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Role of ICTs in Mobilising Indigenous Practices in Kenya's Small-Scale Tea Sector

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Abstract

Rationale of Study – Small-scale tea farmers face challenges transferring and applying indigenous knowledge, partly due to unequal access to information and communication technology (ICT). Although ICT tools are central to knowledge mobilisation (KMb), their effectiveness remains underexplored. Grounded in knowledge mobilisation and technology adoption, this study examines how ICT tools shape knowledge mobilisation, sharing, and application among farmers in Murang'a County, Kenya.

Methodology – Grounded in a pragmatic paradigm, this convergent mixed-methods study used structured surveys and semi-structured interviews. The sample included 74 participants: 39 tea leaf buying centre chairpersons, 16 agribusiness researchers, six agricultural extension officers, and 13 factory managers. Of these, 43 completed surveys and 13 interviews, yielding 56 responses.

Findings – KMb fosters collaborative learning and indigenous knowledge sharing, while WhatsApp, SMS, and video enable peer-to-peer agribusiness knowledge transfer. Barriers include data costs, poor connectivity, limited technical expertise, and low digital literacy. Recommended solutions: training, affordable data and devices, and localised apps.

Implications – ICT tools improve access to and sharing of agribusiness knowledge, supporting indigenous tacit and explicit knowledge flows. They validate, amplify, and coordinate traditional knowledge systems rather than replace their tools.

Originality – The study presents a socio-technical integration framework linking knowledge custodians, mobilisers, platforms, and institutions to guide inclusive digital KMb strategies.

Keywords

Knowledge mobilisation, digital innovation, indigenous knowledge, indigenous practices, ICT-supported knowledge mobilisation, small-scale tea farming, Kenya

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1 Introduction

Over the last two decades, the integration of information and communication technologies (ICTs) into agriculture has transformed how agribusiness knowledge is generated, shared, and utilised, particularly within the small-scale tea-farming subsector (Chege et al., 2020; Farooq et al., 2020; Tiwari, 2022). Digital innovations, including mobile applications, social media platforms, and online advisory services, have expanded farmers' opportunities to access expert guidance, extension support, and peer-learning networks. In Kenya, however, considerable disparities in digital literacy, affordability, and ICT infrastructure continue to constrain equitable access to knowledge and limit the effective utilisation of digital technologies in agricultural development (Cheng, 2021; Klerkx et al., 2019). Existing evidence suggests that although digital technologies have improved knowledge accessibility, their integration with indigenous farming knowledge remains inadequately understood, particularly within smallholder agricultural systems. Consequently, this gap limits the potential of ICT-enabled knowledge mobilisation (KMb) to support contextually relevant and sustainable agricultural practices.

This study therefore examines the interaction between indigenous agronomic knowledge and digital innovation within Kenya's small-scale tea sector, with particular emphasis on Murang'a County. Small-scale farmers produce over 60% of the national tea output and rely heavily on agronomic practices developed through local experimentation and generational transmission (Borthakur & Singh, 2021; Kenya National Bureau of Statistics., 2021). The focus on Murang'a County is justified because it represents one of Kenya's major tea-producing regions, characterised by a high concentration of small-scale tea farmers, active cooperative societies that facilitate knowledge exchange, and an increasing, albeit uneven, adoption of digital advisory and market platforms. These characteristics provide an appropriate context for exploring how ICTs influence the mobilisation, validation, and application of indigenous agronomic knowledge. Accordingly, the study's main objective is to examine the role of ICT-enabled KMb in facilitating the creation, sharing, and utilisation of indigenous knowledge among small-scale tea farmers in Murang'a County, Kenya.

The study assesses the role of KMb in facilitating collaborative learning and the sharing of indigenous knowledge among small-scale tea farmers; examines the role of ICT in facilitating the mobilisation and sharing of indigenous knowledge within Kenya's small-scale tea sector; analyses the factors that facilitate or constrain ICT-enabled mobilisation of indigenous knowledge; and proposes strategies and a framework for strengthening ICT-enabled KMb to enhance

the utilisation of indigenous knowledge among small-scale tea farmers.

2 Literature Review

This segment evaluates the literature on the role of ICTs in mobilising indigenous practices within Kenya's small-scale tea sector. It explores the relationship between knowledge mobilisation (KMb) and knowledge management (KM) and further discusses the relevance of the SECI model in explaining knowledge creation, sharing, and application in agricultural contexts. The review also addresses the role of ICTs in facilitating knowledge exchange among researchers, extension officers, and small-scale tea farmers. Additionally, it examines the technological, institutional, and socio-cultural factors that influence KMb and knowledge utilisation. This literature thus provides both the conceptual and empirical foundation for analysing existing indigenous KMb practices, identifying barriers to effective knowledge use, and informing the development of a KMb framework for the small-scale tea sector.

2.1 Knowledge mobilisation (KMb) and knowledge management (KM) in agriculture

KMb and KM have increasingly attracted scholarly attention because they share a focus on knowledge creation, sharing, and utilisation. Although the two concepts are closely related, they differ in their fundamental focus and intended outcomes. KM primarily concerns the systematic processes through which organisations create, capture, organise, store, and disseminate knowledge to enhance organisational learning, innovation, and performance (Abubakar et al., 2019; Davenport & Prusak, 1998). In contrast, KMb emphasises the purposeful exchange, translation, adaptation, and application of knowledge across diverse stakeholder groups to achieve practical and context-specific outcomes (Ivcovici et al., 2022). Existing literature suggests that whereas KM provides an organisational perspective on managing knowledge resources, KMb extends this standpoint by elucidating how knowledge is mobilised through interactions among researchers, extension officers, cooperatives, and farmers to support informed decision-making and improved agricultural practice (Durrant et al., 2024; MacKillop et al., 2023; Tumwebaze et al., 2024). In agricultural development, the distinction between KM and KMb matters, as knowledge generation alone does not guarantee effective utilisation. The SECI model (Socialisation, Externalisation, Combination, and Internalisation) offers a valuable theoretical framework for understanding how tacit and explicit knowledge interact through continuous cycles of knowledge creation and transfer (Adesina & Ocholla, 2019; Nonaka et al., 1996). This model illustrates how experiential knowledge held by farmers can be articulated, integrated with scientific knowledge, and reapplied to enhance agricultural practices. Consequently, distinguishing KM from KMb clarifies how

this study examines both the organisational mechanisms that facilitate KM and the cross-actor processes through which indigenous agronomic knowledge is mobilised, shared, validated, and applied within Kenya's small-scale tea sector.

