Journal of Agricultural Science and Technology (JAST), 28(5)
In Press, Pre-Proof Version

Grounded Theory Model for Social Media Integration in Agricultural Extension

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Abstract

The rapid spread of digital technologies has created new opportunities for strengthening agricultural extension, yet the systematic integration of social media into extension systems remains poorly understood. This study aimed to develop a grounded theoretical model that explains the drivers, barriers, and strategies for enabling social media adoption in agricultural extension. Eleven semi-structured interviews were conducted with subject-matter experts from extension institutions and digital communication units in Iran, and data were analyzed using open, axial, and selective coding procedures. The coding process generated 57 concepts and 23 categories, which were synthesized into a paradigmatic model encompassing causal, contextual, and intervening conditions, as well as strategies and outcomes. Results showed that policy coordination, institutional collaboration, infrastructure investment, and digital capacity-building are essential conditions for effective adoption. Key barriers identified include weak rural internet coverage, limited digital literacy among farmers, insufficient financial resources, and fragmented policy frameworks. The study also revealed that social media supports faster knowledge dissemination, real-time farmer engagement, and adoption of sustainable agricultural practices. The theoretical model contributes to extension scholarship by linking institutional and contextual enablers to practical outcomes, thereby complementing existing technology-adoption frameworks. Practically, the findings emphasize the need for evidence-based policy frameworks, public–private partnerships, and investments in localized content and farmer training. Strategic use of emerging tools such as big data, IoT, and artificial intelligence can further enhance the effectiveness of social media-based extension. The model provides actionable guidance for policymakers and practitioners to strengthen rural innovation and sustainable agricultural development.

Keywords: Digital Capacity-Building, Emerging Digital Technologies, Farmer Decision-Making, Institutional Collaboration, Policy Framework.

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Introduction

In an era defined by rapid technological advancement, social media has become a transformative force in modern communication, influencing daily life, professional activities, and knowledge dissemination (Kipkurgat et al., 2016). Beyond connectivity, these platforms have emerged as tools for networking, collaboration, and interactive engagement across diverse domains, including education, business, and agriculture (Isiaka et al., 2024). Scholars emphasize the importance of expanding virtual communication platforms and fostering innovation through specialized digital networks to address societal needs in a knowledge-driven economy (Jandaghi et al., 2021).

The agricultural sector, vital for food security and rural livelihoods, is also undergoing this digital transformation. Agricultural extension services, which traditionally focused on face-to-face training, peer exchange, and mass media channels such as radio and television, have faced challenges of scalability, inclusivity, and limited interactivity (Ankita et al., 2023; Ebrahimivand et al., 2023; Mianabadi et al., 2023; Ndege et al., 2024). Constraints such as geographic isolation, limited personnel, and dependency on physical resources highlight the need for more flexible and participatory communication approaches (Daigle, 2020; Kapoor and Singh, 2023). Social media platforms provide new opportunities to complement these traditional systems, offering real-time, accessible, and user-driven channels for information sharing and learning.

Globally, social media tools—including blogs, microblogs (e.g., platform X), podcasts, wikis, and media-sharing platforms—enable bidirectional communication, allowing users to serve simultaneously as content producers and consumers (Jebali, 2024). For agricultural extension, this participatory environment supports problem-solving, strengthens networks, and accelerates the spread of innovations (Khosravipour et al., 2024). Evidence from earlier studies confirms that social media can enhance job performance (Bathaiy et al., 2021), facilitate professional networking (Jafari, 2021), and improve access to scientific resources (Mirzaei et al., 2016), though barriers such as infrastructural limitations and inconsistent information remain (Mohammadi et al., 2019). Despite these benefits, challenges persist. Limited digital literacy among farmers, inadequate rural internet coverage, and fragmented policy frameworks hinder the systematic integration of social media in agricultural extension (Rezvani et al., 2022; Masoumi, 2025). Addressing these barriers requires coordinated policies, capacity-building initiatives, and investments in digital infrastructure (Kolahi et al., 2024a, b, c).

While previous studies have examined the opportunities and constraints of digital platforms, there is still limited theoretical understanding of how technical and institutional conditions interact to shape social media adoption in agricultural extension systems. This research addresses that gap by applying grounded theory to develop a conceptual model that explains causal, contextual, and intervening conditions, along with strategies and outcomes. The study provides a systematic framework for integrating social media into agricultural extension, offering both theoretical contributions and practical guidance for policymakers and practitioners.

