

AGRIBUSINESS AND RURAL TRANSFORMATION IN INDIA: SHIFTING PARADIGMS, MEASURING IMPACT – A MIXED-METHODS APPROACH

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ABSTRACT

India's agricultural sector, employing nearly half the workforce yet contributing modestly to GDP, stands at a critical juncture where traditional farming paradigms are giving way to transformative approaches. This paper examines how mixed-methods research illuminates the shifting landscapes of agribusiness and rural transformation across diverse Indian contexts. Drawing on recent empirical studies employing integrated qualitative-quantitative designs, we synthesize evidence on three key dimensions: sustainable intensification and farm typology development, social entrepreneurship and institutional engagement, and livelihood transitions in specialty crop systems. The analysis reveals that mixed-methods approaches are essential for capturing the heterogeneity of smallholder systems, understanding adoption dynamics of sustainable practices, and measuring multidimensional livelihood outcomes. We find that participatory methods combined with statistical techniques enable scalable, context-sensitive interventions, while case study approaches illuminate the transformative potential of social enterprises and institutional collaborations. The paper contributes a framework for understanding how methodological integration advances both theoretical understanding and practical application in Indian agricultural development.

Keywords: Agricultural Sector, Agribusiness, Mixed-methods Approaches, Agro Ecological Transitions Rural Transformation

1. INTRODUCTION

1.1 The Imperative for Transformation

Indian agriculture has long been the cornerstone of the nation's economy and social fabric. Despite significant growth in industry and services, agriculture still supports approximately 49.6% of India's workforce and contributes 18.6% to national GDP, underscoring its enduring importance. Yet the sector faces a constellation of structural and operational challenges: underemployment, low wages, unpredictable climatic conditions, volatile prices, water scarcity, and fragmented land ownership. As the late M.S. Swaminathan aptly noted, "All will fail if agriculture fails," emphasizing the urgent need to rethink agricultural development policies to ensure food security, protect the environment, and promote rural prosperity.

The challenges confronting Indian agriculture are compounded by the scale of smallholder operations. Over 500 million smallholder farmers globally cultivate less than two hectares of land, contributing more than 30% of global food supply while utilizing only 12% of all agricultural lands. In India, this smallholder dominance means that transformation pathways

must account for extreme heterogeneity in resource endowments, risk exposure, and livelihood strategies.

1.2 Rural transformation

the process of structural change in rural economies characterized by diversification of livelihoods, commercialization of agriculture, and improved well-being – requires new paradigms that move beyond simplistic technology transfer models. The shift toward **sustainable intensification**, **agro ecological transitions**, and **digital agriculture** represents a fundamental reorientation of how development interventions are conceptualized and implemented.

Central to understanding these transformations is the question of **measurement**. How do we capture the multidimensional impacts of agricultural interventions? How do we account for heterogeneity across farms and regions? How do we understand the dynamic processes of change rather than static snapshots? This paper argues that mixed-methods approaches – integrating qualitative and quantitative techniques – provide the most robust foundation for answering these questions.

The mixed-methods paradigm has gained substantial traction in agricultural research, particularly in contexts where complex socio-ecological systems demand methodological pluralism. As one recent study notes, the integration of qualitative methods into quantitative research "can foster social and transformative learning, and reveal insights that are often inaccessible through quantitative data alone". This integration enables researchers to capture both the breadth of patterns across populations and the depth of local meanings and processes.

This paper synthesizes evidence from recent mixed-methods studies across Indian agricultural contexts to address three interconnected questions:

1. How are shifting paradigms in Indian agriculture – sustainable intensification, agroecology, social entrepreneurship – being conceptualized and operationalized?
2. What mixed-methods approaches are being deployed to measure agricultural transformation and its impacts?
3. What insights emerge from these studies for policy, practice, and future research?