2.2 The role of ICT in facilitating KMb

Information and communication technologies (ICTs) have become increasingly essential for mobilising agricultural knowledge, as they enhance communication, improve information accessibility, and promote collaboration among stakeholders in agricultural contexts. Digital tools such as mobile devices, social media networks, and virtual learning communities have broadened opportunities for the dissemination of agricultural knowledge, reduced transaction costs, strengthened extension services, and facilitated interaction among farmers, researchers, extension agents, and other participants in agricultural innovation systems (Deichmann et al., 2016; Gabriel & Gandorfer, 2023). Existing research indicates that ICTs not only increase the speed and reach of knowledge dissemination but also foster collaborative learning and peer-to-peer knowledge sharing, thereby empowering farmers to make well-informed production decisions.

Across sub-Saharan Africa, empirical studies show that mobile-based technologies have expanded farmers' access to agricultural information, including weather forecasts, market prices, farm input details, and extension advice. These services can support farm-level decision-making and agricultural practices, although their contribution to productivity and livelihoods depends on effective adoption and integration into existing extension systems (Ayim et al., 2022; Spielman et al., 2021). In Kenya, the growing adoption of mobile-enabled agricultural platforms highlights ICTs' potential to complement conventional extension approaches by providing timely, locally relevant agricultural knowledge. Nevertheless, digital technologies alone cannot improve knowledge utilisation unless integrated with indigenous knowledge systems and existing community learning structures. Indigenous knowledge remains a valuable source of locally adapted agricultural practices, developed through continuous observation, experimentation, and interaction with local ecosystems (Moustaghfir & Schiuma, 2013). Consequently, ICTs offer opportunities not only to disseminate scientific knowledge but also to document, validate, preserve, and mobilise indigenous knowledge, thereby strengthening knowledge exchange and supporting sustainable agricultural development among small-scale tea farmers.

2.3 Barriers to KMb in ICT-driven contexts

Despite the growing penetration of ICTs in agriculture, several challenges persist that hinder effective knowledge mobilisation in ICT-enabled agriculture. Although digital platforms have created opportunities for

knowledge sharing and collaboration, their distribution within farming communities remains unequal. Existing research identifies key barriers to digital inclusion as low confidence in using digital technologies, limited formal education, and poor digital literacy, particularly among older farmers and resource-constrained households (Birke & Knierim, 2020a; Krell et al., 2021). Furthermore, inadequate ICT infrastructure, such as weak internet connectivity, frequent power outages, limited mobile network coverage in rural areas, and the high costs of internet-enabled devices and mobile data, are still shaping the ability of farmers to restrict farmers' access to digital agricultural services (Choruma et al., 2024). These constraints are especially pronounced in rural areas, where traditional agricultural extension services are already constrained.

Beyond technological limitations, institutional and socio-cultural factors also shape the effectiveness of KMb. Formal agricultural innovation systems often overlook or underuse indigenous knowledge, limiting its documentation, validation, and integration into extension services and policies. Similarly, fragmented institutional coordination, inadequate policy support, and language barriers also affect mobilisation of indigenous knowledge. Weak collaboration among research institutions, extension agencies, farmer organisations, and technology providers further diminishes opportunities for effective knowledge exchange and the co-production of locally relevant agricultural innovations (Birke & Knierim, 2020b; Krell et al., 2021). Collectively, these findings suggest that successful ICT-enabled knowledge mobilisation depends not only on the availability of digital technologies but also on enabling institutional environments, strengthened digital capabilities, inclusive policy frameworks, and greater recognition of indigenous knowledge as a valuable component of agricultural innovation systems.

2.4 Conceptual framework

The conceptual framework for this study integrates the SECI model of knowledge dimensions, Agricultural Innovation Systems (AIS), and KMb principles to explain how indigenous agronomic knowledge is generated, shared, and utilised within ICT-enabled agricultural environments. The SECI model provides the theoretical foundation for showing how tacit and explicit knowledge interact through socialisation, externalisation, combination, and internalisation (Nonaka et al., 1996). Building on this perspective, the framework positions ICT as a mechanism that facilitates knowledge exchange and collaboration among small-scale tea farmers, researchers, extension officers, cooperative societies, and other actors within the agricultural ecosystem. Consequently, the framework acknowledges that effective knowledge mobilisation depends not only on knowledge creation but also on the

interactions and institutional relationships that enable knowledge to move across stakeholder groups and inform agricultural practice.

Within this framework, knowledge mobilisation through ICTs can be examined in three interrelated dimensions. The first dimension is accessibility, which refers to farmers' ability to access timely, relevant knowledge through their digital and conventional knowledge-sharing networks. The second dimension is usability, which reflects the extent to which farmers understand, use, adapt, and apply knowledge to improve agricultural decisions and practices. The third dimension is sustainability, which entails the long-term preservation and use of indigenous knowledge within the digital agricultural innovation system. These three dimensions provide the analytical lens through which this study examines ICTs' contribution to knowledge mobilisation while recognising the technological, institutional, and socio-cultural factors that influence knowledge utilisation among small-scale tea farmers.

