



FARMERS' POLICY-DRIVEN ADAPTATION TO DIGITAL AGRICULTURE: INTERMEDIATION MECHANISMS AND EVIDENCE FROM VIETNAM

LA ADAPTACIÓN DE LOS AGRICULTORES A LA AGRICULTURA DIGITAL IMPULSADA POR POLÍTICAS PÚBLICAS: MECANISMOS DE INTERMEDIACIÓN Y EVIDENCIA EMPÍRICA DE VIETNAM

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ABSTRACT:

This study examines how public support policies are translated into farmers' adaptation to digital agriculture in Vietnam. A mechanism-based analytical framework is developed linking policy mixes, intermediation mechanisms, adaptive capacity, and adaptation outcomes. Empirically, the study draws on policy document analysis and 45 semi-structured interviews with government officials, agricultural extension officers, cooperatives, agribusiness firms, farmers, and experts in Sơn La, Lâm Đồng, and Đồng Tháp provinces. The findings show that policies do not generate adaptation directly; rather, policy instruments are transformed into adaptive practices through six mechanisms: access expansion, capacity formation, standardization, organizational intermediation, market incentives, and institutional constraints. These mechanisms produce four types of adaptation outcomes: process adaptation, data adaptation, organizational adaptation, and market adaptation. The study contributes to the literature by shifting the analytical focus from technology adoption to policy-driven adaptation, conceptualizing the policy mix as a mediated implementation process, and clarifying the roles of cooperatives, agribusiness firms, agricultural extension services, and local governments as adaptive infrastructure that enables smallholders to engage in digital agriculture.

Keywords: Digital agriculture, Farmer's adaptation, Public policy, Intermediation mechanisms, Vietnam.

RESUMEN:

El estudio analiza cómo las políticas públicas de apoyo se traducen en la adaptación de los agricultores a la agricultura digital en Vietnam. Se desarrolla un marco analítico basado en mecanismos que vincula combinación de políticas, mecanismos de intermediación, capacidad adaptativa y resultados de adaptación. Empíricamente, se realizó un análisis de documentos de política y 45 entrevistas semiestructuradas a funcionarios gubernamentales, agentes de extensión, cooperativas, empresas agroindustriales, agricultores y expertos en las provincias de Sơn La, Lâm Đồng y Đồng Tháp. Los resultados muestran que las políticas no generan adaptación de manera directa, sino que se transforman en prácticas adaptativas a través de seis mecanismos: ampliación del acceso, formación de capacidades, estandarización, intermediación organizacional, incentivos de mercado y restricciones institucionales. Estos mecanismos producen cuatro tipos de resultados: adaptación de procesos, adaptación basada en datos, adaptación organizacional y adaptación de mercado. El estudio contribuye al desplazar el foco de análisis desde la adopción tecnológica hacia la adaptación impulsada por políticas, al conceptualizar la combinación de políticas como un proceso de implementación mediado y al clarificar el papel de cooperativas, empresas, servicios de extensión y gobiernos locales como infraestructura adaptativa que facilita la participación de los pequeños agricultores en la agricultura digital.

Palabras clave: Agricultura digital, Adaptación de agricultores, Políticas públicas, Mecanismos de intermediación, Vietnam.



INTRODUCTION

Digital agriculture is increasingly becoming a critical transformation pathway for agri-food systems, in which data, digital platforms, traceability systems, sensors, and e-commerce are reshaping production practices as well as the relationships among farmers, markets, and actors within value chains (Klerkx et al., 2019; Wolfert et al., 2017). However, the benefits of digital agriculture do not automatically translate into higher productivity, increased income, or enhanced competitiveness, particularly in contexts characterized by smallholder farming, fragmented data infrastructure, and limited digital capabilities (FAO & ITU, 2016; World Bank, 2021).

