

CHAPTER 5

Digitalization in African Agrifood Systems: From E-Learning to E-Markets

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Introduction

Digital technologies are reshaping global agrifood systems by offering transformative solutions to long-standing challenges related to productivity, resilience, and sustainability. Digitalization in agrifood systems refers to the systematic integration of digital technologies across the agricultural value chain to enhance productivity, sustainability, market connectivity, and resilience, while addressing the structural and contextual challenges of African smallholder farming systems (Choruma et al. 2024; World Bank 2023a). As per the 2020 ReSAKSS ATOR report, “Digital innovations involve both the technologies themselves and the services/solutions they provide (Baumüller and Addom 2020, para. 7).” Over the past decade, digital innovations, such as mobile-based advisory platforms, artificial intelligence (AI), remote sensing, big data analytics tools, precision agriculture, digital financial services, and blockchain, have increasingly permeated agricultural value chains, improving efficiency and connectivity across production, processing, and marketing nodes (Freund et al. 2025; Conway et al. 2019). For example, recent studies have shown that digital platforms integrating blockchain can significantly improve food traceability and safety, thereby reducing the risks of contamination and enhancing consumer trust (Kamilaris et al. 2019). Developments such as these have spurred significant investment and policy interest worldwide in the digitalization of agrifood systems, though uptake and outcomes vary widely across contexts.

In Africa south of the Sahara, the digital transformation of agrifood systems presents both immense promise and complex challenges. With its rapidly growing population, persistent rural poverty, and vulnerability to climate variability, the region is uniquely positioned to benefit from technological leapfrogging (Jellason et al. 2021). Digital innovations—ranging from Short Message Service (SMS)-based agricultural advisory services to mobile-enabled e-markets—have emerged as strategic tools to support climate-smart agriculture, reduce transaction costs in agrifood systems, and enhance smallholder productivity (Mabaya and Porciello 2022; Ndekwa et al. 2023). The COVID-19 pandemic further accelerated digital transitions, especially in remote market engagement and learning platforms, underscoring the resilience potential of digital tools in crisis settings (Mabaya and Porciello 2022). However, unequal

access to digital devices creates disparities. Evidence shows that youth and women benefit disproportionately less from such technologies, unless deliberate policies support inclusive access (FAO 2023).

Despite growing interest, digitalization in African agriculture remains uneven and often limited to pilot initiatives with restricted scalability. The continent hosts thousands of agricultural technology solutions, yet only a fraction have reached commercial viability or scaled beyond niche markets (Tsan et al. 2019). Infrastructure deficits, low digital literacy, and fragile ecosystems hinder widespread adoption and sustained use of digital tools, particularly among women, youth, and marginalized smallholders (Abdulai 2022). Moreover, the promise of digitalization risks being undermined by a growing digital divide, ethical concerns surrounding data governance, and structural constraints within agrifood markets (Puplampu and Mugo 2023; Freund et al. 2025).

This chapter critically examines the current state, challenges, and pathways of digitalization in African agrifood systems, ranging from e-learning to e-markets. Drawing on recent empirical evidence, case studies, and lessons from the AgriPath project (Kassie et al. 2024), we map the evolving digital landscape and identify enablers and co-benefits as well as constraints and trade-offs that shape the scale and impact of digital innovations.

Our work provides an integrated and evidence-based understanding of the role of digitalization in transforming Africa’s agrifood systems. We analyze how digital solutions can support the achievement of the Sustainable Development Goals (SDGs), promote sustainable agroecological transitions, and enhance equity in access to agricultural resources. In doing so, we highlight the conditions under which digitalization succeeds, the trade-offs it entails, and the strategies needed to foster inclusive, sustainable, and scalable digital innovations.

Current State of Digitalization in Agrifood Systems in Africa

Digital innovations are transforming African agriculture, but their adoption remains uneven across regions, value chains, and within demographic groups. Mobile-based advisory services, e-market platforms, and digital farm management tools have gained traction (Ofosu-Ampong et al. 2025), yet most innovations remain concentrated in a few countries, i.e., Nigeria, Kenya, Egypt, and South Africa. Limited infrastructure, low digital literacy, and weak

investment flows hinder widespread adoption. This section provides a brief overview of the evolving digital landscape by mapping the key players, investment trends, and gaps in the digital transformation of Africa's agrifood systems.

