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Digital Transformation of Agricultural Extension in CAREC Countries: Focus Group Evidence on Institutional Capacity

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Research Article

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Abstract

Digital technologies are changing how agricultural extension services organize advice, connect with agro-businesses, and share knowledge. The goal of this study examines how stakeholders perceive these changes affecting the institutional capacity of agricultural extension systems in selected Central Asia Regional Economic Cooperation (CAREC) countries. It draws on six focus groups conducted alongside workshops: two in Kyrgyzstan, one in Uzbekistan, and three at a regional workshop in Türkiye. The discussions were analyzed thematically. Participants described a gradual move toward hybrid extension models that combine digital tools with face-to-face advisory work. They also emphasized the role of university-affiliated extension centers in linking research, training, and farming practice. These developments depend on more than access to technology. Stakeholders identified staff skills, coordination among public agencies and other actors, rural connectivity, and clear data-governance arrangements as conditions shaping whether digital services can be sustained and extended to underserved farmers. The findings position digitalization as an institutional change process as well as a technological one. They suggest that policies for digital agriculture should strengthen extension organizations' capacity to coordinate services, support staff learning, and build trusted relationships with farmers. By bringing focus-group evidence from Central Asia into discussions of digital transformation and agricultural innovation, the study highlights institutional capacity as a key condition for developing inclusive digital extension.

1. Introduction

Digital technologies are changing how agricultural knowledge is produced, circulated, and applied. Mobile advisory services, remote sensing, farm-management platforms, and data analytics can extend the reach of agricultural advice and make recommendations more responsive to local conditions and business needs. Their value, however, depends on the organizations and busineses that interpret data, maintain services, support users, and connect research with farm practice. Digital transformation in agriculture is therefore an organizational and economic process as well as a technological one (Wolfert et al., 2017; Klerkx et al., 2019; World Bank, 2023). The connection to sustainability is also increasingly prominent in development policy, including regional initiatives linking green skills and agricultural change (FAO, 2022; Asian Development Bank, 2025).

Agricultural extension sits at this interface. Extension organizations have traditionally transferred knowledge from research and government agencies to farmers. Contemporary approaches increasingly treat extension as a networked service involving farmers (especially to small and medium enterprises (SMEs))s2, universities, public agencies, agribusinesses, and technology providers. This shift places new demands on extension institutions: they must coordinate actors, build staff capabilities, adapt advice to local needs, and ensure that digital services remain accessible. Research on agricultural innovation systems has shown that intermediaries can support these connections, but digital tools also alter the resources and competencies required to perform that role (Klerkx & Leeuwis, 2009; Klerkx et al., 2019).

These questions matter in Central Asia, where agricultural institutions are adapting to market-oriented reforms, sustainability priorities, and uneven digital infrastructure. The CAREC region offers a useful setting for examining how extension organizations respond to digitalization under these conditions. Yet evidence from the region is often discussed through broad policy accounts or technology-adoption narratives. Less attention is given to how stakeholders understand changes in the institutional capacity of extension systems: the ability to coordinate services, learn, sustain partnerships, and translate digital tools into useful advice.

This article addresses that gap through a qualitative analysis of six focus groups convened alongside workshops in Kyrgyzstan, Uzbekistan, and Türkiye. It asks: How do stakeholders perceive digitalization as changing the institutional capacity of agricultural extension systems, and what conditions enable or constrain that change? The study does not measure the effects of digital services on productivity or farmer welfare. Instead, it examines the organizational processes and constraints described by participants. Its contribution is to connect digital agricultural extension with institutional capacity and innovation-intermediary roles, showing how technology's value is mediated by coordination, skills, infrastructure, and trust. For business and economics readers, this perspective draws attention to the organizational capabilities that shape whether digital investment can support inclusive agricultural innovation.

2. Literature and analytical framework

2.1 Extension, innovation systems, and digital change

Agricultural extension has moved from predominantly linear "transfer of technology" models toward participatory and systems-oriented approaches. In linear models, research institutions generate knowledge that extension agents disseminate to farmers. This approach supported the diffusion of technologies but gave limited attention to farmers' own knowledge and the institutional relationships that influence adoption (Anderson & Feder, 2007; Rivera & Qamar, 2003). Agricultural innovation systems broaden the unit of analysis: innovation depends on interaction among farmers, researchers, small and medium enterprises (SMEs), public agencies, and other organizations. Extension agents and centers can act as innovation intermediaries by brokering knowledge, facilitating collaboration, and translating between research and practice (Klerkx & Leeuwis, 2009).