Most existing studies continue to approach this issue through a technology-adoption lens, focusing primarily on individual intentions or decisions to use digital tools. Models such as the Theory of Planned Behavior and the Unified Theory of Acceptance and Use of Technology are useful for explaining initial use behavior (Ajzen, 1991; Venkatesh et al., 2003), but they remain insufficient for explaining longer-term changes in production processes, data-recording practices, standards compliance, cooperative participation, and sustained market linkages. This article therefore shifts the analytical focus from “technology adoption” to “adaptation to digital agriculture”. Adaptation is understood as the process through which farmers adjust their capabilities, production practices, organizational arrangements, and market relationships in order to participate in agricultural systems that are increasingly data-driven and standards-based. Digital agriculture is not merely the introduction of technologies into agricultural production; rather, it represents a socio-technical transformation process in which data, standards, platforms, and market relationships are reconfigured (Klerkx et al., 2019; Wolfert et al., 2017). In this context, farmers are required not only to use digital tools, but also to record data, ensure traceability, standardize production processes, coordinate within organizations, and respond to market requirements. Thus, technology access is a necessary but insufficient condition for adaptation.

Individual-level behavioral models are useful for explaining perceived benefits and risks, as well as intentions to use technologies, but they pay limited attention to the organizational and policy conditions that shape farmers’ adaptive behavior (Ajzen, 1991; Klerkx et al., 2019; Venkatesh et al., 2003). For smallholders, adaptive capacity depends heavily on cooperatives, partner enterprises, agricultural extension services, and market signals, because these actors and mechanisms perform intermediary functions in connecting knowledge, technologies, quality standards, traceability requirements, and market outlets (FAO & ITU, 2016; Government of Vietnam, 2018; OECD, 2013; Prime Minister of Vietnam, 2019, 2020b, 2021, 2022; World Bank, 2008, 2021). Adaptation should therefore be analyzed as

an organizational and institutional process through which farmers change their behavior under specific support structures and constraints.

From an educational standpoint, the activities carried out by agricultural extension services and cooperatives such as training, field demonstrations, record-keeping support, and market coordination function as non-formal adult education processes. They create opportunities for situated learning (Lave & Wenger, 1991) and the formation of communities of practice (Wenger, 1998), in which farmers collaboratively develop digital and organizational competencies. Recognizing extension and cooperative intermediation as educational practices is essential because adaptation to digital agriculture requires not merely technical instruction but sustained, practice-based learning embedded in real production settings.

Public policy plays an important role in this process, but its effects are rarely linear or directly translated from policy issuance into behavioral change. In developing countries, digital agriculture policies often take the form of policy mixes that combine digital infrastructure, training, agricultural extension, traceability systems, cooperative support, and market-linkage initiatives. Their effectiveness depends on how these instruments are coordinated and translated through intermediary actors (OECD, 2013; Rogge & Reichardt, 2016). A policy mix is understood as a set of interacting policy objectives, instruments, and implementation processes (Rogge & Reichardt, 2016). In digital agriculture, policy mixes often encompass digital transformation, traceability, agricultural extension, cooperative support, agricultural product marketing and distribution, and value chain development. However, the mere presence of multiple instruments does not guarantee effectiveness if these instruments lack coherence, complementarity, or implementation capacity at the local level.

The Agricultural Innovation Systems (AIS) approach emphasizes that innovation results from interactions among farmers, enterprises, cooperatives, public authorities, extension services, and research organizations (World Bank, 2007; OECD, 2013). However, AIS tends to describe actor structures rather than explain the specific mechanisms through which policies are translated into behavior. This study therefore introduces the concept of “intermediation mechanisms” to refer to the social, organizational, and technical processes through which policy instruments are interpreted, implemented, and internalized in production practices.

Vietnam provides a highly relevant context in which to examine these dynamics. According to 2024 economic structure data released by Vietnam’s General Statistics Office, Vietnam is one of the most dynamic emerging economies, while also retaining a long-standing agricultural foundation. Rural areas account for approximately 63% of the population, 66% of households, and 62% of the labor force

(Lâm Đồng Digital Transformation Portal, 2025). However, agriculture, forestry, and fisheries contribute only 11.86% of national GDP. In the broader Asian context, Vietnam's agricultural labor productivity remains among the lowest in the region. Therefore, examining the mechanisms through which policies enhance farmers' digital adaptive capacity in the context of digital transformation is particularly important. Vietnam has adopted a wide range of policies on digital transformation, traceability, agricultural modernization, and value chain linkages; however, smallholder farming remains prevalent, and intermediary capacities remain uneven across localities. Against this background, the central research question addressed in this study is: Through what mechanisms are digital agriculture support policies translated into farmers' adaptive capacities and adaptive practices?

