Highlighted adoption drivers: labour shortages, weed control, and high transplanting costs.
- Introduced HT rice technologies; first HT hybrid rice launched in 2024.
- Emphasized need for first 30-day crop support, proper genetics, precision seed drills, and extension services.
- Requested policy interventions to subsidize seed drills and machinery to accelerate adoption.

5. Key Reflections on DSR in North-West India
Dr. B. R. Kamboj, Vice Chancellor, CCSHAU, Hisar, Haryana

- Warned of future water scarcity, emphasizing DSR as a proactive solution.
- Advocated a holistic, system-based approach for resource efficiency and resilience.
- Noted DSR benefits: up to 50% water saving, improved weed management, and better yields for subsequent crops.
- Highlighted importance of short-duration varieties and diversified rotations (rice–mustard/moong).

6. Special Remarks
Dr. Sanjay Singh, Director General, UPCAR, GoUP

- UP: over 5.7 million ha under rice, producing ~15 million tonnes annually.
- Challenges: fragmented holdings, declining groundwater, labour shortages, rising costs, climate risks.
- DSR offers water conservation, emission reduction, and drudgery mitigation.
- UPCAR's strategies: DSR-suitable varieties, mechanization promotion, KVK-led training, and modernization of agricultural universities.
- Partnerships with IRRI (UP-AGREES) aim to scale 2 million ha by 2030.

7. ICAR Vision for DSR Scaling
Dr. P. S. Birthal, Director, ICAR-NIAP

- Emphasized DSR as a sustainable pathway amidst climate variability, water scarcity, and labour shortages.

8. Perspectives from Cambodia

Dr. Kong Kea, Cambodia

- DSR reduces production costs and increases farmer incomes.
- Mechanized DSR scaled to 1,600 communes, emphasizing capacity building, private sector engagement, and multi-sectoral cooperation.

9.Perspectives of JS and PS

Shri Ajeet Kumar Sahu, Joint Secretary (Seeds), MoA&FW, Govt. of India

- Agriculture is key to GDP and food security; rice–wheat system remains central.
- Challenges: slow varietal adoption, seed quality, supply-driven releases.
- Initiatives: AI-integrated SATHI portal, Seed Bill reforms, promoting low-GI/nutrient-rich varieties.

Dr. Arabinda Kumar Padhee, Odisha

- Odisha's Six-Point Framework: climate resilience, gender responsiveness, policy coherence, digital advisory, resource-use efficiency, and wide-scale technology adoption.
- DSR pilots: 25,000 farmers, 24% women; 40% seed reduction, lower costs, 230% ROI.
- Emphasized innovation in herbicide-tolerant varieties, safe herbicides, and precision weeding tools.

10. Keynote Address

Dr. Yvonne Pinto, Director General, IRRI

- Reviewed IRRI–India partnership, 141 rice varieties released, stress-tolerant varieties scaled over 2 million ha.
- Emphasized DSR as transformative, reducing methane, labour drudgery, and water use.
- Called for science-policy-partnership integration, public/private investment, and strengthened extension systems for mass adoption.

11.Guest of Honour

Shri D. P. Wickramasinghe, Sri Lanka

- Highlighted need for mechanized DSR, youth engagement in agriculture, land consolidation, and data accuracy.
- Advocated DSR where feasible, PTR where waterlogging persists, with crop intensification through shorter nursery and inter-seasonal gaps.

12.Chief Guest

Dr. Panjab Singh, Chancellor, RLBCAU, Jhansi, UP

- India: 20% of global rice production, nearly 50% of irrigation water.
- DSR can reduce water use by 30–40%, labour by 50%, and methane emissions, benefiting small/marginal farmers (80–85%).
- Emphasized research, farmer awareness, technical training, and public–private partnerships for large-scale adoption.

13. Vote of Thanks

Dr. Sudhanshu Singh, Director, ISARC

- Appreciated farmers' cooperation, especially 40 progressive farmers from Gorakhpur yielding 9 t/ha.
- Acknowledged contributions of dignitaries, government officials, IRRI, private sector partners, and ISARC team.
- Reiterated DSR as transformative, scalable, and promising for India's rice systems.

Key Discussion Points

- **Unsustainability of PTR:** Puddled Transplanted Rice (PTR) is viewed as highly resource-consuming (water, labour, cost), unsustainable, and a contributor to greenhouse gas (GHG) emissions.
- **Low Adoption Barriers:** Farmer adoption of DSR remains low, primarily due to issues in achieving reliable crop establishment and effectively managing weeds.
- In UP and North-West India (Haryana/Punjab), the main driver for DSR is labour shortages and profitability, as water scarcity is less critical than in the region. However, the inevitable future water crisis and the potential for 50% water savings drive for DSR.
- **Economic Imperative:** Any shift, like DSR adoption, must be matched with economic compensation; targeted subsidies are needed to offset any short-term yield loss during transition.
- **Critical Management Phase:** The first 30 days after sowing are crucial for DSR success, demanding precise management, particularly for weed control and mitigating biotic/abiotic stresses.
- **Seed System Lag:** There's a significant time lag between varietal development and farmer adoption; only about 20 old rice varieties account for half of India's production, and poor seed quality is a major concern.
- **Mechanization Need:** DSR requires access to refined seed drill technologies and machinery, often through Custom Hiring Centres (CHCs), to ensure successful crop establishment.
- **International Challenges:** Cambodia faces challenges with current practices that use a high seed dose, and Sri Lanka highlights the need to address an ageing farming population and land fragmentation.

Major Outcomes / Conclusions

- **Strategic Policy Tool:** DSR is unanimously recognized as a transformative innovation and a strategic policy fit for achieving climate resilience, reducing methane emissions, improving labour-use efficiency (30–50% savings), and ensuring long-term water security.
- **Scaling Imperative:** The primary focus must shift rapidly from small-scale pilots to mass, sustainable scaling, requiring the integration of science, policy, and strong partnerships to "take the risk out of technology" for farmers.
- **Yield Potential Validated:** Evidence suggests that initial yield reduction is not a major issue in DSR, provided proper agronomic and weed management is in place.
- **Regional Success/Targets:**
  - Uttar Pradesh plans to convert 2.2 million hectares to DSR within five years.
  - Odisha pilots demonstrated a 40% reduction in seed rate, lower costs, and a 230% return on investment.

  - A field demonstration in Gorakhpur yielded an impressive 9 tonnes per hectare, validating DSR's high-yield potential.

Policy and Institutional Recommendations

- **Subsidies:** Provide targeted subsidies for farmers during the DSR transition period and specifically for the purchase of seed drills and mechanization.
- **Policy Integration:** Integrate DSR and related sustainable technologies into existing national government schemes (e.g., NFSM, PM-KUSUM) rather than relying only on new schemes.
- **Land Suitability:** Conduct comprehensive agro-ecological zone surveys (like Samriddhi Dhan in UP) to identify and prioritize suitable areas for DSR scaling.
- **Seed System Reform:** Expedite the Seed Bill to reform varietal release processes and use the AI-integrated SATHI portal to ensure and track seed quality.
- **Value Chain Approach:** Systematically promote DSR rice varieties by integrating the entire value chain, from production to marketing, similar to the millet promotion model.
- **Policy Coherence:** Ensure alignment across sectors (agriculture, water, rural development) under a unified resilience framework (Odisha's Six-Point Framework).

Research and Innovation Priorities Identified

- **Herbicide-Tolerant (HT) Varieties:** Research efforts must prioritize the development and rapid release of DSR-ready, HT varieties and hybrids to tackle the major challenge of weed control. IRRI has dedicated DSR breeding pipelines.
- **Weed Management Tools:** Develop next generation weed management technologies, including research breakthroughs in safer herbicides and precision weeding tools.
- **Mechanization Refinement:** Innovate and refine precision seed drill technologies and calibration techniques, ensuring machinery is efficient enough to adapt zero-till equipment for DSR.
- **Agronomy:** Research is needed to optimize seed rates, prevent yield penalties from over-seeding, and improve micronutrient efficiency in DSR systems.
- **System Diversification:** Explore and validate alternative, water-efficient crop rotation systems (e.g., short-duration rice followed by pulses) to improve overall system resilience.
- **Value Chain Approach:** Systematically promote DSR rice varieties by integrating the entire value chain, from production to marketing, similar to the millet promotion model.
- **Policy Coherence:** Ensure alignment across sectors (agriculture, water, rural development) under a unified resilience framework (Odisha's Six-Point Framework).