The reviewed literature indicates that ICTs have considerable potential to strengthen KMb by expanding access to agricultural information, supporting collaborative learning, and facilitating the documentation and dissemination of indigenous knowledge. Nevertheless, persistent challenges related to digital inclusion, institutional coordination, and the recognition of indigenous knowledge continue to limit the effectiveness of ICT-enabled knowledge mobilisation. These gaps highlight the need for empirical evidence on how digital technologies can better support the mobilisation and sustainable utilisation of indigenous agronomic knowledge within Kenya's small-scale tea sector. Based on these identified gaps, the study addresses the following research questions:

RQ1: How does KMb support collaborative learning and the sharing of indigenous knowledge among small-scale tea farmers?

RQ2: What role does ICT play in mobilising indigenous knowledge within Kenya's small-scale tea sector?

RQ3: What technological, institutional, and socio-cultural factors facilitate or constrain the ICT-enabled mobilisation of indigenous knowledge?

RQ4: How can ICT-enabled KMb be strengthened to enhance the utilisation and sustainability of indigenous knowledge among small-scale tea farmers?

3 Methodology

This section examines the role of ICTs in mobilising indigenous KMb practices within Kenya's small-scale tea sector. It outlines the convergent parallel mixed-methods design used to investigate KMb practices, stakeholder roles, knowledge exchange mechanisms, and factors that influence knowledge utilisation. Additionally, it details the study area, target population, sampling procedures, data

collection methods, quantitative and qualitative data analysis, integration of findings, and ethical considerations.

3.1 Research design

The study employed a convergent-parallel mixed-methods design, in which quantitative and qualitative data were collected and analysed simultaneously and integrated during interpretation. This design was chosen because it enables statistical patterns to be examined alongside participants' experiences. This not only aids triangulation and corroboration but also enables a more inclusive understanding of ICT-enabled KMb among the small-scale tea farmers(Creswell & Creswell, 2023; Creswell & Plano Clark, 2023; Ngulube, 2022). Because the study involved both trend measurement and qualitative contextual processes, a mixed-methods approach was appropriate given the study's exploratory nature.

3.2 Study area

The study was conducted in Murang'a County, Kenya, one of the country's leading tea-producing regions. The county has a well-established network of small-scale tea farmers, tea factories, agricultural extension services, cooperative societies, and research institutions that collectively support tea production and knowledge exchange. Murang'a County therefore provides an appropriate setting for examining ICT-enabled KMb practices because it combines extensive small-scale tea production with active stakeholder interactions and the adoption of digital agricultural technologies.

3.3 Population and sampling

The study targeted stakeholders directly involved in creating, disseminating, and utilising knowledge within the small-scale tea value chain. The study purposively selected four participant groups because they perform complementary KMb roles within the agricultural system. Chairpersons of tea leaf buying centres represented small-scale farmers and provided perspectives on indigenous knowledge and community-level ICT use. The other groups included agribusiness researchers, who represented knowledge producers; agricultural extension officers, who acted as knowledge intermediaries responsible for technology transfer; and tea factory managers, who contributed organisational and institutional perspectives on knowledge utilisation.

The study employed cluster sampling to identify tea leaf buying centres within the study area, followed by purposive sampling to select participants with relevant knowledge and experience. These methods were considered adequate because they allowed the inclusion of information-rich participants across multiple stakeholder groups while remaining feasible given the geographical distribution of respondents (Dubey & Kothari, 2022; Pandey & Pandey, 2015). The study included 74 participants, distributed across the four stakeholder groups presented in Table 1. Of

these participants, 43 completed usable questionnaires and 13 participated in semi-structured interviews. The lower questionnaire response rate was primarily attributable to work commitments, scheduling conflicts and participants' limited availability during the data collection period. Although the reduced number of completed questionnaires limited inferential statistical analysis, it was sufficient for the study's exploratory purpose and was complemented by qualitative evidence through methodological triangulation.

Table 1. Sample composition

Participants	Sample (n)	Percentage (%)
Chairpersons of small-scale tea farmers	39	52.7
Agribusiness researchers	16	21.6
Agricultural extension officers	6	8.1
Tea factory managers	13	17.6
Total	**74**	**100.0**

3.4 Data collection procedures

Data collection was conducted concurrently using a convergent mixed-methods research (MMR) design, with quantitative and qualitative data gathered in two complementary phases. We administered structured questionnaires to chairpersons of tea leaf buying centres and agribusiness researchers to collect quantitative data on ICT access, ICT use patterns, perceived usefulness, KMb practices, and barriers to ICT adoption. At the same time, we conducted semi-structured interviews with agricultural extension officers and tea factory managers to gain detailed insights into institutional practices, experiences, and challenges that structured questionnaires could not adequately capture.

The questionnaire and interview guide were designed based on the literature review, the study objectives, and the conceptual framework. Before data collection, experts in KM and agricultural extension tested both instruments for validity. A pilot study was then conducted with respondents having characteristics similar to those of the actual respondents. Some modifications were made in order to improve the wording of the research instruments.

3.5 Data analysis and integration

Quantitative data were analysed using descriptive statistics, including frequencies, percentages, means, and standard deviations, to summarise patterns of ICT adoption, KMb practices, and perceived barriers. Due to the relatively small number of completed questionnaires, the quantitative findings were interpreted as descriptive rather than inferential evidence. Qualitative data were analysed thematically using the six-phase framework proposed by Braun and Clarke (2023) and Clarke and Braun (2017). The analysis involved familiarisation with the data, systematic coding, theme development, theme review, theme definition, and report writing.

Themes were generated inductively while remaining aligned with the study's objectives.

Integration of the quantitative and qualitative findings occurred during the interpretation stage through a joint comparison of the two datasets. Quantitative patterns were examined alongside qualitative themes to identify areas of convergence, complementarity, and divergence. This integrative approach enhanced the credibility of the findings by showing how evidence from one dataset confirmed, explained, or extended evidence from the other, providing a more comprehensive understanding of ICT-enabled mobilisation of knowledge.