The analytical framework of this article can be summarized as follows: policy mix, intermediation mechanisms, adaptive capacity, adaptation outcomes. These outcomes refer to farmers' production, business, and service outcomes. Six mechanisms are used for the analysis: access expansion, capacity formation, standardization, organizational intermediation, market incentives, and institutional constraints. This approach makes it possible to explain why the same policy orientation may generate different outcomes across localities, farmer groups, and market-linkage structures.

MATERIALS AND METHODS

This study adopts a qualitative comparative case study design to process-trace farmers' adaptation mechanisms across different contexts, consistent with the case study approach developed by Yin (2018). The cases were purposively selected according to an "information-rich" logic (Patton, 2014). Sơn La represents a model characterized by the development of planting area codes, traceability systems, and export-oriented linkages, thereby enabling an examination of how market-driven standardization requirements stimulate changes in farmers' production practices. Lâm Đồng represents a model of high-tech agriculture and data-based management, allowing the analysis of how technical capabilities and investment capacity shape adaptation to digital agriculture. Đồng Tháp represents a province-level digital transformation model associated with value chain linkages and innovation in agricultural product distribution and market access, thereby reflecting the coordinating role of local governments and market incentives in promoting smallholders' adaptation. Overall, the selection of these three contrasting cases enables the study to compare salient adaptation mechanisms in the context of digital agriculture in Vietnam.

The data comprise policy documents and 45 semi-structured interviews conducted between December 2025 and February 2026. Participants included 12 government

officials, agricultural extension officers and digital transformation officers; 12 representatives of cooperatives, enterprises, or technology platforms; 18 farmers, household producers, or farm owners; and 3 experts, researchers, or project officers. Each locality included 15 interviews distributed across the four participant groups to ensure comparability. The interviews were designed to generate data on four key dimensions: policy instruments, intermediation mechanisms, adaptive capacity, and adaptation outcomes. The interview protocol was developed in accordance with the principles of semi-structured interviewing in qualitative research (Kallio et al., 2016).

The data were analyzed using thematic analysis, combining theory-driven coding with inductive theme development from the empirical material (Braun & Clarke, 2006). The analytical process involved iterative reading, open coding, mechanism-based code clustering, cross-case comparison, and interpretation following the sequence of policy mix, intermediation mechanisms, adaptive capacity, adaptation outcomes. Trustworthiness was strengthened through triangulation across multiple data sources and actor groups, thick contextual description, maintenance of an analytical audit trail, and the use of anonymized participant codes (P01P45), consistent with principles of trustworthiness in qualitative research (Lincoln & Guba, 1985). All participants were informed about the objectives of the study, their right to refuse participation, and the principles of data confidentiality.

RESULTS-DISCUSSION

The results are organized in three parts: first, the digital agriculture policy context in Vietnam is characterized to ground the subsequent analysis; second, the six intermediation mechanisms identified from the interview data are presented; and third, the four resulting types of farmers' adaptation outcomes are described and compared across the three case-study localities.

Digital Agriculture Policy Context in Vietnam

Digital agriculture policies in Vietnam have emerged from multiple policy domains related to national digital transformation, agricultural modernization, traceability, agricultural extension, support for collective economic organizations, and innovation in agricultural product distribution and market access. Decision No. 749/QĐ-TTg identifies agriculture as a priority sector under the National Digital Transformation Programme; Decision No. 150/QĐ-TTg situates agricultural transformation within the strategy for sustainable development and the reorganization of production along value chains; Decision No. 100/QĐ-TTg on traceability and Decision No. 194/QĐ-TTg on innovation in agricultural product distribution and market access provide the foundation for data standardization and the expansion of market channels; while Decree No. 83/2018/NĐ-CP and Decision No. 1804/QĐ-TTg further strengthen

agricultural extension functions and cooperative capacity. Table 1 synthesizes the policy mix, showing the main function of each policy domain and its related intermediation mechanism.

Table 1. Policy Mix in Vietnam's Digital Agriculture and Related Adaptation Mechanisms.