Research and Innovation Priorities Identified

- **Herbicide-Tolerant (HT) Varieties:** Research efforts must prioritize the development and rapid release of DSR-ready, HT varieties and hybrids to tackle the major challenge of weed control. IRRI has dedicated DSR breeding pipelines.
- **Weed Management Tools:** Develop next generation weed management technologies, including research breakthroughs in safer herbicides and precision weeding tools.
- **Mechanization Refinement:** Innovate and refine precision seed drill technologies and calibration techniques, ensuring machinery is efficient enough to adapt zero-till equipment for DSR.

- Agronomy: Research is needed to optimize seed rates, prevent yield penalties from over-seeding, and improve micronutrient efficiency in DSR systems.
- System Diversification: Explore and validate alternative, water-efficient crop rotation systems (e.g., short-duration rice followed by pulses) to improve overall system resilience.

Session Title: Agronomy and Mechanization for DSR-based Systems

Overview / Objective of the Session

The success of Direct-Seeded Rice (DSR) relies on advanced agronomic practices and mechanization that ensure productivity, sustainability, and climate resilience. This session convened researchers, policymakers, and private-sector representatives to examine scientific evidence and innovations in crop establishment, precision water and nutrient management, weed control, and mechanized solutions. By highlighting cutting-edge research, field experiences, and scalable technologies, the session aimed to foster dialogue, collaboration, and knowledge exchange to accelerate large-scale adoption of DSR while ensuring profitability, environmental sustainability, and resilience for rice farmers.

Opening Remarks

Dr. Nguyen Van Bo

- Highlighted rice as a critical crop for food security and rural livelihoods, facing challenges such as labour shortages, water scarcity, and climate pressures.
- Presented DSR as a climate-smart solution, with Vietnam's mechanized DSR systems demonstrating reduced inputs, lower emissions, and sustained yields.
- Emphasized ongoing challenges, including weed control, seed quality, and machinery access.
- Set the stage for discussion on practical, scalable pathways for DSR adoption across Asia and Africa.

Presentations

1. M.S. Bhullar, PAU – Overview of DSR in North-Western India: Challenges and Opportunities

- PAU promotes DSR to address water and labour scarcity, focusing on dry DSR and tar-vattar DSR (developed in 2020).
- **Tar-vattar DSR:** Sown with a modified lucky seed drill and simultaneous pre-emergence herbicide application; requires no irrigation for 21 days, reduces weed pressure, develops deeper roots, and mitigates iron deficiency, achieving yields comparable to PTR. Adoption exceeds 50% in Punjab.
- Success factors include optimal soil moisture, well-prepared seedbeds, skilled operators, and sowing/herbicide application in late evenings to maximize herbicide efficiency.
- Recommended season-long weed control through herbicide-tolerant varieties, mechanical interventions (pressed-wheel drills, raised-bed planting), and intercultural operations.
- **For scaling:** expand lucky seed drill availability, farmer training, fixed sowing dates (around May 25), and limit long-duration varieties.

2. Mahesh Kumar Gathala, CIMMYT – Evidence-Based Role of DSR for Sustainability and Soil Health

- Highlighted DSR as a sustainable practice improving soil health, resource efficiency, and climate resilience.
- CIMMYT-BISA promotes DSR with laser land levelling; adoption has expanded since 2009 in Punjab and Haryana with government support.
- DSR-maize systems show >1 t/ha higher yields than conventional systems and perform better under climate stress.
- Benefits include reduced greenhouse gas emissions, improved soil biological activity, and enhanced physical properties.
- **Future innovations:** Biological Nitrification Inhibitors (BNI), DSR-bred rice varieties, sensor-based nutrient/water management, and carbon credit-linked business models.

Panel Discussions

1. **Dr. Rica Joy Flor, IRRI** – Scaling DSR in Cambodia

- Mechanization accuracy and short planting windows are critical challenges.
- Limited machinery and service providers constrain adoption.
- Weed management remains a concern; farmers rely on post-emergence herbicides and use high seed rates (~300 kg/ha).
- Strengthening mechanization, financial support, and integrated agronomic practices is essential for large-scale adoption.

2. Dr. Buta Singh Dhillon, PAU – Overcoming Crop Establishment Challenges

- DSR requires a package of technologies: quality seed, precise planting depth, and lucky seed drills with press wheels for uniform emergence.
- Critical factors: accurate weather forecasting, DSR-bred genotypes with deep roots, timely sowing, and seed priming (2% potassium nitrate or bioenzyme coating).
- Integration of digital tools, laser land levelling, efficient water management, and capacity building ensures successful adoption.
- DSR is a climate-resilient, scalable technology supported by public–private partnerships.

3. Mr. Krisha Mohan Pathak – Scaling DSR through Custom Hiring Models

- **Lucky Seed Drill yields:** 8–10 kg/acre seed rate producing yields of 30 quintals/acre, versus 20–24 quintals under PTR.
- **Challenges:** limited machinery availability (5–6 machines per area) and need for government financial support.
- Laser land levelling improves water savings and suitability for mechanized sowing.

4. Mr. Rajdeep Singh, National Agro Industries – Mechanization Innovations

- Introduced improved DSR planters with inclined-plate mechanisms, urea briquette placement machines, lucky seed drills integrated with pre-emergence herbicide sprayers and raised-bed planters.
- Incentive schemes (e.g., 80% subsidy for DSR seed drills) improve adoption.
- Priority access to machinery and financial incentives accelerates large-scale adoption.

5. Dr. Senthilkumar Kalimuthu, AfricaRice – DSR in Africa

- Africa produces 28 million tons of rice for a 47-million-ton requirement.
- In Madagascar, mechanized DSR has been promoted in 75% of suitable areas, improving land use and enabling large-scale adoption.

Q&A Highlights

- Basmati Grain Quality: Balanced nutrition, irrigation management, timely sowing, and optimal crop establishment improve grain filling and reduce chaffiness.

Closing Remarks
Dr. V.K. Singh, ICAR-CRIDA

- Emphasized DSR adoption in rainfed areas can significantly boost productivity.
- Key success factors: agronomic practices, suitable varieties, crop establishment, and weed management.
- Mechanization integration, inter-institutional collaboration, industry partnerships, and policy support are essential for upscaling.
- Mechanized DSR planters are critical for smallholder farmer adoption.

Key Discussion Points

- DSR is a climate-smart, sustainable practice enhancing yields, soil health, and resource efficiency while reducing labour, water, and input costs.
- Successful adoption depends on integrated mechanization (lucky seed drills with inclined-plate planters, raised beds, laser land levelling), balanced nutrition, precise sowing, seed priming, and weed management.
- Farmer experiences show higher yields and water savings; key challenges remain: machinery access, skilled operators, and financial support.
- Scaling requires inter-institutional collaboration, industry partnerships, targeted subsidies, capacity building, and research on varieties, agronomic practices, and advanced tools (sensor-based management, BNIs).
- DSR is scalable and climate-resilient, particularly for rainfed areas and smallholders, with mechanization and policy support critical for adoption.

Major Outcomes / Conclusions

- **Integrated Agronomic Package:** The success of Direct-Seeded Rice (DSR) depends on its implementation as an integrated agronomic package that combines quality seed, precise planting, and improved crop establishment practices. Adoption rates increase significantly when these elements are applied together with appropriate mechanization and management strategies.
- **Regional Innovations and Adaptations:** The Tar-wattar DSR system in Punjab, utilizing the Lucky Seed Drill, has achieved yields comparable to transplanted rice while reducing irrigation needs and labour dependency. Similarly, mechanized DSR adoption in several African nations is expanding to suitable rice-growing areas, contributing to reduced reliance on rice imports from Asia.
- **Enhanced Productivity and Resource Efficiency:** Empirical evidence indicates that DSR

enhances yields and overall system sustainability when supported by balanced nutrient management, optimal soil moisture, timely sowing, and deployment of location-specific rice varieties.

- **Enabling Conditions for Large-Scale Adoption:** Widespread DSR adoption requires coordinated efforts in moisture and nutrient management, timely seeding, dissemination of agro-advisories, use of suitable varieties, effective weed control, and policy support. Strong public–private partnerships and institutional collaboration are essential to promote sustainable and climate-resilient DSR systems at scale.