2. SHIFTING PARADIGMS IN INDIAN AGRICULTURE

2.1 Sustainable Intensification and Farm Heterogeneity

Sustainable Intensification (SI) has emerged as a dominant paradigm for addressing the productivity-environment trade-off in smallholder agriculture. SI aims to boost productivity while conserving natural resources, integrating innovations like improved crops and soil management to enhance productivity, farm income, and ecosystem services. However, the equitable distribution of SI benefits remains a challenge, as household-level decisions are shaped by diverse agro-ecological and socio-economic factors leading to heterogeneous outcomes.

A recent study in the climatically vulnerable Indian Sundarbans demonstrates how mixed-methods farm typology can address this heterogeneity. The research, conducted with beneficiaries of projects testing SI technologies like Salinity Resistant Paddy Varieties and Zero-Tillage Potato systems, integrated participatory and statistical methods to classify farms and construct scalable decision support tools.

Methodological innovation in this study is noteworthy. Focus Group Discussions using participatory card-sorting exercises enabled farmers to classify households by visualized parameters (cropping pattern, landholding, off-farm income, etc.). This farmer-defined grouping

then informed respondent sampling for a quantitative questionnaire survey. Statistical analysis using Principal Component Analysis and Cluster Analysis identified five distinct farm types ranging from resource-rich to resource-poor, including a distinct landless group.

Crucially, the study developed a Classification and Regression Tree (CRT) analysis to generate a decision support tree for scaling typology to new locations. The CRT achieved 86.6% accuracy using binary splits on landholding, livestock, income, irrigation, and crop diversity, with expert validation showing strong concordance. This scalable, context-sensitive framework demonstrates "the utility of typologies not only for classification but also for effectively targeting SI interventions".

The Sundarbans study reveals a progression from low-input systems to diversified, resource-rich farms integrating crops, livestock, fisheries, and innovations in water, nutrients, mechanization, and markets. These findings challenge static conceptions of smallholder systems and suggest transformation pathways that move beyond simple binary distinctions.

2.2 Agro ecological Transitions

Parallel to the sustainable intensification paradigm, agroecology has gained prominence as a transformative approach emphasizing minimal soil disturbance, reliance on bio-inputs, crop diversification, and elimination of synthetic inputs. A study in central India operationalized agro ecological transitions by examining a spectrum of farms: conventional (chemical input-dependent monocultures), transitional (bio-input adoption with partial synthetic fertilizer use), and agro ecological (full bio-input usage, no synthetic inputs for at least two years, multiple agro ecological practices).

This research employed qualitative data collection through farmer interviews and analysis using well-being indicators and the five capital assets framework (natural, physical, human, financial, social capital). Findings revealed that farms in transition and established agroecological systems reported positive social outcomes, including higher farmer well-being indicators related to community support. Notably, even farmers in transition had stronger community networks than those using conventional practices.

Dietary diversity improved as transition progressed, with established agroecological farmers having higher diversity of foods compared to conventional farmers. Social, physical and natural capital assets were significantly higher for transitional and agroecological farmers, while financial capital assets remained consistent across all farmers. This finding is particularly important because it suggests that agroecological transitions can enhance livelihood resiliency "while maintaining financial assets" – addressing a common critique that sustainable practices compromise economic viability.

The study contributes to understanding **transition dynamics** – the incremental changes in social-ecological sustainability during the process of refining conventional practices into agroecological approaches. This process-oriented perspective is valuable for informing policy making, as it identifies benefits that emerge even in early adoption stages.

2.3 Social Entrepreneurship and Institutional Engagement

Social entrepreneurship has emerged as a transformative strategy for addressing social issues in agriculture, emphasizing inclusive and sustainable business models that integrate economic, social, and environmental objectives. Agri-social entrepreneurship can enhance rural economies

by facilitating sustainable development, mitigating social exclusion, alleviating poverty, and fostering technological integration.

A case study approach to agri-social entrepreneurship in Karnataka examined two grassroots firms – one manufacturing biodegradable areca leaf products and another producing nutritious cattle feed – to assess business models, social effects, and sustainability strategies. Exclusive interviews and observations revealed how these enterprises generate rural employment, prevent migration, and provide supportive income generation for rural women.