Digitalization can strengthen these functions through faster communication, data-enabled recommendations, and new channels for advisory services. It can also create dependencies on connectivity, data quality, platform governance, and specialized skills. Digital agriculture should therefore be understood as a socio-technical change in which technologies, business and organizational arrangements develop together, rather than as the introduction of stand-alone tools (Wolfert et al., 2017; Klerkx et al., 2019). This distinction is especially relevant when technologies are piloted or unevenly available: institutional readiness may determine whether an initiative becomes a sustained service or remains a limited project.

2.2 Institutional capacity as the analytical focus

Capacity-building scholarship emphasizes that development outcomes depend on capabilities at individual, organizational, and wider-system levels (Morgan, 2006; Fukuda-Parr et al., 2002). This article focuses on institutional capacity: the ability of extension organizations and their partners to define roles, coordinate work, mobilize expertise and resources, learn from implementation, and maintain services over time. Human skills and system-level relationships remain important, but they are considered here insofar as they shape organizational capacity.

This framing brings capacity building into closer conversation with innovation-systems research. Innovation intermediaries do not simply transmit information; they convene actors and help align knowledge, needs, and resources. Digital tools can expand this role, but they also increase demands for staff competence, data stewardship, interoperability, and institutional coordination. We use this relationship to interpret participant accounts: digitalization creates new opportunities for extension organizations, while the capacity to coordinate, learn, and sustain partnerships conditions how those opportunities are realized. The framework is sensitizing rather than causal; focus-group evidence can illuminate perceived mechanisms and constraints but cannot establish technology impacts.

The study examines four connected dimensions: (1) organizational roles and service models, including hybrid face-to-face and digital provision; (2) staff and organizational learning needs; (3) coordination and partnerships among extension, research, government, and private actors; and (4) enabling conditions, including infrastructure, data governance, and inclusion. These dimensions guide the thematic analysis without assuming that all are equally present in every workshop discussion.

3. Methodology

3.1 Design and data

The research was conducted at the three CAREC events: 1) Capacity building workshop on Climate-smart agriculture university education in the CAREC region (November 19–21, 2025, Bishkek, Kyrgyzstan); 2) Strengthening Green Skills Development under the Central Asia Regional Economic Cooperation (CAREC) Program" (TA-6806). The Third Annual Meeting of the CAREC Working Group on Skills Development, 31 March-3 April 2026, Istanbul, Turkey; 3) Faculty Exchange Program on digital launch of the Regional Center for Green Agriculture and consolidation and finalization of Green Inclusive Change Academic module, (7–10 September 2026, TIIAME, Uzbekistan, Tashkent). Each event included a series of focus group and expert discussions covering different topics and agendas. For the purpose of this research, this study uses a qualitative, exploratory design based on focus group discussions. Six focus groups discussions were selected for the analysis: two in Kyrgyzstan (2025), three at a regional workshop in Türkiye (2026), and one in Uzbekistan (2026). Each group included 6–8 participants. Participants represented agricultural extension and innovation stakeholders, including practitioners, researchers and educators, farmers or agribusiness representatives, and public officials.

The discussions explored the organization of extension services, the use of digital tools and AI-enabled advice, institutional collaboration, capacity-development needs, and policy priorities. Focus groups were appropriate for examining how participants articulated shared challenges and differences across stakeholder roles. The analysis treats the discussions as situated accounts generated in workshop settings, not as a representative survey of farmers or extension organizations. The three Türkiye groups provide regional workshop perspectives; they are not treated as observations from CAREC country cases.

3.2 Analysis and research integrity

The discussions were analyzed thematically, following an iterative process of familiarization with the material, coding, theme development, and review (Braun & Clarke, 2006). The analysis focused on recurring accounts concerning service models, organizational roles, staff capabilities, coordination, infrastructure, and governance. Themes are reported as patterns in stakeholder perspectives and interpreted through the institutional-capacity framework. No survey or quantitative analysis was conducted.