Policy and Institutional Recommendations

- **Positioning DSR as a Climate-Resilient and Scalable Technology:** Direct-Seeded Rice (DSR) should be promoted not as a single agronomic practice but as an integrated, climate-resilient, and scalable technology. Its success depends on the combined application of quality seed, precise planting, optimal seeding depth, and mechanization—particularly through the use of Lucky Seed Drills equipped with press wheels.
- **Policy Support for Mechanization and Financial Incentives:** Policy frameworks should prioritize the increased availability of key machinery, including seed drills, inclined-plate planters, and laser land levellers. Financial incentives, subsidies, and credit schemes are necessary to support farmers' access to mechanization and encourage adoption at scale.
- **Institutional Focus on Capacity Building and Research:** Institutional initiatives should strengthen farmer training, skill development, and capacity building. Promotion of fixed sowing dates, DSR-bred varieties with deep root systems and high vigour, and the integration of precision tools—such as digital moisture sensors for efficient water and nutrient management—should be key priorities.
- **Sustainable Agronomic and Weed Management Practices:** Effective weed management strategies, herbicide-tolerant rice varieties, crop rotation with legumes, and balanced nutrition are essential for the sustainability of DSR systems.
- **Strengthening Partnerships and Coordination:** Public–private partnerships, inter-institutional collaboration, and coordinated research on agronomic innovations are critical to scaling DSR, enhancing productivity, improving soil health, and building resilience under changing climate conditions.

Research and Innovation Priorities Identified

- Advancement of DSR agronomic practices through improved mechanization technologies, including upgraded seed drills, Lucky Seed Drills with herbicide applicators, and fertilizer deep-placement equipment (e.g., urea briquette applicators).
- Integration of precision agriculture tools, such as digital moisture sensors and sensor-based nutrient and water management systems, for real-time field optimization.
- Development of DSR-bred rice varieties with deep roots, high vigour, uniform crop establishment, and high yield potential suitable for diverse agro-ecologies.
- Enhancement of weed and nutrient management strategies, including seed priming, bioenzyme seed coating, herbicide-tolerant varieties, and intercultural operations such as tractor-based weed control in DSR fields.
- Promotion of climate-smart and regenerative practices, including crop rotations, cover crops, Biological Nitrification Inhibitors (BNIs), and carbon credit-linked business models.
- Strengthening of capacity building, farmer training, and enabling policy frameworks,

including targeted subsidies, financial incentives, and public–private partnerships for large-scale adoption.

Reflections and Participant Feedback

Participants acknowledged the significant role of DSR in addressing challenges related to labour scarcity, water management, and climate resilience. Successful adoption experiences from Punjab, Cambodia, and several African countries were highlighted as encouraging examples.

Discussions emphasized key barriers such as gaps in weed management, limited machinery availability, shortage of skilled operators, and insufficient policy support for widespread adoption.

Participants agreed that future progress requires continued investment in research, innovation, and supportive policies, particularly focusing on the development of DSR-bred varieties, sensor-based management technologies, and strong public–private partnerships. The session was appreciated for providing valuable scientific insights and practical lessons to guide the next phase of DSR scaling efforts.

Session Title: Geospatial Intelligence & Digital Innovation in Rice-Based Ecosystems

Session Overview and Objectives

The session on "Geospatial Intelligence and Digital Innovation in Rice-Based Ecosystems" convened leading experts from Sri Lanka, India, and the Philippines to discuss how geospatial data, artificial intelligence (AI), and digital technologies are transforming rice-based systems and accelerating the adoption of Direct Seeded Rice (DSR). The discussions highlighted advances in geospatial analytics, digital platforms, and machine learning for climate resilience, sustainability, and productivity in rice cultivation.

Mr. Amit Srivastava, the session moderator, introduced the theme by emphasizing that modern agriculture in Asia must evolve from producing more rice to producing it smarter—guided by data, AI, and digital innovations from sowing to sustainability.

Key Presentations and Highlights

Opening Remarks
Mr. D. P. Wickr amasinghe (Department of Agriculture, Sri Lanka)

Mr. Wickramasinghe underscored that remote sensing has become indispensable for climate-resilient agriculture. Presenting Sri Lanka's GeoGoviya platform, he demonstrated how digital mapping of rice varieties, soil moisture, and DSR suitability informs national policy and targeted farmer support. GeoGoviya's applications have expanded from cultivation mapping to soil moisture forecasting and DSR suitability assessment—positioning Sri Lanka as a model for digital agricultural transformation in South Asia.

IRRI's Geospatial Approach to Rice Ecosystem Dynamics
Dr. Alice Laborte (Senior Scientist II, IRRI, Philippines)

Dr. Laborte outlined IRRI's integrated use of remote sensing (RS), GIS, and crop modeling for mapping rice extent, planting dates, and yield forecasting. Examples from Luzon and Odisha illustrated how these tools support early warning systems, cyclone impact assessments, and DSR suitability mapping using SAR and machine learning. She emphasized that geospatial technologies can bridge data gaps and enhance precision agriculture, nutrient management, and climate adaptation planning.

Intelligent Sensing from Phenomics to Precision Farming
Dr. R. N. Sahoo (Principal Scientist, IARI, New Delhi)

Dr. Sahoo presented IARI's work on integrating phenomics, UAV-based sensing, and AI for monitoring nitrogen and water stress in rice. Highlighting over 10,000 phenotyping studies, he demonstrated how spectral discrimination and UAV-mounted multispectral sensors enable high-resolution monitoring of crop health, supporting real-time, data-driven precision farming.

Scaling Geospatial Research for Operational Applications
Dr. V. K. Sehgal and Dr. R. K. Dhakar (ICAR–IARI, New Delhi)

Dr. Sehgal traced the evolution of remote sensing–based operational systems in India, particularly in residue monitoring and yield estimation. Case studies from Punjab and Haryana showed how geospatial monitoring has informed residue management, subsidy disbursement, and carbon credit schemes. The integration of spectral indices into crop models was presented as a pathway toward more accurate yield forecasting and production planning.

Multispectral Remote Sensing for DSR Monitoring
Mr. Ramachandra Nagaraj (C2C)

Mr. Nagaraj discussed sustainability challenges in DSR systems—soil fertility decline, lack of real-time monitoring, and post-harvest losses—and proposed multispectral sensing, AI-driven agro-advisories, and variable-rate input management as solutions. Ongoing pilots with IRRI in Uttar Pradesh were presented, including automated WhatsApp advisories providing localized irrigation and nutrient recommendations. He emphasized the transformative potential of integrating drone-based sensing with AI for site-specific crop management.

Polarimetric Radar Remote Sensing in Agriculture
Dr. Gulab Singh (Professor, IIT Bombay)

Dr. Singh illustrated the unique advantages of polarimetric Synthetic Aperture Radar (SAR) in agricultural monitoring under cloudy monsoon conditions. He explained the double bounce effect in paddy fields, which improves waterlogging and boundary detection. Applications such as crop type mapping, phenology tracking, and flood assessment were presented, highlighting SAR's operational utility in rice systems.

Harnessing AI/ML for Predictive Yield Modeling in DSR
Dr. Manish Kumar Pandey (Assistant Professor, BIT Mesra)

Dr. Pandey showcased how AI and machine learning (ML) can integrate multi-source datasets—soil, climate, and socio-economic data—to predict yields and identify site-specific DSR suitability. He emphasized explainable AI models such as SHAP for improving interpretability and transparency, enabling smarter, evidence-based decision-making in rice production.

Geospatial Technology for Acreage and Production Forecasting
Dr. S. Bandyopadhyay (Director, MNCFC, New Delhi)

Dr. Bandyopadhyay emphasized radar-based national-scale rice acreage and production forecasting, particularly during monsoon seasons when optical sensors are limited. He discussed integration with digital platforms such as AGRISTACK, UPAg, and Krishi DSS to enhance data-driven agricultural governance. His presentation underscored the need for data standardization, ground-truthing, and interoperability for operationalizing geospatial systems at scale.

NISAR Mission and High-Resolution Soil Moisture Monitoring
Dr. Dharmendra Pandey (Scientist/Engineer "SF", ISRO–SAC, Ahmedabad)

Dr. Pandey introduced the upcoming *NISAR Mission* (NASA–ISRO collaboration), which will provide 100 m soil moisture data every 6–12 days—crucial for irrigation scheduling, sowing window identification, and sustainable DSR scaling. Demonstrations from Punjab and Haryana highlighted how such products can enhance water-use efficiency and guide policy-level decisions for climate-resilient rice cultivation.

