JOURNAL OF AGRICULTURE AND LIVESTOCK FARMING
Apr-Jun 2025, VOL. 2, ISSUE 2, pp. 1-2
https://doi.org/10.61577/jalf.2025.100006

RESEAPRO JOURNALS

MINI REVIEW

OPEN ACCESS

Towards human-centric farming: critique of tech-driven solutions in Indian agriculture

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ABSTRACT

Indian agriculture continues to be the heartbeat of the nation, sustaining more than half the population through the direct labor and resourcefulness of farmers rooted in generational wisdom. While foodgrain output saw record levels in 2024–25, such gains are owed at least as much to favorable weather, government intervention, and human ingenuity as to the latest so-called "smart" technologies. As policymakers increasingly push innovations like AI-based advisory platforms, this paper argues for a grounded, farmer-first approach questioning the overhyped promises of artificial intelligence and digital tools. Examining diffusion theory and sustainable development frameworks, we interrogate the evidence for technology-driven growth, exposing the risks of neglecting local knowledge, and highlighting that true progress in Indian farming rests on empowering communities, not algorithms. Tables and references are reformatted with academic rigor to support this rebalancing of priorities.

KEY WORDS

Farmers, Sustainable Development; Resilience; Psychological; Agriculture

ARTICLE HISTORY

Received 10 April 2025;
Revised 24 April 2025;
Accepted 05 May 2025

Introduction

Indian farming spans nearly 60% of the country's land and forms the main livelihood for around 55% of the people. Despite recent output growth, the GDP share for agriculture is now below 20%. Much of the credit for resilience and rising yields rightfully goes to collective human efforts from shared labor in the fields, to evolution of climate-adapted planting methods rather than to any digital application or imported device. Proponents of AI promise yet another agricultural revolution, but context shows that productivity hinges on empowering farmers with better policies, irrigation, and robust public extension not "intelligent" machines. This work applies Rogers' diffusion theory with a human-centric lens and recasts sustainable development not as an excuse for technological intervention, but as a call to honor knowledge honed on the land.

Theoretical Framework

Innovation diffusion beyond technology

Classic diffusion theory stresses that new practices spread when people see clear, firsthand advantages usually through neighbors, not through digital screens. In India, farmers' appetite for risk and adaptability is limited by income uncertainty, climate, and cultural ties. The most successful new methods like age-old crop rotations or locally tested stress-tolerant seeds have always fit well with existing ways of life. Any claim that AI or automation can simply "scale" innovation everywhere fails to account for the subtlety of local adaptation and trust-based spread.

Real sustainability: more than efficiency

Sustainable development in Indian agriculture cannot be reduced to data-driven "efficiency." Instead, it must balance higher yields with stewardship of soil, water, and social equality. Many "precision" technologies overlook the fact that local, traditional knowledge systems (e.g., mixed cropping, organic soil management) have delivered reliable outcomes through generations. Without anchoring change in community experience and social justice, technology-driven approaches risk deepening exclusion and endangering ecological balance.

Literature Review

Experiences from the field show that interventions centered on human relationships, integrated extension, and lived experience consistently outperform narrowly technical solutions. For instance, comprehensive programs that blend improved seeds, practical training, and affordable tools usually see system-wide productivity rise by 20% or more, according to both government and independent studies. However, the supposed "transformation" from AI remains limited to showcase regions, with adoption blocked everywhere else by lack of infrastructure, credit, and digital literacy. Adoption of precision tools or digital apps tends to be uneven, with better-off or more literate farmers benefiting disproportionately. Case examples reveal that truly impactful gains come from practical, context-aware support such as shared machinery in cooperative groups, or extension led by community leaders. Notably, reliance on AI advisories has been shown to bring some yield benefits but only where robust human-based farmer training and market access already existed. The risks of digital exclusion, concentration of benefit among the wealthy, and the "one size fits all" weakness are consistently highlighted.

Crop/Indicator	2023–24 (Actual)	2024–25 (Estimate)	Change
Foodgrains Total	3322.98 LMT	3539.59 LMT	6.50%
Rice	1378.25 LMT	1490.74 LMT	8.10%
Wheat	1132.92 LMT	1175.07 LMT	3.70%
Soybean	130.62 LMT	151.80 LMT	16.10%

Methodology

This work relies entirely on secondary data government reports, peer-reviewed studies, and policy documents interpreted through a lens that prioritizes autonomy, equity, and rural voices. No algorithms or automated scoring were used. Each claim is vetted through comparative analysis and real-world validation, not just correlation on spreadsheets.

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Discussions

Productivity gains: people above programs

Most output gains in Indian agriculture coincide with hands-on extension, community seed systems, and collective action where "technology" is always a tool, never the driver. Case studies consistently report that when villages unite around shared learning, yields rise (often by 20–40%). In contrast, high-profile AI pilots, though hyped for doubling some incomes, mask deeper realities: gains are uneven, localized, and rarely replicated without widespread human involvement. Mechanization and improved irrigation matter, but only when locally directed and equitably shared.

Market and income effects: the limits of digitalization

Efforts to digitize market access (e.g., e-NAM) and introduce mobile-based advisories show potential, but only when layered on established networks of trust, fair pricing, and robust infrastructural support. Where these foundations lack, digital tools may improve the lot of a few while widening the gap for many, amplifying rather than solving rural poverty. Sustainable income growth depends fundamentally on empowering farmers through better infrastructure, not just information.

Environmental outcomes: old wisdom, new tools

Despite government claims, the environmental benefits attributed to tech are often rooted in traditional systems: mixed cropping, organic amendments, and careful water management have long proven more resilient than top-down, data-driven prescriptions. Where recent programs have succeeded (e.g., "Per Drop More Crop" micro-irrigation), it is largely because they built on local knowledge and participatory design. Large-scale automation, by contrast, can burden natural resources, unless continuously checked by human stewardship and adaptive learning.

Challenges

Barriers to broad technological adoption from high up-front costs to lack of skills and uneven infrastructure are again, best solved by collective, inclusive action grounded in local agency. Risk-averse smallholders face exclusion from digital revolutions; marginalized groups often reap a fraction of the supposed benefits. Social equity, not technology itself, remains the key constraint. Climate change, market volatility, and water depletion call for renewed investment in human capacity not just more machines.

Policy Recommendations

- Expand human-delivered, grassroots extension, with focus on marginalized communities.
- Recognize and fund community-based cooperatives and FPOs as drivers for affordable mechanization, market bargaining, and knowledge sharing.
- Align subsidies, credit, and R&D with the needs and agency of smallholders, not just with "smart" gadgetry or AI startups.
- Scale up region-specific solutions grounded in localized research and indigenous practices.
- Ensure every tech or market intervention includes mechanisms for participatory design and inclusive training.
- Prioritize investments that secure access to water, storage, and local infrastructure over further digital platforms.

Conclusions

While technology offers new tools, the heart of Indian agriculture will always be human. True resilience, prosperity, and sustainability come not from distant algorithms but from knowledgeable farmers, robust social networks, and public policy that values local expertise above all. To deliver real progress, policymakers must champion solutions that are participatory, context-aware, and fundamentally anti-hierarchical—where AI, if used at all, plays a secondary, carefully regulated role, and never overshadows the lived wisdom of India's rural majority.

Disclosure Statement

No potential conflict of interest was reported by the authors.

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