

From Digital Access to Institutional Capability: Explaining Digital Technology Adoption and Organisational Performance in Farmer Producer Organisations

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Abstract

Farmer Producer Organisations (FPOs) seek to overcome structural disadvantages of smallholder agriculture by pooling resources, strengthening bargaining power, reducing transaction costs and improving access to markets, technology and knowledge. However, digital technology availability does not automatically improve FPO performance. The reviewed literature shows that adoption is shaped by infrastructure, financial capacity, managerial competence, member participation, institutional support and market linkages, while outcomes vary across contexts. This paper develops an institutionally embedded conceptual explanation of digital technology adoption in FPOs through an integrative synthesis linking FPO institutional development, transaction-cost reduction, collaborative innovation and digital adoption. Drawing on Institutional Economics, Transaction Cost Economics and Dynamic Capabilities Theory, digital adoption is conceptualised as an organisational capability involving digital readiness, operational integration, routinisation, data governance and continuous renewal. Participatory governance and ecosystem support are proposed as boundary conditions determining whether adoption creates inclusive value or reproduces digital inequality. Seven propositions address antecedents, capability formation, organisational outcomes and contextual contingencies, offering directions for empirical testing, longitudinal research and context-sensitive digital policy.

Keywords: Farmer Producer Organisations, Digital Technology Adoption, Institutional Economics, Transaction Costs; Dynamic Capabilities, Organisational Performance, Collective Action, Rural Development

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1. Introduction

Small and marginal farmers occupy a structurally vulnerable position in agricultural markets because fragmented production, limited access to information, weak bargaining power, high transaction costs and inadequate infrastructure restrict their ability to capture value from increasingly sophisticated agricultural value networks. Research on Indian agricultural markets shows that smallholders often remain dependent on intermediaries and have less access to formal and remunerative markets, while modern value chains increasingly demand quality, traceability and reliable coordination (Singh et al., 2018). FPOs emerged as a collective institutional response to these structural constraints by aggregating production and input demand, enabling economies of scale, strengthening bargaining power and connecting producers with formal markets and service providers (Singh et al., 2018; Gurung et al., 2024).

The empirical case for FPOs is substantial but not unequivocal. Gurung et al. (2024), using propensity score matching on 560 organic farming households in Sikkim, report that FPO members achieved higher net returns, return on investment and profit margins than non-members, although the magnitude of the effect varied across farmer groups. Their review of prior

studies also shows that FPO membership can improve market access, bargaining power, technology adoption and farm practices, while other studies report limited or insignificant effects, indicating that FPO performance is context-dependent rather than automatic. Gokul Vignesh et al. (2019) similarly shows that FPO services can improve access to price information, inputs, technical support and value-addition opportunities, but these benefits depend upon the actual services delivered to members.

The same contingency is visible in studies of organisational sustainability. Singh et al. (2018) show that FPOs in Punjab and Gujarat differed sharply in operational effectiveness, with institutional support, market linkages, managerial skills and coordination emerging as critical conditions. In Punjab, weak post-formation support, logistics constraints and low intra-organisational trust were associated with inactivity, whereas some Gujarat FPOs benefited from stronger institutional linkages, training, procurement coordination, processing and branding. These findings challenge the assumption that organisational form itself is sufficient to generate collective value.

Digital technology intensifies this theoretical problem. FPOs increasingly use digital records, communication platforms, market-information

systems, e-commerce, supply-chain tools and digital payments to coordinate activities, improve traceability and reach customers. The supplied literature indicates that such technologies can reduce information asymmetry, improve coordination and support direct market linkages, but adoption is uneven because infrastructure, skills, financing, governance and ecosystem coordination are unevenly distributed (Shree & Vaishnavi, 2022; Mukherjee et al., 2025). Digital adoption therefore raises the problem that conventional technology-acceptance models do not adequately explain: why do similar technologies generate different organisational outcomes across otherwise similar FPO settings?

This problem is consequential because digitalisation can operate in two directions. On one hand, technology can reduce search, coordination and monitoring costs, improve market information, strengthen traceability and support collaborative innovation. On the other hand, poorly integrated systems can reproduce exclusion, increase dependence on external vendors, deepen differences between digitally capable and digitally marginalised members, and introduce new privacy and cybersecurity risks. The issue is consequently not only adoption, but the organisational capacity to integrate technology into collective routines and institutional governance.

