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Agricultural Insurance and Farmer Empowerment in Uttar Pradesh: A Systematic Review and Conceptual Framework

Kranti Singh[1], Shishir Srivastava[2] and Vishal*[3]

[1] Professor, Department of Commerce, Netaji Subhash Chandra Bose Government Girls P. G. College Aliganj, Lucknow - 226 024, Uttar Pradesh, India
[2] Assistant Professor, Rajkiya Mahila Mahavidyalaya, Sheikh Sarai, Sitapur - 261 402, Uttar Pradesh, India
[3] Research Scholar, Department of Commerce, University of Lucknow, Lucknow - 226 007, Uttar Pradesh, India

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Abstract

Agricultural insurance has emerged as a pivotal instrument for managing farm-level risk and enhancing the socio-economic resilience of farming communities in developing agrarian economies. Despite the Government of India's concerted policy efforts most notably the Pradhan Mantri Fasal Bima Yojana (PMFBY, 2016) awareness and adoption of agricultural insurance among smallholder farmers in Uttar Pradesh remain critically low. This paper presents a conceptual framework and systematic secondary data review examining the role of agricultural insurance as a tool for the empowerment of farmers in Uttar Pradesh. Drawing on published literature, government data, and comparative international evidence, the study identifies five primary dimensions of farmer empowerment financial resilience, economic decision-making autonomy, social capital, sustainable livelihood advancement, and technology-mediated access and maps them against documented barriers to insurance adoption including information asymmetry, administrative complexity, trust deficits, and financial constraints. A conceptual model linking insurance awareness to empowerment outcomes is proposed and discussed. The paper contributes to the limited body of localized research on agricultural risk management in Uttar Pradesh and offers evidence-based recommendations for policymakers, insurance providers, and extension services. The paper develops a conceptual foundation for future empirical investigation.

***Key words*:** Agricultural insurance, Farmer empowerment, PMFBY, Uttar Pradesh, Risk management, Financial inclusion, Smallholder farmers, Conceptual framework

Agriculture is the cornerstone of India's economy, employing nearly 47% of the workforce and contributing approximately 18% to the national GDP [1]. Within this sector, Uttar Pradesh occupies a position of particular national significance - it is India's most populous state and one of its largest agricultural producers, with over 65% of its population dependent on farming for their livelihoods [2]. Yet the farmers of Uttar Pradesh are among the most economically vulnerable in the country, perpetually exposed to an array of production, price, and climate-related risks that can devastate household incomes in a single season. However, agricultural production is increasingly threatened by climate variability, natural disasters, pest infestations, and market uncertainties, which expose farmers to severe financial risks. In this context, agricultural insurance has emerged as an important institutional mechanism for stabilizing farm income, reducing vulnerability, and enhancing resilience among farming communities. The introduction of schemes such as the Pradhan Mantri Fasal Bima Yojana (PMFBY) aimed to provide comprehensive risk coverage and financial security to farmers through affordable premium rates and timely compensation for crop losses [3].

Agricultural insurance, in theory, offers a powerful financial safety net against these uncertainties. By transferring risk from the individual farmer to a broader pool, insurance schemes protect farm income, reduce debt vulnerability, encourage investment in productivity-enhancing inputs, and ultimately empower farmers to make rational, forward-looking economic decisions. The Government of India has made successive efforts to institutionalize agricultural insurance, culminating in the PMFBY - the world's largest crop insurance scheme by coverage area - which subsidizes premiums to as low as 1.5 - 2% for farmers [4]. Nevertheless, the gap between policy intent and ground-level reality remains stark. Empirical studies consistently report that a significant proportion of farmers in Uttar Pradesh are unaware of the PMFBY and other available insurance instruments. Singh and Jain [5] found that only 38% of surveyed farmers in the state were aware of the PMFBY, and adoption rates were even lower. This awareness-adoption gap represents not merely an administrative failure but a profound constraint on the economic and social empowerment of millions of farming households.

Despite the expansion of crop insurance programmes in India, several studies have reported challenges related to low awareness, delayed claim settlements, inadequate compensation, procedural complexities, and uneven adoption across regions and farmer categories. In Uttar Pradesh, where

***Correspondence to:** Vishal, E-mail: contact.vishal.edu@gmail.com; Tel: +91 8802028819

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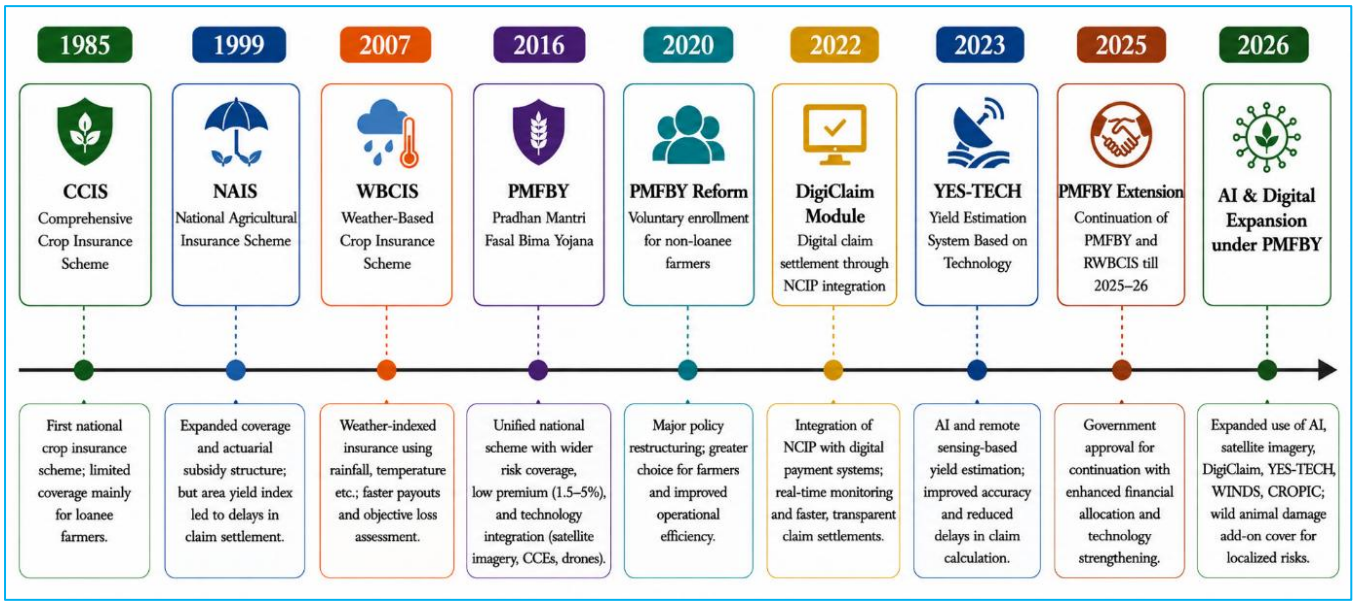
small and marginal farmers dominate the agrarian structure, these issues significantly influence the effectiveness of agricultural insurance in empowering farmers economically and socially [6]. Existing literature suggests that agricultural insurance not only serves as a risk mitigation tool but also enhances farmers' confidence in adopting improved technologies, accessing institutional credit, and making productive farm investments. However, barriers such as limited financial literacy, lack of transparency, and administrative inefficiencies continue to restrict its full potential [7].