3.6 Ethical considerations

This article is drawn from a PhD study that obtained ethical clearance from the University of South Africa (UNISA) Research Ethics Review Board before data collection commenced. The National Commission for Science, Technology, and Innovation (NACOSTI), Kenya, granted research permission. Participation was voluntary, and all respondents provided informed consent. Participants were briefed on the study's purpose, their right to withdraw at any time without penalty, and the steps taken to protect confidentiality and anonymity. All research data were stored securely and used only for academic purposes.

4 Findings

The findings are presented in accordance with the four research questions that guided the study. Data were collected from 56 participants, comprising 43 completed questionnaires and 13 semi-structured interviews. The quantitative component achieved a response rate of 76.8% (43 of 56 distributed questionnaires), while the qualitative component included interviews with all six agricultural extension officers and seven of the thirteen targeted tea factory managers. Quantitative data were analysed using descriptive statistics to identify patterns of ICT use and KMb practices, whereas qualitative data were analysed thematically using the six-phase framework proposed by Braun and Clarke (2023). In line with this approach, the study systematically developed, named, and interpreted qualitative themes to explain participants' experiences and perspectives. These themes were aligned with the quantitative findings and provided the interpretive basis for integrating the two datasets. Integration occurred during the interpretation stage, enabling triangulation of evidence and identifying areas of convergence, complementarity, and divergence across the quantitative and qualitative findings. Table 2 presents the findings.

4.1 Response rates

Table 2: Response rates

Category	(n)	Retrieved	(%)
Chairpersons	39	29	51.8
Researchers	16	14	25.0
Extension Officers	6	6	10.7
Managers	13	7	12.5
Total	**74**	**56**	**100**

The response pattern indicates strong participation among agricultural extension officers and moderate input from tea factory managers. Furthermore, chairpersons of tea leaf buying centres and agribusiness researchers accounted for the majority of completed questionnaires. Consequently, the quantitative findings are based on 43 usable questionnaire responses, while the qualitative findings come from 13 completed semi-structured interviews.

RQ1: How does KMb support collaborative learning and indigenous knowledge sharing among small-scale tea farmers?

To evaluate participants' insights into KMb's role, respondents rated its effectiveness on a five-point Likert scale, where 5 represented the highest perceived effectiveness and 1 the lowest. Table 3 presents the findings.

Table 3: Rating of KMb support for collaborative learning and indigenous knowledge sharing (N = 43)

Rating	n (%)
Very High (5)	15 (34.9)
High (4)	19 (44.2)
Moderate (3)	5 (11.6)
Low (2)	3 (7.0)
Very Low (1)	1 (2.3)
Mean	**4.02**
SD	**1.021**

Overall, 79.1% of respondents rated the effectiveness of KMb as high or very high, indicating strong perceived support for collaborative learning and the sharing of indigenous knowledge. The mean score of 4.02 (SD = 1.021) suggests generally high agreement among respondents, although perceptions varied. These findings indicate that participants regarded KMb as an important mechanism for facilitating experiential learning, peer interaction, and the collective improvement of farming practices.

The qualitative findings reinforced the quantitative results and identified three interrelated themes: peer learning through shared experience, collective problem-solving, and knowledge validation through discussion. Participants explained that KMb platforms enabled farmers to compare experiences, exchange practical knowledge, and learn from one another's successes and challenges. Respondents also noted that farmer groups, cooperatives, and agricultural intermediaries turned individual experimentation into collective learning, strengthening local problem-solving capacity. Additionally, interactions among farmers, extension officers, and researchers provided opportunities to validate indigenous practices and assess their continued relevance under changing agricultural conditions.

As one tea factory manager (MGR-7) observed, "*KMb platforms allow us to share real-time observations from demonstration plots, turning*

individual experiments into collective improvements." Similarly, an agricultural extension officer (AEO-10) remarked, "*We learn from each other's failures; that's innovation*." Collectively, these findings suggest that KMb strengthens collaborative learning by promoting knowledge exchange, collective reflection, and the validation of indigenous agricultural practices. Specific examples of indigenous knowledge shared through these interactions, including soil fertility management and pest control practices, are presented separately in a supporting table or appendix to complement the thematic findings.

RQ2: What role does information technology play in the sharing of indigenous knowledge?

Table 4 below presents the findings on the effectiveness of ICT in facilitating the sharing and mobilisation of indigenous tea-farming knowledge among small-scale tea farmers.

Table 4: Rating of IT effectiveness in enhancing indigenous knowledge sharing (N = 43)

Rating	**n (%)**
Very Effective (5)	18 (41.9)
Effective (4)	16 (37.2)
Neutral (3)	6 (14.0)
Not Effective (2)	2 (4.7)
Extremely Not Effective (1)	1 (2.3)
Mean	**4.12**
SD	**0.981**

Respondents rated information technology as effective or very effective at 79.1 per cent, with a mean score of 4.12 and a standard deviation of 0.981. This indicates that IT is widely perceived as an important enabler of peer-to-peer transfer of indigenous knowledge through platforms such as WhatsApp, Facebook, and SMS. The near equivalence between the findings for research questions 1 and 2 suggests a strong conceptual overlap in respondents' minds: many participants appear to view KMb and IT as mutually reinforcing rather than separate phenomena. This pattern may reflect overlap in the instrument design, but it may also indicate that respondents primarily experience ICT as a vehicle for KMb rather than as a standalone intervention.

The thematic analysis identified three principal themes: rapid circulation of advice, visual demonstration of practices, and validation through digital peer networks. Under rapid circulation of advice, participants observed that group messaging reduced the time between recognising a problem and receiving a response. On visual demonstration, respondents emphasised the importance of videos and images in illustrating application techniques. In validating through digital peer networks, both farmers and officers described how online discussions facilitated comparisons of indigenous practices across different locations.

