

FROM TECHNOLOGY TO TRANSFORMATION: EXTENSION DELIVERY MODEL FOR CLIMATE-RESILIENT PADDY

An Innovation-to-Impact Framework for Ecological, Resource and Labour Resilience



**ICAR-Agricultural Technology Application Research Institute
Zone-I, PAU Campus, Ludhiana-141 004, Punjab, India**

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1. VISION & STRATEGIC BACKGROUND

Paddy cultivation faces increasing water scarcity, labour constraints, rising input costs and ecological stresses, making conventional production systems increasingly vulnerable. The Extension Delivery Model for Adapting to Ecological and Climatic Stresses in Paddy, developed and validated by ICAR-ATARI, Ludhiana, moves beyond conventional technology dissemination by combining climate-resilient technologies with risk-managed adoption, location-specific recommendations, experiential learning and continuous farmer support.

The model recognizes that technologies such as DSR, alternate wetting and drying and residue management are knowledge-intensive and that inappropriate adoption can lead to early failure and farmer disenchantment. The structural paradigm shift from promoting technologies to ensuring successful technology adoption. Instead of treating technology availability as the endpoint, the model creates an enabling pathway:

Right Technology → Right Farmer → Right Location → Right Practice → Successful Adoption → Wider Diffusion → Climate Resilience

Validation Footprint: 21 Districts | 59 Villages | Punjab

2. CORE PILLARS OF THE INNOVATION

The model integrates technical solutions with behavioural, economic and institutional mechanisms to make climate-resilient paddy technologies practical, affordable and scalable.

2.1 RISK-MANAGED ADOPTION

The “Mitigating Disenchantment” strategy reduced the risk of early technology failure by encouraging first-time DSR adopters to begin with only about 20% of their paddy area, enabling them to gain practical experience, build confidence and progressively expand adoption.

2.2 LOCATION-SPECIFIC TECHNOLOGY

The model emphasizes that one technology cannot fit every field. Farmers were guided on suitable soils for DSR, optimum sowing time, laser land levelling, delayed first irrigation, scientific weed management, alternate wetting and drying, and appropriate crop varieties. This reduced the risk of technology failure arising from inappropriate location or practice.



2.3 SEEING IS BELIEVING

Technology adoption was supported through frontline demonstrations, field days, exposure visits and harvest demonstrations to provide farmers with visible, field-level evidence of technology performance, transforming uncertainty into confidence and encouraging wider and sustained adoption.

2.4 FARMER-TO-FARMER EXTENSION

Successful adopters were developed as technology ambassadors and resource farmers, enabling practical knowledge to move horizontally through farming communities, thereby strengthening peer learning and accelerating wider technology adoption.

2.5 LOW-COST MACHINERY INNOVATION

An existing Happy Seeder could be modified into a DSR drill for only ₹1,000–2,000, compared with approximately ₹70,000 for a new drill. By promoting modification and reuse of existing machinery, the approach reduced investment barriers, improved machinery utilization and expanded affordable access to DSR technology

3. THE TECHNOLOGY-TO-RESILIENCE PATHWAY

The model converts climatic and ecological stresses into opportunities for resilient farming through a progressive pathway of right technology, right practice, farmer confidence and sustained adoption.



THE INNOVATION: A 7-STEP EXTENSION PATHWAY

This makes the framework much more innovation- and impact-oriented: the objective is not merely to increase the number of farmers exposed to technologies, but to minimise adoption risk, maximise farmer success and convert successful individual adoption into wider community-level diffusion.

TECHNOLOGY PORTFOLIO	FARMER TARGETING	EXTENSION MECHANISM	RISK-MANAGED APPROACH	EXPECTED IMPACT
Short-duration varieties	Need-based farmers	Sensitization & diagnosis	Technology-farmer matching	Reduced crop duration
Optimum sowing time	Early adopters	Frontline demonstrations	Start with manageable area	Timely crop establishment
Direct Seeded Rice (DSR)	Resource-constrained farmers	Field demonstrations	Limited-area first adoption	Labour saving + water saving
Alternate Wetting & Drying	Water-stressed farmers	Field days	Delayed/controlled irrigation	Water-use efficiency
Laser Land Levelling	Mechanization-oriented farmers	Exposure visits	Demonstrate economic gains	Better water distribution
Leaf Colour Chart	Input-efficient farmers	Capacity building	Avoid over-application	Nitrogen-use efficiency
Residue mulching/ incorporation	CRM adopters	Farmer-to-farmer learning	Avoid unsuitable practices	Residue & soil management
Machine modification/ custom hiring	Machinery users	Technical support & supply	Local adaptation of machines	Labour and cost reduction

“The extension system becomes a bridge between technology availability and farmer success—ensuring that every technology is not only promoted, but appropriately matched, successfully demonstrated, safely adopted and sustainably scaled.”



4. STRATEGIC SCALING: THE 3-S EXTENSION MATRIX

The model progressively shifts the role of extension from direct technology promotion to farmer-led technology diffusion.