Closing Remarks

Mr. Vikas Kanungo (Advisor, World Bank, New Delhi)

Mr. Kanungo concluded the session by calling for integration of spatial and non-spatial datasets into unified, interoperable frameworks. He emphasized that AI and local-language chatbots can make complex analytics farmer-readable, ensuring that digital transformation remains inclusive and farmer-centric. He highlighted examples of AI-based advisories in Maharashtra that empower farmers through accessible, data-informed decision support.

Key Discussion Points

- **Digital Agricultural Transformation:** Remote sensing as a necessity for climate resilience; Sri Lanka's GeoGoviya as a national model.
- **Geospatial Intelligence for Rice Ecosystem Dynamics:** IRRI's advances in mapping, modeling, and SAR-based DSR detection in India and Africa.
- **Precision Agriculture and Phenomics:** AI-integrated UAV and spectral sensing systems for nitrogen and water stress monitoring.
- **Operational Applications and Policy Integration:** Remote sensing in India's residue management and carbon credit initiatives.
- **Sustainability in DSR Systems:** Multispectral and AI-based advisories enhancing resource use efficiency and farmer support.
- **Radar and Polarimetry:** Polarimetric SAR improving rice monitoring under adverse weather conditions.
- **AI/ML for Yield Forecasting:** Explainable models for predictive and site-specific yield estimation.
- **Geospatial Systems for Governance:** Integration with AGRISTACK and Krishi DSS for large-scale data use in decision-making.
- **Soil Moisture Innovation:** NISAR mission enabling high-resolution, actionable soil-water monitoring.
- **AI for Inclusive Agriculture:** Farmer-centric, multilingual digital ecosystems to bridge science and practice.

Major Outcomes

- Geospatial and AI technologies are now central to precision nutrient management, DSR adoption, and sustainable rice production.
- Regional initiatives such as GeoGoviya (Sri Lanka) and IRRI's DSR mapping pilots (India, Africa) demonstrate scalable digital models.
- Radar (SAR) and UAV-based sensing ensure data reliability under monsoon/cloudy conditions.
- The NISAR Mission will revolutionize soil moisture monitoring and water-use optimization.
- Public–private and inter-institutional collaboration is key for data validation, sharing, and farmer engagement.

Policy Recommendations

1. **Institutionalize Digital Agriculture Frameworks:** Establish national digital agriculture missions linking remote sensing, AI, and crop modeling.
2. **Promote Mechanized DSR Adoption:** Incentivize water-efficient technologies and residue management through targeted schemes.
3. **Enable Data Integration Platforms:** Develop interoperable infrastructures (e.g., GeoGoviya, AGRISTACK) for multi-source data convergence.
4. **Invest in Capacity Building:** Strengthen digital literacy and precision agriculture training for farmers and extension personnel.
5. **Encourage Private Sector Participation:** Foster partnerships for sensor manufacturing, analytics, and real-time digital advisory services.

Research and Innovation Priorities

- AI/ML models for DSR suitability and yield forecasting integrating SAR, soil, and socio-economic datasets.
- Validation of UAV and satellite sensing for nitrogen and water stress monitoring.
- Farmer-centric Decision Support Systems translating RS outputs into actionable advisories.
- Utilization of NISAR and RISAT soil moisture data for irrigation optimization.
- Carbon accounting frameworks linking DSR adoption to carbon credit mechanisms.
- Regional collaboration among South and Southeast Asian nations for digital MRV (Measurement, Reporting, and Verification) systems in low-emission rice farming.

Overall, the session reaffirmed that geospatial intelligence, AI, and radar technologies are transforming rice-based ecosystems—paving the way for climate-smart, data-driven, and inclusive agricultural innovation across Asia.

Session Title: Scaling Direct-Seeded Rice: Significance of Varietal Development and Deployment

Session Overview and Objectives

The session on "Scaling Direct-Seeded Rice (DSR): Significance of Varietal Development and Deployment" highlighted the pivotal role of varietal improvement, seed systems, and hybrid technologies in advancing large-scale DSR adoption.

DSR offers a transformative pathway toward sustainable rice cultivation by reducing water and and labour requirements, lowering greenhouse gas emissions, and enhancing farmer profitability. Varietal development—particularly for dry DSR ecosystems—is central to realizing these benefits, as genetic traits such as anaerobic germination, early vigour, weed competitiveness, lodging resistance, and nutrient-use efficiency directly mitigate establishment and yield risks.

The session aimed to:

- Present breeding priorities and market segmentation strategies for DSR-fit varieties, including the DELSR and DMeLSI target segments.
- Discuss seed-system and deployment pathways from early-generation seed to farmer-level dissemination, emphasizing decentralized and cluster-based approaches.
- Share evidence on the role of hybrids and mechanized DSR as scalable and profitable options.
- Identify research, institutional, and policy priorities to accelerate varietal deployment and mainstream DSR adoption.

Opening Remarks

Mr. Ajeet Kumar Sahu, Joint Secretary (Seeds), Government of India

Mr. Sahu emphasized the "lab-to-land" continuum, underscoring the urgency of ensuring that DSR-fit varieties reach farmers efficiently. He highlighted DSR as a practical alternative amidst groundwater depletion and rural labour shortages. Accelerated release and adoption of DSR-suitable varieties and hybrids, supported through government schemes (subsidies, seed village programs, mechanization missions), were strongly recommended. He called for the convergence of schemes such as PMKSY, KVKs, and SHC to reduce farmer risks and costs, while advocating for PPP, AVCD, and cluster-based models.

Technical Presentations

Dr. A. K. Singh, Former Director, ICAR–IARI

Topic: Development and Upscaling of Herbicide-Tolerant Basmati Rice Varieties

Dr. Singh presented ongoing work on herbicide-tolerant (HT) Basmati rice varieties that enable improved crop establishment and effective management of Bakanae disease. The expansion of

Dr. Shalabh Dixit, Senior Scientist I – Plant Breeding, IRRI

Topic: Advancing Direct-Seeded Rice: IRRI's Global Breeding Efforts

Dr. Dixit described IRRI's global breeding network and market segmentation strategy, which align breeding pipelines with DSR-targeted ecologies and consumer preferences. DSR-fit varieties have undergone extensive multi-location testing across Asia and Africa through a robust network of over 60 partners. He underscored that market segmentation ensures targeted varietal delivery and enhances scalability.

Dr. Ranjith Kumar Ellur, Scientist, Division of Genetics, ICAR–IARI

Topic: Towards Development of Dry DSR-Ready Basmati Rice Varieties through Genomics-Assisted Breeding

Dr. Ellur outlined the challenges of DSR in Basmati ecosystems—particularly weed pressure, nematode infestation, iron deficiency, and poor crop establishment. Genomics-assisted backcrossing and molecular introgression of key traits (e.g., Xa13+Xa21+Pi2+Pi54+AHAS) are being employed to develop DSR-compatible Basmati lines. He recommended accelerating varietal pipelines through genomic selection and speed-breeding approaches.

Dr. Swati Nayak, South Asia Lead, Seed Systems, IRRI

Topic: Deployment, Scaling, and Mainstreaming DSR-Fit Varieties and Seeds for Comprehensive Success of DSR

Dr. Nayak emphasized that efficient seed systems are critical to the success of DSR. Through TRICOT-style on-farm trials (OFTs), several superior varieties have been identified across DELSR and DMeLSI market segments—examples include PR 126, Tripura Hakuchuk, ARIZE 6129 Gold, AZ8455DT Hybrid, CR Dhan 602, DRR Dhan 53, and Binadhan 17. She highlighted the importance of decentralized seed production, cluster demonstrations, and linking varietal testing with mechanization and seed enterprise models.

Dr. Amaresh Chandel, Breeding Partnership Lead, Bayer Crop Science

Topic: Empowering Farmers in DSR – Hybrid Rice as a Catalyst for Collaborative Success

Dr. Chandel presented compelling evidence on the yield and profitability advantages of hybrids under DSR conditions. Hybrids demonstrated yield gains of 22% over beushening, 15% over inbred transplanted rice (TPR), and 7% over inbred mechanized DSR. Corresponding net returns were 37%, 44%, and 7% higher, respectively. He advocated hybrid–mechanization integration as a scalable pathway for enhancing farmer profitability.

Panel Discussion and Q&A Highlights

- Volunteer and Weedy Rice Management: Dr. Mridul Chakravarty raised concerns about volunteer weeds in HT rice systems. Dr. A.K. Singh clarified that stewardship guidelines exist and must be implemented rigorously.
- Late-Duration Varieties: Dr. B.N. Singh suggested including late-duration varieties within DSR market segmentation to align with local cropping calendars.