Methodology

This study adopts a qualitative exploratory approach using grounded theory, guided by Strauss and Corbin's (1998) systematic methodology. Grounded theory was selected because it allows for the generation of theoretical models where limited or fragmented conceptual frameworks exist. In this study, prior research had largely described the opportunities and barriers of social media in agricultural extension but lacked an integrated model to explain how contextual, causal, and institutional conditions interact to shape adoption. Grounded theory provided an inductive yet structured framework for systematically transforming data into concepts, categories, and ultimately a paradigmatic model (Kolahi & Boroumand, 2024).

The research sought to construct a theoretical framework explaining the implementation of technical and specialized social media support in agricultural extension. Following Strauss and Corbin (1998), the analytical process included three coding phases—open, axial, and selective coding—leading to the identification of six interconnected dimensions: causal conditions, contextual conditions, intervening conditions, strategies, outcomes, and the core category.

Study Population and Sampling

The study population consisted of subject-matter experts with professional roles in agricultural extension and digital communication. Participants were drawn from the Agricultural Education and Extension Institute, the Network of Knowledge and Extension Media Office, and the Virtual Networks and Technology Group in Kermanshah Province, Iran. A purposive sampling strategy, complemented by snowball sampling, was used to identify experts with extensive knowledge and experience in agricultural extension and the use of digital technologies.

A total of 11 experts were interviewed until theoretical saturation was achieved. Of these, five were senior extension officers with more than 10 years of experience, three were ICT specialists working in agricultural communication, and three were university faculty members specializing in agricultural extension and rural development. Participants were selected on the basis of their expertise, professional role, and direct involvement with digital communication initiatives in agriculture.

Data Collection and Analysis

Data were collected through semi-structured, in-depth interviews. An interview guide was developed based on a preliminary review of the literature and expert input, and was pilot tested prior to use. Interviews were recorded with participant consent, transcribed verbatim, and analyzed immediately after each session to refine subsequent data collection (Figure 1).

Analysis followed the three stages of grounded theory coding:

- **Open Coding**: Breaking down raw data into discrete concepts, yielding 57 initial codes.
- **Axial Coding**: Grouping codes into six overarching dimensions: causal conditions, contextual conditions, intervening conditions, strategies, outcomes, and the core category.
- **Selective Coding**: Integrating and refining the categories into a paradigmatic model representing relationships among the dimensions.

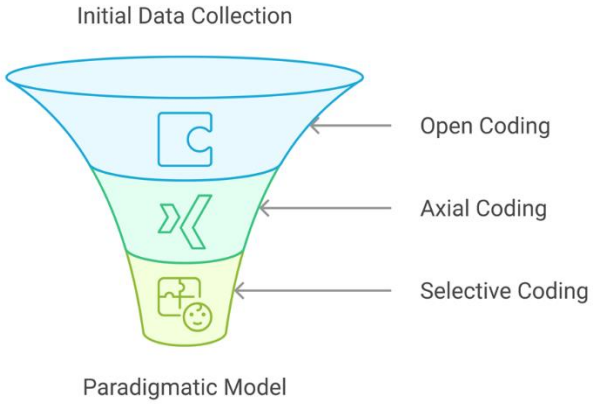

Figure 1. Transforming Data into a Paradigmatic Model.

Reliability and Validity

Several measures were taken to enhance rigor:

To ensure the study's rigor, multiple measures of reliability and validity were employed:

- **Confirmability, Transferability, and Credibility**: Achieved through triangulation of data sources, thick description of processes, and participant validation. Interview summaries and emergent themes were returned to participants for feedback, ensuring accurate representation of their perspectives.
- **Test-Retest Reliability**: To confirm coding stability, three interviews were re-coded after 20 days. Agreement rates were calculated using Kvale's (1996) formula:

$$Percentage\ of\ Retest\ Reliability\ Coeficient = \frac{Number\ of\ Agreements * 2}{Total\ Codes} * 100$$

The reliability score of 85%, well above the 60% threshold, confirmed the robustness of the coding (Table 1).

Table 1. Percentage of Reliability through Re-coding.