Therefore, the present paper attempts to systematically review the existing literature on agricultural insurance and farmer empowerment with special reference to Uttar Pradesh and proposes a conceptual framework linking insurance access, awareness, institutional support, risk reduction, and socio-economic empowerment. The study seeks to synthesize available evidence on the role of agricultural insurance in strengthening farmers' resilience, improving livelihood security, and promoting sustainable agricultural development. The proposed framework is expected to provide valuable insights for policymakers, researchers, and development agencies in designing more inclusive, transparent, and farmer-centric insurance interventions in the agricultural sector.

Evolution of agricultural insurance in India: A policy trajectory

The evolution of agricultural insurance in India reflects a gradual transition from traditional yield-based compensation mechanisms to technologically enabled and digitally integrated risk-management systems. Since the mid-1980s, the Government of India has introduced multiple agricultural insurance schemes aimed at protecting farmers from crop losses arising due to natural calamities, pests, diseases, and climatic uncertainties. These reforms indicate increasing policy recognition of agricultural insurance as a critical instrument for income stabilization, rural resilience, and farmer empowerment.



Note: Fig 1 is adapted and compiled by the authors from Raju and Chand [8]; Vani and John [9]; Verma *et al*. [4]; Mishra and Verma [10]. PMFBY operational documents (pmfby.gov.in); Press Information Bureau [11-14] and Government of India policy updates

Fig 1 Evolution of agricultural insurance policy in India (1985-2026)

The first major initiative, the Comprehensive Crop Insurance Scheme (CCIS), was introduced in 1985 as a centrally sponsored scheme to provide limited crop-loss protection to loanee farmers. Although pioneering in nature, the scheme suffered from restricted coverage, delayed settlements, and inadequate institutional outreach [8]. In 1999, the National Agricultural Insurance Scheme (NAIS) replaced CCIS with broader coverage and actuarial improvements. NAIS significantly expanded farmer participation; however, dependence on area-based yield estimation resulted in delays in claim settlement and weak responsiveness to localized crop damage [9].

To address these limitations, the Weather-Based Crop Insurance Scheme (WBCIS) was introduced in 2007. Unlike earlier yield-based schemes, WBCIS linked compensation to measurable weather parameters such as rainfall, temperature, and humidity. This reduced claim-processing time and improved objectivity in loss assessment, although concerns regarding basis risk and farmer awareness persisted [8].

A major transformation occurred in 2016 with the launch of the Pradhan Mantri Fasal Bima Yojana (PMFBY), which consolidated previous insurance schemes into a unified national framework. PMFBY introduced highly subsidized premium rates, wider risk coverage, and technology-enabled assessment mechanisms including satellite imagery, smartphone-based Crop Cutting Experiments (CCEs), drone surveys, and remote sensing technologies. The scheme was accompanied by the Restructured Weather-Based Crop Insurance Scheme (RWBCIS), further strengthening climate-risk coverage [4].

Subsequent reforms after 2020 increasingly emphasized digitization, transparency, and technology-driven claim management. In 2020, PMFBY was made voluntary for non-loanee farmers, marking a significant restructuring of the scheme and shifting greater emphasis toward farmer choice and operational efficiency. The introduction of the DigiClaim module from Kharif 2022 integrated the National Crop Insurance Portal (NCIP) with digital payment systems to accelerate and monitor claim settlements more transparently. Similarly, the implementation of YES-TECH (Yield Estimation System Based on Technology) from 2023 onwards promoted the use of remote sensing, AI-enabled analytics, and technology-based yield estimation methods for improving assessment accuracy and reducing delays in compensation processing. These reforms signify the increasing integration of digital governance and artificial intelligence within India's agricultural insurance ecosystem.

Recognizing the continuing importance of crop insurance in the context of climate uncertainty and agricultural

vulnerability, the Government of India further extended PMFBY and RWBCIS until 2025-26 with enhanced financial allocation and stronger technological integration. Collectively, these reforms indicate a shift in India's agricultural insurance architecture from conventional subsidy-driven compensation toward integrated, technology-enabled agricultural risk governance. In 2026, PMFBY entered a more advanced phase of technology-driven agricultural risk governance through expanded use of artificial intelligence, satellite imagery, DigiClaim systems, and digital monitoring platforms such as YES-TECH, WINDS, and CROPIC. Additionally, crop losses caused by wild animal attacks were introduced as an add-on localized risk coverage under the scheme [15].

Data depicted in (Table 1) represents the evolution of major agricultural insurance policies and technological reforms in India from 1985 to 2026. The table highlights the gradual transformation of India's agricultural insurance framework from conventional yield-based compensation mechanisms to technologically integrated and digitally governed risk-management systems.