Policy domain	Representative policy document	Main function	Related mechanism
Digital transformation	Decision No. 749/QĐ-TTg	Data, digital platforms, and technology applications	Access expansion
Agricultural modernization	Decision No. 150/QĐ-TTg	Reorganization of production and value chain development	System coordination
Traceability	Decision No. 100/QĐ-TTg	Information standardization, data codification, and supply chain transparency	Standardization
Agricultural product distribution and market access	Decision No. 194/QĐ-TTg	Innovation in distribution channels, e-commerce, and supply-demand connection	Market incentives
Agricultural extension	Decree No. 83/2018/NĐ-CP	Training, advisory services, technology transfer, and practice-based support	Capacity formation
Cooperatives	Decision No. 1804/QĐ-TTg	Organizational capacity building, production linkages, and market linkage support	Organizational intermediation

Note. Illustrative examples for each province: in Sơn La, a cooperative member stated, “We record every pesticide spray in the app because the exporter checks it” (P02); in Lâm Đồng, a high-tech farm manager explained, “I use soil sensors to decide irrigation, not just experience” (P15); in Đồng Tháp, a farmer described, “The district platform connects us directly with retailers, bypassing middlemen” (P30).

The analysis of these documents reveals that Vietnam does not lack policy instruments for digital agriculture. The central issue lies in the degree of integration among these instruments and the capacity to translate them into practices at the farm-household level. Fragmentation across policy domains and administrative levels makes local governments, cooperatives, agricultural extension services, and enterprises decisive actors in connecting policies with adaptive behavior.

Six Intermediation Mechanisms

The interview findings show that policy instruments produce behavioral and organizational change only when they are translated through intermediary actors. The six mechanisms operate sequentially: access creates initial opportunities; capacity enables the use of tools; standardization generates pressure to adjust production processes; organizational intermediation reduces compliance costs; markets determine the sustainability of adaptive practices; and institutional constraints explain variation across localities and farmer groups.

The access-expansion mechanism is reflected in farmers’ exposure to planting area codes, traceability systems, farm production diaries, and digital distribution and market-access channels. However, access does not necessarily lead to effective use: farmers often need concrete guidance from cooperatives, enterprises, or agricultural extension services (P07, P21). The capacity-formation mechanism translates digital tools into practical skills; its effects become evident when training is linked to record-keeping, system operation, and output requirements, rather than being limited to short-term training courses (P04, P15).

Standardization is the mechanism that produces the most visible changes in production processes. Planting area codes, traceability systems, farm production diaries, and quality standards require farmers to shift from experience-based production toward more documented and controlled production practices. As one farmer in Sơn La stated, “without records, products cannot be purchased” (P02); linked enterprises also regard planting-area data as a condition for transactions (P11). However, standardization may also deepen differentiation among smallholders when organizational support is lacking.

Organizational intermediation is reflected in the roles of cooperatives, enterprises, agricultural extension services, and local governments in providing technical guidance, supporting record-keeping, controlling quality, and connecting farmers to market outlets (P12, P25). Market incentives determine the sustainability of digital practices: farmers maintain traceability, record-keeping, or platform use when these practices are linked to contracts, market outlets, or selling prices (P05, P18, P30). This indicates that adaptation to digital agriculture is not only a technological issue but is also associated with the capacity to generate market value, product trust, and quality signals within agricultural supply chains (Ho et al., 2024). For example, a farmer in Đồng Tháp (P18) stated: “I only keep the digital diary because the cooperative sells my fruit at a higher price to the supermarket. Without that premium, I would not bother.” Similarly, an agribusiness manager in Sơn La (P30) explained that farmers who consistently update traceability records receive

priority in contract renewals and occasional price bonuses. These examples illustrate that market incentives transform digital record-keeping from an administrative burden into an economically meaningful practice.

Institutional constraints include limited data interoperability, training that is insufficiently practice-oriented, uneven cooperative capacity, and weak coordination among programmes; these are the main causes of uneven adaptation (P16, P40).

An agricultural extension officer in Lâm Đồng (P16) described the challenge: “Each province uses a different traceability software, so farmers who sell across districts have to enter the same information twice. This duplication demoralizes them.” A cooperative leader in Sơn La (P40) added that training courses frequently fail to address practical skills: “They teach us about digital transformation policies, but not how to use the specific app on our phones.” Such constraints underscore how institutional fragmentation and generic training weaken the translation of policies into sustained adaptive behavior.