Phase	Strategic Focus	Key Action
Stimulate	Awareness & Confidence	Demonstrations, training, technical onboarding and direct monitoring
Stabilize	Successful Adoption & Diffusion	Machinery access, field support, location-specific guidance and farmer-to-farmer extension
Sustain	Farmer-Led Continuity	Technology ambassadors, peer networks and institutionalized local learning

5. QUANTIFIABLE IMPACT

The Innovation-to-Impact Scorecard demonstrates how targeted technology adoption translated into measurable gains in farm profitability, resource efficiency, labour resilience, farmer confidence and climate-resilient paddy production.

Impact Dimension	Quantified Outcome
Scale	21 districts, 59 villages
Technology adoption	DSR expanded from 0.23 lakh ha in 2019 to 5.54 lakh ha during 2021 (labour crisis accelerated adoption and 1.47 lakh ha during 2026 (El Nino induced water crisis)
Farm profitability	10-15% higher net returns under DSR
Economic efficiency	B:C ratio 3.72 under DSR
Cost saving	Approximately ₹4,000/ha reduction in cultivation cost
Machinery innovation	DSR drill modification at ₹1,000-2,000 vs ~₹70,000 new drill
Water efficiency	15-20% higher efficiency with AWD and related practices with reduced ground water-extraction
Labour resilience	Reduced dependence on peak-season transplanting labour
Input efficiency	11-23% higher energy efficiency with improved nitrogen, fuel, water and energy-use efficiency
Technology confidence	Risk-managed adoption reduced early failure and farmer disenchantment
Knowledge diffusion	Farmer-to-farmer extension and technology ambassadors strengthened local adoption

6. ECONOMIC & RESOURCE TRANSFORMATION

The model generated measurable improvements in profitability, cost efficiency and resource conservation. Under DSR, farmers achieved ₹1,00,740/ha net returns, a B:C ratio of 3.72, and approximately ₹4,000/ha savings in cultivation cost, while the integrated package improved the efficiency of water, labour, fuel, nitrogen, machinery, time and energy—demonstrating that resource conservation can go hand-in-hand with higher farm profitability and resilience.

7. CRISIS RESPONSE & CLIMATE ADAPTATION

The model demonstrated exceptional relevance as Punjab's rice-based production system confronted two major external shocks in last 7-8 years—COVID-19-induced labour scarcity (2020-21) and El Niño-related water stress (2026). These crises exposed the vulnerability of conventional puddled transplanted rice, which is highly dependent on migrant labour, repeated tillage and large quantities of irrigation water. Under these circumstances, DSR emerged as a practical adaptation strategy, enabling farmers to reduce dependence on labour, save water and maintain timely crop establishment.

Year	Area under DSR (lakh ha)	Trend
2019	0.23 lakh ha	Initial expansion
2020	5.34 lakh ha	Major surge
2021	5.55 lakh ha	Peak
2022	0.68 lakh ha	Sharp decline
2023	0.69 lakh ha	Marginal recovery
2024	1.02 lakh ha	Strong recovery
2025	1.18 lakh ha	Continued growth
2026	1.47 lakh ha	Major revival

2019 → 2021: Rapid expansion

DSR expanded from about 0.23 lakh ha in 2019 to 5.55 lakh ha in 2021, largely driven by severe labour shortages during the COVID-19 period.

2019 → 2021 | COVID-19: Labour Crisis Accelerated DSR Adoption

The onset of COVID-19 and the associated disruption in migrant labour availability created an unprecedented labour shortage during the rice transplanting season. Farmers were compelled to explore alternatives to



labour-intensive puddled transplanting. Consequently, DSR acreage expanded dramatically from 0.23 lakh ha in 2019 to 5.34 lakh ha in 2020 and 5.55 lakh ha in 2021.

The crisis converted DSR from an alternative technology into an immediate labour-saving solution.

2022 → 2023 | Post-Crisis Correction

With the restoration of migrant labour availability, the immediate pressure to shift away from transplanting diminished, resulting in a sharp contraction in DSR acreage to 0.68 lakh ha in 2022, followed by marginal recovery to 0.69 lakh ha in 2023.

This phase demonstrated that crisis-driven adoption alone was insufficient for sustained scaling; continued adoption required evidence of economic benefits, technical confidence and effective extension support.

2024 → 2026 | Water Stress & Climate Concerns: DSR Regains Momentum

Growing concerns over water scarcity, groundwater depletion and climate variability, including El Niño-related rainfall and water-stress conditions, renewed interest in DSR as a water-smart production technology. Its ability to reduce irrigation demand, shorten field preparation requirements and conserve resources strengthened its relevance under increasingly uncertain climatic conditions.

DSR acreage consequently increased from 1.02 lakh ha in 2024 to 1.18 lakh ha in 2025 and approximately 1.47 lakh ha in 2026, signalling a renewed and more strategic adoption trajectory.