The present paper addresses this gap by making a theoretical shift from viewing digital technology as an external input to viewing digital adoption as an institutionally embedded organisational capability. It asks three research questions: (1) What organisational and institutional conditions shape the depth and continuity of adoption of digital technology in FPOs? (2) Through what capability mechanisms does digital adoption translate into organisational performance? and (3) Under what governance and ecosystem conditions does digital adoption improve inclusion and sustainability rather than intensify organisational inequalities?

The remainder of the paper develops an integrative literature synthesis, establishes the theoretical foundations, proposes an institutionally embedded digital capability framework, develops seven propositions, and discusses theoretical, managerial and policy implications. The paper concludes with a focused research agenda and limitations.

2. Integrative Literature Synthesis

2.1 Review design and analytical approach

This study is a conceptual paper grounded in an integrative synthesis of the research papers supplied for review. The corpus comprised 14 PDF files representing 13 unique studies because two uploaded files were duplicates of the Singh, Budhiraja and

Vatta (2018) study. The review is intentionally corpus-bound: it does not claim to be a database-wide Scopus or Web of Science systematic review. Instead, the supplied papers were analysed as an evidentiary corpus to identify recurring constructs, explanatory mechanisms, boundary conditions and organisational outcomes. This approach is appropriate for conceptual theory building because the objective is to reconcile fragmented findings and develop a theoretically coherent explanation rather than estimate a pooled effect size.

The papers were coded across five dimensions: (i) the institutional role attributed to FPOs; (ii) the nature of digital or technological intervention; (iii) organisational and ecosystem antecedents; (iv) mechanisms through which value is created; and (v) observed outcomes and unintended consequences. This coding shows that the FPO literature combines institutional development, collective action, market access, innovation, sustainability, financial viability, participation and technology adoption. The contribution of the present paper is to connect these streams through a capability-based explanation of digital integration.

2.2 FPOs as hybrid institutions rather than technology recipients

A central insight of the literature is that FPOs cannot be reduced to aggregation mechanisms. Their effectiveness depends on collective governance, coordination, member incentives, market relationships, managerial capability and state support. Institutional Economics is useful because it directs attention toward rules, norms and governance arrangements within which economic exchange occurs (North, 1990, 1991). Jose and Chathukulam (2025) explicitly conceptualise FPOs as hybrid socio-economic institutions embedded within a state–market–community nexus, covering transaction costs, collective governance, inclusion, ecological resilience, livelihood security and state intermediation.

This institutional perspective explains why formally similar FPOs may perform differently. Singh et al. (2018) show that institutional support and coordination strongly affected FPO viability in Punjab and Gujarat, while contemporary work identifies trust, leadership, participation and organisational capability as continuing concerns (Navya et al., 2025; Mukherjee et al., 2025). Digital adoption therefore cannot be separated from institutional competence: technology is embedded in organisational structures that determine who can access it, who controls it, how it is used and whose interests it serves.

Table 1. Analytical Synthesis of the Supplied FPO Literature

Research stream	What the evidence establishes	Persistent limitation	Implication for present framework
FPO economic and market value	Collective action can improve returns, market access, bargaining power and service access, but effects vary across farmer groups and contexts (Gurung et al., 2024; Gokul Vignesh et al., 2019).	Membership alone does not explain variation in outcomes.	Digital adoption should be located within the organisational capabilities that convert collective membership into value.
FPO sustainability and institutional support	Sustainability depends on continuing support after formation, market linkages, managerial skills, processing, branding and coordination (Singh et al., 2018).	Formation-stage support does not ensure long-term viability.	Institutional support is a boundary condition of digital capability.
Collaborative innovation	FPO collaboration generates product, process and technological innovation with economic, social and environmental outcomes (Krishnan et al., 2021).	The mechanisms connecting innovation to durable organisational capability remain under-specified.	Digital integration can be treated as a dynamic capability developed through collaboration and resource reconfiguration.
Institutional and governance perspective	FPOs are hybrid institutions shaped by transaction costs, collective governance, inclusion, ecological resilience, livelihoods and state intermediation (Jose & Chathukulam, 2025).	Technology is often treated as an operational tool rather than an institutional capability.	Digital adoption should be embedded within rules, governance and state–market–community relations.
Sustainability transition	FPOs can act as intermediaries in sustainable agricultural transitions through collaboration with government, finance, civil society and market actors (Pallavi et al., 2024).	Transition capacity depends on ecosystem relations, not technology alone.	Ecosystem support should moderate the conversion of digital capability into sustainability outcomes.
Digital adoption constraints	Infrastructure, skills, finance, governance and systemic fragmentation constrain adoption and can create internal inequalities (Shree & Vaishnavi, 2022; Mukherjee et al., 2025).	Barrier studies often stop at diagnosis.	The relevant construct is depth and integration of adoption, not technology presence.
Participation and financial viability	Training, education, participation, access to finance and business capability influence FPO engagement and viability (Aditi et al., 2025; Thangavel et al., 2025).	Digital programmes may fail when organisational readiness is low.	Financial capacity, participation and managerial competence are adoption antecedents.

