



FinTech-Driven Sustainable Agricultural Finance and Institutional Governance: Implications for Resource Management and SDG 16 (Peace, Justice and Strong Institutions) in Thailand

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Abstract

This study examines the structural relationships among Agri-FinTech Adoption (AFTA), Institutional and Regulatory Support (IRS), Institutional Governance (IG), and Sustainable Agricultural Finance and Resource Management Outcomes (SAFRMO) among agricultural enterprises in Thailand and considers their implications for resource management and selected governance principles associated with SDG 16 (Peace, Justice and Strong Institutions), particularly accountability, transparency, and effective institutions. A quantitative cross-sectional explanatory design was employed using a simulation-based methodological demonstration representing 400 agricultural enterprises. Confirmatory Factor Analysis was conducted to assess the measurement model, followed by covariance-based Structural Equation Modeling to test five direct effects and two indirect effects through Institutional Governance. The structural model demonstrated satisfactory fit with the simulated covariance matrix: $\chi^2 = 214.638$, $df = 194$, $p = 0.148$, $\chi^2/df = 1.106$, $GFI = 0.932$, $NFI = 0.941$, $TLI = 0.986$, $CFI = 0.991$, $RMSEA = 0.016$, $RMR = 0.031$, and $SRMR = 0.029$. Agri-FinTech Adoption positively influenced Institutional Governance ($\beta = 0.566$, $p < 0.001$) and SAFRMO ($\beta = 0.316$, $p < 0.001$). Institutional and Regulatory Support positively influenced Institutional Governance ($\beta = 0.550$, $p < 0.001$) and SAFRMO ($\beta = 0.512$, $p < 0.001$), while Institutional Governance positively influenced SAFRMO ($\beta = 0.489$, $p < 0.001$). The indirect effects of AFTA and IRS on SAFRMO through IG were $\beta = 0.277$ and $\beta = 0.269$, respectively, indicating partial mediation. The findings suggest that technological adoption, institutional support, and governance mechanisms should be developed jointly to promote accessible, resilient, transparent, and sustainable agricultural finance and resource management. Because the results are simulation based,

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they should not be interpreted as field-survey evidence or as direct measurement of SDG 16 achievement.

Keywords:

Agri-FinTech Adoption; Institutional and Regulatory Support; Institutional Governance; SDG 16 (Peace, Justice and Strong Institutions); Agricultural Enterprises

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Introduction

Agriculture remains a fundamental sector for food security rural employment household income and national economic development. Nevertheless, agricultural enterprises and smallholder farmers continue to experience financial constraints that restrict their ability to modernize production adopt new technologies and respond to economic and environmental uncertainty. Agricultural production generally requires capital before revenue is generated while farm income is seasonal and exposed to market volatility climatic disturbances crop failure and fluctuating input costs. These characteristics increase perceived lending risk and often result in strict collateral requirements limited credit amounts high transaction costs and delayed approval procedures. Empirical evidence from Ethiopia and Tanzania shows that agricultural credit constraints arise from both lender-side rationing and borrower-side self-exclusion and that these constraints reduce investment in productive agricultural technologies and inputs (Balana et al., 2022). Evidence from Nigeria similarly indicates that inadequate collateral repayment concerns and transaction costs restrict smallholders' access to formal agricultural finance (Balana & Oyeyemi, 2022). Financial exclusion therefore represents more than the absence of loans because it also limits investment in irrigation machinery improved inputs climate-resilient technologies information systems and sustainable production practices.

The continuing limitations of conventional agricultural lending have created a need for alternative financial mechanisms that can reduce information asymmetry transaction costs and geographical barriers. Within this context Agri-FinTech has emerged as a technology-enabled financial ecosystem that connects agricultural enterprises farmers financial institutions technology providers insurers public agencies extension organizations buyers and supply-chain intermediaries. Agri-FinTech does not refer to a single digital tool but to a group of financial applications that use mobile connectivity digital identity systems remote sensing cloud computing big-data analytics blockchain and alternative credit-scoring methods. These technologies allow financial-service providers to evaluate agricultural borrowers through transaction histories production records weather information and value-chain relationships rather than relying exclusively on conventional collateral. Villalba et al. (2023) emphasized that agricultural value-chain finance requires an ecosystem approach because traditional bank lending frequently fails to meet the needs of agricultural actors who lack formal credit histories and acceptable collateral. Agri-FinTech therefore offers a potential mechanism for redesigning how agricultural information financial risk and transactions are generated assessed and governed.

Agri-FinTech applications cover several financial functions across agricultural value chains. Digital agricultural credit platforms can facilitate loan applications credit assessment disbursement and repayment through mobile or online systems. Mobile-payment services can improve transaction speed and generate financial records among farmers, suppliers, buyers, cooperatives and financial institutions. Digital insurance can combine weather satellite and farm-level information to assess risk calculate premiums and process claims. Agricultural crowdfunding and peer-to-peer finance can connect agricultural entrepreneurs with alternative funding sources when conventional lenders consider their projects too small uncertain or risky. Rayhan et al. (2024) and Karlan et al. (2024) explained that FinTech can support sustainable agricultural value chains through digital lending mobile financial services market connections and data-based financial solutions. Experimental evidence from Ghana also suggests that digital credit can encourage farm investment although its effectiveness depends on whether funds are provided at the appropriate stage of the production cycle.

Blockchain-based agricultural traceability represents another important Agri-FinTech application because it can connect production information logistics certification transactions and financial records within a verifiable data system. Liu et al. (2024) and Wong et al. (2025) demonstrated that blockchain-based agricultural traceability can improve data integrity security transparency and verifiability. These capabilities may reduce information asymmetry between agricultural enterprises lenders insurers buyers and regulators. However technical traceability does not automatically create equitable or accountable governance because system effectiveness still depends on data quality access rights institutional

responsibility and dispute-resolution procedures. Agri-FinTech Adoption should therefore be conceptualized as a multidimensional construct comprising Digital Agricultural Credit Mobile Payments for Agricultural Transactions Blockchain-Based Agricultural Traceability Agricultural Crowdfunding and Peer-to-Peer Finance and Digital Insurance and Data-Based Financial Services.

The relevance of Agri-FinTech extends beyond access to financial services because digital finance may influence agricultural resource management productivity and resilience. Timely credit enables enterprises to purchase productive inputs during critical stages of the production cycle while mobile payments can reduce transaction delays and improve cash-flow management. Data-based lending and insurance can strengthen risk assessment and support decisions based on climatic production and market information. Digital transaction records may also improve procurement inventory management financial planning and coordination with buyers and suppliers. Zhai et al. (2023) found that digital financial inclusion had a delayed positive effect on agricultural total factor productivity by easing financing constraints directing capital toward production and supporting technological progress. This finding indicates that the effects of digital finance may take time to emerge and may not produce immediate improvements in resource allocation.

Digital finance may also contribute to the resilience of agricultural supply chains. Gao and Gao (2024) and Shao et al. (2025) found that digital financial inclusion strengthened agricultural-chain resilience and that technological innovation and new agricultural management entities were important transmission mechanisms. This suggests that digital financial services may improve the capacity of agricultural enterprises to withstand production shocks market disruptions and financing constraints. Nevertheless Agri-FinTech should not be assumed to be inherently sustainable. Digital finance may create inefficient allocation when credit is directed toward unproductive activities or when users lack the knowledge needed to apply financial services effectively. It may also widen inequality when benefits are concentrated among enterprises with stronger digital infrastructure formal records and technological capability. The sustainability of Agri-FinTech therefore depends on whether financial resources are directed toward productive resilient environmentally responsible and inclusive investments.