Increasing evidence on the promise of digital innovations in agricultural advisory services in Africa

Digital agricultural advisory services are fundamentally reshaping how farmers in Africa access information, replacing or complementing traditional extension systems through the use of mobile technology, AI, and big data analytics. These technologies offer timely, localized, and actionable insights on climate-smart agriculture, pest and disease management, market access, and input use. Digital technologies, such as SMS, Interactive Voice Response (IVR) systems, mobile applications, and AI-powered chatbots, are increasingly prevalent and critical in closing the information gap for millions of smallholder farmers (Mulungu et al. 2025; Mabaya and Porciello 2022). An emerging trend is the integration of AI-powered chatbots that deliver localized content in local dialects, enhancing inclusivity and addressing literacy challenges. For instance, the FarmerChat chatbot, deployed in Kenya, India, Ethiopia, and Nigeria, supports text and voice interactions, features an intuitive design for low-literacy users, and adapts content culturally and linguistically (Digital Green 2023). Similarly, the COVID-19-focused chatbot, Shehu, delivered critical health information in Hausa and Kanuri in Nigeria, improving accessibility for diverse populations (Borokini et al. 2023).

Empirical evidence supports the effectiveness of these tools. A systematic review by Mulungu et al. (2025) analyzing 49 information and communication technology (ICT)-based interventions in developing countries found that 76 percent increased the adoption of good agricultural practices, 74 percent led to improved yields, and 68 percent contributed to higher farm incomes. The magnitude of these changes is, however, still limited. Researchers have found that personalized, context-specific advisories tend to have greater impact. For instance, Arouna et al. (2021) demonstrated through randomized controlled trials in Nigeria that personalized digital extension services delivered via mobile apps led to a 7 percent increase in rice yields and a 10 percent increase in profits, without increasing fertilizer use.

The reach of digital agricultural advisory services has expanded exponentially with mobile phone penetration. Early ICT innovations set the stage for more tailored and scalable digital advisory solutions (Gakuru et al. 2009).

A recent study (Abdulai et al. 2023) reported that SMS services providing pest alerts, market prices, and weather forecasts changed farming practices in northern Ghana. Mobile phone usage among smallholder maize farmers in Ghana has been shown to significantly improve productivity by enabling access to timely and actionable information on input use, market prices, and extension services (Issahaku et al. 2018). Similarly, in Tanzania, mobile phone-based advisory services were associated with higher reported maize yields, highlighting their role in enhancing agricultural decision-making and resilience (Quandt et al. 2020). These findings underscore the capacity of SMS-based models to rapidly disseminate life-saving information across broad geographic areas.

Voice-based systems, such as IVR and call centers, offer a critical advantage by overcoming literacy and language barriers. Dione and colleagues (2021) documented how IVR services in Uganda significantly enhanced knowledge and adoption of practices among low-literacy farmers raising pigs. Similarly, Mihretie and Melak (2024) highlight how Ethiopia's multi-platform strategy—combining radio, IVR, and SMS—is instrumental in ensuring equitable access to agricultural knowledge in remote regions.

Mobile applications, particularly those integrating AI and multimedia content, are showing substantial promise in delivering customized advisories. In Ethiopia, Yitayew and colleagues (2023) found that improved digital advisory services were associated with higher wheat yields and greater technical efficiency. In Uganda, evidence suggests that video-based agricultural advice has improved maize yields by 10 percent, primarily by increasing the uptake of recommended practices (van Campenhout et al. 2021). The cost-effectiveness of such platforms is also notable, as digital delivery models reduce per capita advisory costs and allow for rapid scaling (Fabregas et al. 2023).

Moreover, community radios and hybrid digital platforms remain vital in bridging last-mile communication gaps. When coupled with SMS feedback loops or expert call-ins, radio-based advisories foster two-way interaction and social learning. These hybrid models can be instrumental in ensuring inclusive participation, particularly among women and marginalized groups (Fabregas et al. 2019; Mabaya and Porciello 2022).