Four Types of Adaptation Outcomes and Cross-Case Comparison

The six mechanisms identified produce four main types of farmers’ adaptation outcomes in relation to digital agriculture. Process adaptation is reflected in the adjustment of production activities to standards, enhanced record-keeping, and quality control; this form of adaptation is particularly evident in Sơn La, where traceability and export requirements encourage farmers to modify their production processes. Data adaptation refers to the recording, storage, and use of production data in farm management; this form is more apparent in Lâm Đồng, especially among farms and models with technological investment. Organizational adaptation is reflected in farmers’ participation in cooperatives, linkage groups, or coordinated production chains; this is an important condition enabling smallholders to overcome constraints in capital, technical capacity, and information. Meanwhile, market adaptation reflects the capacity to participate in market outlets that require standards, traceability, and production data; this form of adaptation is prominent in Sơn La and Đồng Tháp, but depends substantially on the stability of market outlets.

Table 2 presents a cross-case comparison of the three localities, summarizing their key characteristics, the intermediary actors involved, the salient mechanisms driving adaptation, the main outcomes observed, and the principal limitations encountered.

Table 2. Case Characteristics, Adaptation Mechanisms, and Adaptation Outcomes.

Locality	Key characteristics	Intermediary actors	Salient mechanisms	Main outcomes	Limitations
Sơn La	Planting area codes, traceability, and export-oriented linkages	Cooperatives, enterprises, agricultural extension services	Standardization; organizational intermediation; market incentives	Process adaptation; traceability data	Dependence on cooperative capacity; smallholders face difficulties in maintaining records
Lâm Đồng	High-tech agriculture and production data management	Enterprises, farms, technical service providers	Capacity formation; data use	Technical adaptation; data management	Differentiation between groups with and without investment capacity
Đồng Tháp	Province-level digital transformation and value chain linkages	Local government, cooperatives, enterprises, digital platforms	System coordination; market incentives; organizational intermediation	Organizational adaptation; market adaptation	Dependence on the stability of market outlets and the quality of linkages

The comparison shows that differences among the three localities lie not only in the level of digital agriculture implementation but also in the operational characteristics of adaptation mechanisms. Sơn La illustrates an adaptation model driven by standardization and export markets, with cooperatives and linked enterprises playing prominent intermediary roles. Lâm Đồng reflects a model based on technical capacity and data management, while also revealing differentiation between farmer groups with and without the capacity to invest in technology. Meanwhile, Đồng Tháp represents an adaptation model driven by local government coordination and market linkages, in which cooperatives, enterprises, and digital platforms serve as connectors between farmers and value chains. Taken together, the cases show that digital agriculture policies can generate substantive adaptation only when they are linked to the capacities of intermediary organizations and incentives from market outlets.

DISCUSSION

When the six intermediation mechanisms are placed within a single analytical chain, the findings show that digital agriculture policies generate adaptation only when three conditions are relatively well aligned. The first condition is access, including digital platforms, planting area codes, traceability systems, training, and policy information. This condition creates initial possibilities for participation but is insufficient to produce changes in practice. The second



condition is organizational, reflected in the capacities of cooperatives, enterprises, agricultural extension services, and local governments to interpret policy requirements, provide operational guidance, and reduce compliance costs for farmers. The third condition is market-related: digital practices must be linked to market outlets, contracts, selling prices, product trust, or participation in standardized value chains. In this context, policy instruments and practices such as traceability systems, data recording, and process standardization can help strengthen product credibility and enhance the potential to create value in agricultural markets (Ho et al., 2024). These three conditions help explain why the same policy instrument may produce different adaptation outcomes across localities.

The cross-case comparison illustrates precisely these dynamics. In *Sơn La*, the adaptation chain is initiated primarily through standardization requirements associated with planting area codes and traceability systems. Policies establish the standardization framework, but cooperatives and enterprises are the actors that translate these standards into practices of record-keeping, input control, product classification, and compliance with procurement requirements. Consequently, the most salient adaptation outcome is not farmers' use of an isolated digital platform, but rather the transformation of production processes so that traceability data can be generated and verified. This case demonstrates that standardization can create strong adaptive pressure, while simultaneously increasing organizational requirements for smallholders. Farmers participating in cooperatives or enterprise-linked production arrangements are better able to maintain records and comply with standards, whereas independent farming households often face difficulties because learning costs, time costs, and monitoring requirements exceed their individual capacities.