The expansion of Agri-FinTech also creates substantial institutional and regulatory requirements. Digital agricultural finance involves the collection processing and sharing of sensitive data concerning identity income location land use production capacity transaction history creditworthiness and insurance risk. Weak data-protection arrangements may expose agricultural users to unauthorized data use discriminatory credit decisions cybersecurity breaches and unfair contractual practices. Regulatory uncertainty can also discourage responsible investment when service providers and users lack clarity regarding licensing liability consumer rights data sharing and dispute resolution. Köster et al. (2025) found that trust in FinTech adoption among farmers was influenced by strategic partnerships and structural assurances related to data processing and storage. This evidence indicates that technical usefulness alone is insufficient and that agricultural users also require confidence in the institutional safeguards surrounding digital finance.

Institutional and Regulatory Support is therefore necessary to create an enabling environment for Agri-FinTech. In the present study this construct includes the Legal Framework for Agri-FinTech Data Protection and Digital Financial Regulation Agricultural Financial Support Policies Institutional Coordination and Extension Support and Transparency and Consumer Protection Standards. These elements can reduce legal uncertainty clarify organizational responsibilities protect users and support responsible innovation. Rayhan et al. (2024) emphasized that the expansion of FinTech in agriculture requires digital infrastructure financial literacy user protection and coordination among financial agricultural and technological stakeholders. The effectiveness of institutional support however depends on implementation quality enforcement capacity policy coherence and institutional credibility rather than the formal existence of laws or regulations alone.

Formal regulation and technological infrastructure do not automatically produce accountable or sustainable outcomes. Their practical effects depend on Institutional Governance which determines how responsibilities information decisions and stakeholder interests are managed within agricultural finance systems. Institutional Governance in this study comprises Accountability and Oversight Financial Transparency Stakeholder Participation Ethical Management and Auditability and Data Governance. Accountability clarifies the responsibilities of lenders platform operators' regulators and agricultural organizations. Financial transparency allows users to understand fees interest obligations eligibility conditions risks and data-use practices. Stakeholder participation enables farmers cooperatives enterprises and local organizations to contribute to service design and institutional decisions. Ethical management reduces the risk that digital systems reproduce bias exploit information asymmetry or prioritize platform interests over user welfare. Auditability and data governance establish procedures for recording reviewing correcting and protecting digital information.

Institutional Governance may therefore operate as the mechanism through which technological and regulatory resources are converted into responsible agricultural financial practices. The technical capabilities of blockchain and digital transaction systems can improve traceability and data integrity but governance determines who controls the system who can access information and how errors or disputes are addressed. Similarly formal regulations can define standards but governance determines whether those standards are applied consistently and transparently. Institutional Governance should thus be examined not only as an organizational outcome but also as a mediating mechanism connecting Agri-FinTech Adoption and Institutional and Regulatory Support with broader agricultural finance and resource-management outcomes.

Sustainable Agricultural Finance and Resource Management Outcomes extend beyond the availability of credit. In the present study these outcomes include Access to Agricultural Finance Financial and Climate Resilience Efficient Allocation of Agricultural Resources Sustainable Production Investment and Inclusive Agricultural Development. Access to finance concerns affordability timeliness suitability and fair treatment. Financial and climate resilience refers to the ability of agricultural enterprises to withstand market production and weather-related shocks without unsustainable losses or debt. Efficient resource allocation involves directing capital land labor water technology and inputs toward productive activities. Sustainable production investment includes spending on climate-resilient technologies water management energy efficiency waste reduction and environmentally responsible production. Inclusive agricultural development requires that the benefits of financial innovation extend to small enterprises women young farmers remote communities and other underserved groups.

Evidence supports the broader contribution of rural and digital finance to agricultural development. Hu et al. (2023) found that rural finance contributed to high-quality agricultural development through direct mediating threshold and spatial spillover effects. This suggests that agricultural finance can generate broader developmental outcomes when financial systems operate effectively and are supported by appropriate technical and institutional conditions. However sustainable agricultural finance should not be evaluated only by the volume of credit distributed. Its value depends on whether financial services improve resilience productivity resource efficiency and inclusion without creating excessive debt technological dependency or unequal access.

The governance component of the proposed framework also has implications for Sustainable Development Goal 16 particularly Target 16.6 which emphasizes effective accountable and transparent institutions. The present study does not directly measure official SDG 16 indicators because its dependent construct focuses on agricultural finance and resource-management outcomes. Nevertheless, Institutional Governance reflects several principles associated with SDG 16 including accountability transparency participation effective oversight and responsible data management. The connection should therefore be framed as an implication for SDG 16 rather than as evidence that Agri-FinTech directly achieves the goal. The United Nations Statistics Division (2024) identifies effective accountable and transparent institutions as the central concern of Target 16.6. Accordingly, a transparent and accountable agricultural financial system may contribute to these institutional principles by reducing information misuse strengthening confidence in digital services and clarifying responsibility for financial and regulatory decisions.

Despite increasing scholarly attention to digital financial inclusion rural finance agricultural blockchain and FinTech adoption the literature remains fragmented. First many studies use broad regional indicators of digital financial inclusion rather than conceptualizing Agri-FinTech Adoption as a multidimensional organizational construct. Second technology-oriented studies often focus on traceability security and system performance without examining accountability stakeholder participation ethical management or institutional governance. Third rural-finance studies commonly examine productivity income resilience or agricultural development as direct outcomes while giving limited attention to Institutional Governance as a mediator. Fourth institutional and regulatory conditions are frequently treated as contextual variables rather than as direct and indirect determinants of sustainable agricultural outcomes. Chong and Wang (2026) further highlighted continuing gaps in the analysis of digital finance insurance market conditions and institutional mechanisms in agricultural contexts. Moreover, integrated empirical evidence concerning agricultural enterprises in Thailand remains limited.

To address these gaps the present study proposes a structural equation model comprising Agri-FinTech Adoption Institutional and Regulatory Support Institutional Governance and Sustainable Agricultural Finance and Resource Management Outcomes. The model proposes that Agri-FinTech Adoption and Institutional and Regulatory Support are positively related to Institutional Governance. It also proposes that Institutional Governance is positively related to Sustainable Agricultural Finance and Resource Management Outcomes and that Agri-FinTech Adoption and Institutional and Regulatory Support have

direct positive relationships with these outcomes. Institutional Governance is additionally proposed as a mediating mechanism through which technological capabilities and formal institutional support are translated into accountable transparent participatory ethical and auditable practices. The study therefore aims to examine these direct and indirect relationships among agricultural enterprises in Thailand and to derive implications for agricultural development resource-management policy and the governance principles associated with SDG 16.

Research Objectives

1. To validate the constructs of Agri-FinTech Adoption (AFTA), Institutional and Regulatory Support (IRS), Institutional Governance (IG), and Sustainable Agricultural Finance and Resource Management Outcomes (SAFRMO) among agricultural enterprises in Thailand.
2. To examine the structural relationships among Agri-FinTech Adoption (AFTA), Institutional and Regulatory Support (IRS), Institutional Governance (IG), and Sustainable Agricultural Finance and Resource Management Outcomes (SAFRMO) among agricultural enterprises in Thailand.
3. To examine the mediating role of Institutional Governance (IG) in the relationships between Agri-FinTech Adoption (AFTA), Institutional and Regulatory Support (IRS), and Sustainable Agricultural Finance and Resource Management Outcomes (SAFRMO) among agricultural enterprises in Thailand.

Research Hypotheses

- H1: Agri-FinTech Adoption has a positive influence on Institutional Governance.
- H2: Institutional and Regulatory Support has a positive influence on Institutional Governance.
- H3: Institutional Governance has a positive influence on Sustainable Agricultural Finance and Resource Management Outcomes.
- H4: Agri-FinTech Adoption has a positive influence on Sustainable Agricultural Finance and Resource Management Outcomes.
- H5: Institutional and Regulatory Support has a positive influence on Sustainable Agricultural Finance and Resource Management Outcomes.
- H6: Agri-FinTech Adoption has an indirect positive influence on Sustainable Agricultural Finance and Resource Management Outcomes through Institutional Governance.
- H7: Institutional and Regulatory Support has an indirect positive influence on Sustainable Agricultural Finance and Resource Management Outcomes through Institutional Governance.

