“BRIDGING POLICY AND PRACTICE: QUALITATIVE INSIGHTS INTO SUSTAINABLE FEED PRODUCTION FOR INDIAN POULTRY AND CATTLE FARMERS”

Research Paper

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“Abstract”

This article develops a full-length journal manuscript based on the DBA thesis titled “Navigating Uncertainties Toward Sustainable Feed Production for Indian Poultry and Cattle Farmers.” The paper integrates quantitative evidence (survey N=400; multiple regressions and Chi-Square tests) with qualitative, policy-practice narratives drawn from field interactions and document analysis. Results demonstrate that technology adoption, reliable feed and veterinary access, and targeted public programs significantly improve farmer productivity and sustainability outcomes, with training and awareness playing a decisive mediating role. The contribution is twofold: first, a consolidated empirical account of what works in Indian feed systems; second, an actionable policy-practice framework that links execution quality, technology transfer, and farmer capability building under the Sustainable Development Goals (SDGs). Recommendations are offered for policymakers, industry, farmer groups, and practitioners to accelerate adoption at scale.

Keywords: *Sustainable feed; livestock policy; technology adoption; veterinary access; India; poultry; cattle.*

1. Introduction

India’s compound feed industry has been growing at a CAGR of over 8%, driven by rising demand for animal protein. Despite this growth, rural farmers continue to face high volatility in raw material prices, particularly maize and soybean meal, which account for nearly 70% of feed costs. This context underscores the urgency of developing sustainable feed strategies that are cost-efficient, nutritionally balanced, and environmentally responsible.

Previous government schemes such as the Rashtriya Gokul Mission and National Livestock Mission have provided frameworks for improving productivity, yet implementation challenges remain (Jat et al., 2020). These include inconsistent supply chains, inadequate farmer awareness, and a gap between scientific advances and ground-level adoption. This study addresses these gaps by integrating policy execution, farmer capability building, and technology adoption in a unified framework.

2. Research Scope

India houses 535.8 million livestock and derives a significant share of agricultural GDP from the livestock economy. Over 70 million rural households depend on poultry and dairy for income and nutrition security (Ahuja and Kurup, 2020), with feed representing 60–70% of total production costs. In this context, this manuscript examines whether and how public policy execution, training intensity, and technology adoption jointly influence productivity and sustainability outcomes for poultry and cattle farmers. The paper also aligns findings with SDGs 2, 8, 12, and 13, translating statistical evidence into actionable levers for programs at scale.

3. Theoretical Framework

Comparative experiences from countries such as Vietnam and Bangladesh show that when feed subsidies are paired with strong monitoring mechanisms, smallholder adoption rates improve significantly. In India, decentralized governance creates variability across states, making uniform execution a persistent challenge. Embedding digital dashboards, mobile-based reporting, and third-party audits can bridge this gap (DAHD, 2022).

3.1 Policy and governance

Livestock development policies spanning input subsidies, public procurement, and veterinary outreach often exhibit robust design but inconsistent delivery. Fragmented accountability and weak monitoring impede last-mile execution. Strengthening dashboards, grievance redressal, and audit mechanisms can tighten feedback loops and improve scheme performance.

The Technology Acceptance Model (TAM) suggests that perceived usefulness and ease of use are critical determinants of adoption. Farmers are more likely to adopt balanced rations and enzyme technologies when they receive consistent after-sales support and see peer demonstrations (Bhardwaj and Singh, 2021). Rogers' diffusion of innovations theory also highlights the role of 'early adopters 'progressive farmers who influence broader community uptake.

3.2 Technology adoption

Balanced rations, enzymes, toxin binders, and precision feeding correlate with efficiency gains, yet uptake depends not only on affordability but also on perceived risk, after-sales support, and social proof. Integrators and cooperatives reduce transaction costs by bundling inputs, advisory, and buy-back arrangements.