- Farmer Risk and Cost Considerations: Participants emphasized factoring herbicide costs, farmer risk aversion, and the need for targeted subsidies and scheme convergence to reduce adoption barriers.

Closing Remarks

Dr. Mayank Rai, Dean, DRPCAU, Pusa (Bihar)

Dr. Rai noted that the foundation for DSR adoption has been firmly established. He emphasized the necessity of breeding specialized varieties with DSR-specific traits (including nutrient-use efficiency) and strengthening seed systems through speed-breeding and genomics-enabled approaches.

Key Discussion Points

- **Varietal Traits:** Priority DSR traits include anaerobic germination, rapid and uniform emergence, early vigour, weed competitiveness, lodging resistance, nutrient-use efficiency, and pest/disease resistance.
- **Breeding Pipelines:** IRRI's DELSR and DMeLSI segmentation frameworks guide breeding for specific ecologies and market needs, including Basmati and long-grain segments.
- **Genomic Tools:** Genomic-assisted backcrossing, marker introgression, and genomic selection are being applied to integrate DSR traits into elite germplasm.
- **Seed Systems:** Decentralized seed production and seed-village models are critical to ensure timely farmer access; linkages to mechanization and private-sector business models are essential.
- **Hybrids and Mechanization:** Evidence supports the hybrid–mechanization combination as a high-payoff scaling strategy.
- **Stewardship:** HT rice requires robust stewardship frameworks to manage volunteer weeds and resistance evolution.
- **Policy Convergence:** Faster varietal release, targeted subsidies, and PPPs are vital to accelerate scaling and adoption.

Major Outcomes and Conclusions

1. **Varietal Development:** Breeding for DSR-specific traits, including hybrids and Basmati-adapted lines, must be prioritized and accelerated.
2. **Seed Systems:** Strengthening decentralized and cluster-based seed production is crucial for timely and equitable seed access.
3. **Hybrids and Mechanization:** Evidence underscores strong yield and profitability advantages, making this combination a key driver of scale.
4. **Stewardship:** Proper management and regulation of HT technologies are essential to mitigate risks of volunteer and weedy rice.
5. **Policy Support:** Convergence of schemes, targeted subsidies, and PPP frameworks are critical for scaling adoption and reducing farmer risk.

Policy and Institutional Recommendations

- **Faster Varietal Release:** Simplify and expedite release and seed multiplication pathways for DSR-fit varieties and hybrids.
- **Targeted Subsidies:** Align government schemes (NFSNM, PMKSY, Seed Village, PM Krishi Vikas Yojana) to incentivize DSR adoption and mechanization.

- HT Stewardship: Develop and enforce stewardship protocols in partnership with private seed companies.
- Public–Private Partnerships: Strengthen PPPs for seed multiplication, hybrid scaling, and mechanization services.
- Decentralized Seed Systems: Support seed villages and FPO-led multiplication to ensure local availability.

Research and Innovation Priorities

- Accelerate breeding pipelines for anaerobic germination, early vigour, weed competitiveness, and NUE through genomics and molecular breeding.
- Develop hybrids specifically adapted to dry DSR ecologies and assess long-term performance.
- Advance integrated weed management and stewardship practices for HT rice.
- Strengthen seed system research on decentralized multiplication, forecasting, and business models.
- Utilize speed-breeding and genome-editing tools to shorten breeding cycles for DSR traits.

Reflections and Participant Feedback

Participants appreciated the robust evidence and international examples demonstrating DSR's water, labour, and emission benefits. They welcomed the integration of varietal development, seed systems, and mechanization as a cohesive scaling pathway.

Key feedback included:

- Need for clear action timelines and accountability for DSR Conclave Phase III.
- Urgency for immediate stewardship training on volunteer and weedy rice management.
- Requests for state-specific varietal and management recommendations.
- Strong support for accelerated release and multiplication of DSR-fit lines, particularly for Basmati and long-grain markets.

Session Title: Carbon Market Potential for Direct-Seeded Rice (DSR): Opportunities and Pathways

Session Overview and Objectives

The session explored the potential of carbon markets as a driver for scaling Direct-Seeded Rice (DSR) in India. DSR offers substantial environmental and economic benefits, including reduced greenhouse gas (GHG) emissions, water savings, and improved resource-use efficiency. The discussion focused on how voluntary carbon markets can incentivize farmers to adopt DSR and contribute to India's climate and food security goals.

The objectives of the session were to:

- Present scientific evidence on GHG mitigation potential through DSR.
- Examine policy and institutional frameworks for carbon market participation.
- Identify pathways for equitable and scalable DSR adoption.

Bringing together researchers, policymakers, private sector leaders, and development practitioners, the session featured expert presentations and a panel discussion to identify opportunities, challenges, and actionable recommendations for leveraging carbon markets to accelerate DSR adoption.

Opening Address
Dr. N. P. Singh, Former Director, ICAR–IIPR, Kanpur & Former Vice-Chancellor, BUAT, Banda

Dr. Singh emphasized the dual benefits of water savings and emission reductions achievable through DSR adoption in India. He underlined India's significant potential to scale DSR as part of national and global climate mitigation efforts. Dr. Singh highlighted the need for partnership across research, policy, and private sectors, underscoring the opportunity to reward farmers for climate-friendly practices.

Technical Presentations
Presentation 1: Emission Reduction Potential of DSR-Based Systems and Scaling Pathways
Dr. Arti Bhatia, Principal Scientist (Climate Change Impacts, Adaptation, Mitigation and Modelling), ICAR–IARI, New Delhi

Dr. Bhatia presented strong evidence of DSR's environmental and agronomic benefits:

- Benefits: Reduced methane emissions (by 45–90% in dry DSR and 20–38% in wet DSR), and

20–38% in wet DSR), improved soil health, and labour and water savings.

- **Challenges:** Potential N_2O emissions, weed diversity, and limited access to mechanization.
- **Impact:** Overall, DSR can reduce the global warming potential (GWP) by 35–50%. Subsequent crop yields can increase by up to 10%. Despite DSR covering over 50% of the rice area in states like Punjab and Haryana, national adoption remains below 4%.

Dr. Bhatia stressed that scaling DSR is essential, supported by varietal innovation (including herbicide-tolerant rice), strong institutional mechanisms, PPPs, and ICT-enabled MRV tools to ensure transparency and farmer inclusion in carbon markets.

Presentation 2: Emission Reduction through Crop Residue Management
Dr. Sandip Gangil, Head, Agricultural Energy & Power Division, and Platform Coordinator – Energy from Agriculture, ICAR–CIAE, Bhopal

Dr. Gangil highlighted the significance of crop residue management as a complementary strategy for emission reduction. Both in-situ methods (bio-decomposers, mulching, incorporation) and ex-situ options (baling, briquetting, biochar production, fodder use) were presented as effective pathways to prevent residue burning—a major contributor to air pollution. He emphasized that residue management not only mitigates emissions but also supports domestic energy generation and soil fertility restoration.

Presentation 3: Domestic Carbon Market Policy and Carbon Credit Project Experiences in India
Mr. Niroj Mohanty, Managing Director and CEO, Core CarbonX Solutions Pvt. Ltd.

Mr. Mohanty underscored the importance of robust methodologies and transparent monitoring, reporting, and verification (MRV) systems for credible carbon credit generation. With rice contributing around 10% of global methane emissions, site-specific mitigation strategies—such as delayed flooding, AWD, early drainage, and DSR—were presented as eligible practices. He stressed the need for updated methodologies and digital MRV platforms to enhance credibility and farmer participation.

Panel Discussion

The moderated discussion focused on institutional linkages, stakeholder collaboration, and enabling frameworks for integrating DSR into carbon market mechanisms.

Ms. Yeshika Malik, Climate Change Specialist, World Bank Group

Ms. Malik emphasized the importance of connecting stakeholders—farmers, FPOs, private sector, government, and NGOs—to build inclusive carbon markets. Robust data collection, evidence generation, and collaborative engagement were identified as key to achieving both climate and socio-economic outcomes.

Mr. Navin Vivek Horo, Country Project Lead, Carbon Offsetting Rice Emissions (CORE), i4Ag, GIZ

Mr. Horo highlighted India's transition from food security to nutritional security and sustainability. He stressed the need for integration across technology, finance, and institutional resources to create a resilient agricultural carbon ecosystem.