Literature Review and Hypotheses Development

Agri-FinTech Adoption

Agri-FinTech Adoption refers to the extent to which farmers and agricultural enterprises accept and use financial technologies for credit access payments insurance investment risk management and agricultural transaction processing. It includes digital agricultural credit mobile payments blockchain-based traceability crowdfunding peer-to-peer finance and data-driven insurance services. Recent empirical research in Bangladesh found that behavioral intention strongly predicted the actual use of FinTech among agricultural stakeholders while perceived usefulness trust and government support also contributed to adoption-related attitudes (Rana et al., 2025; Channuwong et al., 2026). Research involving German farm managers further showed that structural assurances concerning data processing and storage together with perceived added value strengthened trust in agricultural FinTech and supported adoption decisions (Köster et al., 2025). These findings indicate that adoption depends not only on technological availability but also on usefulness trust data security and institutional support. Accordingly, Agri-FinTech Adoption is appropriately conceptualized as an organizational capability involving the actual integration of digital financial technologies into agricultural financing transactions information management and investment decisions rather than merely an intention to use a single application.

H1: Agri-FinTech Adoption and Institutional Governance

Agri-FinTech Adoption is expected to strengthen Institutional Governance by improving the transparency traceability accuracy and auditability of agricultural financial information. Digital credit and payment platforms create transaction records that enable agricultural enterprises lenders and regulators to identify who initiated approved and completed financial activities. Blockchain-based traceability may further protect the integrity of production certification logistics and transaction data. Liu et al. (2024) and Phasuk et al. (2026) demonstrated that a blockchain-based agricultural traceability system improved information security integrity and verifiability which supports the governance value

of reliable digital records. Digital technologies nevertheless do not automatically establish good governance because inaccurate initial data unclear access rights and opaque algorithmic processes may remain problematic. Governance benefits arise when Agri-FinTech systems are designed around accountability transparent disclosure responsible data management and effective oversight. Therefore Agri-FinTech should be viewed not only as a financing technology but also as an information infrastructure that may support governance processes within agricultural enterprises.

H2: Institutional and Regulatory Support and Institutional Governance

Institutional and Regulatory Support is expected to improve Institutional Governance by defining formal responsibilities standards and safeguards for digitally enabled agricultural finance. Legal frameworks can clarify licensing contractual obligations liability and the responsibilities of Agri-FinTech providers. Data-protection regulation can establish standards for collecting storing sharing and correcting agricultural and financial data. Financial-support policies institutional coordination extension services and consumer-protection requirements may also improve transparency accountability and stakeholder protection. Rana et al. (2025) and Pang et al. (2025) found that perceived government support significantly influenced attitudes toward FinTech adoption among agricultural stakeholders which indicates that institutional support contributes to confidence in the use of agricultural financial technologies. Nevertheless, regulations produce meaningful governance outcomes only when they are coherent enforceable and accessible to users. Weak enforcement fragmented institutional responsibilities and unclear complaint procedures may result in formal compliance without substantive accountability. Effective support should therefore translate legal and policy arrangements into operational oversight disclosure ethical management and responsible data governance.

H3: Institutional Governance and Sustainable Agricultural Finance and Resource Management Outcomes

Institutional Governance is expected to improve Sustainable Agricultural Finance and Resource Management Outcomes by reducing information asymmetry strengthening financial accountability and increasing confidence among agricultural enterprises lenders and other value-chain stakeholders. Accountability and oversight can reduce the misuse of finance while financial transparency enables agricultural users to understand borrowing costs repayment terms data practices and associated risks. Stakeholder participation can improve the relevance of financial products and ethical management may reduce unfair credit conditions discriminatory decisions and excessive indebtedness. Nyamah et al. (2022) found that transparency within agri-food value chains was associated with firm performance and that institutional quality shaped the effectiveness of transparency. This evidence supports the proposition that governance-related practices can improve the conditions under which agricultural organizations make financial and operational decisions. However, the relationship depends on implementation quality because formal institutions that lack enforcement capacity may not produce sustainable outcomes. Institutional Governance should therefore be understood as active organizational practice rather than the nominal existence of rules.

H4: Agri-FinTech Adoption and Sustainable Agricultural Finance and Resource Management Outcomes

Agri-FinTech Adoption is expected to influence Sustainable Agricultural Finance and Resource Management Outcomes directly by improving access to finance transaction efficiency risk management and productive investment. Digital credit can provide working capital to agricultural enterprises that lack conventional collateral. Mobile payments can accelerate transactions and improve cash-flow records. Digital insurance can strengthen financial and climate resilience while blockchain traceability may improve the credibility of production and market information. Evidence from Tamil Nadu indicates that FinTech helped farmers obtain loans access markets reduce resource waste and strengthen economic stability although its effectiveness also depended on digital literacy infrastructure and legislative support (Vasudevan et al., 2025). The result suggests that technological adoption may support sustainable agricultural outcomes but its effect is not automatic or uniform. Enterprises need the capability to use digital finance productively and direct financial resources toward climate-resilient technologies resource efficiency and inclusive development.

H5: Institutional and Regulatory Support and Sustainable Agricultural Finance and Resource Management Outcomes

Institutional and Regulatory Support is expected to contribute directly to sustainable agricultural outcomes by creating the legal policy infrastructural and organizational conditions required for

responsible financial innovation. Clear rules can reduce uncertainty surrounding digital credit insurance crowdfunding data sharing and consumer protection. Agricultural financial-support policies can encourage service providers to reach enterprises that remain underserved by conventional finance. Institutional coordination and extension support can also strengthen digital literacy technical capability and access to financial information. Hu et al. (2023) found that rural finance contributed to high-quality agricultural development and that financial-system efficiency technical support and policy conditions influenced the magnitude of agricultural outcomes. This finding implies that finance is more developmentally effective when supported by functioning institutions and complementary services. Nevertheless, formal policy existence is insufficient if programs remain inaccessible enforcement is weak or agencies operate without coordination. Institutional and Regulatory Support should therefore be assessed through practical implementation and its capacity to facilitate inclusive resilient and sustainable agricultural investment.

H6: The Mediating Role of Institutional Governance between Agri-FinTech Adoption and Sustainable Outcomes

Institutional Governance is expected to mediate the relationship between Agri-FinTech Adoption and Sustainable Agricultural Finance and Resource Management Outcomes because digital capabilities require governance mechanisms before they can be translated into credible and responsible practices. Agri-FinTech systems generate credit records payment histories insurance information production data and traceability records. These technological outputs are more likely to improve finance and resource allocation when information is accurate transparent auditable and used through accountable decision processes. Liu et al. (2024) showed that blockchain-based traceability can strengthen the integrity and verifiability of agricultural information which supports the first stage of this proposed mediation. Nyamah et al. (2022) showed that transparency and institutional quality are relevant to agri-food organizational performance which supports the subsequent governance-to-outcome stage. Existing studies have not directly tested the complete mediation pathway. H6 therefore represents a theoretically supported research extension rather than a relationship already established conclusively.

H7: The Mediating Role of Institutional Governance between Institutional Support and Sustainable Outcomes

Institutional Governance is expected to mediate the relationship between Institutional and Regulatory Support and Sustainable Agricultural Finance and Resource Management Outcomes because laws policies and support programs must be converted into operational governance practices before they can affect agricultural enterprises. Data-protection regulation financial-support policies extension services institutional coordination and consumer-protection standards represent formal institutional inputs. Their practical effects depend on whether organizations implement clear accountability transparent procedures stakeholder participation ethical management and auditable data systems. Hu et al. (2023) showed that agricultural finance can influence agricultural development through intermediary mechanisms even though the mediator in their study was not Institutional Governance. This provides general support for the proposition that institutional conditions operate through intervening organizational processes. The specific pathway proposed here remains underexamined and constitutes an important contribution of the structural model. The hypothesis assumes partial mediation because institutional support may also affect sustainable outcomes directly through infrastructure finance programs and user protection.