Table 1 Evolution of major agricultural insurance policies and technological reforms in India (1985-2026)

Scheme	Year	Coverage basis	Premium rate	Key features
CCIS (Comprehensive Crop Insurance Scheme)	1985	Yield-based crop insurance	Subsidized by Government of India	First national agricultural insurance scheme introduced primarily for loanee farmers; aimed to provide compensation against crop failure due to natural calamities
NAIS (National Agricultural Insurance Scheme)	1999	Area yield index	Actuarial premium with government subsidy	Expanded crop and farmer coverage beyond loanee farmers; broader risk protection; improved subsidy structure
WBCIS (Weather-Based Crop Insurance Scheme)	2007	Weather-indexed parameters such as rainfall, temperature, and humidity	Actuarial premium supported by government subsidy	Faster and objective claim settlement through weather indicators; reduced dependence on crop-cutting experiments
PMFBY (Pradhan Mantri Fasal Bima Yojana)	2016	Yield loss and localized weather risks	Highly subsidized farmer premium (1.5%-5%) with Centre-State cost sharing	Unified national crop insurance framework; technology integration through satellite imagery, drones, smartphone-based Crop Cutting Experiments (CCEs), and remote sensing; wider risk coverage
PMFBY Reform Measures	2020	Yield and weather risk protection	Voluntary enrollment for non-loanee farmers	Major restructuring of PMFBY; improved operational flexibility; increased choice for farmers; subsidy rationalization
DigiClaim Module and NCIP Integration	2022	Digital claim management and monitoring	Government-supported digital infrastructure	Integration of National Crop Insurance Portal (NCIP) with direct digital claim settlement systems; improved transparency and faster claim disbursement
YES-TECH (Yield Estimation System Based on Technology)	2023	AI-enabled and remote sensing-based yield estimation	Government-supported technology initiative	Use of artificial intelligence, satellite imagery, remote sensing, and digital analytics for accurate crop-loss estimation and reduction in settlement delays
Extension of PMFBY and RWBCIS till 2025-26	2025	Integrated agricultural risk governance	Enhanced financial allocation by Government of India	Continuation of PMFBY and Restructured WBCIS with stronger emphasis on technological strengthening and digital governance
AI and Digital Expansion under PMFBY	2026	Technology-driven agricultural risk management	Government-supported digital modernization	Expanded use of AI, DigiClaim, YES-TECH, WINDS, CROPIC, satellite monitoring, and digital crop assessment systems; inclusion of wild animal attack add-on coverage under localized risks

Note: (Table 1) is adapted and compiled by the authors from Raju and Chand [8]; Vani and John [9]; Verma *et al*. [4]; Mishra and Verma [10]; PMFBY operational documents, and Government of India policy updates

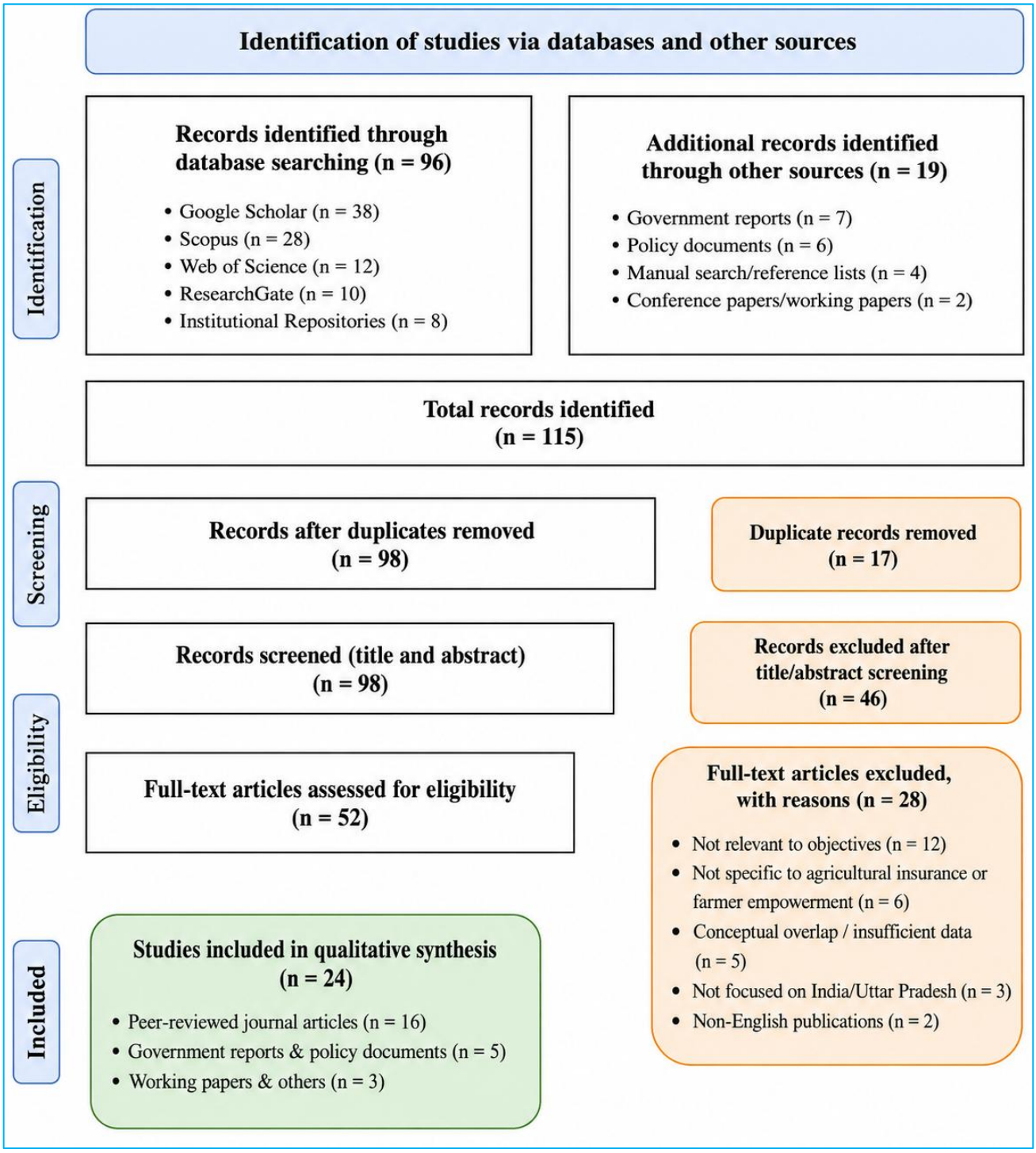
Theoretical underpinnings

Risk management theory and agricultural insurance

The economic rationale for agricultural insurance is grounded in expected utility theory [16], which posits that risk-averse agents - a well-established characteristic of smallholder farmers - are willing to pay a premium above the actuarially fair price to eliminate income variance. Under this framework, insurance functions as a welfare-enhancing mechanism by enabling farmers to smooth consumption across good and bad seasons, thereby reducing the poverty trap effects associated with uninsured agricultural shocks [17].