Dr. Shantanu Ku Dubey, Director, ATARI

Dr. Dubey presented data on water and emission savings, noting that DSR saves approximately 1,853.28 m^3/ha of blue water, achieving 30% water savings at the system level. He noted that emissions from puddled transplanted rice (PTR) are six times higher than from DSR and related systems. He called for science-based, farmer-centric carbon markets supported by private sector partnerships, financial institutions, and extension systems.

Closing Remarks

Dr. Anthony Fulford summarized the proceedings, highlighting the importance of transdisciplinary collaboration and the integration of agronomy, policy, and finance to effectively generate carbon credits through DSR systems. He emphasized that the future of low-emission rice systems depends on collective action across research, technology, and governance.

Key Discussion Points

- **DSR as a Low-Carbon Opportunity:** DSR can reduce GHG emissions by up to 90% compared to puddled transplanted rice, offering a key pathway for low-carbon rice systems.
- **Balancing Emission Trade-offs:** While methane emissions decrease, potential N_2O increases require careful nutrient management.
- **Scaling and Adoption Gaps:** Despite progress in certain states, national DSR adoption remains below 4%, calling for stronger incentives and mechanization support.
- **Farmer-Centric Carbon Markets:** Ensuring that at least 60–70% of carbon credit revenue reaches farmers was seen as critical for equity and motivation.
- **Stakeholder Collaboration:** Multi-stakeholder engagement—across public, private, and civil sectors—was identified as essential for scaling.
- **Institutional and Policy Integration:** Alignment of agricultural sustainability missions with carbon finance frameworks is crucial.
- **Public and Private Roles:** Both sectors must work together to de-risk farmers, promote technology diffusion, and strengthen value chains.

Major Outcomes and Conclusions

1. **Evidence-Based Validation:** DSR can reduce the GWP of rice systems by 35–50% while improving soil health and yields under best management practices.
2. **DSR as a Climate-Smart Practice:** Integrating DSR with AWD and residue management can transform rice systems into carbon credit-generating landscapes.
3. **Carbon Market Potential:** With carbon credit values of ₹230–₹250 per tonne of CO_2e, there is significant incentive potential for farmers and aggregators.
4. **Integrated Approach:** Transitioning from chemistry-based to biology-based systems, emphasizing regenerative and nature-positive agriculture, is key to sustainability.
5. **Collaborative Scaling:** Success requires alignment between policy, private investment, and scientific innovation to mainstream DSR as a mitigation strategy.

Policy and Institutional Recommendations

- **Policy Alignment and Incentives:** Embed DSR in national climate and agricultural sustainability programs, linking incentives with carbon credit mechanisms.
- **Institutional Capacity Building:** Strengthen PPP and Custom Hiring Centre (CHC) models to improve mechanization and reduce adoption barriers.
- **Carbon Market Governance:** Establish transparent, digital, and science-based MRV systems to ensure credibility and farmer trust.
- **Integrated Extension Support:** Expand awareness through KVKs, ATARIs, and private partners to improve farmer understanding of DSR and carbon benefits.
- **National Coordination Platform:** Form a multi-stakeholder DSR–Carbon Coordination Platform connecting research, finance, policy, and farmer networks.

Research and Innovation Priorities Identified

- **Varietal and Trait Innovation:** Develop herbicide-tolerant and water-efficient rice varieties suited to DSR conditions.
- **MRV Development:** Design site-specific, digital MRV tools using satellite, IoT, and AI technologies for accurate emission tracking.
- **Methodology Refinement:** Update carbon credit accounting methodologies for Indian agroecological zones.
- **Socio-Economic Studies:** Conduct research on farmer risk perceptions, cost-benefit dynamics, and gendered adoption.
- **Residue Management Innovations:** Advance technologies like biochar, briquetting, and bio-decomposers to link DSR with circular bioeconomy models.

Reflections and Participant Feedback

Participants commended the session's transdisciplinary approach, linking scientific evidence, policy instruments, and market mechanisms. Both government and private representatives recognized the urgency of evidence-based scaling models and farmer inclusion frameworks. The session was widely acknowledged as a key step toward positioning India as a leader in low-emission, carbon-smart rice systems and in building a transparent, equitable carbon market ecosystem.

Session Title: 150th Anniversary of the Department of Agriculture: Exploring Pathways for Making Uttar Pradesh the Global Food Basket by 2030

This session marked 150 years of the Department of Agriculture, celebrating its legacy while positioning Uttar Pradesh as the new food basket of the world. The discussions focused on transformative pathways for sustainable intensification, climate-smart practices, and innovative partnerships to accelerate agricultural growth in the state. The session featured two high-level sessions. First, on 'Session on Mission 2 million ha DSR by 2030 in Uttar Pradesh' that will bring together policymakers, scientists, and private sector leaders to explore strategies for achieving large-scale adoption of DSR as a sustainable, low emission, and resource efficient rice establishment method across 2 million ha by 2030. The second session is on '150th Anniversary of Department of Agriculture: Exploring Pathways for Making Uttar Pradesh the Global Food Basket by 2030', which will deliberate the achievements of the Department of Agriculture and vision to make UP as a Global Food Basket. The discussions will emphasize integrated solutions including timely planting, improved varieties, mechanization, crop diversification, resource-use efficiency, and digital innovations for resilient and resource efficient rice-based systems.

Session on Mission 2 million ha DSR by 2030 in Uttar Pradesh
Keynote Address: Dr. R.K. Malik, IRRI

- The adoption of zero tillage (ZT) and mechanized direct seeded rice (DSR) practices has demonstrated significant potential in improving resource-use efficiency and water conservation.
- Preliminary observations indicate that HT rice varieties cultivated over 16–18 acres per hectare are performing well.
- Ex-situ residue management is being effectively implemented, with crop residues processed into pellets and supplied to gaushalas for sustainable utilization.
- The integration of DSR and zero tillage practices is expected to enhance yield performance.

Keynote Address: Dr. Anjali Suneel Parasnis, Technical Lead – Sustainable Agriculture UP Accelerator Program 2030 Water Resource Group, World Bank.

- The Samriddh Dhan Network (SDN) was launched in June 2023, marking a milestone initiative to promote sustainable rice cultivation and stakeholder collaboration.
- The DSR program (2024–2027) focuses on policy to practice transition, emphasizing integration and scaling of innovations across the value chain.
- Strong partnerships have been developed to enable convergence among multiple stakeholders.
- Digital tools are being integrated for monitoring, learning, and capacity building.
- Numerous training programs have been organized, ensuring participation from a wide network of stakeholders.

- Continuous efforts are being made in recognizing innovations and linking them to markets, thereby strengthening the ecosystem for sustainable DSR adoption in Uttar Pradesh.

Keynote Address: Dr. A.K. Singh, Ex-Director, IARI

- Linking the Direct Seeded Rice (DSR) program with carbon credits and targeted incentives can unlock massive savings over ₹2,000 crore in transplanting costs alone on 2 million hectares, while reducing water use, fuel consumption, and greenhouse gas emissions, enabling the branding of DSR produce as “low carbon rice” with premium market potential.
- To achieve this, district- and block-level area mapping, assured irrigation before monsoon, and initial government incentives (as seen in Haryana’s ₹4,500/acre model) will be critical to drive large-scale adoption and long-term sustainability.
- Mapping DSR areas in Uttar Pradesh is underway to identify suitable zones for scaling adoption.
- It was highlighted that DSR is not a uniform or comfortable practice for all farmers, as field conditions and resource availability vary widely across regions.
- The state of Haryana provides incentives to farmers adopting DSR, which serves as a potential model for replication and policy learning in Uttar Pradesh.

Keynote Address: Dr. Sangeeta Mendiratta, Lead- Government Affairs, Public Affairs & Sustainability, IBSL, Bayer Crop Science

- Bayer’s Rice Transformation Policy is strategically structured to promote sustainable and scalable rice production systems across India
- Public–Private Partnership (PPP) model has played a key role in scaling up Direct Seeded Rice (DSR) adoption to nearly 2 million hectares, starting from Uttar Pradesh and expanding Pan-India by 2023.
- Bayer Direct Acres Program aims to cover 30 districts across Uttar Pradesh, strengthening the ecosystem for climate-smart and resource-efficient rice production.

Keynote Address: Mr. Ajai Rana, CEO & MD, Savannah Seeds

- Savannah follows a systems-based approach to rice cultivation. Recognizing that not all varieties are suitable for Direct-Seeded Rice (DSR), the company emphasizes the importance of genetics in variety selection.
- Their hybrid rice is developed with seed treatments to enhance tolerance against biotic and abiotic stresses, and products such as SQUAD, FULL PAGE, and Smart Rice are recommended as part of the package.