Interview Number	Total Codes	Number of Agreements	Number of Disagreements	Test-Retest Reliability (%)
1	29	12	5	83
2	21	9	3	85
3	23	10	3	87
Overall	73	31	11	85

Expert Validation

The final paradigmatic model developed through selective coding was shared with five independent experts in agricultural extension and social media research. Their feedback confirmed the accuracy and practical relevance of the categories. Minor suggestions, such as clarifying the scope of contextual conditions and refining terminology, were incorporated. Continuous consultation with methodological experts ensured that analytical procedures were transparent and consistent with grounded theory standards.

Results

The findings of the grounded theory analysis are organized into six key dimensions:

1. Causal Conditions

Causal conditions represent the fundamental drivers that influence the adoption and implementation of social media in agricultural extension. From the interviews, 17 concepts were identified and grouped into seven overarching themes (Table 2; Figure 2). These conditions provide the foundation for developing effective support mechanisms for social media integration.

Table 2. Identified Concepts and Categories Related to Causal Conditions.

Coding Dimension	Categories	Concepts
Causal Conditions	Development of Farmers' Technical Knowledge	Enhancing public awareness; increasing technical expertise; expanding professional agricultural knowledge
	Familiarity with Media-Related Institutions and Strengthening Cooperation	Collaboration between institutions and farmers; improving awareness of agricultural media organizations
	Reducing Farmers' Time Spent Searching for Information	Minimizing search time; using modern technologies for access
	Facilitating Sustainable Agricultural and Environmental Development	Promoting environmental conservation; advancing sustainable agriculture
	Expanding the Coverage of Extension Activities	Linking to global networks; extending outreach of extension services
	Rapid Dissemination of Extension Messages	Exchanging knowledge; delivering diverse, relevant messages; storing and reusing messages; ensuring swift communication

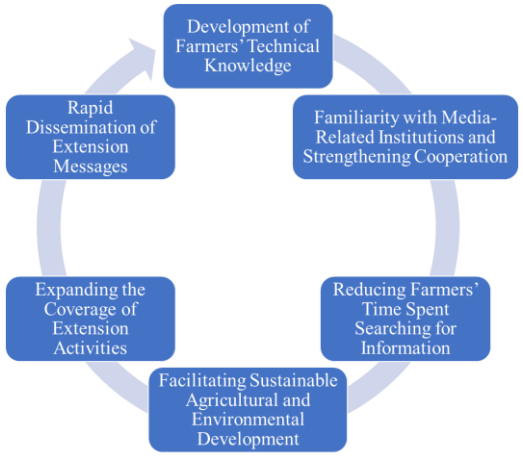

Figure 2. Cycle of Causal Conditions for Social Media Integration in Agriculture.

One major driver is the development of farmers' technical knowledge, which motivates decision-makers to invest in social media initiatives. As an interviewee explained:

> *"Agricultural extension within the ecosystem requires raising public awareness in various agricultural fields."*

While productivity improvements were frequently mentioned by respondents, these are considered outcomes rather than direct causal conditions. Therefore, such elements are reported in the Outcomes and Impacts section rather than listed here as drivers.

Another key causal factor is farmers' familiarity with media-related institutions (e.g., the Telecommunications Company, Ministry of Industry, Mine, and Trade) and the importance of

cross-sectoral collaboration. Respondents emphasized that sustainable integration requires both hardware and software development.

Access to up-to-date global agricultural information was also identified as a crucial enabler, reflecting the role of social media in bridging knowledge gaps. One participant noted:

> *"Providing accurate and timely information about modern agricultural technologies through social media can enhance their adoption."*

Finally, sustainable agricultural and environmental goals were consistently cited as motivating factors, aligning with the broader responsibility of extension systems to promote eco-friendly practices.

2. Core Category (Central Phenomenon)

The core category represents the central phenomenon around which the model is structured: the acceptance and use of social media in agricultural extension, supported by technical and specialized mechanisms.

Analysis revealed nine core concepts, grouped into three major themes (Table 3; Figure 3). These themes reflect the multidimensional nature of adoption, including technological modernization, local empowerment, and cultural adaptation.

Table 3. Identified Concepts and Categories Related to the Core Category.