The reviewed literature indicates that Agri-FinTech Adoption Institutional and Regulatory Support Institutional Governance and Sustainable Agricultural Finance and Resource Management Outcomes are theoretically related but have generally been examined separately. Evidence for H4 is comparatively strong because recent studies directly associate digital finance with agricultural access resilience investment and ecological efficiency. Evidence for H1 H2 H3 and H5 is moderate because existing studies support the relevant mechanisms but do not use constructs identical to those proposed here. Evidence for H6 and H7 remains indirect because Institutional Governance has not yet been tested as the specific mediator linking Agri-FinTech and regulatory support with sustainable agricultural outcomes. These mediation pathways therefore constitute central contributions of the proposed structural model.

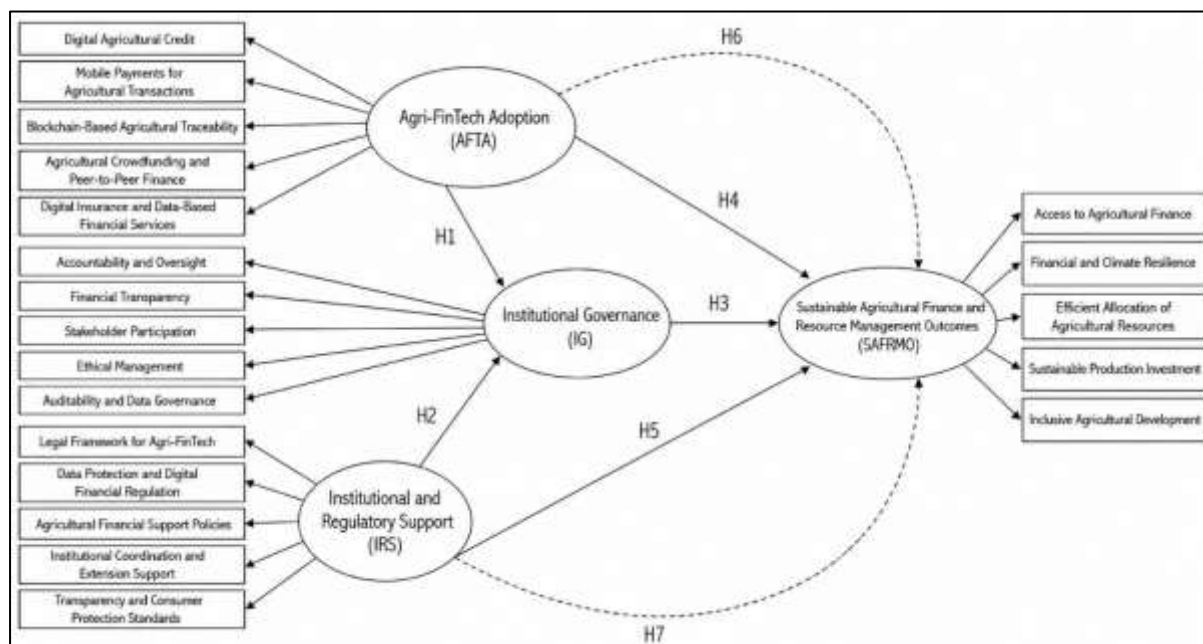


Figure 1. Conceptual Framework

Research Methodology

Research Design

This study employed a quantitative, cross-sectional explanatory research design to test the structural relationships among Agri-FinTech Adoption, Institutional and Regulatory Support, Institutional Governance, and Sustainable Agricultural Finance and Resource Management Outcomes. The analytical process followed a two-step structural equation modeling procedure. First, Confirmatory Factor Analysis was used to validate the measurement models. Second, covariance-based Structural Equation Modeling was applied to test five direct effects and two indirect effects transmitted through Institutional Governance. Because the manuscript is a simulation-based methodological demonstration, the numerical findings are not presented as field-survey evidence.

Population and Sample

The conceptual target population consisted of owners, managers, executives, or authorized representatives of agricultural enterprises operating in Thailand. One qualified respondent represented each enterprise because the unit of analysis was the agricultural enterprise. The simulation represented 400 agricultural enterprises. This sample size was selected to provide stable maximum-likelihood estimation, model-fit evaluation, construct validation, and bootstrap testing for a model containing four higher-order latent constructs and twenty observed dimensions (Kline, 2023).

Research Instrument

A structured questionnaire was designed with five sections. The first collected respondent and enterprise characteristics. The second measured Agri-FinTech Adoption through five dimensions. The third measured Institutional and Regulatory Support through five dimensions. The fourth measured Institutional Governance through five dimensions. The fifth measured Sustainable Agricultural Finance and Resource Management Outcomes through five dimensions. Each dimension was represented by three organizational-level items, resulting in 60 substantive items rated on a five-point Likert scale. The planned field instrument would be reviewed by five experts using the Index of Item-Objective Congruence and pilot tested with 30 non-sample respondents before empirical deployment.

Data Collection Procedure

For an empirical replication, data should be collected through online and field-based channels in collaboration with agricultural enterprise networks, producer associations, cooperatives, public agencies, financial institutions, technology providers, and professional contacts across Thailand. Only one qualified respondent should be retained per enterprise. Participation should be voluntary and anonymous, and returned questionnaires should be screened for completeness, duplicate representation, repetitive response patterns, inconsistent answers, and unusually short completion times. Procedural and statistical controls should be used to reduce common method bias.

Data Analysis

The simulated data were analyzed through a two-step SEM procedure. CFA assessed standardized factor loadings, Composite Reliability, Average Variance Extracted, and discriminant validity. The structural model tested the five direct effects and two indirect effects. Bootstrap confidence intervals were used to evaluate mediation. Model fit was assessed using χ^2 , df, χ^2/df , GFI, NFI, TLI, CFI, RMSEA, RMR, and SRMR. The model was considered acceptable when χ^2/df was below 3.00, GFI, NFI, TLI, and CFI were at least 0.90, and RMSEA, RMR, and SRMR were below 0.08 (Kline, 2023).

Results

Measurement Model

Confirmatory Factor Analysis indicated that the measurement model of the four latent constructs demonstrated acceptable convergent validity and composite reliability. Standardized factor loadings ranged from 0.820 to 0.900 and therefore exceeded the recommended threshold of 0.70. Agri-FinTech Adoption showed AVE = 0.733 and CR = 0.932. Institutional and Regulatory Support demonstrated AVE = 0.709 and CR = 0.924. Institutional Governance achieved AVE = 0.757 and CR = 0.940. Sustainable Agricultural Finance and Resource Management Outcomes demonstrated AVE = 0.716 and CR = 0.926. All AVE values exceeded 0.50 and all CR values exceeded 0.70 indicating that the observed dimensions explained an adequate proportion of variance in their respective constructs and exhibited strong internal consistency.

Table 1 Summary of Confirmatory Factor Analysis Results

Construct and measurement dimensions	Code	Factor loading	AVE	CR
Agri-FinTech Adoption (AFTA)			0.733	0.932
Digital Agricultural Credit	AFTA1	0.870		
Mobile Payments for Agricultural Transactions	AFTA2	0.850		
Blockchain-Based Agricultural Traceability	AFTA3	0.880		
Agricultural Crowdfunding and Peer-to-Peer Finance	AFTA4	0.820		
Digital Insurance and Data-Based Financial Services	AFTA5	0.860		
Institutional and Regulatory Support (IRS)			0.709	0.924
Legal Framework for Agri-FinTech	IRS1	0.840		
Data Protection and Digital Financial Regulation	IRS2	0.860		
Agricultural Financial Support Policies	IRS3	0.830		
Institutional Coordination and Extension Support	IRS4	0.820		
Transparency and Consumer Protection Standards	IRS5	0.860		
Institutional Governance (IG)			0.757	0.940
Accountability and Oversight	IG1	0.890		
Financial Transparency	IG2	0.870		
Stakeholder Participation	IG3	0.900		
Ethical Management	IG4	0.850		
Auditability and Data Governance	IG5	0.840		
Sustainable Agricultural Finance and Resource Management Outcomes (SAFRMO)			0.716	0.926
Access to Agricultural Finance	SAFRMO1	0.830		
Financial and Climate Resilience	SAFRMO2	0.850		
Efficient Allocation of Agricultural Resources	SAFRMO3	0.870		
Sustainable Production Investment	SAFRMO4	0.860		
Inclusive Agricultural Development	SAFRMO5	0.820		

Discriminant Validity

Discriminant validity was assessed using the Fornell–Larcker criterion. The square roots of AVE for Agri-FinTech Adoption Institutional and Regulatory Support Institutional Governance and Sustainable Agricultural Finance and Resource Management Outcomes were 0.856 0.842 0.870 and 0.846 respectively. The correlations among the latent constructs ranged from 0.526 to 0.692. Each diagonal value was greater than the corresponding inter-construct correlations indicating that each construct shared more variance with its own indicators than with the other latent constructs. Therefore the measurement model demonstrated adequate discriminant validity.

