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Role of ICTs in Agricultural Knowledge Management

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Abstract: -

Information and Communication Technologies (ICTs) have transformed how agricultural knowledge is produced, shared, stored, and applied. This paper examines the role of ICTs in agricultural knowledge management (AKM), describing major tools and platforms (mobile phones, SMS systems, web portals, geospatial technologies, IoT, big data and AI), functions of AKM (knowledge capture, codification, dissemination, application), illustrative case examples, challenges (digital divide, gender gaps, data governance, infrastructure and literacy), and policy and implementation recommendations. Drawing on FAO (2017), World Bank (2017), peer-reviewed reviews and recent empirical studies (Mapiye et al., 2023; Khan, 2025; Ahmadi et al., 2025), the paper argues that ICTs—when designed inclusively and integrated into robust knowledge management strategies—can significantly improve decision-making, productivity, market access, and resilience for smallholder farmers. Finally, it outlines practical steps for policymakers, researchers, and practitioners to strengthen ICT-enabled AKM systems.

Keywords: ICTs, agricultural knowledge management, e-agriculture, digital agriculture, extension, knowledge sharing, smallholders.

Introduction:

Knowledge underpins agricultural productivity, innovation, and resilience (FAO, 2017). Agricultural Knowledge Management (AKM) refers to processes and systems used to generate, capture, store, share, and apply the knowledge needed across the agricultural value chain—from farmers' indigenous practices to formal scientific research (World Bank, 2017).

Historically, AKM depended on face-

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to-face extension services, printed materials, and farmer-to-farmer networks (UNAPCICT, 2019). In the last two decades, rapid expansion in Information and Communication Technologies (ICTs) has reshaped AKM, enabling faster, broader, and more tailored flows of information and knowledge (Mapiye et al., 2023). This article synthesizes the literature and practice on how ICTs support AKM. It describes ICT tools and platforms, maps ICT functions to knowledge management tasks, highlights illustrative cases and evidence of impacts, identifies constraints, and offers recommendations for designing inclusive, sustainable ICT-enabled AKM systems. The review emphasizes smallholder contexts and low- and middle-income countries, where the potential for welfare gains is greatest but where barriers are also most acute (Ahmadi et al., 2025).

Conceptual framing: Knowledge management in agriculture

AKM distinguishes between tacit knowledge (skills, experiential know how embedded in people) and explicit knowledge (codified information such as manuals, datasets, advisories) (FAO, n.d.). Effective AKM integrates both: capturing farmers' tacit knowledge, codifying best practices, and circulating actionable information to diverse actors (Short, 2023). Knowledge management functions commonly used in AKM include:

- **Knowledge creation and capture:** research outputs, farmer observations, local innovations (Khan, 2025).
- **Codification and storage:** databases, knowledge repositories, manuals, decision trees (World Bank, 2017).
- **Dissemination and sharing:** extension, advisory services, digital platforms, social media (FAO, n.d.).
- **Application and feedback:** adoption by farmers, iterative improvement, and local adaptation (Ahmadi et al., 2025).
- **ICTs interact with every stage:** they enable new ways of capturing data (remote sensing, IoT), of storing and organizing knowledge (cloud repositories, semantic tagging), and of sharing and tailoring information (mobile apps, SMS, interactive voice response) (Mapiye et al., 2023).

When combined with institutional reforms and capacity building, ICTs can help create knowledge ecosystems rather than one-way information flows (World Bank, 2017).

Major ICT tools and platforms used in AKM

1. Mobile phones and SMS/IVR:

Widely available even in remote areas, mobile phones are primary channels for advisories, market prices, weather alerts, and farmer-to-farmer exchange. Simple text messaging (SMS) and Interactive Voice

Response (IVR) extend reach to low-literacy users (Just Agriculture, 2022).

2. **Web portals and knowledge repositories:**

Centralized platforms (national egriculture portals, research repositories) store manuals, best-practice guides, and datasets, enabling extension agents and policymakers access to curated knowledge (FAO, 2017).

3. **Mobile and web-based advisory apps:**

Apps provide decision-support tools such as pest/disease diagnostics, fertiliser calculators, and planting calendars. Some combine local contextualization with multimedia instructions (Khan, 2025).

4. **Geospatial technologies and remote sensing:**

Satellite imagery and GIS enable field-level monitoring, early warning systems for pests/diseases and drought, and support precision recommendations (Mapiye et al., 2023).

5. **Internet of Things (IoT) and sensor networks:**

Soil moisture sensors, weather stations, and on farm sensors feed real-time data to analytics platforms that inform irrigation, fertilization, and risk management decisions (Ahmadi et al., 2025).

6. **Big data and analytics / Artificial Intelligence (AI):**

Machine learning on large datasets (remote sensing, market, climate, yield) generates predictive models and tailored recommendations. AI-powered chatbots and diagnostic tools are increasingly used for automated advisory services (Short, 2023).

7. **Social media and farmer networks:**

Platforms such as WhatsApp, Facebook groups, and local digital forums foster peer-to-peer learning and rapid dissemination of field observations and innovations (Just Agriculture, 2022).

8. **SMS-based market information systems and e-marketplaces:**

These platforms connect producers to buyers, display transparent price information, and reduce transaction costs (World Bank, 2017).