Public-private partnerships can also be essential in sustaining and scaling digital agricultural advisory services. Programs like mNutrition (CABI 2017) and AgriPath (AgriPath 2025) have demonstrated that co-designing tools with users, integrating local languages, and embedding services in broader development

programs enhance adoption and impact (Mulungu et al. 2025; Okalas Ossami et al. 2023).

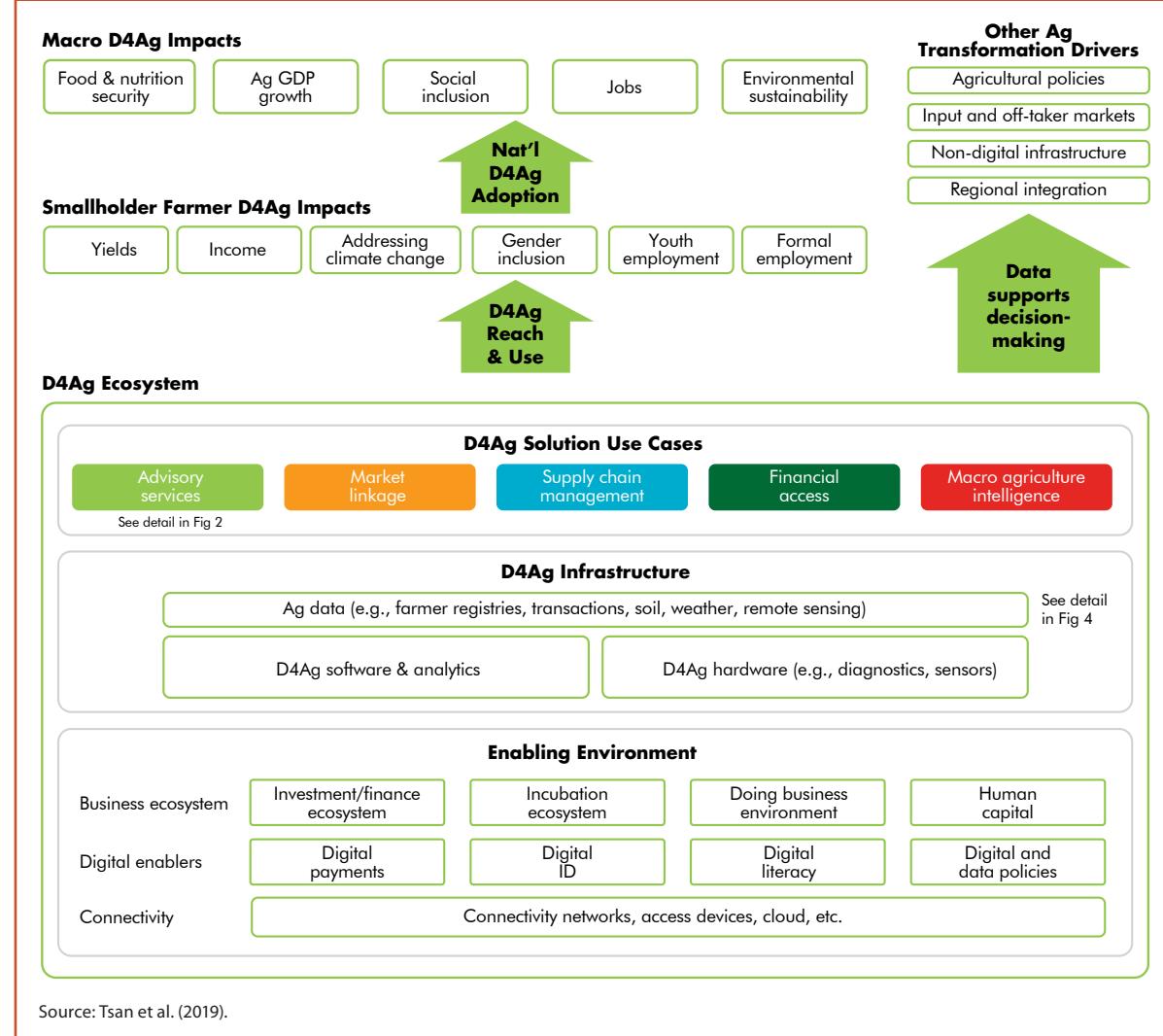
In summary, digital advisory services hold transformative potential for African agrifood systems, and, if provided with the right enabling conditions and support, can drive gains in productivity, resilience, and income. Their effectiveness is maximized when delivery models are participatory and inclusive, localized, and supported by strong institutional frameworks.