Extending this, the moral hazard and adverse selection problems in insurance markets [18] are particularly pronounced

in agriculture, where information asymmetries between farmers and insurers are high. Index-based insurance products, such as weather-indexed schemes, were theoretically developed to mitigate these issues by tying payouts to exogenous, verifiable parameters rather than individual farm-level losses [19]. However, basis risk - the mismatch between the index trigger and actual farm-level loss - remains a significant theoretical and practical challenge [20].



Note: Figure 2 is adapted and developed by the authors based on PRISMA 2020 guidelines [25]

Fig 2 PRISMA flow diagram of the study selection process (Agricultural Insurance and Farmer Empowerment in Uttar Pradesh)

Empowerment theory

The concept of empowerment in development literature is multidimensional, encompassing economic, social, and political dimensions [21-22]. In the agricultural context, farmer empowerment is understood as the process by which farmers gain the resources, capabilities, and agency to make informed decisions, take calculated risks, and participate meaningfully in market and governance structures. Narayan [23] identifies four key empowerment pillars: access to information, inclusion and participation, accountability, and local organizational capacity. Agricultural insurance intersects with this framework at multiple points. First, by providing financial security, it expands the "capability set" [21] of farmers, enabling investment in better seeds, inputs, and farming practices without the fear of catastrophic loss. Second, awareness and comprehension of insurance products require and, in turn, build informational literacy - itself an empowering resource. Third, participatory insurance design and community-based claim verification processes can strengthen local organizational capacity and social trust.

Technology acceptance and diffusion of innovation

Rogers' [24] diffusion of innovations framework provides a useful lens for understanding why agricultural insurance adoption follows a slow S-curve in rural India. Key determinants of adoption - relative advantage, compatibility, complexity, trialability, and observability - map directly onto reported barriers: the perceived relative advantage of insurance over informal coping mechanisms (e.g., distress sales, migration, borrowing) is insufficiently communicated; the complexity of enrollment and claim procedures reduces adoptability; and low observability of successful claims among peers limits social proof. Addressing these dimensions through targeted communication and simplification strategies is therefore theoretically foundational to improving adoption.

Systematic literature review

PRISMA-based review methodology

This study adopts the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach to ensure transparency, methodological rigor, and systematic selection of relevant literature [25]. The PRISMA framework was employed to identify, screen, evaluate, and synthesize scholarly literature relating to agricultural insurance, farmer empowerment, crop insurance adoption, and agricultural risk governance in India, with special emphasis on Uttar Pradesh. Relevant literature published between 2005 and 2026 was identified through electronic databases including Google Scholar, Scopus, Web of Science, ResearchGate, and institutional repositories of government organizations, policy agencies, and agricultural research institutions. The search process utilized combinations of keywords such as "agricultural insurance India," "PMFBY," "crop insurance Uttar Pradesh," "farmer empowerment," "agricultural risk management," "insurance awareness," "technology-enabled crop insurance," "financial inclusion," and "digital agricultural governance."

The review included peer-reviewed journal articles, government reports, policy papers, working papers, and institutional publications written in English. Particular preference was given to studies focusing on PMFBY implementation, agricultural insurance awareness, technological reforms, socio-economic determinants of adoption, and farmer empowerment outcomes in Uttar Pradesh. Duplicate records, unrelated conceptual discussions, non-English publications, and studies lacking relevance to the objectives of the present research were excluded from the final review.

A total of 96 records were identified through major databases including Google Scholar, Scopus, Web of Science, ResearchGate, and institutional repositories, while 19 additional records were obtained from government reports, policy documents, manual search, and reference lists, resulting in 115 total records. After removing 17 duplicate records, 98 studies were screened based on title and abstract. Forty-six studies that were not relevant to the objectives of the study were excluded. Subsequently, 52 full-text articles were assessed for eligibility. Twenty-eight studies were excluded due to reasons such as lack of relevance, conceptual overlap, insufficient data, non-focus on India or Uttar Pradesh, and non-English language. Finally, 24 core empirical and conceptual studies satisfying the inclusion criteria were incorporated into the qualitative synthesis. These studies form the theoretical, empirical, and policy foundation of the present research framework. Following PRISMA screening procedures, the selected studies were evaluated on the basis of thematic relevance, methodological quality, regional applicability, and contribution to the conceptual objectives of the study. (Fig 2) presents the PRISMA flow diagram of the literature selection process.

Agricultural insurance and risk management: National perspective

Agricultural insurance has emerged as one of the most significant institutional mechanisms for managing production risk and stabilizing farm income in developing agrarian economies. In India, agricultural insurance policies have evolved gradually from conventional yield-based compensation systems toward integrated and technology-enabled risk-management frameworks. Existing literature consistently emphasizes that agricultural insurance reduces vulnerability to climatic shocks, supports post-disaster recovery, and enhances farmers' willingness to adopt productivity-enhancing agricultural practices [17]. Raju and Chand [8] observed that early agricultural insurance schemes in India suffered from low penetration, delayed claim settlement, and inadequate institutional outreach. Their study highlighted the structural limitations of area-based crop insurance models and emphasized the need for actuarially sound and technologically efficient insurance mechanisms. Similarly, Vani and John [9] identified operational inefficiencies and administrative delays as major constraints affecting the effectiveness of crop insurance delivery in rural India.

The introduction of the Pradhan Mantri Fasal Bima Yojana (PMFBY) in 2016 marked a significant shift in India's agricultural insurance landscape. Verma *et al*. [4] argued that PMFBY represented a major policy reform because of its low premium structure, wider risk coverage, and technological integration through satellite imagery, smartphone-based Crop Cutting Experiments (CCEs), remote sensing, and drone-based assessment. However, despite policy innovation, implementation-related issues including delayed settlement, awareness deficits, and institutional mistrust continued to limit farmer participation. Mishra and Verma [10] emphasized that agricultural insurance in India remains heavily dependent on state capacity, extension services, and digital infrastructure. Their review concluded that although PMFBY substantially improved risk coverage and accessibility, socio-economic inequalities and regional disparities continue to influence adoption outcomes. Similarly, Goodwin and Smith [26] noted that even internationally successful crop insurance systems require strong institutional infrastructure, rapid claim settlement mechanisms, and sustained farmer trust for long-term effectiveness.