Inaugural Session on “150th Anniversary of Department of Agriculture: Exploring Pathways for Making Uttar Pradesh the Global Food Basket by 2030”

Welcome Address: Dr. Sudhanshu Singh, Director, ISARC

- Dr. Singh welcomed participants, highlighting the historic gathering of 16 country representatives and 70 scientists. He acknowledged the presence of the Hon’ble Chief Minister of Uttar Pradesh, Shri Yogi Adityanath Ji, and expressed gratitude for his unwavering support to ISARC and for providing the opportunity to host the session celebrating the 150th Anniversary of the Uttar Pradesh Department of Agriculture during the DSR Conclave.

- The welcome address also highlighted ISARC's major achievements since its inauguration by the Hon'ble Prime Minister in 2017, including IRRI's contributions to the release of 141 climate-resilient rice varieties like Manaviya, Manila Sanchit Dhan, the revival of traditional rice accessions (e.g., Kalanamak), the promotion of DSR and natural farming, and the establishment of world-class facilities such as the Speed Breeding Centre and NABL-accredited CERVA laboratories.
- He also underpinned the ISARC's collaborations with the national & international agencies including UP government and Sri Lanka.

Keynote Address: Dr. Simon Heck, Director General, CIP

- Over 3 million acres in South and Southeast Asia are under sustainable rice and crop management practices.
- Uttar Pradesh is a prime location for collaborative research, being a leading producer of rice and potatoes (33% of India's total output, ~12 million tonnes).
- Establishment of the CIP–South Asia Regional Centre (CIP-SARC) in Agra was approved in July, supported by the Government of India and Government of Uttar Pradesh.
- Focus on improved varieties, higher seed quality, and sustainable practices to increase farmer incomes and economic value.
- Collaborative work with IRRI, state agricultural universities, and private partners on zero-tillage, residue management, and pest/disease control.
- Marks 50 years of CIP presence in India, reinforcing collaboration with IRRI and UP Government.

Keynote Address: Dr. Yvonne Pinto, Director General, IRRI

- The Director General of IRRI extended heartfelt congratulations to the Government and people of Uttar Pradesh on the occasion of the 150th Anniversary of the State Department of Agriculture, commending the legacy and resilience of the farming community that has made Uttar Pradesh the food heartland of India
- She highlighted India's central role in IRRI's global mission and emphasized that the establishment of ISARC in Varanasi stands as a testament to the strong partnership between IRRI, the Govt. of India and Govt. of UP
- She underpinned the IRRI's Works with over 53 NARES partners covering the entire rice value chain. Also highlighted the IRRI's focus on low-GI, climate-resilient, and nutritionally rich rice varieties that generate livelihood opportunities, particularly for women and youth.

Shri Surya Pratap Shahi, Hon'ble Minister for Agriculture, GoUP

- Commended IRRI and UP Department of Agriculture for organizing the DSR Conclave.
- Emphasized the vision of Uttar Pradesh as a global food basket.
- Noted historical context: DSR was a traditional practice replaced by Puddled Transplanted Rice (PTR).
- Highlighted climate-smart DSR adoption to mitigate erratic rainfall and methane emissions.
- Observed strong farmer interest in modern DSR experiments in Varanasi and other districts.
- Acknowledged PM Modi's vision inspiring ISARC's establishment and UP's agricultural achievements in rice, wheat, milk, and vegetables.

Shri Yogi Adityanath, Hon'ble Chief Minister of Uttar Pradesh

- Welcomed scientists, dignitaries, and delegates; commended IRRI and UP Department of Agriculture for convening the conclave.
- Highlighted agriculture's cultural and spiritual significance in India.
- Underlined India's agricultural endowment: largest arable land, favorable agro-climatic conditions, and advanced irrigation infrastructure.
- Recognized UP's exceptional contribution: 21% of India's food grains from only 11% of land.
- Celebrated research and institutional strengths, including four state agricultural universities, two central universities, and 89 Krishi Vigyan Kendras (KVKs).
- Recalled ISARC's achievements since 2018 and expansion of international research presence, including CIP–SARC.
- Announced establishment of a 250-acre Seed Park in Lucknow for climate-smart seed development.
- Reiterated agriculture's central role in achieving UP's $1 trillion economy target by 2029–30.

Shri Baldev Singh Aulakh, Hon'ble State Minister for Agriculture Education and Research, GoUP

- Reaffirmed UP's role as India's granary and recognized farmers' contributions.
- Highlighted paddy-based value chains and initiatives promoting nutritious, value-added rice products.
- Emphasized youth and women entrepreneurship in agriculture.
- Reinforced the vision of UP as a global food basket through increased productivity, quality production, and integration with modern scientific technologies and market access.

Key Discussion Points and Insights

1. Potential of DSR and Zero Tillage (ZT):
  - Mechanized DSR + ZT increases yield, improves water-use efficiency, reduces GHG emissions, and lowers cultivation costs (~₹2,000 crore savings for 2 million hectares).

2. Multi-Stakeholder Collaboration:
  - The Samriddh Dhan Network (SDN) integrates government, IRRI, private sector (Bayer, Savannah), and FPOs for scaling DSR adoption.

3. Uttar Pradesh as an Innovation Hub:
  - Hosts IRRI South Asia Regional Centre (ISARC) and CIP–SARC for potatoes.
  - Positioned as a leader in agricultural transformation and research.

4. Technological and Genetic Advancements:
  - Development of Herbicide Tolerant (HT) rice varieties, new herbicides (e.g., Vazir), hybrid seeds, seed treatments, low-GI and climate-resilient rice (e.g., Kalanamak).

5. Integrated Systems and Value Chains:
  - Focus on rice-potato systems, effective residue management (straw pelletization), and sustainable practices linked to premium "low-carbon rice" markets.

Key Debates

- **Traditional vs. Modern Practices:** DSR revival is a modernized, science-backed approach to historical practices, addressing climate change and water scarcity.
- **Universality of Adoption:** DSR is site-specific; not all farmers or fields are suitable for uniform adoption.

Recommendations

1. **Scale DSR Adoption with Government Support:**
    - Implement targeted incentives to de-risk farmer adoption.
2. **Data-Driven Approach:**
    - District- and block-level mapping to identify suitable areas.
    - Use FPOs for clustered adoption, capacity building, and awareness.
3. **Strengthen Innovation Ecosystem:**
    - Continue partnerships with IRRI, CIP, universities.
    - Operationalize the 250-acre Seed Park in Lucknow.
4. **Develop Market Linkages and Carbon Credits:**
    - Link DSR with carbon markets and promote "low-carbon rice" branding.
5. **Capacity Building and Digital Tools:**
    - Expand training programs and integrate digital monitoring for sustainability.

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5. **Capacity Building and Digital Tools:**
    - Expand training programs and integrate digital monitoring for sustainability.

Policy and Institutional Recommendations

Policy Recommendations:

- Implement direct financial incentives for DSR adoption (e.g., Haryana model).
- Integrate DSR with carbon credit programs and "low-carbon rice" branding.
- Fast-track the 250-acre Seed Park in Lucknow.
- Ensure pre-monsoon irrigation to facilitate DSR adoption.

Institutional Recommendations:

- Strengthen PPPs for scaling DSR.
- Enhance multi-stakeholder platforms (e.g., SDN).
- Adopt FPO-led, clustered approaches for capacity building and dissemination.
- Promote digital tools for monitoring, training, and MEL frameworks.
- Sustain long-term collaboration with IRRI, CIP, state agricultural universities, and KVKs.

Strategic Recommendations:

- Prioritize DSR + ZT expansion (2 million hectares by 2030, 2 million hectares by 2024–25).

- Focus on genetic improvement and integrated crop management (e.g., seed treatments, HT rice, low-GI varieties).
- Implement data-driven, region-specific DSR strategies.
- Develop value chains connecting farmers to profitable markets.
- Align agriculture with UP's economic growth goals, ensuring inclusive and sustainable development.

Session Title: DSRC Meeting and Discussion on Stakeholder Assessment to Support Scaling of Mechanized DSR

1. Overview / Objective of the Session

The session aimed to scientifically examine key achievements and chart a vision for scaling Direct-Seeded Rice (DSR), emphasizing its transformative potential in rice-based agri-food systems under climate change, water scarcity, and labor shortages. Drawing upon empirical evidence from country experiences, the session highlighted progress in productivity, resource-use efficiency, and environmental sustainability through DSR adoption, while identifying necessary technological, agronomic, and policy innovations.