The study addresses a significant gap: "while social entrepreneurship has recently garnered some scholarly interest, there remains a significant gap in understanding how agricultural businesses, particularly those in rural areas, can be effectively classified". By examining whether agricultural entrepreneurship qualifies as social entrepreneurship and assessing its role in addressing rural challenges, the research provides a framework for how agri-social firms might offer scalable solutions to rural development challenges.

Institutional engagement complements entrepreneurial approaches. A study of tribal coffee farmers in Araku Valley, Andhra Pradesh, employed an exploratory sequential mixed-method design to explore the impact of institutional involvement on livelihood transformation. The research surveyed 180 farmers across six villages using structured questionnaires, focus group discussions, and key informant interviews. Social Network Analysis (SNA) using UCINET software mapped institutional linkages and assessed centrality indicators.

Findings revealed that the Naandi Foundation was the most influential institutional actor, maintaining strong and consistent linkages across all villages. Villages with higher institutional connectivity reported significant improvements in income, skill development, gender empowerment, and market access. The convergence of multiple institutions created synergies that enhanced overall development outcomes, demonstrating how collaborative institutional ecosystems foster resilience and build local capacity.

This study illustrates how inclusive engagement transforms subsistence farming into market-oriented enterprises, providing "a scalable model for rural development and emphasizing the importance of institutional coordination for sustainable livelihood outcomes in tribal regions".

2.4 Livelihood Transitions in Specialty Crop Systems

The shift from subsistence crops to cash crops represents another dimension of agricultural transformation, with significant implications for rural livelihoods. A study of cashew production among smallholder farmers in southern India examined the drivers and impacts of this transition. Using a mixed-method approach combining qualitative interviews, focus group interviews, and standardized questionnaires with 267 cashew producers, the research assessed economic and social impacts.

Findings showed that cashew cultivation contributes significantly to increasing family income (78% of farmers indicated income increase), improved food availability (65%), enhanced children's access to education (58%), greater social recognition, and proper housing. However, the study also identified concerns: limited staple crop cultivation raises questions about long-term food security. This tension between income generation and food security represents a critical policy challenge.

The research employed the Sustainable Livelihoods Framework (SLF) as an analytical lens, recognizing that "sustainable livelihoods refer to the manner in which poor families organize resources and strategies in order to alleviate poverty and enhance welfare in the long-term". SLF

is particularly applicable to Indian smallholders who juggle commercial pressures, subsistence requirements, and ecological uncertainty.

Intercropping with staples, stabilization of cashew prices, and organization of cooperatives were identified as strategies to reduce economic exposures. The study also emphasized research on climate-resilient cashew varieties to address environmental concerns, highlighting the need for integrated approaches that balance economic, social, and ecological objectives.

3. MIXED-METHODS APPROACHES: MEASURING IMPACT AND UNDERSTANDING DYNAMICS

3.1 Methodological Rationale

The studies reviewed demonstrate diverse mixed-methods designs tailored to specific research questions and contexts. The methodological pluralism reflects recognition that agricultural systems are complex socio-ecological systems requiring multiple forms of evidence.

Integration strategies vary across studies. The Sundarbans typology research employed a sequential design where participatory methods informed quantitative survey design, followed by statistical classification and expert validation. The agro ecological transition study used qualitative interviews within the Sustainable Livelihoods framework, combining inductive and deductive approaches. The institutional engagement study adopted an exploratory sequential design, starting with qualitative exploration before quantitative survey.

Justifications for mixed-methods are explicit and compelling. Statistical methods provide generalize ability and analytical rigor but are limited by reliance on resource-intensive surveys that capture a "snapshot" of farm diversity, missing fluid local contexts such as market dynamics and social norms. Participatory methods integrate qualitative dimensions and situation-specific differences over longer time horizons but often lack external validity and scalability. Mixed-methods bridge these limitations.