Coding Dimension	Categories	Concepts
Core Category	Strengthening and Modernizing Communication Technology Networks	Establishing and improving communication networks
		Leveraging modern communication technologies
	Media Needs Assessment and Local Empowerment	Identifying regional and local needs related to social media development
		Enhancing local and individual capacities
	Localization and Cultural Adaptation of Media Practices	Customizing social media platforms for local agricultural use
		Promoting media literacy and awareness
	Establishing Social Media Platforms and Groups	Creating appropriate social media platforms
		Forming discussion groups and channels on messaging apps

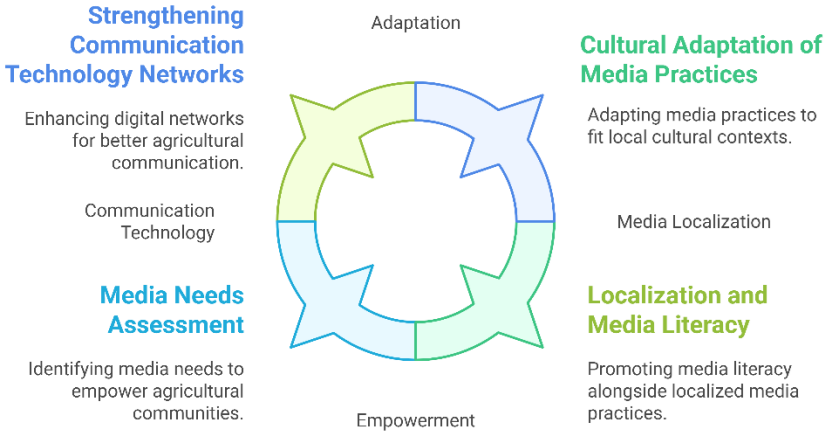

Figure 3. Core Category of Social Media Adoption in Agricultural Extension.

3. Contextual Conditions

Contextual conditions represent the institutional and environmental factors shaping adoption, such as supportive policies, infrastructure, training, and financing (Table 4; Figure 4).

Table 4. Identified Concepts and Categories Related to Contextual Conditions.

Coding Dimensions	Categories	Concepts
Contextual Conditions	Provision of Equipment and Infrastructure for Social Media	Quantitative and qualitative development of internet services
		Establishment of hardware infrastructure (electronic and specialized equipment) for the use of social media by the government
	Policy-Making and Inter-Institutional Cooperation Related to Social Media	Agricultural policymakers' belief in the effectiveness of social media in extension services
		Formulation of supportive policies and regulations for social media in agricultural extension
		Cooperation and interaction with agencies involved in social media operations
	Education and Research on Social Media	Research on improving the effectiveness of social media in agricultural extension
		Training extension agents in the use of social media for agricultural outreach
	Financial Resource Allocation for Social Media Development	Allocation of government funding and financial resources for integrating social media in agricultural extension
		Attracting financial sponsors for social media development
		Government support in the form of loans and financial incentives to help farmers acquire smartphones
		Providing farmers with access to smartphones to facilitate social media usage

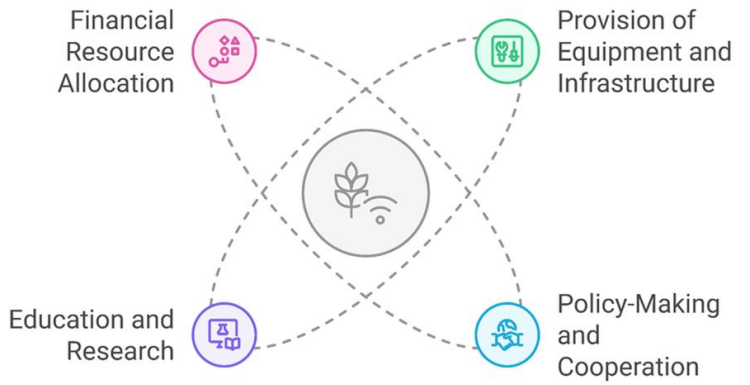

Figure 4. Components of Contextual Conditions for Social Media Integration in Agriculture.

4. Intervening Conditions

Intervening conditions are external dynamics—economic, technological, and political—that either enable or hinder adoption (Table 5; Figure 5). These include government promotional policies, social capital and trust, economic and market conditions, and limitations caused by international sanctions.

Table 5. Identified Concepts and Categories Related to Intervening Conditions.