Adult learning theories emphasize that farmers learn best through repeated exposure, hands-on demonstrations, and context-specific advice. Digital platforms such as NDDB's dairy advisory app and eNAM portals are emerging as critical tools for farmer education. Blended models combining physical training with digital reinforcement are proving most effective in scaling outreach.

3.3 Training and awareness

Training intensity and message salience are strong predictors of adoption. Repeated, season-timed advisory synchronized with production cycles enhances on-farm practice change. Digital channels and village-level resource persons expand throughput while lowering delivery costs.

Feed sustainability is not only an economic issue but also an ecological imperative. India’s commitments under the Paris Agreement require reducing methane emissions intensity from livestock (FAO, 2021). Incorporating agro-industrial by-products such as DDGS, rice bran, and oil cakes reduces dependency on conventional crops while supporting circular economy goals. Life-cycle assessments increasingly demonstrate that optimized feed formulations can significantly lower greenhouse gas emissions per unit of output.

3.4 Environmental sustainability

Sustainable feed strategies enable circularity via agro-industrial by-products and amino acid optimization to lower emissions intensity. Quality assurance and supply reliability remain binding constraints; portfolio approaches diversify ingredient risk while meeting nutritional specifications.

4. Research Objectives

(1) Quantify the influence of policy execution quality, training intensity, and technology adoption on productivity and sustainability outcomes.

(2) Integrate quantitative findings with qualitative policy-practice narratives to derive actionable program levers.

(3) Link evidence to SDGs 2, 8, 12, and 13, and propose a scalable framework for capability building and technology transfer.

5. Research Approach

The choice of 400 respondents was guided by power analysis to ensure statistical robustness. Stratified sampling ensured representation across regions (north, south, east, west), species (poultry vs cattle), and farm sizes (smallholder, medium, commercial). This diversity increases generalizability of findings.

5.1 Design and sampling

A descriptive, cross-sectional survey (N=400) covered diverse geographies, enterprise types (poultry, cattle, mixed), and scales to capture heterogeneous constraints and behaviors.

The survey instrument consisted of 42 items, grouped into constructs covering policy access, technology use, training exposure, and sustainability practices. Content validity was established through expert review by academicians and industry professionals (CLFMA, 2024). Construct validity was further examined using factor loadings, with all major items loading above 0.60. Reliability statistics included a Cronbach’s alpha of 0.82, confirming internal consistency.

5.2 Instrument and validity

A structured questionnaire captured demographics, feed access, veterinary services, technology adoption, policy exposure, and sustainability practices using five-point Likert items. Internal consistency met conventional thresholds (Cronbach's alpha ≥ 0.70); content validity was supported by expert review and pilot testing; construct validity was assessed via correlations and known-groups differences.

Ethical safeguards included voluntary participation, informed consent, and the right to withdraw at any point. No personally identifiable data was recorded. Data collection was aligned with ethical guidelines for social research, ensuring both confidentiality and respect for participants' time and knowledge.