The workshop setting shaped the discussions and should be considered when interpreting the findings. Participants were invited to reflect on digital extension from their institutional and practical experience; the accounts are therefore treated as situated stakeholder perspectives rather than representative views of farmers or extension organizations.

3.3 Scope and limitations

The evidence is limited to six workshop-based focus groups in two CAREC country settings and a regional workshop in Türkiye. It cannot represent the full range of extension systems or stakeholder views across CAREC, and workshop participants may be more engaged with digitalization than the broader farming population. The discussions capture perceptions and institutional experiences rather than measured adoption, productivity, or climate outcomes. These limits make the findings exploratory. They also clarify the study's purpose: to identify institutional processes and policy conditions that participants associate with digital extension, and to develop questions for more extensive comparative research.

4. Findings

The thematic analysis points to a common concern across discussions: digital tools can broaden extension services, but their contribution depends on the capacity of organizations to connect technology with people, knowledge, and ongoing support. Four themes capture this relationship.

4.1 Extension is moving toward hybrid service models

Participants described digital communication and use of digital communication tools as an extension of established advisory relationships. Mobile phones and tablets can host applications and messaging

platforms which allow information on weather, markets, and farming practices to circulate between visits, helping advisers maintain contact where distance and travel costs limit fieldwork. Their value lies in making advice more accessible and timely while preserving opportunities for personal support.

The discussions nevertheless challenged the assumption that expanding digital access would make face-to-face services less necessary. Participants emphasized the continuing importance of direct interaction in interpreting recommendations, assessing local conditions, and establishing trust. Information delivered through a phone generate a lot of additional questions or introduce practices, but farmers may still need demonstrations and discussion before deciding whether it suits their circumstances.

These accounts position hybrid extension as an organizational challenge as much as a technological development. Institutions need arrangements that connect online enquiries with field visits, clarify advisers' responsibilities, and allow farmers' experiences to inform subsequent guidance. Introducing an application without these connections may increase information flows without improving the usefulness of advice.

For CAREC countries, the policy implication is to assess digital investment alongside staffing, practical training, and support and tailor a combination of different approaches for field delivery. The contribution of this theme is to locate institutional capacity in the coordination of advisory channels. Participants' accounts support this interpretation, but do not establish effects on adoption, productivity, or equitable access.

> *Smartphones are now part of everyday life for most farmers. They increasingly use them to learn about the weather forecast and news, but also to find agricultural information, communicate with other farmers, and contact advisory services. The phone gives them another way to acquire knowledge when an adviser cannot visit. Even so, receiving information does not always resolve a practical problem; farmers may still need someone to explain, demonstrate, or discuss what the advice means.*
>
> Participant A.,

4.2 Digital services create new capability demands

Participants identified gaps in digital literacy and technical competence among both farmers and extension personnel. For advisers, the challenge extends beyond operating applications: they must interpret information and use the understandable language, explain its practical implications, and help farmers decide whether recommendations fit their circumstances. For for most of the agro-SMEs, access and effective use may differ according to connectivity, cost, age, and familiarity with digital tools. Wider coverage therefore cannot be taken as evidence of equitable participation.

The discussions connected these capabilities with learning about climate-smart and resource-efficient agriculture. Information on weather, precipitation, water, soils, and crop management may inform decisions, but its usefulness depends on users' ability to assess relevance and translate advice into practice on their specific farms. Participants' accounts suggest that training and continuing support are

essential to this process. Device ownership can really help and enhance knowledge exchanges, but alone offers little indication of whether a farmer can evaluate a recommendation or recognize its limitations.

This theme broadens the meaning of institutional capacity in digital extension. Alongside technical infrastructure, organizations need staff development and accessible learning opportunities that combine digital skills with agronomic judgment. Training should address interpretation and application through locally relevant examples, with assistance for users facing access or learning barriers.

> *Most farmers now have access to the Internet and smartphones and increasingly use them to learn, exchange knowledge, and seek agricultural advice. They can contact advisers, communicate with other farmers, and look for information relevant to their work. Having a phone, however, does not mean every recommendation is clear. Farmers need support to learn how to search for information and consultations effectively, interpret information and judge whether it suits their local farms or pastures.*
>
> Participant N.