An extension officer (AEO-6) stated, "*When I post a pest issue in our WhatsApp group, I receive guidance within minutes from farmers who have dealt with the same problem before*." A factory manager (MAN-10) noted, "*Videos made by researchers show the farmers exactly how to apply manure more effectively than written instructions."* These accounts underscore technology's central role in sharing

and validating indigenous knowledge and practices related to tea farming.

RQ3: What are the obstacles to using ICT in the mobilisation of indigenous knowledge?

Table 5 below presents the findings on the barriers that hinder the adoption of ICTs for the mobilisation of indigenous knowledge among small-scale tea farmers.

Respondents identified the cost of data and devices as the most significant barrier, closely followed by unreliable network connectivity, technical skills, and digital literacy. These findings indicate that ICT penetration alone does not automatically translate into effective mobilisation and use, particularly where affordability, infrastructure, and user capability remain substantial constraints. Qualitative data supported these quantitative patterns by highlighting the practical challenges farmers face. Four themes emerged: affordability pressures, unstable connectivity, limited technical confidence, and uneven digital competence. These themes recurred across interview accounts. One farm manager (MGR-5) reported, "*The high cost of mobile data limits farmers' access to farming information; some check WhatsApp messages only twice weekly and consequently miss important updates.*" An agricultural extension officer (AEO-13) explained, "*Frequent network disruptions during periods of rainfall are particularly problematic, as they occur at times when farmers most urgently require technical support.*" Together, these accounts illustrate that technological accessibility remains strongly influenced by economic and infrastructural conditions.

Table 5: Factors hindering ICT adoption (N = 43)

Factor n (%)	Very Significant (5)	Significant (4)	Moderate (3)	Less significant (2)	Not significant (1)	Mean	SD
Data/Device Cost	22 (51.2)	14 (32.6)	3 (7.0)	3 (7.0)	1 (2.3)	4.24	0.992
Network Connectivity	20 (46.5)	15 (34.9)	5 (11.6)	2 (4.7)	1 (2.3)	4.19	0.945
Technical Skills	16 (37.2)	18 (41.9)	6 (14.0)	2 (4.7)	1 (2.3)	4.07	0.921
Digital Literacy	14 (32.6)	17 (39.5)	8 (18.6)	3 (7.0)	1 (2.3)	3.93	0.981

RQ4: Which ICT implementation strategies facilitate the mobilisation of indigenous knowledge?

We examined ICT implementation strategies to identify priority areas for improving practice. Table 6 presents the findings.

Table 6: Key implementation strategies (N = 43)

Strategy	Mean	SD
Training/Capacity Building	4.44	0.751
Low-Cost Data/Devices	4.28	0.812
Localised Applications	4.19	0.831

Training and capacity building emerged as the highest-ranked strategy for strengthening ICT-

enabled KMb (mean = 4.44), followed by improved access to affordable mobile data and digital devices (mean = 4.28), and the development of locally relevant ICT applications (mean = 4.19). These findings indicate that respondents regarded human capacity development, affordable digital access, and contextually appropriate technologies as complementary requirements for effective KMb among small-scale tea farmers. The qualitative findings reinforced these results by highlighting the importance of practical training and local adaptation for successful implementation of digital technologies. Participants consistently stressed that technological solutions should include ongoing user support and be tailored to local linguistic and cultural contexts. As one tea factory manager (MAN-3) observed, "*Farmers need opportunities to receive practical training rather than relying solely on digital platforms.*" Similarly, an agricultural extension officer (AEO-2) remarked, "*An application developed in the Kikuyu language with voice features would significantly improve ease of use and adoption.*" Collectively, these findings suggest that strengthening ICT-enabled knowledge mobilisation requires an integrated approach that combines capacity building, affordable access to digital technologies, and user-centred system design that reflects local needs and contexts.

5 Discussion

The study's findings demonstrate that ICT has considerable potential to strengthen KMb practices among small-scale tea farmers in Murang'a County. However, its effectiveness depends on the interaction of technological, institutional, and human factors that shape knowledge creation, exchange, and utilisation. Rather than replacing indigenous knowledge systems, ICT was found to complement and enhance existing knowledge-sharing practices by facilitating communication, collaborative learning, and the wider dissemination of locally generated knowledge. These findings suggest that the value of ICT-enabled knowledge mobilisation lies not in the technology itself, but in its ability to reinforce existing social and institutional networks through which indigenous knowledge is created, validated, and applied. Consequently, this study contributes to the growing body of evidence that digital technologies are most effective when integrated into established community and institutional knowledge systems, rather than implemented as stand-alone technological interventions.

The first research question examined KMb's role in promoting collaborative learning and the sharing of indigenous knowledge. The high ratings and qualitative evidence indicate that KMb facilitates reciprocal learning through peer interaction, collective experimentation, and shared problem-solving. These findings support the KMb perspective, which views knowledge as co-produced through ongoing interaction among diverse actors, rather than transferred unidirectionally from experts to

users (Sales et al., 2024). The findings are also consistent with the SECI model (Nonaka et al., 1996) whereby tacit knowledge developed through farmers' experience is externalised through dialogue, combined with scientific knowledge from researchers and extension officers, and subsequently internalised through practical application. Similar observations have been reported in studies of agricultural innovation in sub-Saharan Africa, where collaborative learning networks have strengthened farmers' adaptive capacity and local innovation (Osumba et al., 2021; Sanyang et al., 2016).