Agricultural insurance literature in Uttar Pradesh

Uttar Pradesh occupies a distinctive position within India's agricultural economy due to its large agrarian population, regional diversity, and high dependence on monsoon-sensitive farming systems. Despite being one of India's largest agricultural states, awareness and adoption of agricultural insurance schemes remain uneven across districts and socio-economic groups. Singh and Jain [5] found that awareness of PMFBY among farmers in Uttar Pradesh was significantly low, particularly among small and marginal farmers. Their study reported that only a limited proportion of surveyed farmers possessed adequate understanding of premium structures, claim procedures, and eligibility criteria. The authors further observed that awareness was positively associated with education level, institutional credit access, and interaction with agricultural extension services. Regional disparities in insurance uptake have also been widely documented. Singh *et al*. [27] conducted a district-level analysis of agricultural insurance adoption in Uttar Pradesh and

identified considerable variation between western, central, eastern, and Bundelkhand regions. Western districts demonstrated relatively higher insurance enrolment due to better banking infrastructure, stronger institutional networks, and greater access to extension services, whereas eastern Uttar Pradesh and Bundelkhand exhibited lower participation rates. Kumar and Baliyan [28], in their study of the drought-prone Bundelkhand region, found that positive claim settlement experiences significantly influenced re-enrolment behaviour among farmers. Their findings suggested that trust in insurance institutions is strongly shaped by timely compensation and procedural transparency. Farmers who received compensation promptly were substantially more likely to continue participation in subsequent crop seasons. Gupta *et al*. [29] highlighted the importance of extension infrastructure in improving insurance awareness in Uttar Pradesh. Their study revealed that farmers who regularly interacted with Krishi Vigyan Kendras (KVKs), agricultural officers, or training programmes demonstrated significantly higher awareness and enrolment levels under PMFBY. The study further emphasized that institutional outreach remains one of the most effective mechanisms for reducing information asymmetry in rural insurance markets. Technological barriers also remain a critical issue in Uttar Pradesh. Mishra *et al*. [30] argued that digital agricultural governance initiatives, while theoretically efficient, may unintentionally exclude farmers lacking smartphones, internet connectivity, or digital literacy. This concern is particularly relevant in rural Uttar Pradesh where infrastructural disparities continue to affect access to digital insurance platforms and claim-processing systems.

Socio-economic determinants of insurance adoption

A substantial body of literature identifies socio-economic variables as major determinants of agricultural insurance awareness and adoption. Education level, farm size, annual household income, credit accessibility, and institutional connectivity have consistently emerged as statistically significant predictors of participation in agricultural insurance programmes [10]. Small and marginal farmers often face multiple structural disadvantages including limited financial resources, weak bargaining power, and restricted access to institutional finance. These vulnerabilities reduce their ability to participate effectively in formal insurance systems. Narayan [23] argued that access to institutional information and participation mechanisms forms an essential component of empowerment, particularly among economically vulnerable populations. Gender also represents an important but underexplored dimension within agricultural insurance literature. Kabeer [22] observed that women farmers frequently encounter greater informational and institutional barriers due to lower literacy levels, restricted mobility, and exclusion from formal agricultural networks. In Uttar Pradesh, where agriculture is increasingly experiencing feminization due to male migration, gender-sensitive insurance outreach remains insufficiently developed. Rogers' [24] diffusion of innovations framework further explains that adoption of insurance schemes depends on perceived relative advantage, compatibility, complexity, observability, and trust. Farmers are more likely to adopt insurance when they observe successful claim experiences among peers and perceive insurance as beneficial relative to informal coping mechanisms such as borrowing, distress sale of assets, or migration.

Institutional and administrative barriers

Institutional inefficiencies continue to constitute one of the most significant barriers to agricultural insurance adoption in India. Sharma and Singh [31] observed that procedural complexity, document verification requirements, delayed premium transfers, and lack of transparency in claim settlement create deep institutional mistrust among farmers. Enrolment procedures often require multiple interactions with banks, insurance agencies, and government offices, increasing transaction costs for rural households. Such administrative complexity disproportionately affects illiterate and semi-literate farmers with limited mobility and weak institutional connectivity. Delayed compensation further undermines farmer confidence in agricultural insurance systems. Kumar and Baliyan [27] found that dissatisfaction with claim settlement was among the most frequently cited reasons for non-renewal of insurance participation in Uttar Pradesh. Negative claim experiences generate adverse social perceptions that discourage enrolment among non-participating farmers as well. The literature increasingly highlights technology-driven governance as a potential solution to these institutional barriers. Sharma and Singh [31] proposed blockchain-enabled claim management systems for improving transparency, accountability, and procedural efficiency in agricultural insurance. Similarly, recent policy initiatives including DigiClaim, YES-TECH, WINDS, and CROPIC emphasize digital monitoring, remote sensing, and AI-enabled yield estimation systems for faster and more objective claim assessment.

Farmer empowerment and insurance linkages

The relationship between agricultural insurance and farmer empowerment represents an emerging area within agricultural development literature. Sen's [21] capability approach conceptualizes empowerment as the expansion of individual capacities, opportunities, and decision-making freedom. Within agricultural contexts, insurance functions not merely as a compensation mechanism but as an institutional instrument enabling risk-taking, investment, and livelihood security. Existing literature suggests that effective agricultural insurance contributes to multidimensional empowerment outcomes including financial resilience, investment confidence, social participation, and technological inclusion. Hazell *et al*. [17] argued that insurance mechanisms reduce vulnerability to catastrophic income shocks, thereby enabling farmers to adopt higher-productivity agricultural practices. Narayan [23] further emphasized that empowerment is closely linked with access to information, institutional participation, accountability, and organizational capacity. Agricultural insurance intersects with these dimensions through extension services, digital platforms, financial inclusion initiatives, and community-level participation structures. However, existing literature remains heavily concentrated on awareness and adoption patterns rather than long-term empowerment outcomes. Most studies conducted in Uttar Pradesh focus primarily on enrolment levels, claim experiences, or policy implementation challenges. Limited empirical evidence exists regarding the impact of agricultural insurance on livelihood diversification, debt reduction, educational outcomes, social capital formation, and technology-mediated inclusion among farming households.