2.3 Digital adoption as a capability problem

The supplied evidence indicates that FPO digitalisation spans several layers. Digital records and transaction tracking can improve traceability and reduce administrative errors; market-information systems can improve price discovery and demand visibility; communication platforms can strengthen member and customer interaction; and e-commerce can create direct-to-consumer opportunities. Such uses are consistent with the broader FPO evidence that technology and innovation generate value when combined with collaboration, training, market linkages and organisational support (Krishnan et al., 2021; Singh et al., 2018).

The distinction between availability and capability is critical. A platform may exist without being routinely used; usage may remain concentrated among a few members; data may not flow across procurement, production, inventory and sales functions; or the organisation may lack the skills and governance arrangements needed to maintain the system. Digital adoption should therefore be treated as a continuum of organisational integration rather than a binary technology decision.

2.4 From transaction-cost reduction to value creation

Transaction Cost Economics provides a first explanation of why digital adoption should matter for

FPOs. Smallholders face information-search costs, negotiation costs, monitoring costs, logistics costs and uncertainty over prices and demand. Singh et al. (2018) describe FPOs themselves as mechanisms for reducing transaction costs and improving market access, while Krishnan et al. (2021) show how digital information flows, databases, social media and collaborative processes improve planning, procurement, order management and customer interaction.

Yet transaction-cost reduction is not a sufficient theory of digital value. Technology can reduce some costs while creating others through implementation expenditure, maintenance, vendor dependence, cybersecurity exposure and skill requirements. Evidence on FPO sustainability confirms that finance, infrastructure, managerial capability and market linkage remain critical constraints (Shree & Vaishnavi, 2022; Thangavel et al., 2025). Digital adoption becomes economically valuable when the organisation possesses the capability to integrate technology into routine and governance mechanisms.

2.5 Digitalisation, innovation and sustainability

Innovation provides a second bridge. Krishnan et al. (2021) show that collaboration among FPOs, farmers and customers generated product, process and technological innovations and that these innovations created economic, environmental and social sustainability outcomes. Their Dynamic Capabilities perspective emphasises resource complementarity, knowledge sharing and co-value creation as mechanisms of capability building. Pallavi et al. (2024) extend this logic to sustainability transitions by showing that FPOs can act as intermediaries between farmers and broader ecosystems involving civil society organisations, financial institutions, market partners and government agencies.

The implication is that digital capability should be connected to organisational learning and sustainable innovation rather than measured only through technology ownership. Digital tools may increase the speed and quality of information exchange, enable traceability and improve resource planning, but such benefits depend on the organisation's ability to learn and reconfigure its practices.

2.6 The problem of unequal digitalisation

Digitalisation also creates a distributional problem. Mukherjee et al. (2025) identify member engagement, governance, finance and uneven capability as sustainability challenges, while Aditi et al. (2025) show that education, gender, age, farm size, training and skills influence FPO participation. Gurung et al. (2024) also find heterogeneous economic effects of FPO membership. Digital inclusion therefore cannot be assumed from organisational membership alone.

The research problem is consequently not simply whether FPOs adopt digital technologies. The more consequential question is whether they develop the organisational capacity to integrate digital technologies into inclusive, accountable and sustainable institutional routines.