Agricultural technology ecosystem: Startups, private sector, government, NGOs, ecosystem supporters

Startups and private firms drive innovation in Africa's agricultural technology sector, while NGOs provide crucial support through farmer training and subsidy programs. Governments play a limited role, with only a few countries actively promoting digital agriculture policies (Ayim et al. 2022). This subsection maps the key players in Africa's digital agricultural landscape and explores the roles of venture capital, corporate partnerships, and government-led initiatives. Several case studies are presented that illustrate how startups and the private sector, government, NGOs, and digital ecosystem supporters are shaping the adoption of digital technology in agrifood systems. The discussion also examines gaps in coordination among these actors and the need for stronger regulatory frameworks. Without robust policy frameworks, technology startups in the agrifood sector face a high risk of collapse. Collaborative models where governments co-invest with private actors are shown to sustain innovations longer (World Bank 2023b).

Tsan et al. (2019) developed a model of the digitalization for agriculture (D4Ag) ecosystem specifically for Africa, whereas Beanstalk AgTech (2023) later

FIGURE 5.1—DIGITALIZATION FOR AGRICULTURE (D4AG) ECOSYSTEM MAP



created a broader model of the ecosystem for low- and middle-income countries in general. This chapter uses the D4Ag ecosystem map (Tsan et al. 2019) as the basis for our analysis (Figure 5.1).

Beyond the actual providers of digital solution use cases, as shown in the section entitled 'D4Ag Solution Use Cases' in Figure 5.1, the D4Ag ecosystem

also includes the relevant components of infrastructure and enabling environment needed for digital technologies in agriculture to achieve the impact goals for their users and the agrifood systems of the countries within which they are deployed.

By 2022, across the African continent, over 650 digital solutions focused on agriculture had been developed, the largest number among the global regions (Beanstalk AgTech 2023). Between 2012 and 2018, the number of digital solutions in agriculture grew by 33 percent. Growth in the development of such technologies slowed thereafter, growing by 9 percent between 2018 and 2022. However, of the over 1,200 digital agricultural technologies globally, only 27 reached more than 1 million users in 2023. Of the private firms deploying them in Africa, only 39 percent were profitable, which is below the average of 47 percent across all low and middle-income countries globally (Beanstalk AgTech 2023). As a result, while there is no dearth of solutions for most use cases, there are clear shortcomings when it comes to the actual value many of these solutions provide. Additional challenges for D4Ag ecosystems include limited funding, a lack of strong infrastructure, and often incoherent policy environments.

Key challenges to expanding the use of digital agricultural technologies are the scale and viability of their associated business models. These challenges are inherently linked to the low funding levels for such technologies in Africa. Without sufficient funding, many promising technologies will remain unimplemented, as implementing sustainable business models to deploy them profitably takes time and investment. Africa received only 1.6 percent of global investment in agricultural technologies in 2024, down from 2 percent (US\$ 257 million) in 2023 (AgFunder 2024). Commercial funding of digital agricultural technologies in Africa had halved by 2024, while non-commercial funding had increased (Briter 2024). With the closure of the United States Agency for International Development (USAID) in early 2025 and announcements of development budget cuts more widely across the global North, we expect non-commercial funding for digital agricultural technologies to decrease in line with the decline in commercial capital from 2025 onwards. We project that startups—both venture-capital-funded and grant-funded—will either quickly find innovative ways to achieve profitability or cease operations over the next few years. A greater concentration of players and a sharper focus on generating revenue from African customers could present an opportunity to strengthen product-market fit and

profitability across the sector as a whole, while reducing duplicative efforts. Nonetheless, a substantial risk persists that startups focused on creating value in new markets will be shuttered, further marginalizing accessibility and slowing down overall innovation in the agrifood sectors in Africa.