Coding Dimensions	Categories	Concepts
Intervening Conditions	Government Promotional Policies on Social Media	Government policies and strategies regarding social media
		Institutions related to agricultural extension
	Social Capital and Public Trust	Farmers' social capital
		Farmers' trust in social media as an agricultural extension tool
	Economic Development of Communication Technology	Development of communication technologies
		Economic and market conditions affecting technology access
	Limitations in Access to Advanced Technical Knowledge Due to Sanctions	Comprehensive international sanctions
		Lack of access to cutting-edge global technical knowledge in satellite and communication technologies
		Restrictions on securing internet and web-based infrastructure

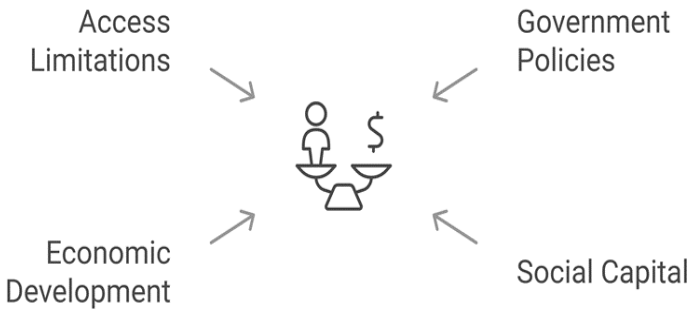

Figure 5. Intervening Conditions Impacting Social Media Support in Agriculture.

5. Strategies and Actions

Strategies highlight practical measures for implementation, including creating platforms, promoting participatory extension, and building institutional collaborations (Table 6; Figure 6).

Table 6. Identified Concepts and Categories Related to Strategies and Actions.

Coding Dimensions	Categories	Concepts
Strategies and Actions	Establishment of Social Media Platforms and Communities	Development of suitable platforms for social media engagement in agriculture
		Formation of groups and channels on social media and messaging applications
	Participatory Extension Approach	Enhancing the attractiveness of educational content for dissemination through social media
		Strengthening connections between extension services and influential figures in the agricultural sector to facilitate content creation in digital spaces
		Expanding participatory extension efforts by leveraging the capabilities of social media
		Promoting the adoption of advanced technologies related to social media in agricultural outreach

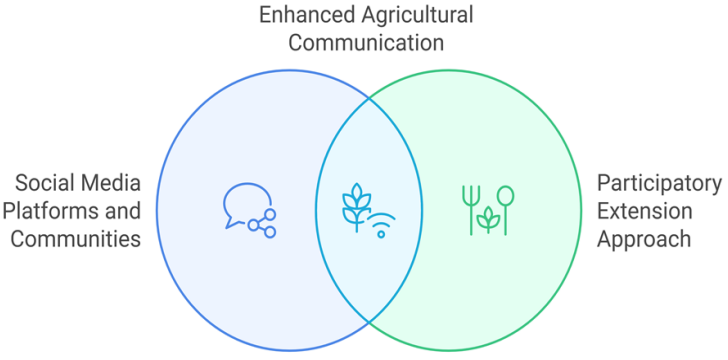

Figure 6. Strategies for Adopting Social Media in Agricultural Extension.

6. Outcomes and Impacts

Social media integration results in transformative outcomes, including improved agricultural performance, accelerated learning, and enhanced farmer participation (Table 7; Figure 7). These outcomes illustrate how social media fosters innovation, expands access to global knowledge, and contributes to sustainable farming. For instance, one interviewee explained:

> *"Using social media in agricultural extension can significantly enhance public knowledge in various agricultural domains."*

Table 7. Identified Concepts and Categories Related to Outcomes and Impacts.

Coding Dimensions	Categories	Concepts
Outcomes and Impacts	Enhancing Farmers' Access to Global Agricultural Knowledge	Increased access to up-to-date agricultural information and knowledge
		Improvement of farmers' awareness and expertise through social media utilization
	Boosting Farmers' Confidence Through Accelerated Learning	Strengthening farmers' motivation and self-confidence
		Accelerating the learning process for farmers
	Promoting a Culture of Innovation and Entrepreneurship	Encouraging creativity and innovation in the agricultural sector
		Promoting entrepreneurial practices within agriculture
		Enhancing efficiency in agricultural education and extension activities
		Enriching the content of extension training programs

Figure 7. Enhancing Agricultural Outcomes through Social Media Integration.

Theoretical Model and Analytical Approach

The integration of all six dimensions led to the development of a theoretical model of social media adoption in agricultural extension (Figure 8). Unlike narrow adoption models, this framework

emphasizes both institutional drivers (e.g., policies, infrastructure) and external constraints (e.g., sanctions, digital divides).