3. Theoretical Foundations

3.1 Institutional Economics

Institutional Economics explains economic behaviour as embedded within formal rules, informal norms, governance arrangements and historical structures rather than treating markets as frictionless systems (North, 1990, 1991). FPOs are therefore institutional arrangements that reduce coordination and exchange problems while simultaneously creating collective-governance challenges. Jose and Chathukulam (2025) operationalise this logic through clusters covering transaction costs, governance, inclusion, ecological resilience, livelihood security and state intermediation.

From this perspective, digital technology does not sit outside the institution. It becomes part of the rules and routines through which members access information, record transactions, communicate decisions, monitor performance and engage with markets. Digital adoption should therefore be evaluated by the institutional changes it enables, not only by the technologies installed.

3.2 Transaction Cost Economics

Transaction Cost Economics argues that organisational arrangements are partly shaped by the costs of coordinating exchanges under conditions of uncertainty and information asymmetry (Williamson, 1981). In FPOs, digital information can reduce search and coordination costs, improve transparency, support demand aggregation and make market relationships more predictable. Evidence from FPO supply chains shows that digital databases and customer-facing communication improve supply visibility and planning, consistent with the transaction-cost rationale of collective organisation (Krishnan et al., 2021).

At the same time, the same logic implies that digital systems create governance and implementation costs when transactions become dependent on proprietary platforms, data quality is weak or members lack capabilities to use the technology. A stronger theoretical explanation therefore requires a distinction between digital access and organisationally embedded use.

3.3 Dynamic Capabilities Theory

Dynamic Capabilities Theory explains how organisations build, integrate and reconfigure resources in changing environments (Teece et al., 1997). This is directly relevant to FPOs because

digital technology is not static: market platforms, data systems, traceability tools and digital service models evolve continuously. Krishnan et al. (2021) uses a dynamic capabilities lens to explain how collaboration facilitates resource complementarity, knowledge sharing and co-value creation within FPO supply chains.

The dynamic-capabilities perspective clarifies why technology access is insufficient. The relevant organisational capability lies in sensing digital opportunities, selecting appropriate technologies, integrating them into routines, learning from use and reconfiguring practices as technologies and markets change. This paper therefore combines the institutional embeddedness of FPOs with the adaptive character of digital capability.

4. Proposed Framework: Institutionally Embedded Digital Capability

The paper defines **Institutionally Embedded Digital Capability (IEDC)** as the FPO's collective ability to acquire, assimilate, integrate, routine, govern and renew digital technologies across its operational and institutional activities. The construct is deliberately broader than technology adoption conceived as binary use/non-use. It captures the depth of adoption and the organisational capability required to convert technology into repeatable value creation.

IEDC has five interrelated dimensions. First, digital readiness refers to infrastructure, connectivity, hardware, finance and baseline skills. Second, digital integration refers to the extent to which technology connects procurement, records, supply-chain operations, member communication, market information and customer engagement. Third, digital routinisation refers to the extent to which digital practices become embedded in standard procedures rather than remaining pilot projects. Fourth, digital governance concerns data ownership, transparency, accountability, privacy, cybersecurity and member participation. Fifth, digital renewal captures continuous learning, upgrading and adaptation as technologies and market conditions change.

Two boundary conditions are incorporated. Participatory governance determines whether members have voice in technology choices, access and data rules. Ecosystem support encompasses government agencies, resource institutions, financial institutions, market partners, technology providers and training organisations. These conditions are consistent with evidence that FPO sustainability depends on institutional support, coordination, managerial capacity and stakeholder relationships (Singh et al., 2018; Pallavi et al., 2024; Mukherjee et al., 2025).