Research gaps identified from the literature

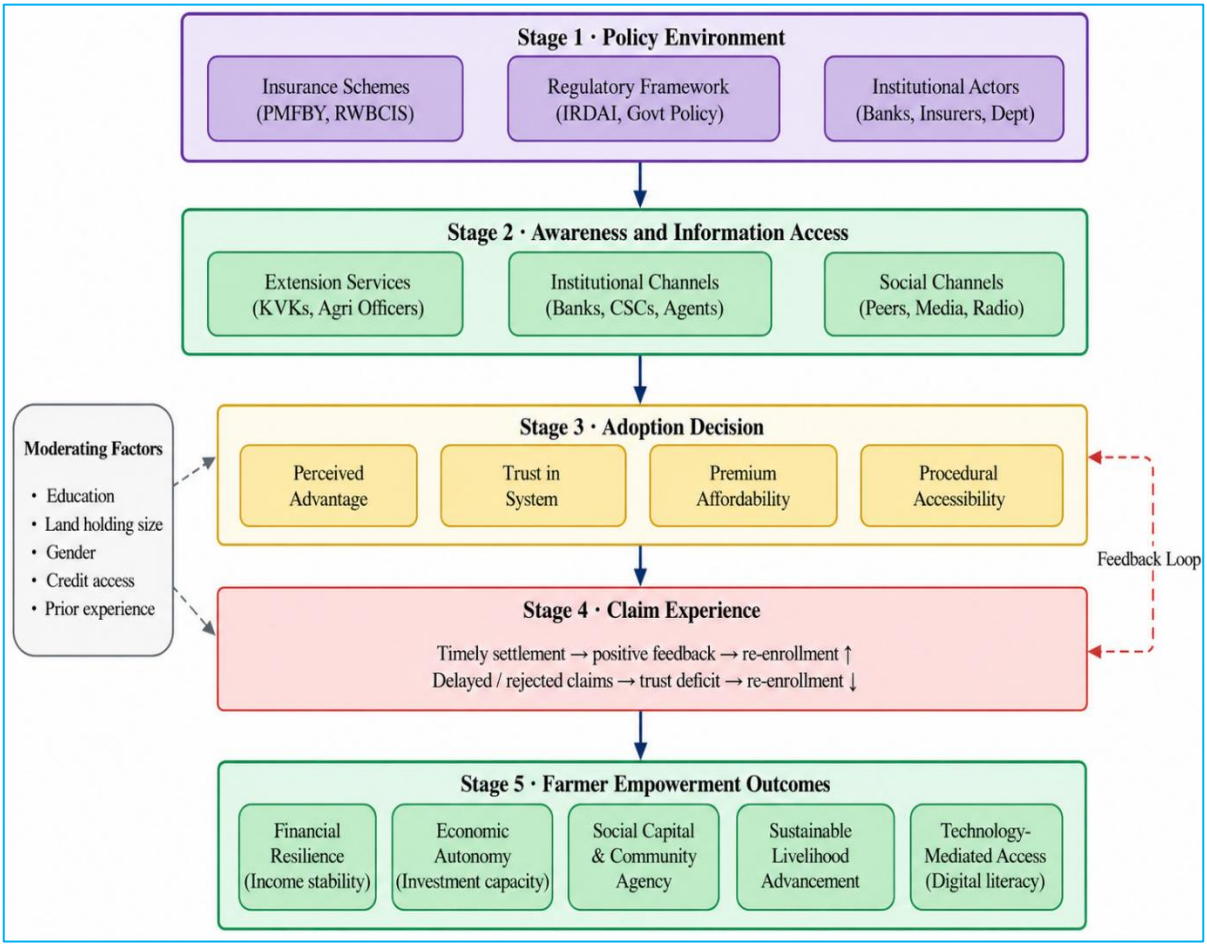
The reviewed literature reveals several important research gaps, particularly within the context of Uttar Pradesh. First, most existing studies operate at national or state levels, masking substantial intra-state disparities across districts and agro-economic regions. District-level empirical evidence examining insurance awareness, claim experiences, and empowerment outcomes remains limited. Second, longitudinal studies evaluating the long-term socio-economic effects of

sustained insurance participation are largely absent. Existing research remains predominantly cross-sectional and descriptive in nature. Third, gender-sensitive analyses of agricultural insurance remain insufficiently developed despite increasing feminization of agriculture in Uttar Pradesh. The differential experiences of women farmers regarding awareness, accessibility, and institutional participation require greater scholarly attention. Fourth, limited empirical work has examined the interaction between digital governance systems and agricultural insurance accessibility among marginalized communities. As PMFBY increasingly adopts AI-enabled and digital monitoring systems, understanding the implications of the digital divide becomes critically important. Finally, while several studies discuss agricultural insurance awareness and adoption, comparatively little research examines agricultural insurance as a multidimensional farmer empowerment mechanism. This gap provides the conceptual foundation for the present study and supports the development of the Agricultural Insurance-Farmer Empowerment Linkage Model (AI-FELM).

Proposed conceptual framework

Based on the synthesis of theoretical perspectives and empirical literature, this paper proposes a conceptual framework titled the Agricultural Insurance-Farmer Empowerment Linkage Model (AI-FELM). The proposed AI-FELM (Agricultural Insurance- Farmer Empowerment Linkage Model) framework integrates agricultural risk management theory, empowerment theory, and innovation diffusion perspectives into a unified conceptual model. The framework conceptualizes the pathway from policy design to farmer empowerment as a multi-stage process mediated by awareness, adoption, and claim experience, and moderated by socio-economic, institutional, and contextual factors. The framework shows that effective policy support and institutional infrastructure first influence farmer awareness through extension, institutional, and social communication channels. Awareness subsequently affects adoption decisions, which are shaped by factors such as perceived advantage, trust, affordability, and procedural accessibility. The model further highlights that positive claim experiences strengthen re-enrollment and trust, creating a feedback loop that enhances sustained participation in insurance schemes. Ultimately, continuous engagement with agricultural insurance contributes to multidimensional farmer empowerment through improved financial resilience, economic autonomy, social capital, sustainable livelihood advancement, and technology-mediated access to services.