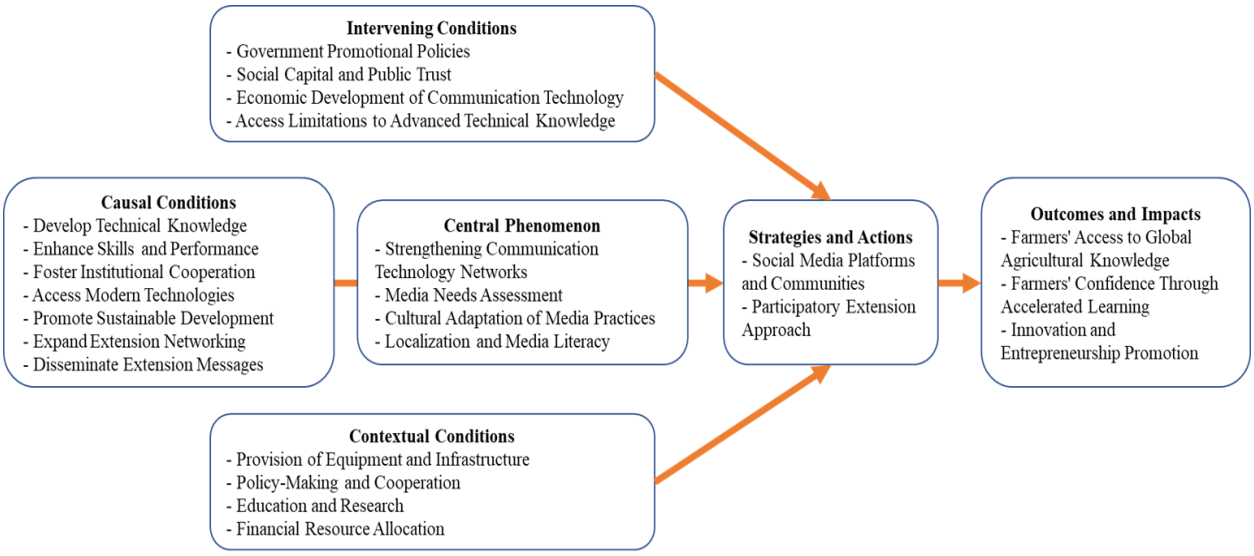

Figure 8. Theoretical Model of Social Media Adoption in Agricultural Extension.

Discussion

This study sought to generate a grounded theoretical model explaining how technical and professional support for social media can be implemented within agricultural extension systems. The model integrates six empirically derived dimensions—causal conditions, core category (adoption/use), contextual conditions, intervening conditions, strategies, and outcomes—based on 11 in-depth expert interviews and inductive coding (57 concepts → 23 categories).

Our findings show that the causal conditions (e.g., enhancement of farmers' technical knowledge; access to up-to-date information; local needs assessment) principally enable the acceptance and use of social media by shaping demand and perceived usefulness. These drivers align with the problem described in the Introduction: traditional extension approaches struggle with scale and interactivity, and social media can address these gaps if enablers are present. Empirically, a plurality of interviewees emphasized knowledge-access as the primary motivation for adoption; this is consistent with Aker (2011) and Mittal & Mehar (2016), who identify information timeliness as central to improved decision-making. In our data, the pathway from causal conditions to outcomes (for example, improved farm practices and accelerated learning) was repeatedly reported: respondents tied knowledge access (causal) through platform use (core category) to measurable practice changes (outcomes). Consequently, the model helps explain how social media

adoption contributes to agricultural sustainability — via accelerated diffusion of environment-friendly practices, faster troubleshooting (pest/disease), and improved adoption of resource-efficient techniques — all of which were cited by participants as examples.

The Role of Social Media in Agricultural Extension

The qualitative evidence indicates that extension-oriented use in the respondents' context is dominated by messaging apps and locally available platforms (messaging channels, groups and channels on national apps), as well as broad platforms used for content dissemination (e.g., Telegram historically, messaging and video platforms). The interview sample (experts from extension offices, ICT units and academia) reported high institutional usage of messaging channels for announcements and advisories, while direct farmer adoption was described as variable: experts noted widespread use among younger or better-connected farmers, and limited adoption among remote smallholders. These observations are consistent with Mohammadi et al. (2019), who documented limited effective use among farmers, and Mirzaei et al. (2016), who showed heavy use of social networks among educated students—indicating that uptake is uneven and often correlated with connectivity and digital literacy. Furthermore, our interview data substantiates patterns (institutional use > partial farmer uptake) and highlights the need for quantitative surveys to measure adoption rates among farmers.