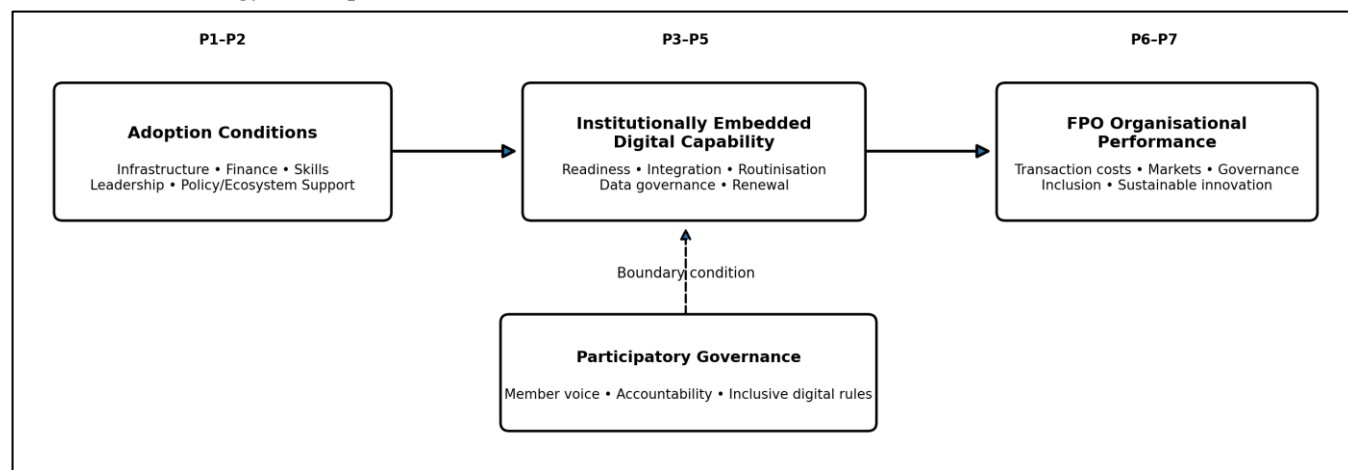


Figure 1. Institutionally Embedded Digital Capability Framework for FPOs

Note: Solid arrows indicate proposed explanatory relationships; the dashed arrow represents a boundary condition.

5. Propositions Development

5.1 Adoption readiness and depth of digital adoption

The literature consistently shows that digital adoption is constrained when infrastructure, finance, skills and managerial capacity are weak. Shree and Vaishnavi (2022) identify inadequate finance, limited awareness, weak market information and institutional linkages as persistent FPO constraints, while Thangavel et al. (2025) report limited credit, marketing infrastructure and business-management capability as barriers to financial viability. Mukherjee

et al. (2025) similarly place infrastructure, finance, human-resource development and innovation at the core of the FPO sustainability ecosystem. These findings imply that adoption depth should be conditioned by organisational readiness rather than treated as an independent managerial choice.

Proposition 1: Higher FPO digital readiness, comprising infrastructure, financial capacity, digital skills and managerial competence, is positively associated with the depth and continuity of digital technology adoption.

5.2 Institutional alignment and digital integration

Technology generates value only when organisational routines, governance structures and capabilities are aligned with it. Singh et al. (2018) show that the same FPO model produced different outcomes under different institutional-support conditions, while Jose and Chathukulam (2025) conceptualise governance and institutional coordination as central components of FPO performance. Participatory governance is particularly important because digital systems alter information access and decision rights. Top-down implementation can exclude ordinary members, whereas participatory implementation can strengthen ownership and utilisation.

Proposition 2: Participatory and institutionally aligned governance strengthens the positive relationship between digital readiness and institutionally embedded digital capability.

5.3 Digital capability and transaction cost efficiency

The transaction-cost logic of FPOs rests on reducing search, coordination, monitoring and market-access frictions. Digital databases, market information systems, communication platforms and direct-order channels can improve information flow and reduce uncertainty. Krishnan et al. (2021) show how digital information and collaborative practices improve demand visibility, planning and customer coordination, while Singh et al. (2018) identify transaction-cost reduction as a core purpose of FPO collectivisation.

Proposition 3: Institutionally embedded digital capability is positively associated with FPO transaction-cost efficiency and information transparency.

5.4 Digital capability and market-linkage performance

Market access is one of the strongest expected benefits of FPOs, but it remains fragile when FPOs lack demand information, processing capability, branding and logistics. Gurung et al. (2024) show that FPO membership can produce higher economic returns, while Singh et al. (2018) demonstrate that market linkages, processing and branding distinguish stronger from weaker FPOs. Digital channels can reinforce these functions by improving market intelligence, customer communication, direct selling and traceability.

Proposition 4: Institutionally embedded digital capability is positively associated with FPO market-linkage effectiveness, including market intelligence, direct customer access, traceability and value-realisation capacity.