Figure 3 presents the Agricultural Insurance-Farmer Empowerment Linkage Model (AI-FELM), which explains the sequential relationship between agricultural insurance policy environment and farmer empowerment outcomes.



Note: Figure 3 is adapted and developed by the authors based on Narayan [23], Sen [21], Rogers [24], Singh and Jain [5], Mishra *et al.* [30], Sharma and Singh [31], Mishra and Verma [10] and related literature on agricultural insurance, farmer empowerment, and technology-enabled risk governance in India

Fig 3 Proposed conceptual framework (AI-FELM: Agricultural Insurance - Farmer Empowerment Linkage Model)

Stage 1: *Policy environment*

The framework's foundation is the policy environment comprising government insurance schemes (PMFBY, RWBCIS), regulatory infrastructure (IRDAI guidelines), and institutional actors (insurance companies, banks, state agriculture departments). The quality and design of this

environment - specifically the affordability of premiums, simplicity of processes, and adequacy of subsidy - determine the theoretical accessibility of insurance to farmers.

Stage 2: *Awareness and information access*

Awareness is conceptualized as the necessary first-order mediator between policy availability and adoption. Three channels of awareness creation are identified: (a) formal extension services (KVKs, agricultural officers); (b) institutional channels (banks, insurance agents, Common Service Centres); and (c) informal/social channels (peer farmers, local leaders, mass media). The relative efficacy of these channels varies by farmer socio-economic profile and geographic location.

Stage 3: *Adoption decision*

The adoption decision is modeled as a function of perceived relative advantage, trust in the insurance system, affordability of premiums, and procedural accessibility - consistent with Rogers' [24] diffusion theory. Moderating this decision are socio-demographic factors (education, landholding, credit access, gender) and contextual factors (agro-climatic risk exposure, prior insurance experience, social norms around risk-sharing).

Stage 4: *Claim experience and feedback loop*

Post-adoption claims experience acts as a powerful reinforcer or deterrent for continued participation. Timely, transparent, and adequate claim settlement strengthens trust and increases retention, creating a positive feedback loop into future adoption cycles. Conversely, negative claim experiences - delays, partial settlements, disputes - are shown to significantly reduce re-enrollment and generate negative social proof that deters non-insured peer farmers from adopting [28].

Stage 5: *Empowerment outcomes*

The framework identifies five measurable dimensions of farmer empowerment as outcomes of sustained insurance engagement:

1. *Financial resilience*: Reduced income volatility, faster post-disaster recovery, and diminished debt burden.

2. *Economic decision-making autonomy*: Greater willingness to invest in productivity-enhancing inputs (quality seeds, fertilizers, irrigation) and adopt improved agricultural practices.

3. *Social capital and community agency*: Enhanced collective action, peer learning, and participation in agricultural cooperatives and formal credit markets.

4. *Sustainable livelihood advancement*: Long-term improvements in household welfare, children's education, and occupational diversification.

5. *Technology-mediated access to services*: Familiarity with digital insurance platforms creates broader financial and technological literacy, enhancing access to other agri-digital services.

The proposed Agricultural Insurance - Farmer Empowerment Linkage Model (AI-FELM) framework provides the conceptual basis for understanding the barriers and enabling conditions influencing agricultural insurance adoption in Uttar Pradesh.

Barriers and enablers: A synthesis

Barriers to agricultural insurance adoption in Uttar Pradesh. The literature reveals a structured set of barriers operating at multiple levels:

Information asymmetry and low awareness: The most pervasive barrier is the persistent deficit of accurate, timely, and accessible information about scheme eligibility, premium rates, coverage scope, and claim procedures. This asymmetry disproportionately affects illiterate and semi-literate smallholder farmers [5].

Administrative complexity and trust deficit: Bureaucratic enrollment processes, opaque premium computation, and historically poor claim settlement performance have generated deep institutional distrust. Sharma and Singh [31] documented that over 40% of farmers who did not re-enroll cited negative prior claim experiences as the primary reason.

Financial constraints: Even subsidized premium rates pose a liquidity challenge for marginal and sub-marginal farmers whose cash flows are highly seasonal and who lack access to formal credit [30]. The mandatory linkage of insurance enrollment to crop loans partially addresses this for loanee farmers, but excludes a large segment of non-borrowers.

Structural and geographic inequality: Uneven distribution of banking infrastructure, KVKs, and insurance agents across Uttar Pradesh's 75 districts creates geographic inequity in insurance access. Eastern UP and the Bundelkhand region are particularly underserved [28].

Technological barriers: Digital enrollment portals, while theoretically efficiency-enhancing, have created new barriers for farmers without smartphones, internet access, or digital literacy. The digital divide in rural UP remains significant [30].

Enablers and opportunities

Against these barriers, the literature identifies several enabling conditions and strategic opportunities:

Extension service enhancement: Gupta *et al*. [29] found that structured, periodic farmer-extension agent interactions significantly improved PMFBY enrollment. Strengthening the Krishi Vigyan Kendra network and equipping extension agents with updated scheme knowledge and enrollment capabilities represents a high-impact lever.

Mobile and community-based communication: Singh *et al*. [32] demonstrated the effectiveness of mobile advisory services - including SMS alerts, IVR calls, and WhatsApp-based information dissemination - in raising awareness among farmers with basic phone access. Community radio and Gram Sabha platforms offer complementary channels for digitally excluded households.

Simplified and transparent processes: Blockchain-based claim management [31], single-window enrollment through Common Service Centres, and Aadhaar-linked premium disbursement have demonstrated potential for reducing transaction costs and improving transparency.

Positive claim experience as a catalyst: Timely claim settlement in even a few cases within a village creates powerful social proof that drives enrollment among previously skeptical farmers [28]. Prioritizing claim speed and completeness in pilot districts is therefore strategically valuable.

International comparative perspective

A comparative analysis of agricultural insurance systems in developed and developing economies illuminates the structural conditions under which agricultural insurance achieves high penetration and meaningful farmer empowerment.