The second research question examined the role of ICTs in facilitating the mobilisation of indigenous knowledge. Although respondents perceived ICTs as highly effective, the findings indicate that digital technologies function primarily as enabling mechanisms rather than as the principal drivers of KMb. The close comparison between participants' ratings of KMb and ICT effectiveness suggests that respondents viewed digital technologies as strengthening existing collaborative learning and knowledge-sharing processes, rather than replacing traditional mechanisms of knowledge exchange. This finding aligns with the Agricultural Innovation Systems (AIS) perspective, which conceptualises innovation as an outcome of interactions among multiple actors, institutions, and technologies, rather than as technological adoption in isolation (Klerkx & Begemann, 2020). Similar evidence from Kenya and other East African countries demonstrates that mobile phones, WhatsApp groups, and digital advisory platforms enhance communication and improve access to agricultural information, but their sustained effectiveness depends on established social relationships, trust, and local knowledge networks (Ajani et al., 2024; Mallory et al., 2022; Mutuma et al., 2023). Collectively, these findings reinforce the view that ICTs are most effective when they complement and strengthen existing indigenous knowledge systems and collaborative learning structures.

The third research question examined the barriers that constrain the adoption of ICT for mobilising indigenous knowledge among small-scale tea farmers. The findings reveal a clear hierarchy of constraints, with the high cost of mobile data and digital devices emerging as the most significant barrier, followed by unreliable internet connectivity, limited technical skills, and low levels of digital literacy. These findings indicate that barriers to ICT-enabled mobilisation of knowledge extend beyond technological limitations and reflect the combined influence of affordability, infrastructure, and users' digital capabilities. Consequently, the findings suggest that improved access to digital technologies should not be equated with meaningful or sustained utilisation. For instance, owning a mobile phone or accessing digital platforms does not necessarily translate into effective KMb, particularly where farmers face high

connectivity costs or unreliable network coverage.

These findings align with evidence from smallholder agricultural systems, where nominal access to digital technologies often coexists with irregular use and selective engagement due to persistent socio-economic and infrastructural constraints (Ajani et al., 2024; Cheng, 2021). Furthermore, the study demonstrates that these barriers affect not only whether ICTs are adopted but also how they are utilised in practice. Participants reported using digital technologies strategically for rapid communication and routine information exchange, while continuing to rely on face-to-face interactions for sharing experiential, context-specific, and tacit knowledge. This pattern helps explain why some respondents expressed neutral or less favourable perceptions of ICT effectiveness despite generally positive attitudes towards digital technologies. Collectively, these findings highlight that the perceived usefulness of ICTs alone is insufficient to ensure effective KMb unless accompanied by affordable digital access, reliable infrastructure, and the capabilities required for sustained and meaningful use.

The fourth research question examined strategies for strengthening ICT-enabled KMb among small-scale tea farmers. The findings strongly support a socio-technical approach, showing that effective KMb depends on aligning three interdependent elements: appropriate digital technologies, users' knowledge and capabilities, and supportive institutional arrangements. Training and capacity building were the top-priority intervention, followed by affordable access to digital devices and mobile data, and the development of locally relevant ICT applications. The results suggest that the effective use of digital technologies depends not only on their availability but also on users' skills, local language, and the institutional contexts in which they are adopted. The emphasis on Kikuyu language apps and voice functionality further shows that digital access depends not only on connectivity but also on linguistic appropriateness, usability, and inclusive system design.

These findings align with the socio-technical systems approach, which argues that organisations should plan and develop the social and technical aspects of a system as an integrated whole rather than as separate components (Klerkx & Begemann, 2020; Marcon et al., 2024). At the small-scale tea sector level, this means integrating digital technologies into existing farmer cooperatives, agricultural extension services, and hands-on farmer training programmes to maximise their contribution to KMb. Capacity building should therefore be regarded as a core element of ICT implementation, not merely an add-on activity. Farmers need the ability and confidence to understand, analyse, incorporate, and use digital information

meaningfully in their local agronomic, cultural, and institutional contexts. Collectively, these results show that mobilising knowledge through ICTs requires a combination of technological innovation, human capacity building, and supportive institutional systems.

To conclude, the results indicate that ICTs have significant potential to enhance the mobilisation of indigenous knowledge in small-scale tea enterprises in Kenya. However, their effectiveness depends on socio-technical integration rather than on technology availability alone. Additionally, the sustainable use of ICT-enabled KMb demands affordable access to digital technology, ongoing capacity building, locally relevant and user-centred system design, and supportive institutional arrangements that foster collaboration among farmers, cooperatives, researchers, and extension services. Collectively, these findings confirm that digital technologies are most effective when integrated into trusted social and institutional networks and aligned with the practical, cultural, and knowledge requirements of small-scale tea farmers.

6 Conclusion

This study examined the role of ICT in facilitating the mobilisation of indigenous knowledge among small-scale tea farmers in Murang'a County, Kenya. The findings show that ICTs have substantial potential to support the mobilisation of indigenous knowledge through enhancing collaborative learning, improving access to agronomic information, and supporting the exchange and application of indigenous knowledge. Respondents strongly supported using digital platforms to facilitate indigenous knowledge sharing among agribusiness stakeholders. However, the study also found that the effectiveness of ICT-enabled knowledge mobilisation remains constrained by persistent challenges, including the high cost of mobile data and digital devices, unreliable network connectivity, limited digital literacy, and inadequate technical skills.

The study further demonstrates that successful KMb depends on more than the mere availability of digital technologies. Sustainable ICT-enabled KMb requires integrating affordable digital access, reliable infrastructure, user-centred technologies, continuous capacity building, and supportive institutional arrangements. Training appeared to be the most essential facilitator, accentuating the need to equip farmers with the skills necessary to access, interpret, evaluate, and apply digital information effectively. Equally important is the role of cooperatives, agricultural extension services, and research institutions in fostering supportive environments that facilitate collaborative learning and the validation of indigenous knowledge.