In *Lâm Đồng*, the mechanisms of capacity formation and data adaptation are more evident. High-tech agriculture, commercialized production, and technical service provision create favorable conditions for the use of data in production management. However, the findings also indicate that data adaptation is unevenly distributed. Farms, enterprises, and households with greater investment capacity have better access to digital tools, technical services, and operational knowledge, whereas smallholders continue to depend heavily on external support and often use digital tools only at a minimal level. *Lâm Đồng* therefore illustrates a form of internal differentiation: even within a locality characterized by a relatively advanced technological base, adaptive capacity varies substantially according to production scale, investment capacity, managerial capability, and the degree of integration with enterprises or service organizations.

In *Đồng Tháp*, the adaptation chain highlights the coordinating role of local government and the importance

of market incentives. Province-level digital transformation policies provide a coordination framework, but the sustainability of digital practices depends on whether policy instruments are linked to value chain integration, e-commerce, traceability systems, and stable market outlets. This case shows that policy coordination is an important condition for reducing fragmentation among support programmes, but coordination becomes effective only when connected to concrete economic incentives for farmers. When market outlets are unstable or market benefits remain unclear, farmers tend to perceive record-keeping, traceability, or data updating as additional costs. Conversely, when cooperatives, enterprises, and local governments collectively establish market channels with standardized requirements, digital practices are more likely to be sustained over time.

Taken together, the three cases suggest that adaptation to digital agriculture is a layered process rather than a single decision. The first layer involves initial exposure and use; the second concerns the development of practical skills; the third involves process standardization and data generation; the fourth entails organizational institutionalization through cooperatives, enterprises, or linkage groups; and the fifth concerns the maintenance of practices through market incentives. When policies focus only on access or training, outcomes are often short-term and unsustainable. By contrast, when policies simultaneously activate intermediary organizations and market signals, adaptive capacity is more likely to develop. This layered structure also helps explain the risk of exclusion: farmers lacking organizational support, market linkages, or learning capacity may struggle to keep pace with the data and standardization requirements of digital agriculture.

Educational Dimensions of Intermediation Mechanisms

The capacity-formation mechanism operates largely through extension services and cooperative training activities, which can be conceptualized as situated learning processes (Lave & Wenger, 1991). Unlike formal classroom instruction, effective capacity building in digital agriculture occurs when farmers engage in authentic tasks "such as operating traceability apps, recording production data, or interpreting market information" within their own farming contexts. This aligns with the principles of extension education, where learning is embedded in the everyday practices and problems of agricultural work (Leeuwis & van den Ban, 2004). The interview data suggest that when training is disconnected from farmers' immediate operational needs, it fails to produce lasting changes; conversely, practice-oriented guidance linked to output requirements fosters the development of adaptive competences.

The organizational-intermediation mechanism similarly exhibits educational features through the creation of communities of practice (Wenger, 1998). Cooperatives and

enterprise-linked production groups bring together farmers, agribusiness technicians, and extension officers around shared goals such as traceability compliance and market access. In these settings, less experienced farmers learn not only through formal instruction but also through peripheral participation in collective data management, peer observation, and joint problem-solving. This communal dimension is especially important for smallholders, who often lack individual resources for trial-and-error learning. Thus, cooperatives and similar organizations act as learning infrastructures that enable the gradual acquisition of digital and organizational skills a process that is central to policy-driven adaptation but frequently overlooked in technology-adoption models.