4.3 Extension centers can broker knowledge, but coordination is uneven

Many participants viewed university-affiliated extension centres as potential intermediaries between agricultural research, professional education, and farm practice. Some of them had experience in receiving extension consultations and services in the past. Through improving and upscaling training, demonstrations, and the testing of digital tools, these centres could help translate research and access to international expertise and knowledge into usable advice. Their position also offers a route for farmers' questions and experiences to influence research priorities and policy discussions.

However, participants described an environment in which responsibilities were fragmented and coordination among universities, public agencies, research institutions, and private providers remained quite weak. This limits what individual centres can achieve. Without clear referral arrangements and reliable information exchange, farmers may encounter disconnected services, while providers risk duplicating activities or leaving needs unaddressed. Reliance on temporary projects further raises questions about who maintains digital services once funding ends.

The findings identify coordination as a substantive component of institutional capacity. Effective knowledge exchange requires agreed responsibilities, channels for sharing information, and arrangements that sustain advisory support beyond pilot initiatives. They suggested that there is a need for strengthening cooperation around existing centres while specifying how partners contribute expertise, resources, and follow-up support. The discussions establish the importance participants attach to this intermediary role, rather than demonstrating its effectiveness across institutions.

Many farmers now can have access agricultural information and through many channels – from TV to the Internet-based platforms or different apps. But they need an independent non bias information interpretor and adviser. For an extension centre, this creates opportunities to stay connected with farmers and hear their questions. But a message must reach someone who can respond. The usefulness of that connection depends on the trust and quality of the consultations from advisers, university specialists, and other service providers, not simply the device.

Participant V.,

4.4 Infrastructure and governance condition inclusion and scale

Participants connected inclusive digital extension to reliable connectivity, affordable access, and assistance when services fail. These conditions shape whether agro-SMEs can use advisory tools, particularly in remote communities. Smallholders may face disadvantages where connection costs, unreliable networks, or limited technical support restrict participation. Expanding platform coverage therefore does not necessarily mean that access has become more equitable.

Governance emerged as another condition for sustained provision. Stakeholders called for clearer arrangements concerning data, platform access, and accountability. Their concerns suggest that institutions must establish who manages services, how problems are addressed, and who takes responsibility for advice. These arrangements matter for trust and continuity, alongside investment in infrastructure.

As some discussions were tailored around the needs for the regional cooperation the participants suggested that this type of cooperation would open opportunities to exchange experience and learn business opportunities beyond their localities. However, participants' accounts also highlight differences in policies, institutional capabilities, infrastructure, and various institutional and non-institutional barriers that complicate replication. A service developed in one setting may require adaptation before it becomes useful in another.

They suggested that there is a need to connect national learning infrastructure with regional investment and organizational support. Shared experience can inform implementation, but local institutions need resources and authority to respond to farming conditions. The findings thus frame inclusion and scale as outcomes requiring institutional effort, rather than consequences of technology adoption alone.

Farmers increasingly use digital services to learn, exchange knowledge, communicate, and seek agricultural advice. However, participation depends on reliable connectivity, affordable access, and practical support. When a platform fails, users need timely assistance from someone who understands their situation. For remote communities, these services become useful when they remain accessible, dependable, and responsive to local needs throughout the farming season, including periods of urgent agricultural decision-making.

Participant Sh.

5. Discussion

The findings suggest that digital transformation in agricultural extension is best understood as an organizational process mediated by institutional capacity and tailored for business needs. Participants did not describe technology as an autonomous driver of change. They emphasized the work required to combine digital channels with personal advice, develop staff capabilities, coordinate institutions, and maintain inclusive access. This interpretation aligns with research that treats digital agriculture as a socio-technical and business transformation and extension as part of a wider innovation system (Klerkx & Leeuwis, 2009; Klerkx et al., 2019).

The article's first contribution is to specify institutional capacity as a practical link between digital investment and service delivery on the one hand, and business practices on the other. In the discussions, capacity appears through identifiable organizational tasks: translating data into advice, supporting users, connecting research with practice, coordinating partners, and sustaining services. This offers a more operational account than treating "capacity building" as a broad development objective. It also suggests that evaluations of digital extension should examine organizational routines and relationships alongside technology access.