Mapping of digital tools available along agrifood value chains in Africa

Africa's agricultural landscape is witnessing a digital revolution with a diverse array of technological tools and platforms emerging across different stages of the value chain. However, their distribution, accessibility, and impact remain uneven across the continent. Here, we review the availability of various tools across the different nodes of agrifood value chains and provide insights into ownership and sustainability.

Input stage

At the input stage, which primarily involves the supply and distribution of inputs such as seeds and fertilizers, there is a moderate number of digital solutions focused on input access. Notable examples include Apollo Agriculture in Kenya (Apollo Agriculture 2023), Kobiri Digital Platform in Guinea (Bamako.com 2020), and GeoAgro-MiSR in Egypt (Govind 2023). Most of the apps or digital platforms in this category provide recommendations on inputs to use and link farmers to input markets. A key human dimension here is to eliminate the use of counterfeit inputs. Fake seeds and fertilizers not only reduce yields but also erode farmers' trust in digital platforms, requiring stronger regulatory oversight (BMGF and Monitor Deloitte 2019). In addition, the proper use of inputs specific to particular crops or locations is enhanced through digital platforms.

Digital agricultural solutions at the input stage have four primary functions:

- Digital input marketplaces to connect farmers to sources of seeds, fertilizers, and pesticides.
- Input authenticity verification systems to combat counterfeit products.
- Access to input financing solutions and digital credit platforms.
- Weather and soil information for input use planning.

The ownership of input-stage digital agricultural technologies involves a mix of private sector startups, predominantly local African companies, international

donors, non-governmental organizations, and some government-supported platforms. Compared with agricultural technologies at other value chain stages, input-focused technologies show higher private sector ownership.

Regionally, East Africa, particularly Kenya, leads in the use of input-focused digital tools, followed by West Africa, with more limited coverage in Central and North Africa (FAO and ITU 2022).

Regarding the predominant business model employed by input-stage digital agricultural technologies, most digital platforms and apps are commission-based, providing users with access to purchase inputs or machinery. However, there are still some, particularly those coming from projects, that provide information on inputs without any commissions involved. Moving forward, it is expected that marketplace models will continue to advance strongly, particularly the commission-based payment models.

Production stage

The highest concentration of digital tools is found in the production stage of agricultural value chains. These tools include Hello Tractor in Nigeria (Hello Tractor 2025), SunCulture, DigiFarm, and iCow in Kenya (SunCulture 2024; DigiFarm 2025; iCow 2021), Farmerline's 399 Service in Ghana (Farmerline 2025), and Plantix, which is based in Germany, but available to farmers in developing countries (Plantix 2025). Most focus on providing farmers with advice on production techniques, climate-smart agriculture, nutrient recommendations, pest management, and other new farming technologies.

At the production stage, digital agricultural solutions are centered on five primary functions:

- Digital extension and advisory services.
- Precision agriculture tools for monitoring crops and livestock.
- Mechanization services, including tractor booking and equipment sharing.
- Weather forecasts and early warning systems.
- Remote sensing and farm management platforms.

An example of an emerging frontier in the production stage is drone-based precision agriculture. Early pilot projects, including nutrient mapping in wheat fields and drone-assisted livestock services in countries such as Rwanda,

demonstrate that significant yield improvements can be achieved. However, scalability remains limited due to the costs and infrastructure gaps (Dronlytics 2024).

Another production frontier is tillage by digitally controlled tractors. Remote farming with automatic tractors in countries like South Africa is emerging, driven by precision agriculture technologies, such as GPS steering systems and AI. These technologies enable farmers to remotely monitor and control machinery, reducing labor and improving productivity and efficiency. However, these tools also raise concerns about labor displacement.

The ownership of production-stage digital agricultural technologies is quite diverse, with significant involvement of international technology companies, non-governmental organizations, telecommunications companies, and donor-supported initiatives. According to a recent study (Tsan et al. 2019), African-based enterprises developed and owned 58 percent of production-stage digital agricultural technologies, of which 83 percent were commercial, and donors or non-profits financed 17 percent. International entities owned the remaining 42 percent. At the launch of their businesses, many firms supplying production-focused tools in Africa relied on blended financing models with substantial donor funding.