Building on this integrated interpretation, the study makes three specific contributions to the literature. First, it repositions adaptation to digital agriculture beyond technology adoption. The findings show that farmers do not merely decide whether to use digital tools; rather, they must simultaneously adjust production processes, generate data, participate in organizations, and respond to market requirements. This is consistent with the view of digital agriculture as a systemic transformation (Klerkx et al., 2019; Wolfert et al., 2017), while further suggesting that, in smallholder contexts, adaptation is shaped by policy, intermediary organizations, and market incentives. The concept of “policy-driven adaptation” therefore provides a more useful explanation of how policy instruments are translated into practical behavior. Second, the study extends the policy mix approach by conceptualizing the policy mix as a mediated process through which effects are transmitted to policy beneficiaries. Existing literature often emphasizes the structure of policy instruments and the coherence of policy mixes (Rogge & Reichardt, 2016). The findings show that the presence of instruments alone is insufficient; effectiveness depends on the capacity to activate an intermediation chain comprising access expansion, capacity formation, standardization, organizational intermediation, market incentives, and institutional coordination. Third, the study clarifies the role of intermediary actors in farmers’ adaptation to digital agriculture. Recent studies on digital agriculture indicate that agricultural digital transformation depends not only on individual farmers’ decisions, but also on actor networks, data infrastructure, support services, coordination mechanisms, and market-linkage capacity (Klerkx et al., 2019). In Vietnam, this intermediary role is clearly expressed through cooperatives, linked enterprises, agricultural extension services, and local governments. These actors can be understood as “adaptive infrastructure” that translates policy mixes into concrete changes in farmers’ production processes, data management, organizational linkages, and market participation (Klerkx et al., 2019; Rogge & Reichardt, 2016).

In terms of policy implications, the findings suggest four directions. First, digital agriculture policies should move beyond the provision of technologies toward strengthening intermediary capacity, particularly that of cooperatives, agricultural extension services, and market-linkage organizations. Second, data interoperability and coordination among policy instruments should be enhanced to reduce fragmentation. Third, digital practices should be linked to clear market incentives through contracts, standards, traceability, and stable market outlets. Fourth, policies should be designed in accordance with local contexts and farmer groups, avoiding a uniform model that may intensify differentiation between households with investment capacity and small-scale farmers. Rather than evaluating the success of agricultural digital transformation through the number of platforms, training sessions, or demonstration models, assessment should focus on the extent to which these instruments are translated into stable practices at the farm-household and value-chain levels. This requires policy indicators to incorporate the intermediary capacity of cooperatives, the degree of data interoperability, the quality of post-training support, the level of integration with market outlets, and the capacity to reduce compliance costs for farmers. Such an evaluative approach is more consistent with the nature of digital agriculture as a process of reorganization production, organizational, and market systems, rather than merely a process of technology diffusion.

Regarding transferability, the six mechanisms identified “access expansion, capacity formation, standardization, organizational intermediation, market incentives, and institutional constraints” capture generic functions that are likely to be relevant in other developing-country settings where smallholder-dominated agriculture intersects with digital transformation policies. For instance, in Latin America, extension systems have historically combined public advisory services with strong cooperative movements (Landini, 2016), suggesting that similar intermediation mechanisms may operate there. However, the specific configuration and relative weight of these mechanisms are shaped by Vietnam’s institutional landscape, including the prominent role of state-led agricultural extension, the centralized policy mix, and the reliance on cooperatives as primary intermediaries. In contexts where private advisory services, farmer associations, or indigenous community networks are more prevalent, the mechanisms of capacity formation and organizational intermediation may operate through different channels while retaining analogous functions. Future comparative research across countries would be valuable to test the framework’s applicability beyond Vietnam.

This study is limited by its focus on three cases and by its qualitative design, which does not allow for statistical generalization. Future research could expand the

geographical scope, combine qualitative analysis with quantitative surveys, and test the relative role of each mechanism across different production contexts.

CONCLUSIONS

This study analyzed farmers' adaptation to digital agriculture in Vietnam through a policy mix and intermediation-mechanism lens. Evidence from Sơn La, Lâm Đồng, and Đồng Tháp shows that adaptation does not unfold as an individual-level technology adoption process, but rather as the outcome of interactions among policy, intermediary organizations, and markets.

The article identified six intermediation mechanisms: access expansion, capacity formation, standardization, organizational intermediation, market incentives, and institutional constraints. These mechanisms generate four types of adaptation outcomes: process adaptation, data adaptation, organizational adaptation, and market adaptation. The mechanism chain indicates that a weakness in any link may disrupt the translation of policies into practices.

The main contribution of this study is threefold: it shifts the analytical focus from technology adoption to policy-driven adaptation; reframes the policy mix as a mediated implementation process; and clarifies the roles of cooperatives, enterprises, agricultural extension services, and local governments as adaptive infrastructure.

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CONFLICTS OF INTEREST

The author declares no conflicts of interest.

Author	Roles
Van Manh Hoang	Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing - original draft, Writing - review & editing

Author Contributions

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