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Mobile learning and indigenous knowledge for climate resilience

Climate resilience in Sub-Saharan Africa depends on more than technological innovation. It also requires the preservation and transmission of locally embedded agricultural knowledge. Drawing on evidence from the ICRAFS project in Northern Ghana, this brief examines the conditions under which voice-based mobile learning can support climate adaptation among smallholder farmers. The audio modules were delivered through Farmerline's Mergdata platform and reached more than 50,000 farmers in six local languages. They combined mobile learning with indigenous farming knowledge and Latvian seed-saving experience. Survey and fieldwork evidence show that digital extension is most effective when it is trusted, timely, intelligible across local languages and dialects, attentive to household decision-making, and linked to farmers' economic realities. The brief argues that climate-resilient food systems require hybrid knowledge systems: scalable digital tools combined with community-based knowledge, locally adapted farming practices, and institutional support. It also shows how comparative lessons, such as Latvia's seed-saving experience, can inform policy without being replicated directly.

Digital extension and climate resilience

Climate change is increasing production risks for smallholder farmers, particularly in regions where food systems are highly vulnerable to environmental and economic shocks. In this brief, climate resilience refers to the ability of smallholder farmers and the wider food systems they depend on to adapt to climate-related shocks while sustaining production and livelihoods. In Sub-Saharan Africa, rising temperatures, irregular rainfall, soil degradation, and growing pest outbreaks are placing increasing pressure on agricultural productivity and rural livelihoods.

At the same time, access to mobile technologies has expanded rapidly. Even in remote and hard-to-reach rural areas, mobile phones have become a central infrastructure for communication and information exchange, alongside local radio stations and community hubs. However, many smallholder farmers continue to rely on basic feature phones rather than smartphones, making voice-based communication systems especially important for agricultural extension services.

International organisations and development agencies, including the Food and Agriculture Organization of the United Nations (FAO), the World Bank, and the United Nations Development Programme (UNDP), have increasingly supported digital agricultural extension and mobile-based advisory systems as part of broader efforts to strengthen climate resilience and food security. Throughout this brief, digital agricultural extension refers to the use of mobile and digital tools to deliver farming advice

and information. These systems create new opportunities for delivering agricultural knowledge at scale.

However, digital access alone does not automatically improve climate resilience. Extension systems that focus mainly on technological delivery risk overlooking social realities such as literacy barriers, local ecological knowledge, gendered patterns of information-sharing and decision-making, and trust in advisory systems. The key policy question is therefore not whether digital tools can reach farmers, but whether they can reach them in ways that are trusted, understandable, timely, and useful for real-time farming decisions.

Evidence from Northern Ghana suggests that digital agricultural extension is most effective when technology functions as a mediator that strengthens and amplifies existing community knowledge systems.

The ICRAFS project: evidence from Northern Ghana

The “Building Digital Education of Indigenous/Heritage Crops for the Resilience of African Food Systems in the Climate Crisis” (ICRAFS) project brought together Latvian and Ghanaian partners, including BICEPS, Farmerline, CSIR-Savanna Agricultural Research Institute, and the Latvian Permaculture Association, a leading organization behind Latvia’s seed savers movement. By combining development policy expertise, digital extension infrastructure, and local agricultural research capacity, the project explored how indigenous knowledge and digital learning can support climate adaptation among



smallholder farmers. As part of the project, two educational modules were developed, each consisting of ten short audio lectures. The lectures covered regenerative agriculture, indigenous crops, seed-saving practices, soil management, pesticide reduction, and climate adaptation strategies. To ensure accessibility, the content was delivered in six local languages (Dagbani, Konkomba, Buli, Sissale, Chokosi, and English) through voice-based systems compatible with basic feature phones.

The audio content reached more than 50,000 farmers through Farmerline's Mergdata platform, a Ghanaian digital agricultural extension system that combines mobile-based advisory services with AI-enabled tools designed for low-connectivity and low-literacy rural contexts. The educational content and broader community-based approach were developed in cooperation with the Latvian seed savers movement, whose experience in preserving heirloom crops and decentralised seed-sharing networks informed both the training materials and the wider vision for strengthening local resilience systems in Ghana.