Overall, the findings reinforce the view that ICT-enabled knowledge mobilisation is fundamentally a socio-technical process rather

than a purely technological one. The effectiveness of digital technologies depends on their alignment with local languages, cultural contexts, users' capabilities, and existing social and institutional knowledge networks. This study therefore contributes to the growing body of literature advocating integrated approaches to digital agricultural development that combine technological innovation with human capacity building and institutional support. Future interventions should prioritise the co-design of locally relevant digital solutions, strengthen partnerships among key agricultural stakeholders, and promote inclusive digital ecosystems that position farmers as active contributors to knowledge creation and mobilisation. Further research is recommended to evaluate the long-term sustainability of ICT-enabled KMb initiatives and to examine the potential of emerging digital technologies to better integrate indigenous knowledge across agricultural value chains.

7 Implications and recommendations

Drawing on the study's findings and conclusions, this section outlines the research's theoretical and practical implications. It also presents recommendations for enhancing ICT-enabled KMb among small-scale tea farmers in Murang'a County and comparable contexts.

7.1 Implications

This study makes four interrelated contributions to the literature on KMb, KM, and digital agricultural innovation.

First, the findings extend the Agricultural Innovation Systems (AIS) perspective by showing that technological innovation alone is insufficient to achieve effective knowledge mobilisation. Instead, ICT-enabled knowledge mobilisation emerges from interactions among digital technologies, institutional coordination, human capabilities, and local knowledge networks. This finding reinforces the central premise of AIS that agricultural innovation is a collaborative and socio-technical process involving multiple actors, institutions, and knowledge sources, rather than the outcome of technology adoption in isolation (Klerkx & Begemann, 2020).

Second, the study advances the application of the Socialisation Externalisation Combination Internalisation (SECI) model by illustrating how digital technologies support the continuous conversion of tacit and explicit knowledge within agricultural innovation systems (Nonaka et al., 1996). The findings indicate that contextual factors shape socialisation, externalisation, combination, and internalisation, including the affordability and accessibility of digital technologies, users' digital capabilities, and support from intermediary institutions. Consequently, the study suggests interpreting the SECI model as a context-dependent process whose

effectiveness depends on the socio-economic and institutional conditions in which knowledge is mobilised.

Third, the findings strengthen the conceptual distinction between KM and KMb. While KM primarily concerns the creation, organisation, storage, and dissemination of knowledge within organisations, KMb focuses on the collaborative processes through which knowledge is exchanged, contextualised, validated, and translated into practice across multiple stakeholder groups. The study therefore shows that indigenous knowledge should be understood not as a static resource to be documented, but as a dynamic and evolving form of knowledge continually refined through interactions among farmers, researchers, agricultural extension officers, tea factory managers, and other actors within the agricultural innovation system.

Finally, this study proposes a Socio-Technical Integration Framework for ICT-Enabled KMb, which integrates insights from the SECI model, the Agricultural Innovation Systems (AIS) perspective, and KMb literature. The framework illustrates that effective ICT-enabled KMb arises from the interaction of digital technologies, indigenous knowledge, intermediary institutions, and enabling policy mechanisms. It is the study's principal theoretical contribution, showing that sustainable mobilisation of indigenous knowledge depends on socio-technical integration rather than technological adoption alone. Figure 1 presents the proposed framework.

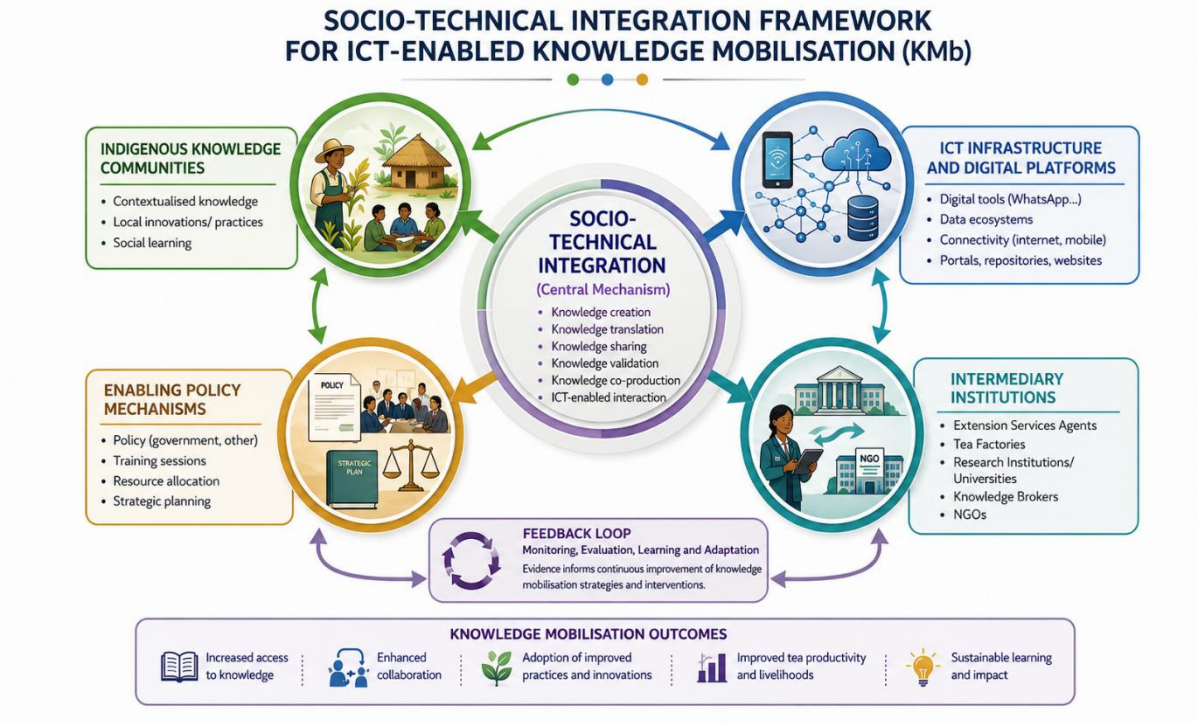


Figure 1: Socio-Technical Integration Framework for ICT-Enabled KMb.