Although widely distributed across Africa south of the Sahara, the countries with the highest density of production-focused digital tools for agriculture are in Kenya, Nigeria, Ghana, and South Africa (FAO and ITU 2022). Farmers in the more fragile states of Africa generally have limited access to such tools.

Processing stage

The processing stage has the fewest digital tools among agricultural value chain segments, representing a significant gap in the digital agricultural technology ecosystem. Among the few examples is Twiga Foods in Kenya (Twiga 2025). This gap illustrates a missed opportunity for digital solutions to add value to agricultural commodities post-harvest, where losses may exceed 30 percent. For example, smart processing and cold-chain monitoring technologies, including real-time sensors, AI-powered predictive modeling, and advanced imaging systems, can sharply reduce post-harvest losses and food spoilage by ensuring optimal storage conditions for preservation and efficient inventory management (Pindi 2025).

Digital agricultural solutions at the processing stage are centered on four primary functions:

- Processing equipment management systems.
- Quality control and traceability.
- Inventory management.
- Processing scheduling and optimization.

The ownership of processing-stage digital agricultural technologies is primarily held by the private sector, with a greater involvement of long-established agribusinesses rather than startups. Few donor organizations have been involved in the development and deployment of tools for processing-stage activities.

Processing-stage digital agricultural technologies in Africa are concentrated in the more industrialized African economies, including South Africa, Kenya, and Nigeria. There are significant gaps in access to these tools across most of the continent.

Market access stage

Digital tools that seek to connect farmers to markets are numerous—Twiga Foods in Kenya (Twiga 2025), AgroMarketDay in Uganda (AgroMarketDay 2025), FreshSource in Egypt (FreshSource 2025), Farmcrowdy in Nigeria (Farmcrowdy 2025), and Pa Market in Zambia (Pa Market 2025). A key hurdle these tools must surmount to succeed is the fundamental human-centered concerns of trust and fairness—farmers often fear exploitation by digital intermediaries. Digital platforms can also serve as the basis for building cooperatives among agricultural producers or traders, thereby strengthening their bargaining power, facilitating efficient self-organization, and ensuring equitable distribution of work among themselves (ILO 2021).

At the marketing stage, digital agricultural tools are centered on five primary functions:

- Serving as digital marketplaces to connect farmers to buyers.
- Providing price data as a market information system.
- Offering mobile payment and financial transaction platforms, such as M-Pesa (M-Pesa 2025).
- Logistics and transportation coordination.
- Providing traceability and certification systems.

There is a strong private sector presence in digital agricultural tools operating at the market access stage. These firms often have significant venture capital investment. Tools in this stage of agricultural value chains are more likely to have commercially viable business models than those in other value chain segments. Major telecommunication companies have a significant presence in the ownership and operations of payment platforms.

Market-focused digital agricultural tools are quite widespread across Africa, with East Africa leading in such innovations, particularly Kenya.

Comparative analysis and gaps

Digital agricultural technology tools are concentrated at the production and market access stages of agrifood value chains, with significant gaps at the processing and post-harvest stages. This imbalance reflects patterns of investor interest and farmers' immediate needs. Commercial viability increases along the value chain, with more sustainable business models found in market access tools compared to input and production solutions, which tend to rely more heavily on donor support. For example, Beanstalk AgTech (2023) found that most digital agricultural tools or apps that are successful are those linked to the market, as they offer more sustainable payment methods, such as commissions. In contrast, digital agricultural tools operating primarily at the production stage, such as agricultural advisory platforms, rely mostly on subscriptions. Simple SMS or Unstructured Supplementary Service Data (USSD)-based tools dominate in the production stage, while smartphone apps and web platforms are more common in market access solutions. Advanced technologies, such as AI, the Internet of Things, or blockchain, remain limited in digital tools across all agrifood value chain segments in Africa.