The analysis draws on a baseline survey of 367 farmers and mixed-methods fieldwork with 60 farmers in Northern Ghana. Together, these data provide insight into the conditions under which mobile-based agricultural learning can support climate adaptation, highlighting the importance of design choices around language, trust, timing, and local knowledge.

Lessons from the Latvian seed savers movement

The Latvian seed savers movement provided an important practical and conceptual reference point for the ICRAFS project.

The Latvian case shows that food-system resilience also depends on cultural memory, social networks, and ecological diversity. Community-based seed-saving systems contribute to ecological resilience by preserving genetic diversity, locally adapted crop varieties, and cultivation practices developed through long-term interaction with specific environmental conditions. Heirloom crops function not only as biological resources, but also as carriers of local memory, identity, and intergenerational knowledge. In Latvia, seed-saving also helps preserve agricultural knowledge, rural identity, and community ties in the context of demographic decline and countryside depopulation.

For digital agricultural systems in Sub-Saharan Africa, the Latvian case offers a useful policy lesson. It should not be treated as a model for direct replication, but as evidence that resilient food systems depend on institutions and networks that protect local varieties, preserve practical knowledge, and maintain trust between farmers, communities, and knowledge holders. Educational initiatives are more effective when they connect climate adaptation and agricultural advice to local cultural experience and community-based knowledge systems.



Main findings

Digital access and adoption

Research findings suggest that mobile phone ownership was nearly universal among surveyed farmers (98%), despite the majority of respondents relying on basic feature phones rather than smartphones. Approximately 72% reported receiving educational agricultural messages via mobile phones, while around 70% stated that they actively applied the information received to production and input-purchasing decisions.

Trust in digital advisory systems was also relatively high: among farmers who had received educational messages, approximately 78% reported trusting the source. Engagement data showed particularly high interest in traditional agricultural knowledge, regenerative farming methods, and seed-saving practices, with listening rates exceeding 70%.

These findings suggest that reach matters, but it is not sufficient. Digital extension becomes meaningful when farmers trust the source, understand the content, and can apply the information in farming and input decisions.

The strongest initial interest was recorded for content on diversification into indigenous crops. However, completion and listening rates suggest that initial curiosity is not enough to sustain engagement. For digital learning to remain useful, content on crop diversification needs to be closely connected to farmers' immediate production choices, input constraints, market opportunities, and expected livelihood benefits.

In this context, digital agricultural extension services are most useful when they improve

accessibility and personalisation, for example through voice-based interaction, local-language delivery, farmer profiling, and more targeted advisory content.

Indigenous knowledge and hybrid resilience systems

Evidence from Northern Ghana demonstrates that climate resilience is deeply rooted in locally embedded knowledge systems developed across generations. Farmers rely on sophisticated ecological knowledge to manage agricultural risks under uncertain climatic conditions.

Field observations identified a range of indigenous adaptation practices, including traditional composting systems, organic soil-fertility management, smoke-based seed preservation methods, and the use of ash to protect stored crops from pests. Farmers also rely on ecological indicators to interpret environmental change. For example, the presence of the weed *Striga* ("bochaa") is widely understood as a sign of declining soil fertility or soil acidity.

High engagement with content on indigenous crops further suggests strong farmer interest in locally adapted crop systems as part of climate adaptation strategies.

Importantly, farmers do not perceive digital information as a replacement for indigenous knowledge. Instead, mobile-based advisory systems are integrated into existing local decision-making processes. This creates a hybrid resilience model in which indigenous knowledge provides contextual interpretation, while digital systems support broader dissemination, coordination, and



real-time information sharing. However, the effectiveness of these hybrid resilience systems remains constrained by broader structural inequalities.

Structural barriers to effective digital extension

Despite the potential of mobile-based agricultural learning, several structural barriers continue to limit effectiveness.

Gender, language, and accessibility

Digital extension is not equally accessible to all farmers. Mixed-methods evidence from Northern Ghana shows that gender roles shape both access to technology and agricultural decision-making. Although women represented the majority of respondents, men often remained household gatekeepers, controlling mobile-device ownership and broader agricultural resource allocation. This creates asymmetries between formal access to information and effective control over decisions. It also means that digital extension must consider how agricultural information is shared within households, not only whether a message reaches a phone.

Low literacy levels further reinforce the importance of voice-based communication. Approximately 62% of respondents reported having no formal education, and farmers consistently found voice-based messages in local languages easier to understand than text-based formats. However, linguistic accessibility goes beyond translation: dialects, locally used farming vocabulary, and informal agricultural expressions strongly shape whether advice is understood, trusted, and acted upon.