A special focus was given to mechanization as a critical enabler for large-scale adoption. The concluding segment involved a stakeholder assessment workshop to systematically identify constraints, opportunities, and partnership models to accelerate mechanized DSR adoption, aiming to establish a science-based roadmap for sustainable intensification of rice systems across diverse agro-ecologies.

2. Opening Remarks

Dr. Virender Kumar

- Highlighted that DSR, as an emerging technology, requires strong policy-level convergence and coordination to enable large-scale adoption.
- Identified labor and water scarcity as key drivers for the shift from puddled transplanted rice to DSR, citing Cambodia's experience where DSR is widely practiced.
- The DSR Consortium (established in 2018) has progressed through Phases I and II in identifying research gaps and mitigating risks to make DSR more farmer-friendly and resilient.
- Effective and sustainable weed control remains a major challenge, necessitating continuous refinement of agronomic practices and integrated solutions.
- Development of DSR-suited, stable-yielding varieties and strengthened public–private partnerships are essential for accelerating scaling efforts.
- Collaborative initiatives across India, South, and Southeast Asia are ongoing to catalyze DSR adoption, exemplified by Uttar Pradesh's target of 2 million hectares under DSR by 2030.

3. Key Presentations

3.1 Dr. Nguyen Van Bo, Former President, Vietnam Academy of Agricultural Sciences

Topic: *DSR Vision: Key Achievements and Vision for DSR Scaling – Vietnam*

- In the Mekong Delta, DSR adoption has reached 60–65% of cultivated area, enabled by mechanization supporting 2–3 rice crops per year, with yields averaging 6 t/ha.

- Key challenges include high seed rates (120–150 kg/ha), excessive fertilizer use (over 110 kg N/ha), high labor and water costs, post-harvest inefficiencies, and low farmer incomes.
- Adoption remains limited in northern Vietnam due to smaller landholdings and mechanization constraints.
- The "1 Million Ha – High-quality, Low-Emission Rice Program" (launched Dec 2023) integrates balanced fertilization, mid-season drainage, site-specific nutrient management, and innovative rice straw management.
- Emphasized the importance of public-private partnerships, field demonstrations, national guideline integration, mechanization services, and digital monitoring for successful DSR scaling.

3.2 Dr. Rica Joy Flor, Scientist, IRRI
Topic: DSR Vision: Key Achievements and Vision for DSR Scaling – Cambodia

- Mechanized DSR in Cambodia integrates cultural norms, industry practices, and strategic interventions, enabling adoption of best practices.
- Challenges include limited availability of quality seed, lack of seeder services, insufficient biocontrol agents, high equipment costs, and weed management.
- Farmers often use high seed rates (~300 kg/ha) and may resist lower recommended rates.
- Strengthening mechanization through business models, service provision frameworks, financial support, and integrated agronomic practices is key to promoting adoption.
- A dashboard was created to improve access, service provision, and knowledge outreach, aligning stakeholders toward unified mechanized DSR practices.

3.3 Ms. Vinny, Bayer
Topic: *Bayer's DSR Scaling Experience and Learning + Future Vision*

- DSR adoption in India is driven by labor shortages, government policies, advocacy, and access to farming credit, currently covering ~1 lakh hectares and 15,500 farmers.
- To scale DSR to 1 million hectares, farmers were categorized as initial adopters, partially successful, successful, and non-believers to tailor interventions.
- Digital tools (FarmRise platform, Deena WhatsApp chatbot) provide real-time guidance on DSR practices.
- Cluster-based scaling (15–20 villages per cluster) demonstrates mechanization and profitable business models for service providers.
- Evidence-based solutions integrating mechanized services and agro-advisory support have resulted in high adoption and retention.
- Remaining challenges include linking DSR to carbon credits, profitability assurance, and yield maintenance.

4. Stakeholder Assessment Workshop
Facilitator: Dr. Rica Joy Flor

- Participants were organized into thematic groups (research institutions, universities, private sector, Southeast Asian stakeholders, farmers, extension personnel).
- Groups received presentations outlining objectives and discussion points for focused deliberation.
- Discussions centred on stakeholder network mapping, roles in the change process, and

- linkages to strengthen scaling strategies.
- Strategic partnerships were prioritized, challenges identified, and actionable linkages proposed to facilitate integration and collaboration.
- Outcomes were presented and deliberated to generate a broader vision for upscaling DSR, considering implementation status, contextual interpretation, and potential results.

5. Q & A Discussion

Q1: Is there a low-emitting rice variety, or is it the package of practices that makes rice low-emission?
A1: No specific low-emission variety exists yet. Low-emission outcomes are achieved through packages of practices including improved land preparation, irrigation management, and use of short-duration genotypes.

Q2: What is the suitability and area of DSR in India, and can a holistic publication be developed?
A2: A comprehensive publication covering state-wise DSR areas, suitability zones, and potential scaling targets is under preparation.

Q3: How can varieties be made suitable for DSR across diverse agro-ecologies?
A3: Varieties must be tested under different agro-ecological conditions to identify those most adaptable for DSR systems.

Q4: What is the role of HT rice and policy implementation in DSR scaling?
A4: Research and policy support for HT rice could enhance DSR adoption and upscaling.

6. Closing Remarks

Dr. Senthilkumar Kalimuthu, Program Leader, SPE, Africa Rice

- Summarized key presentations and lessons learned from Vietnam, Cambodia, and India.
- Highlighted collaborative efforts with private partners in promoting DSR adoption and scaling.
- Emphasized region-specific, comprehensive DSR packages incorporating land preparation, irrigation management, weed control, and agronomic practices.
- Noted the importance of adapting DSR to local conditions for effective scaling and productivity enhancement.
- Encouraged learning from Southeast Asian experiences to strengthen policy frameworks and institutional support.
- Invited partners to collaborate in Africa to enhance rice production and achieve food security through DSR technology.

7. Key Discussion Points

- DSR Consortium (2018) identified research gaps, mitigated risks, and promoted eco-friendly DSR.
- Continuous refinement of agronomic practices, especially weed management, is a priority.
- **Vietnam:** 60–65% DSR adoption in Mekong Delta; challenges include high seed/fertilizer use, low farmer income.
- **Cambodia:** Progress in mechanized DSR; constraints in seed quality, mechanization services, and weed management.

- **India:** BAYER's Direct Acres program targets 1 million ha; cluster-based scaling, digital tools, demonstrations, and service provider business models enhance adoption and retention.
- Collaborative efforts in India, South, and Southeast Asia, including Uttar Pradesh's target of 2 million ha under DSR by 2030.
- Structured stakeholder assessment emphasized network mapping, strategic partnerships, and actionable linkages to strengthen scaling strategies.

8. Major Outcomes / Conclusions

- Strong policy-level convergence and institutional support are critical for scaling DSR adoption.
- Development of DSR-suited varieties, effective weed management, and integrated agronomic packages remain top priorities.
- Challenges include high input use, equipment costs, and farmer reluctance. Linking DSR to carbon credits, providing subsidies, and ensuring profitability are crucial.
- Southeast Asian experiences highlight the importance of local adaptation and region-specific approaches.
- Strengthening stakeholder networks, business models for service providers, and integration into national guidelines are essential.

9. Policy and Institutional Recommendations

- Establish policy-level coordination across ministries, state governments, and research institutions.
- Utilize dashboards, monitoring tools, and farmer-focused platforms (e.g., WhatsApp chatbots, FarmRise) for advisory and evidence-based policymaking.
- Encourage collaboration between government, private sector, service providers, and farmer groups to scale mechanization and input supply.
- Develop viable business models for mechanization, provide financial incentives, and expand cluster-based scaling models.
- Integrate DSR into climate adaptation and carbon credit frameworks to reduce GHG emissions and enhance resource-use efficiency.

10. Research and Innovation Priorities

- Promote mechanized and precision DSR technologies, including deep fertilizer placement and site-specific nutrient management.
- Develop comprehensive DSR packages integrating land preparation, irrigation, agronomy, and post-harvest management.
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11. Reflections / Participant Feedback

- The conclave provided a strong platform for knowledge exchange, networking, and collaboration among researchers, policymakers, and private sector actors.

- Participants emphasized the need for continued research, innovation, and region-specific solutions for DSR adoption.
- Valuable insights were shared on low-emission practices, varietal suitability, and policy needs for scaling.
- Overall, the event was recognized as well-organized and impactful in shaping the future of rice cultivation.

Glimpses of the Global DSR Conclave 2025

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