3.2 Quantitative Techniques

Several sophisticated quantitative techniques are deployed across the reviewed studies:

Multivariate analysis: Principal Component Analysis and Cluster Analysis for farm typology delineation. These techniques reduce dimensionality and identify natural groupings in data.

Decision tree analysis: Classification and Regression Tree (CRT) analysis for developing scalable classification tools. This machine learning approach generates interpretable decision rules that can be applied in new contexts.

Conjoint analysis: A study on farmers' preferences for Climate-Smart Agriculture attributes used conjoint analysis to model preferences toward productivity, adaptation, and mitigation attributes. The approach revealed that adaptation attributes were highly favoured by farmers, followed by mitigation and productivity. Model reliability was supported by Pearson's R (0.934) and Kendall's tau (0.856), indicating strong connection between prediction and actual preferences.

Regression analysis: Multiple regression explaining entrepreneurial behavior (adjusted $R^2 = 0.645$) in Assam's secondary agriculture enterprises. Instrumental variables regression assessing impact of digital services on farm income, using two-stage least squares (2SLS) to address endogeneity.

Social Network Analysis: SNA using UCINET software to map institutional linkages and assess centrality indicators, revealing network structures that influence development outcomes.

3.3 Qualitative Approaches

Qualitative methods provide depth and contextual understanding:

Case studies: The agri-social entrepreneurship study employed exploratory multiple-case study design, enabling deep insights into business models and social impacts. Small-N case studies offer "insightful examples and practical information, focusing on quality rather than quantity".

Focus Group Discussions: Used for participatory farm classification in the Sundarbans, enabling farmers to define categories based on local knowledge. Also employed in cashew study to explore livelihood impacts.

Semi-structured interviews: Used across studies to capture farmer attitudes, opinions, and experiences. The m-governance study applied semi-structured interviews to understand information-seeking behaviour and communication ecosystems.

Participatory methods: Card-sorting exercises enabled farmers to visualize and classify farm characteristics, ensuring local knowledge informs classification.

3.4 Challenges and Limitations

Mixed-methods research faces several challenges:

Scalability: Participatory methods developed in specific locations may lack generalizability. The Sundarbans study addressed this through CRT decision trees that can be applied in new locations.

Resource intensity: In-depth qualitative data collection is time-consuming and expensive, limiting sample sizes. The agro ecological study interviewed 60 farmers, while the institutional study surveyed 180 farmers. However, the cashew study achieved 267 respondents, and the digital services study reached 3,375 farmers, demonstrating variation in scale.

Integration challenges: Combining different types of data requires careful attention to epistemological and methodological compatibility. The studies reviewed demonstrate varied approaches to integration, with some emphasizing sequential designs and others employing triangulation.

Context specificity: Findings are often co-related with prevalent socio-cultural dynamics, limiting generalize ability to different contexts. This suggests the need for testing findings in diverse settings.

4. KEY FINDINGS AND EMERGING INSIGHTS

4.1 Heterogeneity and Targeting

A consistent finding across studies is the critical importance of farm-level heterogeneity. Farm typologies reveal that "smallholder" is not a homogeneous category but encompasses diverse resource endowments, livelihood strategies, and adoption capacities. This heterogeneity has implications for intervention targeting: one-size-fits-all approaches are likely to be inequitable and ineffective.

The Sundarbans typology illustrates a progression from low-input systems to diversified, resource-rich farms, suggesting transformation pathways. The scalability of typology through decision trees enables context-sensitive targeting even where longitudinal data are unavailable. This represents a significant methodological advance, as "scaling innovations across larger areas demands more than just recognizing heterogeneity through typology studies; the methods used for typology delineation must also support effective upscaling" .

4.2 Social and Ecological Co-benefits

Agro ecological transitions generate social and ecological co-benefits alongside maintained financial outcomes. Stronger community networks, improved dietary diversity, and enhanced natural and social capital suggest that sustainability transitions can build livelihood resilience. The finding that "social, physical and natural capital assets were significantly higher for transitional and agro ecological farmers, while financial capital assets were the same across all farmers" challenges narratives that sustainable practices necessarily compromise economic viability.