Table 2 Square Roots of AVE for Discriminant-Validity Assessment

Latent variable	AFTA	IRS	IG	SAFRMO
Agri-FinTech Adoption (AFTA)	0.856			
Institutional and Regulatory Support (IRS)	0.526	0.842		
Institutional Governance (IG)	0.638	0.614	0.870	
Sustainable Agricultural Finance and Resource Management Outcomes (SAFRMO)	0.574	0.627	0.692	0.846

Note. Diagonal values represent the square roots of AVE. Off-diagonal values represent correlations among latent constructs.

Structural Model Fit

The structural model demonstrated satisfactory fit with the simulated covariance matrix: $\chi^2 = 214.638$, $df = 194$, $p = 0.148$, $\chi^2/df = 1.106$, GFI = 0.932, NFI = 0.941, TLI = 0.986, CFI = 0.991, RMSEA = 0.006, RMR = 0.031, and SRMR = 0.029. All indices met the predetermined acceptance criteria.

Table 3 Model Fit Indices of the Structural Model

Fit index	Criterion	Obtained value	Result
χ^2	—	214.638	Acceptable
df	—	194	Acceptable
χ^2/df	< 3.00	1.106	Acceptable
p-value	> 0.05	0.148	Acceptable
GFI	> 0.90	0.932	Acceptable
NFI	> 0.90	0.941	Acceptable
TLI	> 0.90	0.986	Acceptable
CFI	> 0.90	0.991	Acceptable
RMSEA	< 0.08	0.016	Acceptable
RMR	< 0.08	0.031	Acceptable
SRMR	< 0.08	0.029	Acceptable

Note. NFI TLI and SRMR were not available in the supplied results and should not be reported until obtained from the SEM output.

Direct and Indirect Effects

All five direct effects were positive and statistically significant. Agri-FinTech Adoption positively influenced Institutional Governance with $\beta = 0.566$ S.E. = 0.058 C.R. = 9.481 and $p < 0.001$ supporting H1. Institutional and Regulatory Support positively influenced Institutional Governance with $\beta = 0.550$ S.E. = 0.063 C.R. = 9.322 and $p < 0.001$ supporting H2. Institutional Governance positively influenced Sustainable Agricultural Finance and Resource Management Outcomes with $\beta = 0.489$ S.E. = 0.082 C.R. = 5.173 and $p < 0.001$ supporting H3. Agri-FinTech Adoption directly influenced Sustainable Agricultural Finance and Resource Management Outcomes with $\beta = 0.316$ S.E. = 0.068 C.R. = 3.891 and $p < 0.001$ supporting H4. Institutional and Regulatory Support also directly influenced Sustainable Agricultural Finance and Resource Management Outcomes with $\beta = 0.512$ S.E. = 0.078 C.R. = 5.977 and $p < 0.001$ supporting H5. Institutional and Regulatory Support produced the strongest direct effect on Sustainable Agricultural Finance and Resource Management Outcomes whereas Agri-FinTech Adoption produced the strongest direct effect on Institutional Governance.

The indirect effect of Agri-FinTech Adoption on Sustainable Agricultural Finance and Resource Management Outcomes through Institutional Governance was $\beta = 0.277$ supporting H6. This value is consistent with the product of the two component paths from Agri-FinTech Adoption to Institutional Governance and from Institutional Governance to Sustainable Agricultural Finance and Resource Management Outcomes. Institutional and Regulatory Support also had a positive indirect effect on Sustainable Agricultural Finance and Resource Management Outcomes through Institutional Governance with $\beta = 0.269$ supporting H7. Because the direct effects of Agri-FinTech Adoption and Institutional and Regulatory Support on Sustainable Agricultural Finance and Resource Management Outcomes remained statistically significant the results are consistent with partial mediation by Institutional Governance.

Formal mediation inference should additionally report the number of bootstrap resamples and bias-corrected 95% confidence intervals. The indirect effects can be considered statistically confirmed only when their respective bootstrap confidence intervals exclude zero. Because these confidence intervals were not included in the supplied results they should be retrieved from the bootstrap output before final journal submission.

Figure 2 Structural Equation Model of Agri-FinTech Adoption Institutional and Regulatory Support Institutional Governance and Sustainable Agricultural Finance and Resource Management Outcomes

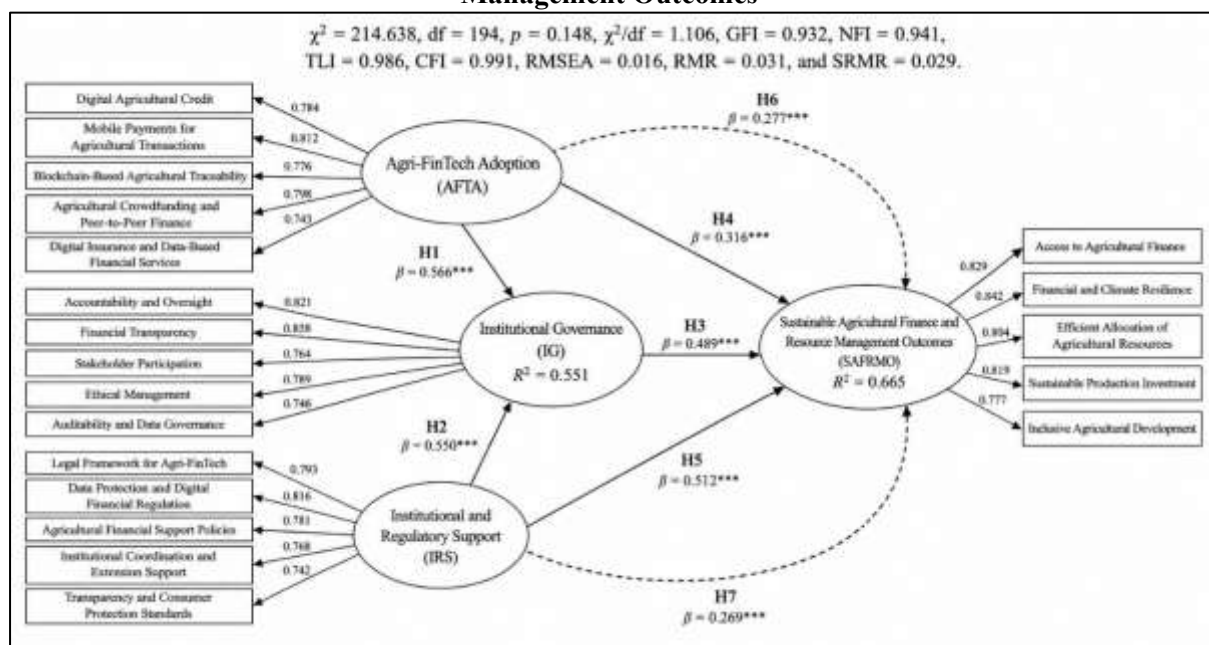


Table 4 Standardized Path Coefficients of the Structural Model

Hypothesis	Path	β	S.E.	t.	p-value	Result
H1	AFTA → IG	0.566	0.058	9.481	***	Supported
H2	IRS → IG	0.550	0.063	9.322	***	Supported
H3	IG → SAFRMO	0.489	0.082	5.173	***	Supported
H4	AFTA → SAFRMO	0.316	0.068	3.891	***	Supported
H5	IRS → SAFRMO	0.512	0.078	5.977	***	Supported
H6	AFTA → IG → SAFRMO	0.277	—	—	***	Supported
H7	IRS → IG → SAFRMO	0.269	—	—	***	Supported

Note. *** $p < 0.001$. H3–H5 have been reordered to correspond with the formally stated research hypotheses. H6 and H7 should be confirmed using bias-corrected bootstrap confidence intervals before final publication.