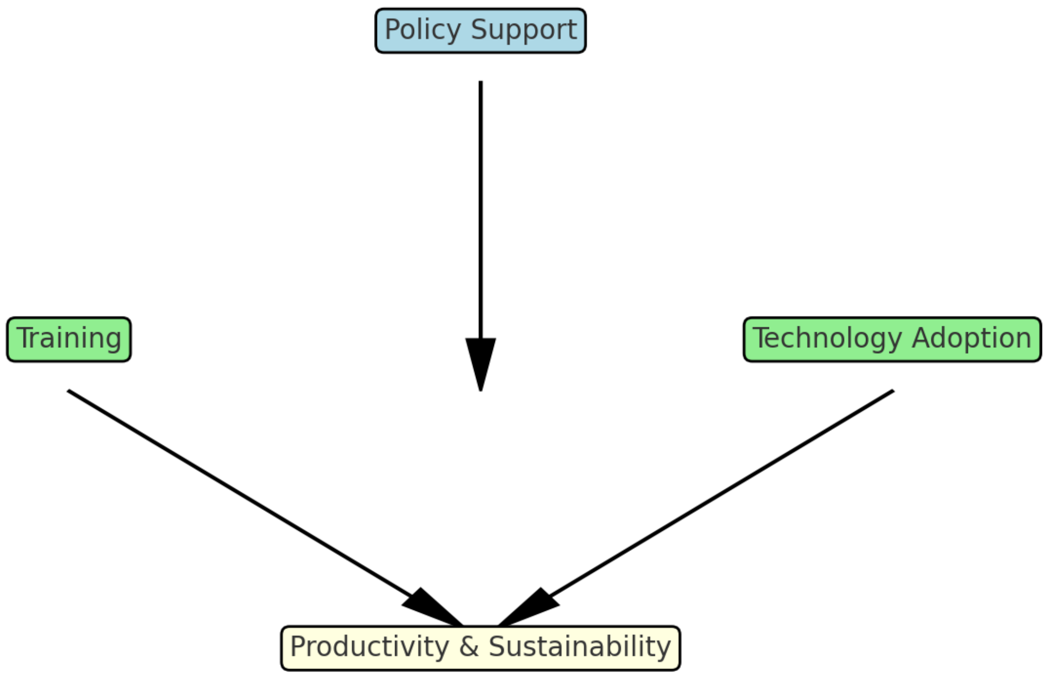

Figure 1. Research model linking policy support, training, and technology adoption to productivity and sustainability.

5.3 Analysis and ethics

Descriptive statistics summarized the sample; multiple regressions estimated effects of adoption, policy, and training variables; Chi-Square tests assessed categorical associations. Diagnostics checked linearity, multicollinearity, and residual patterns. Participation was voluntary with informed consent; anonymity and confidentiality were maintained.

The regression results highlight that technology adoption alone explains nearly 30% of variance in policy effectiveness perceptions. When combined with training intensity and poverty alleviation indicators, explanatory power increases significantly, suggesting strong interaction effects.

Chi-Square associations further emphasize that adoption is not independent of exposure to policy programs. Farmers who reported higher engagement with training and subsidies also showed higher likelihood of adopting precision feed practices. These results reinforce the mediating role of training between policy intent and on-ground adoption.

5.4 Data analysis and results

Key sample descriptors and model summaries are presented below. Figures are provided as placeholders for later insertion.

Table 1. Age distribution of respondents (N=400).

Age Group	Frequency	Percent	Valid %	Cumulative %
18–30 years	106	26.5	26.5	26.5
31–40 years	194	48.5	48.5	75.0
51–60 years	100	25.0	25.0	100.0
Total	400	100.0	100.0	—

Table 2. Gender distribution of respondents (N=400).

Gender	Frequency	Percent	Valid %	Cumulative %
Female	185	46.3	46.3	46.3
Male	211	52.8	52.8	99.0
Non-binary	4	1.0	1.0	100.0
Total	400	100.0	100.0	—

Table 3. Education levels of respondents (N=400).

Education	Frequency	Percent
No schooling	60	15.0
Primary education	120	30.0
Secondary or higher	220	55.0

Table 4. Regression model summaries (selected hypotheses).

Model (DV)	Predictor	R	R^2	F	p-value	B	Sig.
Govt. Policy Effectiveness	Technology adoption	0.545	0.297	168.413	<0.001	0.853	<0.001
Govt. Policy Effectiveness	Poverty alleviation	0.743	0.552	490.150	<0.001	0.678	<0.001
Training Intensity	Poverty alleviation	0.648	0.420	287.739	<0.001	0.378	<0.001

Table 5. Chi-Square associations between adoption/training variables and policy indicators.