5.5 Digital capability, governance and inclusion

Digital systems can improve accountability by making records, transactions and decisions more traceable. At the same time, they can create new forms of exclusion when access is concentrated among technologically capable members. Mukherjee et al. (2025) identify digital inequality, member engagement and governance as intertwined sustainability challenges, while Aditi et al. (2025) show that participation in FPOs is shaped by education, gender, age and training. Digitalisation can therefore be inclusion-enhancing only when system design and governance deliberately distribute capability and access.

Proposition 5: Institutionally embedded digital capability improves FPO governance and member inclusion when digital systems are implemented through participatory, accessible and accountable governance arrangements; otherwise, adoption may increase intra-FPO digital inequality.

5.6 Digital capability and sustainable innovation

The link between innovation and sustainability is strongly supported by the FPO literature. Krishnan et al. (2021) demonstrate that collaborative product, process and technology innovation can generate economic, environmental and social benefits, while Pallavi et al. (2024) show that FPOs can act as intermediaries in sustainability transitions through relationships with government, civil society, finance and market actors.

Proposition 6: Institutionally embedded digital capability is positively associated with FPO sustainable innovation across economic, social and environmental dimensions, subject to the availability of complementary ecosystem resources.

5.7 Ecosystem support as a boundary condition

FPOs operate within broader institutional ecosystems. Singh et al. (2018) show that post-formation resource-institution support is a critical determinant of sustainability, while Mukherjee et al. (2025) propose an eight-component ecosystem comprising market, policy, infrastructure, services, inputs, HRD, finance and innovation. Pallavi et al. (2024) likewise emphasise the roles of external actors in enabling sustainability transitions. Digital adoption should therefore yield stronger organisational outcomes when ecosystem actors provide finance, training, technical support, market linkage and interoperable infrastructure.

Proposition 7: Ecosystem support positively moderates the relationship between institutionally embedded digital capability and FPO organisational performance, such that stronger ecosystem support strengthens the realised value of digital adoption.

6. Discussion

The framework makes a conceptual distinction that is underdeveloped in FPO research: digital adoption is not equivalent to digital capability. Adoption can be observed as access, initial use or technology installation. Capability, in contrast, concerns the organisational capacity to integrate digital tools across activities and make them part of repeatable decision and governance routines. This distinction helps reconcile apparently inconsistent findings in the FPO literature. If performance depends on complementary resources and institutional conditions, then different FPOs can produce different outcomes from similar digital technologies.

Second, the framework repositions institutional conditions from background variables to explanatory mechanisms. Singh et al. (2018) show that institutional support, trust and market coordination can determine whether FPOs remain operational, while Jose and Chathukulam (2025) demonstrate that governance, inclusion and state intermediation are integral parts of FPO institutional performance. Digital systems consequently become part of institutional architecture: they allocate information, create records, structure interactions and potentially redistribute power within the organisation.

Third, the framework bridges the innovation and digitalisation literatures. Krishnan et al. (2021) show that collaboration produces product, process and technological innovation and that these innovations contribute to sustainability. Digital capability can be understood as the infrastructure through which FPOs sense market information, coordinate stakeholders, experiment with new practices and scale successful routines. This connects the dynamic-capabilities logic of resource reconfiguration with the institutional logic of governance and collective action.

Finally, the framework introduces a more nuanced view of inclusion. Digital transformation is often framed as inherently empowering because it expands access to information. Yet Aditi et al. (2025), Navya et al. (2025) and Mukherjee et al. (2025) indicate that participation, training, leadership and access remain uneven. The model therefore treats inclusion as an outcome that must be governed, not a benefit that can be presumed.

7. Theoretical Contributions

The paper offers four theoretical contributions. First, it extends Institutional Economics into the study of digital transformation by conceptualising technology as embedded in the rules and governance of collective organisations. Second, it extends Transaction Cost Economics by recognising that digitalisation can reduce exchange frictions while also generating new costs associated with implementation, dependency and governance. Third, it extends

Dynamic Capabilities Theory into FPO research by conceptualising digital integration, routinisation and renewal as capability-building processes rather than one-time technology choices. Fourth, it integrates these perspectives into an institutionally embedded digital capability construct that explains why technology availability alone does not ensure organisational performance.

The framework also responds to the research structure identified by Bhunia and Singh (2025), whose bibliometric meta-review of producer-organisation research shows that the field has developed around governance, market linkage, membership effects, bargaining power and sustainable development. The present model advances this literature by asking how digital capability can strengthen or weaken these established institutional functions rather than treating technology as a separate technical stream.