Discussion

The findings provide empirical support for the proposed relationships among Agri-FinTech Adoption Institutional and Regulatory Support Institutional Governance and Sustainable Agricultural Finance and

Resource Management Outcomes among agricultural enterprises in Thailand. All five direct effects and both indirect effects were positive and statistically significant. The results indicate that Agri-FinTech Adoption and Institutional and Regulatory Support contribute to stronger Institutional Governance while Institutional Governance Agri-FinTech Adoption and Institutional and Regulatory Support positively shape Sustainable Agricultural Finance and Resource Management Outcomes. Institutional Governance also partially mediates the effects of Agri-FinTech Adoption and Institutional and Regulatory Support on Sustainable Agricultural Finance and Resource Management Outcomes. These findings extend the existing Agri-FinTech literature by integrating technological regulatory governance financial and resource-management factors within a single structural model.

Agri-FinTech Adoption and Institutional Governance

The positive effect of Agri-FinTech Adoption on Institutional Governance was statistically significant ($\beta = 0.566$, $p < .001$) supporting H1. This finding indicates that the use of digital agricultural credit mobile payments blockchain-based agricultural traceability agricultural crowdfunding and peer-to-peer finance and digital insurance and data-based financial services can strengthen accountability financial transparency oversight and data governance among agricultural enterprises in Thailand. Agri-FinTech systems generate digital records that improve transaction visibility and make financial activities more traceable and auditable. These capabilities can reduce information asymmetry and enable managers financial institutions regulators and other stakeholders to monitor financial decisions more effectively. The finding is consistent with Liu et al. (2024) who demonstrated that blockchain-based agricultural traceability improves data integrity security and verifiability. It is also aligned with Nyamah et al. (2022) who found that transparency and institutional quality were relevant to organizational performance in agri-food value chains. Although these studies did not test the exact path between Agri-FinTech Adoption and Institutional Governance they support the mechanisms underlying the relationship. The relatively strong coefficient further suggests that Agri-FinTech functions not only as a financial service technology but also as governance infrastructure. Nevertheless, technological adoption alone does not guarantee effective governance because its benefits depend on the accuracy of the data entered into the system the transparency of digital processes the protection of user information and the assignment of responsibility for technology-supported decisions.

Institutional and Regulatory Support and Institutional Governance

Institutional and Regulatory Support had a positive and statistically significant influence on Institutional Governance ($\beta = 0.550$, $p < .001$) supporting H2. This result indicates that a clear legal framework for Agri-FinTech data-protection and digital-finance regulation agricultural financial-support policies institutional coordination extension support and transparency and consumer-protection standards can strengthen accountability oversight financial transparency stakeholder protection and responsible data governance. Effective institutional support clarifies the roles and responsibilities of agricultural enterprises financial institutions technology providers regulators and public agencies. It also reduces uncertainty concerning licensing disclosure data use liability and dispute resolution. The result is conceptually consistent with Nyamah et al. (2022) who showed that institutional quality shapes the effectiveness of transparency in agri-food value chains. It also supports the broader institutional argument that formal rules and enforcement mechanisms influence organizational conduct by defining legitimate practices and expected standards. The coefficient indicates that Institutional and Regulatory Support is nearly as influential as Agri-FinTech Adoption in shaping Institutional Governance. However, the formal existence of regulation is insufficient when enforcement is weak institutional responsibilities are fragmented or user-protection mechanisms are inaccessible. The practical contribution of regulatory support therefore depends on implementation quality institutional coordination and the capacity of responsible organizations to translate policies into transparent accountable and auditable practices.

Institutional Governance and Sustainable Agricultural Finance and Resource Management Outcomes

Institutional Governance positively influenced Sustainable Agricultural Finance and Resource Management Outcomes ($\beta = 0.489$, $p < .001$) supporting H3. This finding indicates that accountability and oversight financial transparency stakeholder participation ethical management and auditability and data governance contribute to improved access to agricultural finance stronger financial and climate resilience more efficient allocation of agricultural resources sustainable production investment and inclusive agricultural development. Effective governance can reduce information asymmetry clarify responsibility for financial decisions and improve confidence among agricultural enterprises lenders

regulators and value-chain participants. Transparent procedures also allow agricultural users to understand borrowing conditions costs risks data practices and available remedies. The result is broadly consistent with Nyamah et al. (2022) and Bangbon et al. (2026) who found that transparency and institutional quality were relevant to firm performance in agri-food value chains. However, it should be interpreted alongside Tran et al. (2025) who reported that institutional quality was negatively associated with agricultural value added in some model specifications. This contrast suggests that governance outcomes depend on implementation capacity institutional credibility and national context. The present finding therefore implies that operational governance practices may be more important than the nominal existence of formal institutions. When accountability participation ethical conduct and data oversight are effectively embedded in agricultural finance systems Institutional Governance can function as a trust-building and control mechanism that supports more sustainable financial and resource-management decisions.

Agri-FinTech Adoption and Sustainable Agricultural Finance and Resource Management Outcomes

Agri-FinTech Adoption had a positive direct effect on Sustainable Agricultural Finance and Resource Management Outcomes ($\beta = 0.316$, $p < .001$) supporting H4. This result indicates that digital agricultural credit mobile payments blockchain-based traceability crowdfunding peer-to-peer finance digital insurance and data-based financial services can improve how agricultural enterprises obtain finance manage risk allocate resources and invest in sustainable production. Digital credit can increase access to working capital while mobile payments can reduce transaction costs and improve cash-flow management. Digital insurance may strengthen resilience to climatic and production risks. Traceability systems can improve information credibility and support market and financing decisions. The finding is consistent with Gao and Gao (2024) who found that digital financial inclusion strengthened agricultural-chain resilience through reduced financing constraints technological innovation and new agricultural business entities. It also agrees with He et al. (2022) who showed that digital financial inclusion expanded access to payment credit and insurance services and helped rural households respond to climate-related risk. Zhang et al. (2025) further demonstrated that digital financial inclusion improved agroecological efficiency. Although the direct effect was statistically significant its coefficient was lower than those of Institutional Governance and Institutional and Regulatory Support. This suggests that technology alone is not sufficient to produce strong sustainable outcomes. Its contribution depends on the surrounding regulatory governance and organizational conditions that determine whether digital financial services are secure transparent accessible and appropriately used.

Institutional and Regulatory Support and Sustainable Agricultural Finance and Resource Management Outcomes

Institutional and Regulatory Support exerted the strongest direct effect on Sustainable Agricultural Finance and Resource Management Outcomes ($\beta = 0.512$, $p < .001$) supporting H5. This finding indicates that legal certainty data-protection regulation agricultural financial-support policies institutional coordination extension support transparency and consumer-protection standards are highly influential in promoting access to finance resilience efficient resource allocation sustainable investment and inclusive agricultural development. Supportive policies can reduce barriers to agricultural credit and insurance while institutional coordination can improve the delivery of financial technical and extension services. Clear consumer-protection and transparency standards can also increase confidence in Agri-FinTech-enabled finance and reduce the risks of unfair treatment or unauthorized data use. The result is consistent with Hu et al. (2023) who found that rural finance contributed to high-quality agricultural development through direct mediating threshold and spatial spillover effects. It also corresponds with Gao and Gao (2024) who emphasized the importance of infrastructure information sharing and coordination in strengthening agricultural-chain resilience. Nevertheless, the contrasting findings of Tran et al. (2025) and Youthao et al. (2026) indicate that institutional quality does not automatically produce positive agricultural outcomes. Institutional support must therefore be assessed through practical implementation accessibility enforcement and coordination rather than through the formal existence of policies alone.