The Socio-Technical Integration Framework for ICT-Enabled KMb, illustrated in Figure 1, conceptualises the mobilisation of indigenous knowledge among small-scale tea farmers as an integrated, collaborative, and iterative socio-technical process. The framework assumes that effective KMb depends not only on digital technologies but also on interactions among indigenous knowledge communities, intermediary institutions, and an enabling policy environment. It brings together four interdependent domains: indigenous knowledge communities, ICT infrastructure and digital platforms, intermediary institutions, and enabling policy mechanisms, all centred around a core socio-technical integration mechanism.

At the centre of the framework is Socio-Technical Integration, which links the social and technological dimensions of KMb through six processes: knowledge creation, knowledge translation, knowledge sharing, knowledge validation, knowledge co-production, and ICT-enabled interaction. These processes show that KMb not only transfers information from experts to small-scale tea farmers. Instead, it encompasses interaction among diverse knowledge holders, through which knowledge is generated, interpreted, exchanged, assessed, and adapted for local use. ICT provides additional channels for communication and interaction, while social and institutional actors determine how effectively these technologies support knowledge mobilisation.

The next domain is indigenous knowledge communities, which places small-scale tea farmers at the centre of the knowledge mobilisation process. This domain encompasses contextualised knowledge, local innovations and practices, and social learning. Farmers are therefore regarded as active knowledge holders and producers whose experiential knowledge can be shared, documented, and integrated with scientific knowledge. The ICT infrastructure and digital platforms domain provides the technological foundation for this interaction, including digital tools such as WhatsApp, data ecosystems, internet and mobile connectivity, and portals, repositories, and websites. However, technology alone does not guarantee effective KMb; its contribution depends on accessibility, digital skills, connectivity, usability, and the relevance of available information.

Intermediary institutions include extension service agents, tea factories, research institutions and universities, knowledge brokers, and non-governmental organisations (NGOs). These actors facilitate networks between farmers, knowledge sources, and digital platforms by supporting knowledge interpretation, validation, training, collaboration, and the adoption of innovation. Enabling policy mechanisms include policies, training programmes, resource allocation, and

strategic planning. These mechanisms create the institutional conditions necessary to sustain ICT infrastructure, strengthen capacity, support collaboration, and integrate KMb into agricultural development activities.

The four domains are interdependent and collectively shape KMb effectiveness. Farmers contribute indigenous and experiential knowledge; ICT provides channels for knowledge exchange; intermediary institutions facilitate connections and validation; and policy mechanisms offer governance, skills and resources. This interaction enables multi-directional knowledge flows and supports the integration of indigenous and formal knowledge. The framework is iterative rather than linear, incorporating ongoing monitoring, evaluation, learning and adaptation. KMb experience and outcomes guide improvements to digital platforms, institutional practices, training, and policy. These processes promote access to knowledge, collaboration, innovation uptake, tea productivity and livelihoods, and sustainable learning. Overall, the framework presents an adaptive, collaborative socio-technical perspective. It depicts an ecosystem in which technologies, farmers, institutions and policies interact to create, mobilise, adapt and utilise knowledge for improved tea farming and sustainable livelihoods.

7.2 Recommendations

County-level digital coordination frameworks should be established to link tea factories, extension services, research institutions and farmers, with a view to securing dedicated ICT budgets and subsidised data plans. Network infrastructure upgrades should be mandated in tea-growing regions, and policies aligned to ensure that digital extension services receive sustained funding beyond individual project cycles. Integrated digital ecosystems should be institutionalised through cooperative and factory governance structures to enhance continuity. Drawing on the empirical intuitions synthesised in the proposed framework, relevant institutional stakeholders and policymakers should adopt this conceptual model as an operational template to guide strategic planning and process evaluation.

Prioritise continuous digital literacy and capacity-building programmes as a core component of ICT-enabled knowledge mobilisation. Training must emphasise practical, hands-on learning using Kikuyu-language interfaces, voice-enabled applications, and effective management of digital communication platforms such as WhatsApp. Peer-learning approaches, including mentorship programmes that pair digitally experienced lead farmers with older or less digitally skilled farmers, should be encouraged to strengthen collaborative learning and facilitate the validation and transfer of indigenous knowledge.

Digital agricultural platforms should be designed to meet the needs and realities of small-scale tea farmers. Developers ought to prioritise low-data, offline-capable mobile

applications that integrate information on indigenous soil fertility and pest management practices with market intelligence and advisory services. User-centred design principles should guide digital platform development by incorporating local-language interfaces, voice functionality, simplified navigation and iterative usability testing with farmers throughout the design process. Hybrid communication models that combine SMS-based services with WhatsApp communities of practice should also be adopted to enhance accessibility across varying levels of digital connectivity.

Multi-stakeholder digital extension committees should be established at the sub-county level to coordinate platform maintenance, localisation, user feedback and continuous improvement. These committees should include representatives from tea factories, cooperative societies, agricultural extension services, research institutions, ICT providers, lead farmers, and relevant government agencies. Dedicated financial resources, clearly defined institutional responsibilities, and strengthened inter-organisational collaboration initiatives are also essential to reduce fragmentation and ensure the long-term sustainability of ICT-enabled KMb initiatives.

Future studies should undertake longitudinal investigations across multiple tea-growing counties to assess the long-term effectiveness, scalability, and sustainability of ICT contributions to KMb. Further research should also explore emerging digital technologies, including artificial intelligence (AI)-enabled advisory systems, chatbots, drone imagery, and hybrid extension models, to support documenting, validating, and mobilising indigenous agricultural knowledge. Future studies on public–private partnership models are also needed to identify sustainable financing mechanisms that can support farmer-centred digital knowledge platforms beyond donor-funded programmes. Regarding the framework, future research could apply the proposed model across different geographical regions and sub-sectors to broaden its scope. Comparative studies would help determine whether the framework's core components apply across diverse socio-economic and institutional contexts.

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