8. Managerial and Policy Implications

For FPO managers, the central implication is that digitalisation should be sequenced as an organisational-capability programme rather than a procurement project. Investments in platforms should be accompanied by member training, data governance, workflow redesign, digital accountability and mechanisms for evaluating actual usage. This is consistent with evidence that managerial skills, market linkages and continuing institutional support are important for long-run FPO sustainability (Singh et al., 2018; Shree & Vaishnavi, 2022).

For policymakers, digital FPO initiatives should prioritise interoperability and capability building alongside infrastructure. Mukherjee et al. (2025) emphasise coordination across schemes, digital infrastructure, training, finance and governance, making clear that digitalisation cannot be isolated from market, finance and HRD support. Public support should therefore move beyond subsidising hardware toward long-term organisational development and interoperable systems.

For development partners and financial institutions, digital investments should be assessed jointly with organisational maturity and market-linkage capability. Financial support for technology without working capital, managerial capability or route-to-market support may produce underutilised systems. Conversely, investment in digital integration can strengthen value-chain coordination when linked to procurement, traceability, customer engagement and data-driven decision-making.

Finally, inclusion should be treated as a design principle. Low-literacy interfaces, multilingual communication, accessible mobile applications, transparent data rules and member participation in digital governance can help avoid reproducing

inequalities. This is consistent with evidence that FPO effectiveness depends not only on commercial performance but also on member participation, governance and social resilience (Jose & Chathukulam, 2025; Mukherjee et al., 2025).

9. Future Research Agenda

The framework generates a focused empirical agenda. First, researchers should operationalise institutionally embedded digital capability and examine whether its dimensions—readiness, integration, routinisation, governance and renewal—form a multidimensional construct. Second, longitudinal designs are needed because digital adoption is not a single event; adoption may move through pilots, scaling, institutionalisation and renewal. Third, comparative studies across states, commodities and FPO maturity levels can test boundary conditions because existing evidence demonstrates substantial regional and organisational variation (Singh et al., 2018; Gurung et al., 2024).

Fourth, empirical work should examine heterogeneous digital effects across gender, age, education, farm size and leadership position, building on evidence that FPO participation and outcomes vary across farmer categories (Gurung et al., 2024; Aditi et al., 2025; Navya et al., 2025). Fifth, technology-specific research should distinguish digital recordkeeping, market-information systems, e-commerce, social media, AI-based decision support, traceability systems and digital payments rather than treating digital technology as a single undifferentiated construct. Sixth, future studies should examine negative outcomes, including digital exclusion, privacy risks, cybersecurity vulnerabilities, vendor dependence and technological obsolescence—alongside efficiency and market benefits.

10. Limitations

This paper is conceptual and is based on an integrative synthesis of the supplied literature rather than original primary data. The corpus is intentionally curated and therefore should not be interpreted as an exhaustive database-wide review of all FPO research. The framework is broad because the supplied studies vary in methodology, geography, commodity, organisational form and outcome measures. Empirical research is therefore required to establish the dimensionality of institutionally embedded digital capability, estimate effect sizes and test the proposed boundary conditions. The propositions should be viewed as theoretically derived and researchable statements rather than established causal relationships.

11. Conclusion

Digital transformation is increasingly unavoidable for Farmer Producer Organisations, but the central

challenge is not technology acquisition. It is the organisational capacity to turn technology into collective value. Evidence across the reviewed literature shows that FPO performance depends on market linkage, governance, skills, financial viability, institutional support, collaboration and member participation (Singh et al., 2018; Gurung et al., 2024; Jose & Chathukulam, 2025). Technology interacts with all of these conditions rather than replacing them.

This paper responds by proposing Institutionally Embedded Digital Capability as a theoretical construct through which digital technology adoption can be understood. The framework connects digital readiness with the ability to integrate, routinise, govern and renew technology, while positioning participatory governance and ecosystem support as critical boundary conditions. The central implication is that FPO digitalisation should be understood as a process of institutional capability formation, not as a procurement or access problem. This shift provides a stronger basis for explaining variation in outcomes and for designing digital interventions that improve market access, governance, inclusion and sustainability without reproducing the institutional inequalities they are intended to overcome.

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