From Crisis Response to Climate-Smart Adaptation

The DSR journey demonstrates how external shocks can accelerate agricultural innovation when a suitable technology is available and supported by effective extension:

COVID-19 → Labour shortage → Need to reduce transplanting dependence → Rapid DSR adoption

El Niño & water stress → Water scarcity concerns → Need for water-efficient rice establishment → Renewed DSR adoption

In essence, Punjab's DSR journey reflects a transition from labour-driven adoption to water-smart and climate-resilient agriculture. This demonstrated

that a combination of appropriate technology, farmer confidence, targeted extension and resource-conserving practices can enable rapid adaptation when conventional production systems face sudden disruption.

8. SOCIAL & BEHAVIOURAL TRANSFORMATION

The model shifted the focus from counting technology adoption to building sustained farmer behaviour change. It moved from technology promotion to technology suitability, from blanket adoption to risk-managed adoption, and from classroom-based training to experiential “learning by doing.”

Extension evolved from one-way dissemination to farmer-to-farmer diffusion, while individual technology uptake developed into community knowledge networks.

This approach built confidence, reduced adoption risks, strengthened peer learning and enabled farmers to become active change agents, making technology adoption more relevant, resilient and sustainable.

9. FROM INNOVATION-TO-IMPACT

The Extension Delivery Model for Adapting to Ecological and Climatic Stresses in Paddy demonstrates that climate adaptation requires more than technology transfer. It demands the integration of right technology, targeted interventions, affordability, location-specific agronomy, risk management, experiential learning and farmer-led diffusion.

The model transforms conventional extension from **“Promote → Adopt”** to **“Target → Demonstrate → Support → Succeed → Diffuse → Sustain.”** It creates an enabling architecture that makes climate-resilient technologies technically appropriate, economically viable, socially acceptable and practically adoptable.





Ultimately, the model turns climate and ecological stress into an opportunity for transformation—building farmer confidence and collective learning for more profitable, resource-efficient and climate-resilient paddy farming.

10. POLICY & SCALABILITY IMPLICATIONS

The model demonstrates that scaling climate-resilient agriculture requires more than technology availability or machinery distribution. It requires an extension ecosystem that simultaneously addresses technical suitability, affordability, farmer confidence, local conditions and peer learning. This include:

- Promote risk-managed adoption rather than blanket technology promotion.
- Institutionalize location-specific advisories for knowledge-intensive technologies.
- Promote low-cost machinery modification and reuse to reduce investment barriers.
- Strengthen Farmer-to-Farmer Extension through successful technology adopters.
- Link demonstrations with measurable outcomes in profitability, water, labour and input efficiency.
- Position KVKs as local climate-adaptation hubs connecting technology, farmers and service providers.

The Core Policy Message

“Shift from 'Technology Transfer to Technology Success'—establishing a risk-managed, farmer-centred extension pathway that ensures climate-resilient technologies are not merely promoted, but appropriately targeted, successfully adopted, economically viable, sustained and scaled for resilient paddy farming.”

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Business Standard

Thursday, September 03, 2026 | 01:16 PM IST

Punjab DSR area rises 36% to over 400K acres in Kharif 2026: State agri min

Punjab's area under direct-seeded rice rose 36% to over 4 lakh acres in Kharif 2026, aided by incentives and efforts to conserve groundwater

Khudian said the sharp rise in DSR adoption reflects growing farmer confidence in the technique as a sustainable alternative to conventional paddy transplantation (Photo: Facebook)



Directorate of Information & Public Relation Punjab
Government of Punjab



DSR GETS BOOST IN PUNJAB; WITNESSES 15% SURGE IN AREA UNDER WATER CONSERVING TECHNIQUE

July 4, 2024

₹50 crore allocated to provide ₹1500 financial assistance per acre to farmers opted DSR, says Gurmeet Singh Khudian

• Farmers can register on the portal till July 15 to get financial assistance

The Tribune

VOICE OF THE PEOPLE

Thursday, September 3, 2026

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DSR makes patchy progress

Direct seeding of rice (DSR) was a boon for Punjab's farmers during the Covid lockdown in 2020 when most of the migrant labourers returned to their home states; one-fifth of the total area under rice in the state came under DSR. The area under DSR rose from 5 lakh hectares in 2020 to 6.01 lakh hectares in 2021; this year, the government has set a target of bringing 12 lakh hectares under DSR. Even as data for 2022 is being compiled, sources say only 2-3 lakh hectares are estimated to be covered under DSR.

Recognition for Field-Level Impact



The Technology for Extension Delivery Model for Adapting Ecological and Climatic Stresses in Paddy has been certified by the Indian Council of Agricultural Research (ICAR), New Delhi, vide **Certificate No. ICAR-AEXT-ATARILDH-Model-2024-042**, in recognition of its field-validated approach, measurable environmental outcomes and demonstrated potential for technology at scale.



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