Institutional support: forms and mechanisms

Respondents described multiple, concrete forms of institutional support and policy instruments that enable social media integration. These include:

- **Regulatory and strategic measures**: formal national/regional digital extension strategies, ministerial directives, and standard operating procedures for digital advisories (e.g., endorsed content protocols and liability guidelines).
- **Budgetary/financial measures**: designated budget lines for digital extension, subsidies or loan programs for farmer smartphones, and public–private financing for platform development.
- **Infrastructure investments**: public investment in rural broadband and targeted ICT infrastructure such as BTS sites and fiber backhaul to improve coverage.

- **Organizational mechanisms**: inter-agency coordination platforms (MOUs between agriculture and communications ministries), dedicated extension ICT units, and partnerships with telecommunication companies to prioritize agricultural messaging.

These concrete forms correspond directly to the contextual and intervening dimensions in our model and are supported by respondents' accounts. Literature (for example, Barau & Afrad, 2017) also stresses institutional backing and infrastructure as core enablers; our study extends these insights by mapping how different institutional instruments align with model components (e.g., budgets → contextual condition; MOUs → enabling policies for strategies).

Barriers and locally grounded evidence

Respondents repeatedly cited limited rural internet infrastructure, digital illiteracy among certain farming cohorts, distrust in platform data quality, and financial constraints as barriers — themes that occur in the broader literature (Musa et al., 2014; Van Zoonen et al., 2016). Importantly, our dataset provided local-scale nuances: experts pointed to fragmentation (multiple platforms, some requiring VPNs in the national context), lack of local language and culturally suitable content, and uneven device access. These local barriers explain why adoption is patchy and why institutional instruments should be targeted (e.g., smartphone subsidies combined with tailored local content and trust-building).

Model novelty, theoretical contribution, and relationship to existing frameworks

Several diffusion and technology adoption models (TAM/UTAUT, diffusion of innovations) emphasize perceived usefulness, ease of use, and social influence. Our grounded model differs by offering an institutionally and operationally explicit account: rather than focusing only on individual perceptions, it situates adoption within a system of technical support mechanisms (policy, infrastructure, capacity building) and identifies mediating and contextual factors specific to agricultural extension. In other words, the study's novelty lies in linking institutional levers (policy, budgets, inter-agency cooperation) with micro-level outcomes (farmer learning and behavior) via operational strategies (platforms, participatory extension), which existing individual-level adoption models do not fully specify. This contribution advances extension theory by demonstrating that achieving beneficial outcomes from social media requires simultaneous alignment across multiple institutional and technical dimensions.

Policy and practice implications

The policy recommendations presented in Results and earlier (in brief: infrastructure investment, capacity building, institutional coordination, localized content, financing mechanisms, and trust-building) are not speculative; they directly follow from empirical statements by interviewees about what they perceive as gaps and enablers. For example, the call for smartphone access and budget allocations reflects multiple respondents' concrete suggestions; recommendations for localized content and extension agent training are grounded in participants' reports of low digital literacy and lack of regionally relevant materials. Thus, each recommendation is traceable to specific categories in the model (Contextual Conditions → Policy & Finance; Strategies → Platform creation and participatory extension; Outcomes → improved learning and performance).

Limitations, unsettled points and future work

Consistent with the grounded theory tradition and the study's qualitative design, the findings generate a mid-range, contextually grounded model rather than claims of statistical generalizability. Notable unsettled points that merit future empirical testing include: (1) quantifying farmer adoption rates across demographic groups and regions; (2) testing causal linkages in the model (e.g., the mediating role of institutional coordination between infrastructure investment and outcomes); and (3) empirically integrating technology characteristics (complexity, usability) with the institutional model (TAM/UTAUT variables) — the latter was beyond the present study's scope but flagged by respondents as relevant for future mixed-methods research.

Conclusions

This grounded theory study produced an empirically-based model explaining how technical and specialized support can enable social media adoption in agricultural extension; it highlights that coordinated policy action, targeted infrastructure investment, institutional collaboration, and context-sensitive capacity-building are necessary preconditions for realizing the knowledge-sharing and sustainability benefits of digital platforms.

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