Timing and economic incentives

Agricultural information is highly time-sensitive. Farmers reported that advice loses value if delivered outside key planting, harvesting, pest-management, input-purchasing, or output-selling windows. This means that digital extension depends not only on content quality, but also on synchronisation with local agricultural and market calendars.

Farmers also evaluate new practices through immediate economic outcomes. Long-term climate adaptation goals alone are often insufficient under conditions of economic vulnerability. Qualitative interviews suggest that farmers are more likely to adopt new practices when they are connected to visible benefits such as improved yields, lower input costs, reduced risk, or stronger market opportunities.

Overall, the main policy challenge is not simply expanding digital access, but designing extension systems that are trusted, locally intelligible, timely, and economically relevant. Voice-based delivery can help overcome literacy and smartphone barriers, but it is most effective when integrated with local radio, farmer groups, community leaders, and extension agents.

Policy recommendations

The following recommendations are particularly relevant for rural agricultural regions in Sub-Saharan Africa and other low-income contexts where smallholder farming, limited digital infrastructure, low literacy rates, and dependence on feature phones continue to shape access to agricultural information and climate adaptation resources. They are addressed to agricultural



ministries, extension agencies, donors, digital service providers, development partners, and farmer organisations working in rural, low-connectivity contexts.

1. Shift voice-based systems from providing information to making information usable.

Voice-based advisory systems should be accessible through basic feature phones and combined with local radio, TV, farmer groups, and community-based extension channels. Their success should be assessed not only by reach, but also by whether farmers understand, trust, and use the information in agricultural decisions.

2. Integrate indigenous knowledge into digital extension design.

Digital agricultural content should be co-designed with farmers, local extension agents, and community knowledge holders. Indigenous knowledge, local dialects, and farmer-used agricultural vocabulary should be integrated into digital platforms to improve trust, cultural relevance, and adoption.

3. Account for gendered decision-making in digital extension.

Digital extension should account for the fact that receiving agricultural information does not always mean having the authority, resources, or training needed to act on it. Household decision-making over land, inputs, sales, technology use, and production priorities may still be shaped by gender roles. Advisory services should therefore support direct communication with women farmers, while also encouraging household-level information-sharing so that relevant advice

reaches those involved in production and household food security.

4. Align advisory services with agricultural and market calendars.

Advisory messages should be timed around key planting, harvesting, pest-management, input-purchasing, and output-selling periods, reaching farmers before decisions are made.

5. Link climate adaptation to immediate economic benefits.

Climate adaptation should be communicated through immediate livelihood gains, linking regenerative agriculture, indigenous crops, seed-saving, and soil-management practices to improved productivity, lower input costs, reduced risk, and stronger market opportunities.

6. Support community seed-saving and knowledge networks.

Community seed-saving initiatives, indigenous crop preservation, and farmer-to-farmer knowledge networks should be supported. Latvian experience shows that such systems can strengthen agrobiodiversity, reduce dependency on external inputs, and preserve locally adapted knowledge. In African contexts, these models should be adapted through local farmer organisations, extension services, and community institutions rather than replicated directly.

Conclusions

The evidence from Northern Ghana shows that digital agricultural extension can support climate resilience when it is designed around the realities of smallholder farmers. Voice-based mobile learning can reach farmers with limited literacy,



limited internet access, or only basic feature phones, but technology alone is insufficient to change agricultural practices. Digital extension is most effective when it is trusted, accessible in local languages and dialects, responsive to how farming decisions are made within households, delivered at the right moment in the agricultural or market cycle, and linked to visible economic benefits.

Indigenous knowledge should not be treated as a barrier to innovation. Rather, it provides the local interpretation, ecological memory, and practical experience that make digital advisory systems more relevant and credible. The Latvian seed savers movement offers a useful comparative lesson: community-based knowledge systems can preserve biodiversity, strengthen rural identity, and maintain trust across generations.

The main policy implication is to treat digital extension as part of a broader rural resilience strategy. Investments in digital advisory systems and voice-based communication should be accompanied by support for local-language content, community institutions, farmer-to-farmer knowledge exchange, and locally adapted seed-saving and farming practices.

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