The United States Federal Crop Insurance Program (FCIP), administered by the USDA Risk Management Agency, covers approximately 90% of planted crop acres through a combination of yield protection, revenue protection, and catastrophic coverage products [26]. The FCIP's success is attributed to mandatory agent-based outreach, actuarially sound product design, rapid claim settlement infrastructure, and decades of farmer familiarity developed through generational participation. The program's subsidy burden, however, has attracted scrutiny regarding market distortions and regressive benefit distribution [26].

Canada's AgriStability and Agri-Insurance programs adopt a whole-farm income stabilization approach, supplementing crop-specific indemnity with broader revenue margin protection - a model increasingly relevant to India's polyculture smallholder context. European Union programs under the Common Agricultural Policy (CAP) increasingly integrate weather-indexed instruments with income support, reflecting a recognition that pure actuarial insurance is insufficient for farms with high livelihood dependence on agriculture.

In the context of developing countries, Ethiopia's Index-Based Livestock Insurance (IBLI) program offers a relevant precedent for index-based product design with community-embedded distribution. Barnett and Mahul's [20] evaluation demonstrated that IBLI's integration with local pastoralist institutions significantly reduced basis risk perception and improved adoption among low-literacy communities. The lesson for Uttar Pradesh is clear: technology-enabled products must be paired with community-embedded trust infrastructure.

China's experience is perhaps most instructive. China rapidly scaled its agricultural insurance penetration from near zero in 2007 to covering over 200 million households by 2018, driven by high central government subsidies (often 80-90% of premium), provincial co-financing, and mandatory bundling with credit products for loanee farmers [33]. The resultant high enrollment, however, has raised concerns about adverse selection and moral hazard due to limited verification capacity - a caution equally relevant to the PMFBY's expansion strategy in India [34].

Research gaps and future directions

The foregoing review reveals several significant lacunae in the existing body of knowledge, particularly in the Uttar Pradesh context, that the forthcoming primary research study will seek to address:

Localized, district-level empirical studies: The vast majority of reviewed studies operate at the state or national level, masking the substantial intra-state heterogeneity within Uttar Pradesh. District-level disaggregated data on awareness, adoption, and empowerment outcomes are critically needed.

Longitudinal impact assessment: Cross-sectional studies dominate the literature. Longitudinal research examining how sustained insurance participation affects long-term livelihood outcomes, agricultural investment patterns, and debt dynamics is largely absent for the UP context.

Gendered analysis of insurance access and empowerment: The differential experience of male and female farmers with respect to insurance awareness, adoption barriers, and empowerment outcomes is poorly documented. Given the growing feminization of agriculture in UP, this is a critical gap.

Technology adoption and digital divide in insurance: The interaction between digital literacy, smartphone access, and insurance enrollment - particularly for marginalized communities - has not been empirically examined in UP. As PMFBY increasingly moves toward digital enrollment, this gap has direct policy urgency.

Behavioural and psychographic determinants: Beyond socio-economic variables, the psychological determinants of adoption - including risk attitudes, trust in government and insurance companies, past experience with formal finance, and fatalistic worldviews - are understudied. Mixed-methods approaches integrating qualitative depth with quantitative breadth are needed.

Economic valuation of insurance benefits: Comprehensive cost-benefit analyses of agricultural insurance from the farmer's perspective - accounting for premium costs, opportunity costs of enrollment effort, and expected claim values - are largely absent for the Indian smallholder context.

Policy recommendations

Based on the synthesized evidence and conceptual framework, the following recommendations are advanced for policymakers, insurance providers, and agricultural development institutions:

Invest in hyperlocal awareness campaigns: Insurance awareness efforts must move beyond state-level mass media to targeted, gram panchayat-level campaigns delivered by trained, trusted community intermediaries. Content should be available in local dialects and visual formats accessible to low-literacy audiences.

Redesign enrollment and claim processes around farmer convenience: Single-window, doorstep enrollment through Common Service Centres and mobile banking correspondents, combined with Aadhaar-linked premium auto-deduction, can dramatically reduce transaction costs for marginal farmers.

Strengthen and incentivize agricultural extension services: Extension agents should be equipped, trained, and incentivized to function as frontline insurance ambassadors. Performance metrics for extension personnel should include insurance awareness and enrollment outcomes in their service areas.

Implement technology with inclusion safeguards: Digital solutions must be designed to complement, not replace, human-mediated enrollment channels. Offline enrollment capability, voice-based interfaces, and community technology access centres can mitigate digital exclusion risks.

Create a dedicated grievance redressal mechanism: A transparent, time-bound, and accessible grievance system - with mobile-accessible status tracking - is essential to rebuilding farmer trust and generating the positive claim experiences that drive sustained adoption.

Design gender-inclusive insurance products and outreach: Women farmers' groups and self-help networks should be engaged as primary channels for insurance awareness

and enrollment. Insurance products should recognize joint or female-managed landholdings and remove documentation barriers specific to women.

CONCLUSION

Agricultural insurance, when well-designed and widely accessible, represents far more than a financial product - it is an instrument of economic and social empowerment for the millions of farming families who constitute the human foundation of India's food system. In Uttar Pradesh, the gap between insurance availability and insurance utility remains large and structurally entrenched. This paper has sought to illuminate that gap through a conceptual and literature-based analysis, proposing an Agricultural Insurance-Farmer Empowerment Linkage Model (AI-FELM) that traces the pathway from policy design through awareness, adoption, and claim experience to multidimensional empowerment outcomes. The evidence reviewed consistently points to information asymmetry, administrative complexity, institutional trust deficits, and structural exclusion as the primary barriers to insurance adoption - barriers that are mutually reinforcing and that require simultaneous, coordinated interventions across policy, institutional, and community levels. International comparisons reveal that high insurance penetration is achievable in developing country contexts when community-embedded distribution, simplified processes, and sustained government commitment are aligned. This paper positions itself as a conceptual and theoretical foundation for forthcoming primary research that will empirically investigate awareness levels, adoption determinants, and empowerment outcomes across diverse districts of Uttar Pradesh. The AI-FELM framework provides a structured basis for instrument design, hypothesis formulation, and analytical modeling in that subsequent work. Together, the conceptual and empirical phases of this research program aim to generate actionable insights that can meaningfully narrow the distance between India's agricultural insurance policy ambition and its on-ground reality - ultimately serving the farmers whose resilience and empowerment are the ultimate measure of success.

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