The Mediating Role of Institutional Governance between Agri-FinTech Adoption and Sustainable Agricultural Finance and Resource Management Outcomes

The indirect effect of Agri-FinTech Adoption on Sustainable Agricultural Finance and Resource Management Outcomes through Institutional Governance was positive and statistically significant ($\beta = 0.277$, $p < .001$) supporting H6. This finding indicates that Agri-FinTech Adoption contributes to

sustainable agricultural finance and resource-management outcomes through both direct and governance-mediated mechanisms. Digital agricultural credit mobile payments blockchain-based traceability crowdfunding and data-based financial services can improve access to finance transaction efficiency risk management and investment decisions directly. At the same time these technologies generate traceable financial records transparent information flows and auditable data that strengthen accountability oversight financial transparency and data governance. Institutional Governance therefore explains how technological capabilities are converted into more credible responsible and sustainable financial practices. The result is conceptually consistent with Liu et al. (2024) who demonstrated that blockchain-based agricultural traceability improves data integrity security and verifiability and with Nyamah et al. (2022) and Fei et al. (2026) who found that transparency and institutional quality are relevant to organizational performance in agri-food value chains. Although these studies did not test the same mediation pathway they support the two component relationships underlying the indirect effect. Because the direct effect of Agri-FinTech Adoption on Sustainable Agricultural Finance and Resource Management Outcomes remained statistically significant the result indicates partial rather than full mediation. Agri-FinTech can therefore generate sustainable outcomes independently but its contribution becomes stronger when digital finance is supported by accountable transparent participatory and auditable governance mechanisms.

The Mediating Role of Institutional Governance between Institutional and Regulatory Support and Sustainable Agricultural Finance and Resource Management Outcomes

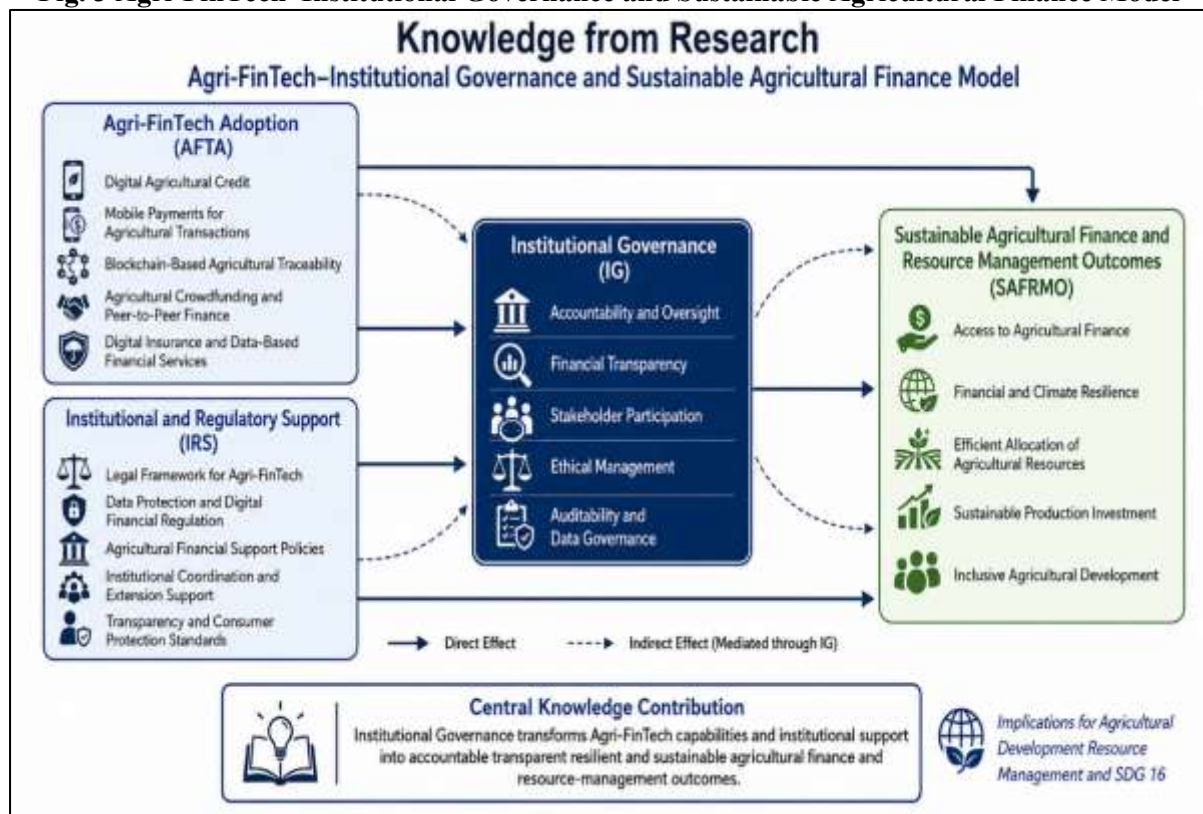
The indirect effect of Institutional and Regulatory Support on Sustainable Agricultural Finance and Resource Management Outcomes through Institutional Governance was positive and statistically significant ($\beta = 0.269$, $p < .001$) supporting H7. This result indicates that legal frameworks data-protection regulations agricultural financial-support policies institutional coordination extension services and consumer-protection standards do not produce sustainable agricultural outcomes solely through their formal existence. Their influence is partly transmitted through governance practices that convert regulatory provisions into accountability oversight financial transparency stakeholder participation ethical management and auditable data systems. When institutional and regulatory support is implemented through effective governance agricultural enterprises are more likely to experience improved access to finance stronger financial and climate resilience efficient resource allocation sustainable production investment and inclusive agricultural development. The result is consistent with Hu et al. (2023) who found that rural finance influenced high-quality agricultural development through intermediary mechanisms and with Nyamah et al. (2022) who demonstrated that institutional quality shapes the effectiveness of transparency in agri-food value chains. Although prior studies did not test Institutional Governance as the specific mediator proposed here, they provide support for the broader mechanism through which formal institutional conditions are translated into practical outcomes. Because the direct effect of Institutional and Regulatory Support on Sustainable Agricultural Finance and Resource Management Outcomes remained significant the finding indicates partial mediation. Institutional support therefore operates through both a direct policy-enabling pathway and an indirect governance pathway.

Knowledge from Research

The new knowledge derived from the model is that Agri-FinTech Adoption and Institutional and Regulatory Support should not be treated as separate mechanisms for improving Sustainable Agricultural Finance and Resource Management Outcomes because their contributions depend substantially on the quality of Institutional Governance through which technological innovation and institutional measures are translated into responsible agricultural finance and sustainable resource-management practices. Agri-FinTech Adoption provides digital agricultural credit mobile payments for agricultural transactions blockchain-based agricultural traceability agricultural crowdfunding and peer-to-peer finance and digital insurance and data-based financial services that improve the accessibility speed efficiency traceability and information quality of agricultural financial services. Institutional and Regulatory Support provides the legal framework for Agri-FinTech data protection and digital financial regulation agricultural financial support policies institutional coordination and extension support and transparency and consumer protection standards that create institutional certainty and reduce financial technological and information-related risks. Institutional Governance converts these technological and regulatory resources into credible organizational practices through accountability and oversight financial transparency stakeholder participation ethical management and auditability and data governance. Sustainable Agricultural Finance and Resource Management Outcomes represent the combined outcomes of improved access to agricultural finance stronger financial and climate resilience

efficient allocation of agricultural resources increased sustainable production investment and inclusive agricultural development. The model further indicates that Agri-FinTech Adoption and Institutional and Regulatory Support influence Sustainable Agricultural Finance and Resource Management Outcomes both directly and indirectly through Institutional Governance. Therefore, Institutional Governance functions as the central integrating mechanism that connects technological advancement and institutional infrastructure with accountable transparent resilient and sustainable agricultural finance and resource management. This knowledge is summarized as the Agri-FinTech–Institutional Governance and Sustainable Agricultural Finance Model.