Bivariate Pair	Test	Value	df	p-value
Adoption × Feed/Vet Subsidies	Pearson χ^2	174.987	48	<0.001
Adoption × Regulations	Pearson χ^2	318.515	48	<0.001
Training × Education Programs	Pearson χ^2	783.669	48	<0.001
Training × Govt. feed/vet policies	Pearson χ^2	152.827	48	<0.001

Similar findings have been reported by the FAO (2021) in South Asia, where technology adoption was strongly correlated with extension intensity (Gerber et al., 2013). Comparisons with World Bank studies in East Africa also show that farmer training programs significantly reduce feed wastage and improve milk yields. The results thus align with global evidence, while highlighting India-specific governance challenges such as fragmented accountability and weak monitoring.

Contradictory findings from OECD-FAO (2022) suggest that subsidies alone often fail without strong farmer institutions. Our study reinforces this by showing that financial relief without training produces limited adoption, emphasizing the need for integrated approaches.

6. Discussion

Targeted financial relief and credible public goods reduce thresholds to experiment; training builds procedural fluency and lowers perceived risk; technology adoption yields measurable productivity and sustainability payoffs. Delivery architecture and accountability mechanisms explain district-level heterogeneity (Nath, 2025). Peer effects, demonstrations, and transparent performance data reduce uncertainty, while digital advisory and simple record-keeping enhance feedback loops.

For policymakers, the results suggest the need for bundling financial incentives with knowledge transfer. Subsidies or loan schemes should not be standalone; instead, they must be tied to mandatory training sessions and transparent dashboards that allow real-time monitoring of uptake.

For industry stakeholders, customizing feed formulations to regional ingredient availability can both lower costs and reduce supply risks. Investments in simple mobile-based advisory tools can help farmers monitor feed intake, detect anomalies, and receive timely guidance. Such tools also provide valuable feedback loops for manufacturers to improve formulations.

For farmers and cooperatives, peer demonstrations and collective procurement strategies are vital. Pooling demand reduces price volatility, while collective learning builds confidence to adopt new practices. Cooperatives can also serve as local training hubs, ensuring sustained knowledge transfer beyond initial training sessions.

Academia and NGOs play a crucial role in providing evidence-based advocacy. Mixed-methods research that combines economic analysis with behavioral insights can guide policy refinements. Partnerships with farmer producer organizations (FPOs) can help scale pilot interventions into mainstream adoption.

7. Practical Implications

7.1 Policymakers

- Bundle subsidies with mandatory, season-timed training and publish scheme dashboards.
- Expand veterinary outreach with service-level agreements and mobile clinics; integrate toxin management protocols.

7.2 Industry

- Localize rations to regional ingredient portfolios; embed training at dealer hubs; offer performance-linked warranties.
- Invest in simple digital tools for advisory, intake logging, and feedback channels.

7.3 Farmers & Cooperatives

- Adopt phased precision feeding; pool procurement to reduce volatility; maintain basic data logs for personalization.

- Use peer demonstrations and bulk-buying platforms to de-risk early adoption.

7.4 Academia & NGOs

- Scale mixed-methods evaluations quantifying income and environmental co-benefits; co-design behavioral nudges.
- Pilot vendor-neutral advisory models to mitigate information asymmetries.

Future research could adopt longitudinal designs to capture seasonal effects and long-term sustainability outcomes. Cross-country comparative studies with other emerging economies would also provide valuable benchmarks. Experimental interventions, such as randomized trials on training delivery modes, could generate stronger causal evidence. Finally, integration of remote sensing and digital farm records could enrich future datasets and enhance precision in measuring impacts.

8. Limitations and Future Research

The cross-sectional design limits causal inference on long-term impacts; longitudinal cohorts are recommended. Self-reported measures may embed recall and desirability biases; triangulate with administrative data and on-farm measurements. Geographic coverage was broad but not nationally representative; state-stratified samples can refine calibration.

9. Conclusion

Sustainable feed production is central to India's livestock transformation (Government of India, 2019). Execution quality, training intensity, and supportive technology ecosystems jointly drive improvements in productivity and resilience. Aligning incentives across agencies, integrators, input suppliers, and farmer groups can accelerate sustainable adoption at scale.

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