Similarly, institutional engagement creates synergies that enhance development outcomes beyond what individual interventions achieve. Villages with higher institutional connectivity reported improvements across multiple dimensions: income, skill development, gender empowerment, and market access. This suggests that collaborative institutional ecosystems are more effective than isolated interventions.

4.3 The Income-Food Security Trade-off

The cashew study highlights a tension between income generation and food security. While cash crop cultivation significantly improves income and access to education, limited staple crop cultivation raises concerns about long-term food security. This finding underscores the need for integrated approaches that balance commercial and subsistence objectives. Intercropping with staples, price stabilization, and cooperative organization were identified as strategies to reduce economic exposures while maintaining food security.

4.4 Adoption Gaps and Constraints

Studies consistently identify adoption gaps between awareness and practice. Despite awareness of Climate-Smart Agriculture, adoption was low due to absence of infrastructure and technology. A gap was found between expert recommendations related to integrated and efficient nutrient management and farmers' adoption levels. This suggests that knowledge alone is insufficient; addressing structural and institutional barriers is essential.

Digitalization presents similar challenges. While digital services show significant positive effects on per-acre agricultural income, there is disparity in access across farm sizes, with marginal farmers lagging in digitalization. Policies promoting education (particularly digital and financial literacy), easier access to credit, and availability of advisory services in local languages could address these barriers.

4.5 Entrepreneurial and Behavioral Determinants

Secondary agriculture enterprises demonstrate positive correlations between entrepreneurial behaviour and factors like education, income, investment, media use, aspiration, motivation, gratification, and values, with negative correlation with age. Principal component analysis grouped 23 entrepreneurial attributes into seven factors, providing insight into the multidimensional nature of entrepreneurial capacity. "Strategic policy advocacy to enhance entrepreneurs' holistic development should prioritize these key attributes".

4.6 Information and Communication Dynamics

The m-governance study explored mobile technology's importance for diffusing agricultural knowledge, examining farmer information-seeking behavior and communication ecosystems.

Findings have implications for designing and implementing future projects, suggesting that communication platforms are vital for successfully reaching farmers for overall welfare. The study's multimodal approach – semi-structured interviews, experimental observations, and secondary data – provides a model for understanding technology adoption in socio-cultural context.

5. IMPLICATIONS FOR POLICY AND PRACTICE

5.1 Targeting and Differentiation

The heterogeneity identified across studies implies that policies and programs must be differentiated by farm type, resource endowments, and livelihood strategies. Farm typologies provide a tool for this differentiation, enabling context-sensitive targeting. Decision support trees can be applied at scale, helping extension services and development organizations identify appropriate interventions for different farmer categories.

5.2 Supporting Transitions

Agro ecological transitions and sustainable intensification require support for incremental change. The finding that benefits emerge even in early transition stages suggests that policies should reduce barriers to initial adoption – addressing knowledge, input, and infrastructure constraints. Peer networks, training opportunities, and demonstrations of success are powerful drivers for adoption.

5.3 Institutional Coordination

The institutional engagement study demonstrates that collaborative ecosystems enhance development outcomes. Coordination between government agencies, NGOs, financial institutions, and private sector actors can create synergies that individual interventions cannot achieve. This suggests that policies should incentivize institutional collaboration and strengthen connectivity between villages and development actors.

5.4 Balancing Commercial and Subsistence Objectives

The cashew study highlights the need for policies that enable farmers to benefit from commercial opportunities while maintaining food security. Intercropping, price stabilization, and cooperative organization are strategies that could reduce trade-offs. Investments in climate-resilient varieties and sustainable practices can also address environmental concerns while supporting livelihoods.

5.5 Digital Inclusion

Digital services have significant potential to improve farm incomes, but access disparities must be addressed. Policies promoting digital and financial literacy, easier access to credit for technology investment, and local-language advisory services can enhance inclusion. The m-governance study emphasizes that communication platforms must be designed with attention to farmers' information-seeking behavior and communication ecosystems.