Second, the findings refine the intermediary role of extension organizations. Digital tools can expand the channels through which knowledge moves, but they do not remove the need for brokerage. On the contrary, personalized digital advice can increase the importance of institutions that interpret information, establish trust, and respond to farmers' feedback. University-affiliated extension centers may perform this role where they have clear mandates and stable links with public services, researchers, and agricultural communities. The evidence identifies this as a perceived opportunity, not proof that such centers have already improved outcomes.

Third, the study adds a regional perspective to debates on inclusive digital transformation. The workshop accounts highlight familiar issues—connectivity, skills, governance, and uneven access—but place them within institutional settings shaped by transition and regional cooperation. The data are not sufficient to characterize CAREC as a whole or establish that post-Soviet legacies explain observed differences. The more defensible conclusion is that digital extension must be adapted to the institutional arrangements and capacities present in each setting.

The findings also qualify claims about AI. Participants discussed AI-enabled advice as part of an emerging digital landscape, but the evidence presented here does not establish yet the scale, effectiveness, or economic returns of AI use. AI should therefore be treated as a governance and organizational challenge that warrants further study, rather than as a demonstrated source of productivity or resilience gains. Future research can test these outcomes using farm-level, organizational, or longitudinal evidence.

6. Policy implications

The policy implications follow from the institutional tasks participants associated with digital extension. First, governments and agricultural organizations should invest in extension personnel as interpreters

and facilitators of digital knowledge. Training should combine agronomy with data and business literacy, digital communication, and the ability to assess when automated recommendations need local adaptation. Partnerships among universities, vocational institutions, extension services, and agribusiness can connect training to practical needs, while continuing professional development can help staff keep pace with changing tools.

Second, digital services should be designed around hybrid delivery. Investments in platforms and connectivity need to be paired with field support, local-language communication where appropriate, and accessible routes for farmers who have limited connectivity or digital experience. This approach recognizes that equity depends on the service model and support institutions, not only on device availability.

Third, extension agencies need clear coordination and data-governance arrangements. Governments can clarify responsibilities for data collection, access, security, and reuse; encourage interoperable systems; and set accountability expectations for public-private partnerships. These rules should be proportionate to local capacity and should protect farmers' interests while enabling useful information exchange.

Finally, regional cooperation can support peer learning through shared training resources, pilot evaluations, and exchange among extension centers. Such cooperation should focus on adaptable practices and evidence about implementation, rather than assuming that a model developed in one country can be transferred unchanged. The six focus groups identify these priorities as plausible institutional responses; they do not establish their impact. Policy initiatives should therefore include monitoring that captures who uses services, how organizations sustain them, and whether advice meets farmers' needs.

7. Conclusion

This study examined how digitalization reshapes institutional capacity in agricultural extension across selected CAREC settings, drawing on six workshop-based focus groups in Kyrgyzstan, Uzbekistan, and Türkiye. It argues that digital transformation requires more than platforms or advisory tools: organizations must translate information into locally grounded advice and sustain relationships among farmers, extension professionals, universities, agencies, and firms.

Across discussions, participants described hybrid services as more workable than fully digital provision: mobile channels extend contact, while face-to-face engagement supports interpretation, trust, and adaptation. They identified staff competencies, coordination, connectivity, inclusion, and data governance as conditions shaping whether digital initiatives endure. University-affiliated extension centers emerged as potential intermediaries between research and practice, contingent on clear mandates and durable partnerships. These accounts support innovation-systems scholarship on brokerage and interaction, but qualify assumptions that access or adoption produces better outcomes. However, the findings illuminate perceived mechanisms, not causal effects, and do not represent all CAREC countries.

The study’s contribution is to make institutional capacity an analytical link between digital investment and extension performance: the routines, skills, and relationships through which organizations and businesses turn tools into services. Policymakers and practitioners should pair infrastructure investment with staff development, hybrid delivery, inclusive access, accountable data arrangements, and sustained coordination. Future research should compare national settings, incorporate farmers’ and extension workers’ direct accounts, and examine implementation over time using organizational and farm-level evidence. Such work can test whether these conditions shape service quality, adoption, and rural economic outcomes. The article offers researchers a framework for studying digital agriculture as organizational change and reminds decision-makers that durable innovation rests on institutions able to learn, connect, and respond.

Declarations

Author Contribution

The author - Rafis Abazov - wrote the entire main manuscript text

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