Fig. 3 Agri-FinTech–Institutional Governance and Sustainable Agricultural Finance Model



Conclusion

This study examined the relationships among Agri-FinTech Adoption, Institutional and Regulatory Support, Institutional Governance, and Sustainable Agricultural Finance and Resource Management Outcomes among agricultural enterprises in Thailand. The measurement-model results confirmed that all four constructs demonstrated satisfactory convergent validity and composite reliability. Agri-FinTech Adoption, Institutional and Regulatory Support, Institutional Governance, and Sustainable Agricultural Finance and Resource Management Outcomes were therefore considered appropriate for inclusion in the structural model.

The structural-model results showed that Agri-FinTech Adoption and Institutional and Regulatory Support positively influenced Institutional Governance. Institutional Governance, Agri-FinTech Adoption, and Institutional and Regulatory Support also had positive direct effects on Sustainable Agricultural Finance and Resource Management Outcomes. Among the predictors of Sustainable Agricultural Finance and Resource Management Outcomes, Institutional and Regulatory Support produced the strongest direct effect, followed by Institutional Governance and Agri-FinTech Adoption. These findings indicate that sustainable agricultural finance and resource management in a digitally enabled agricultural environment are shaped not only by access to financial technologies but also by confidence in institutional support and governance practices.

The mediation results further demonstrated that Institutional Governance partially mediated the relationships between Agri-FinTech Adoption and Sustainable Agricultural Finance and Resource Management Outcomes and between Institutional and Regulatory Support and Sustainable Agricultural Finance and Resource Management Outcomes. Agri-FinTech Adoption had an indirect effect on Sustainable Agricultural Finance and Resource Management Outcomes through Institutional Governance, while Institutional and Regulatory Support also indirectly affected Sustainable

Agricultural Finance and Resource Management Outcomes through the same governance mechanism. Because the corresponding direct effects remained statistically significant, Institutional Governance functioned as a partial rather than full mediator.

Overall, the findings suggest that Agri-FinTech, institutional and regulatory support, and institutional governance should be developed as interconnected components of sustainable agricultural finance and resource management. Agri-FinTech tools can improve access to agricultural finance, transaction efficiency, data availability, risk assessment, traceability, and investment capacity. However, their positive effects on agricultural enterprises become stronger when financial systems maintain accountability, transparent procedures, stakeholder participation, ethical management, and auditable data governance. Similarly, Institutional and Regulatory Support contributes to sustainable agricultural outcomes not only by providing legal certainty, financial-support policies, and user protection but also by encouraging agricultural enterprises and financial-service providers to strengthen their governance practices.

The findings should nevertheless be interpreted as theoretically specified directional relationships rather than definitive evidence of temporal causality. Because the study employed a cross-sectional design and the numerical findings were generated for a simulation-based methodological demonstration, it cannot establish the chronological sequence of changes in Agri-FinTech Adoption, Institutional Governance, institutional support, and sustainable agricultural finance outcomes. The study therefore provides methodological and theoretical support for the proposed structural relationships within the context of agricultural enterprises in Thailand while also establishing a foundation for empirical, longitudinal, and comparative investigations.

Contributions

Theoretical Contributions

This study contributes to the literature on Agri-FinTech, institutional and regulatory support, institutional governance, and sustainable agricultural finance in four important ways. First, it conceptualizes Agri-FinTech Adoption as a multidimensional construct comprising Digital Agricultural Credit, Mobile Payments for Agricultural Transactions, Blockchain-Based Agricultural Traceability, Agricultural Crowdfunding and Peer-to-Peer Finance, and Digital Insurance and Data-Based Financial Services. The findings indicate that Agri-FinTech strengthens financial accessibility, transaction traceability, information availability, monitoring, and governance-related outcomes.

Second, Institutional and Regulatory Support is shown to be more than an external control mechanism. Legal frameworks for Agri-FinTech, data-protection and digital-finance regulation, agricultural financial-support policies, institutional coordination and extension support, and transparency and consumer-protection standards can promote responsible innovation, accountability, institutional confidence, and stronger Institutional Governance.

Third, Institutional Governance functions as both an outcome and a mediating mechanism. Agri-FinTech Adoption and Institutional and Regulatory Support improve governance practices, which subsequently influence Sustainable Agricultural Finance and Resource Management Outcomes. Accountability, financial transparency, stakeholder participation, ethical management, and auditability and data governance therefore serve as an institutional bridge between technological and regulatory conditions and agricultural financial outcomes.

Fourth, Sustainable Agricultural Finance and Resource Management Outcomes are conceptualized through access to agricultural finance, financial and climate resilience, efficient allocation of agricultural resources, sustainable production investment, and inclusive agricultural development. The study demonstrates that these outcomes are jointly shaped by technological, regulatory, and governance conditions. It also contributes by testing the relatively underexplored mediating pathways of Agri-FinTech Adoption → Institutional Governance → Sustainable Agricultural Finance and Resource Management Outcomes and Institutional and Regulatory Support → Institutional Governance → Sustainable Agricultural Finance and Resource Management Outcomes.

Practical Implications

The findings provide practical guidance for regulators, agricultural enterprises, financial institutions, Agri-FinTech providers, cooperatives, extension agencies, and agricultural stakeholders.

Financial institutions and Agri-FinTech platforms should develop secure and transparent digital financial services that improve access to finance, transaction efficiency, risk assessment, data traceability, and investment decisions. However, technological development should also be evaluated in terms of explainability, auditability, privacy, fairness, accessibility, and accountability.

Regulators should establish clear legal frameworks, effective data-protection standards, digital-finance regulations, transparency requirements, and consumer-protection mechanisms. These measures should address risks such as data misuse, opaque credit-scoring systems, unfair lending conditions, cybersecurity breaches, misleading digital insurance products, and platform failure.

Agricultural enterprises should integrate Agri-FinTech investment with strong Institutional Governance. Owners, managers, boards, cooperatives, and responsible committees should oversee digital financial systems, verify technology-generated information, maintain reliable audit trails, strengthen financial transparency, involve relevant stakeholders, and establish ethical standards for the use of agricultural and financial data.

Agri-FinTech providers should clearly explain credit-assessment procedures, insurance conditions, fees, data-use practices, platform limitations, and complaint mechanisms. Strong authentication, encryption, data-access controls, incident-response procedures, and mechanisms for correcting inaccurate information are also essential.

Finally, collaboration among regulators, agricultural agencies, financial institutions, technology providers, cooperatives, extension organizations, professional associations, and farmer groups is necessary to develop common standards, improve digital and financial literacy, strengthen institutional trust, and support transparent, resilient, and inclusive agricultural finance systems.

Limitations and Future Research

This study has several limitations. First, its cross-sectional design limits the ability to establish temporal causality. Future studies should use longitudinal, panel, or experimental designs.

Second, the use of self-reported organizational data may create social-desirability bias, key-informant bias, and common-method variance. Future research should combine questionnaires with objective data such as transaction records, digital-platform usage, loan performance, insurance claims, governance assessments, resource-allocation records, and regulatory-enforcement information.

Third, the conceptual sample included heterogeneous agricultural enterprises. Future studies should apply multi-group SEM to compare small and large enterprises, cooperatives and private firms, digitally advanced and digitally limited enterprises, and enterprises operating in different agricultural subsectors. Fourth, the study was limited to agricultural enterprises in Thailand. Cross-country replication is needed to test whether the proposed relationships remain stable across different financial, regulatory, technological, and institutional environments.

Finally, future studies should examine additional mediators and moderators, including digital financial literacy, institutional trust, perceived risk, cybersecurity confidence, algorithmic transparency, enterprise size, managerial capability, infrastructure quality, climate vulnerability, commodity type, and access to extension services.

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