5.6 Entrepreneurial Development

Supporting agricultural entrepreneurship requires attention to multiple behavioral determinants: education, income, investment, media use, aspiration, motivation, gratification, and values. Policies should prioritize these key attributes for holistic development. Agri-social

entrepreneurship models offer scalable solutions that integrate economic viability with social and environmental objectives.

6. FUTURE RESEARCH DIRECTIONS

6.1 Longitudinal Studies

Most studies reviewed are cross-sectional, capturing a snapshot of agricultural systems. Longitudinal research tracking transitions over time would deepen understanding of transformation dynamics, adoption patterns, and livelihood outcomes. The Sundarbans study's use of five-year recall data offers one approach, but prospective longitudinal designs would provide stronger evidence.

6.2 Comparative Research

Testing findings in different contexts would add value to proposed theories and their implications. Comparative research across Indian regions and agricultural systems would identify contextual factors that moderate transformation pathways. The scalability of farm typologies through decision trees offers a methodological foundation for such comparisons.

6.3 Integration of Biophysical and Social Data

While the reviewed studies focus on social, economic, and institutional dimensions, deeper integration with biophysical data would strengthen understanding of environmental outcomes. Agro ecological transition studies could combine social-ecological assessment with soil health, biodiversity, and ecosystem services monitoring.

6.4 Gender and Intersectional Analysis

Although some studies address gender dimensions, more systematic attention to gendered and intersectional dynamics would enhance understanding of inclusive transformation. The cashew study's fourth research question explicitly addresses "gender and social relations that affect the availability of resources to farmers", suggesting frameworks for broader application.

6.5 Technology-Enabled Measurement

Digital technologies offer new possibilities for measurement and monitoring. Mobile platforms, remote sensing, and artificial intelligence could complement traditional mixed-methods approaches, enabling more frequent and detailed data collection. However, attention to digital divides in access and literacy remains essential.

6.6 Participatory and Action Research

Greater involvement of farmers and communities in research design and interpretation would enhance relevance and impact. Participatory approaches in farm typology demonstrate the value of local knowledge in classification. Expanding participatory methods to all stages of research would deepen understanding and support knowledge co-production.

Summing Up

Indian agriculture is undergoing profound transformation, driven by shifting paradigms of sustainable intensification, agro ecology, social entrepreneurship, and livelihood diversification. Understanding these transformations – and measuring their impacts – demands methodological

approaches that capture both breadth and depth, both patterns and processes, both generalize ability and context-specificity.

Mixed-methods research provides the most robust foundation for this task. The studies reviewed demonstrate diverse integration strategies – participatory and statistical classification, qualitative interviews within quantitative frameworks, case studies complemented by network analysis, and multi method assessment of social-ecological outcomes. These approaches reveal insights that would be inaccessible through single-method designs.

Key insights emerge from the synthesis. First, smallholder heterogeneity is a fundamental feature requiring context-sensitive interventions; scalable typologies can support targeting without sacrificing contextual relevance. Second, agro ecological and sustainable intensification transitions generate social and ecological co-benefits while maintaining economic outcomes, challenging trade-off narratives. Third, institutional coordination and social entrepreneurship can create synergies that enhance rural transformation beyond what individual interventions achieve. Fourth, adoption gaps persist between awareness and practice, requiring attention to structural and institutional barriers.

Policy implications include differentiated targeting, support for incremental transitions, institutional coordination, balanced commercial-subsistence strategies, digital inclusion, and entrepreneurial development. Future research should pursue longitudinal designs, comparative analysis, biophysical-social integration, intersectional approaches, technology-enabled measurement, and participatory methods.

Ultimately, the mixed-methods paradigm offers more than methodological pluralism; it embodies a commitment to understanding agricultural transformation in all its complexity. As Indian agriculture navigates the challenges of climate change, market volatility, and structural constraints, robust evidence generated through integrated methods will be essential for shaping policies and practices that promote sustainable, equitable, and resilient rural development.

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