How ICTs support knowledge management functions

Knowledge capture and creation:

ICTs broaden the sources of knowledge beyond formal R&D.; Farmer field data (via mobile surveys, photos, and voice notes), citizen-science inputs, and sensor streams can be captured at scale. Geotagged data allow mapping of practices and problems across landscapes, enabling researchers to detect patterns and emergent issues rapidly (FAO, 2017; Mapiye et al., 2023).

Codification and storage:

Digital repositories, cloud databases, and knowledge management systems make explicit knowledge searchable and

interoperable. Metadata standards and tagging improve retrieval (World Bank, 2017). Digital formats also enable multimedia codification (video tutorials, pictorial guides). that are more accessible to low-literacy users (Just Agriculture, 2022).

Dissemination and sharing:

ICTs provide multiple dissemination channels—from mass SMS alerts to targeted app push notifications—allowing segmentation of messages by crop, location, or farmer profile. Multi-channel approaches (SMS + radio + village extension) increase reach and reinforce learning (Ahmadi et al., 2025).

Application, feedback, and learning:

Digital tools can track uptake and outcomes through usage analytics and remote monitoring. Feedback loops—farmer reporting, ratings of advisory accuracy, and community forums—help adapt content and improve relevance (Short, 2023).

Evidence of impacts and illustrative cases

A growing body of literature documents positive outcomes where ICTs are combined with sound KM practices. Major institutional resources and studies document these impacts:

- **World Bank (2017):** Synthesizes evidence that ICTs improve access to market information, extension, and financial services, while emphasizing the need for user-centred design and institutional integration.
- **FAO (2017; n.d.):** Highlights national e-agriculture strategies and knowledge repositories that have improved coordination and sharing of agricultural knowledge.
- **Recent reviews (Mapiye *et al.*, 2023; Ahmadi *et al.*, 2025; Khan, 2025):** Show ICTs enhance awareness, information access, and adoption outcomes, while impacts on productivity depend on complementary inputs and local context.

Case examples:

- **Market Information Systems:** SMS-based price alert services have improved farmers' bargaining positions and reduced price variability at the farm gate (World Bank, 2017).
- **Digital Plant Clinic and Diagnostic Tools:** AI-enabled apps and extension hotlines have accelerated pest and disease diagnosis and response, reducing crop losses (Ahmadi et al., 2025).
- **Farmer Helplines and Voice-based Services:** IVR helplines in South Asia and Africa have reached low-literate farmers with tailored advisories, improving knowledge and some on-farm practices (Just Agriculture, 2022).

Constraints and challenges

Despite promise, ICT-enabled AKM faces several barriers:

1. **Digital divide and access:** Unequal access to devices, connectivity, and electricity disproportionately affects women, poorer farmers, and remote areas (World Bank, 2017).
2. **Literacy and digital skills:** Low general and digital literacy limit effective use of many ICT services (Ahmadi et al., 2025).
3. **Content relevance and language:** Generic content fails if not localized by language, cropping system, and socio-cultural context (FAO, n.d.).
4. **Institutional fragmentation:** ICT platforms that operate in silos without integration into extension systems lose sustainability and impact (UNAPCICT, 2019).
5. **Data quality, privacy, and governance:** Large-scale data collection raises concerns about ownership, consent, and use of farmers' data (Short, 2023).
6. **Sustainability and business models:** Projects often depend on donor funding and lack viable models for long-term operation (Khan, 2025).
7. **Technological complexity and interoperability:** Incompatible standards impede seamless knowledge flows across actors (Mapiye et al., 2023).

Policy and practice recommendations

To harness ICTs for effective AKM, the following actions are recommended:

1. **Adopt user-centred design:** Co-create content with farmers and extension agents to ensure relevance, language appropriateness, and usability (Ahmadi et al., 2025).
2. **Blend digital with human extension:** Use ICTs to augment—not replace—face to face extension (World Bank, 2017).
3. **Invest in digital inclusion:** Improve connectivity, affordability, and digital literacy, with specific strategies to reach women, youth, and marginalized groups (FAO, 2017).
4. **Build interoperable KM architectures:** Use open standards, APIs, and shared metadata to connect repositories, advisory systems, and research outputs (UNAPCICT, 2019).
5. **Ensure data governance and privacy:** Establish clear policies for data ownership, consent, anonymization, and benefit sharing (Short, 2023).
6. **Support sustainable business models:** Explore public–private partnerships, subscription models, and bundled services for sustainability (Khan, 2025).

7. **Monitor, evaluate, and iterate:** Incorporate impact evaluation in AKM platforms to measure adoption, productivity, and equity outcomes (Mapiye et al., 2023).

Conclusion

The integration of ICTs into agricultural knowledge management has opened unprecedented opportunities for transforming the way knowledge is created, shared, and applied in farming systems. By enhancing access to timely, relevant, and localized information, ICTs strengthen decision-making, improve productivity, and foster resilience against climate and market shocks (World Bank, 2017; FAO, 2017; Khan, 2025). However, their effectiveness depends on addressing persistent challenges such as the digital divide, limited literacy, weak data governance, and fragmented institutional support (Ahmadi et al., 2025). Sustainable success requires inclusive design, hybrid models blending digital and human support, strong governance frameworks, and business models that ensure continuity (Mapiye et al., 2023). Ultimately, ICT-enabled AKM should aim not only to transfer information but also to empower farmers, amplify their voices, and integrate their experiential knowledge into formal systems (Just Agriculture, 2022). With supportive policies and inclusive approaches, ICTs can play a transformative role in shaping resilient, knowledge-driven agricultural futures.

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