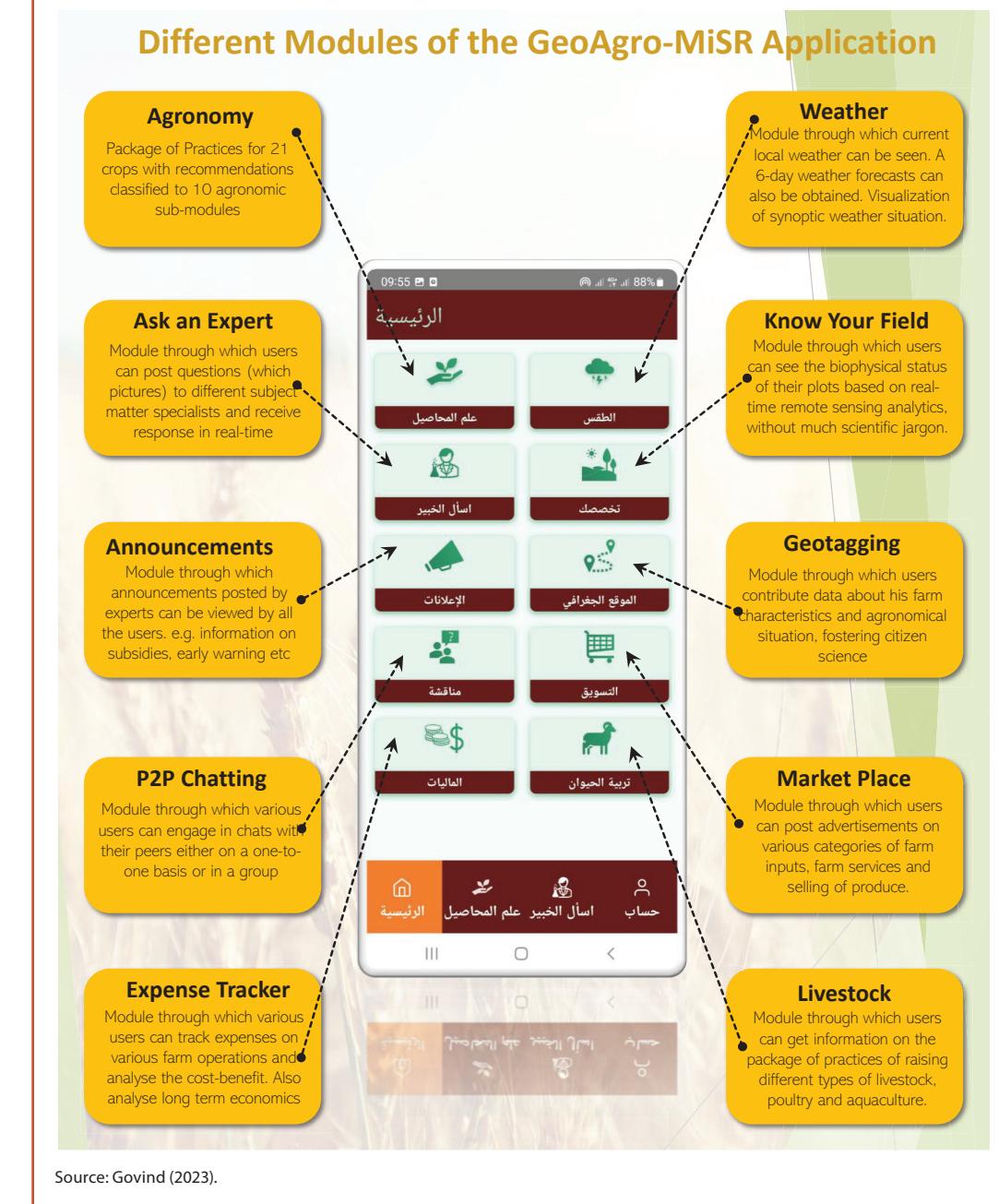
Most digital tools operate in silos, focusing on specific value chain nodes rather than providing integrated solutions across the entire value chain. Few platforms offer end-to-end services, resulting in fragmentation within the digital agricultural tool ecosystem. These integrated solutions often achieve greater impact and sustainability by addressing interconnected challenges faced by farmers and other value chain actors. However, they remain few. Beanstalk AgTech (2023) found that more than 62 percent of such tools focused on a single use case, addressing one main issue. However, multi-function tools generally demonstrate higher user retention and stronger business models. This is a result of several factors:

- **Data advantage:** By collecting information across multiple value chain stages, these multi-function platforms develop richer farmer profiles that they can use to improve service delivery and provide more sophisticated offerings, such as credit scoring.
- **Reduced user acquisition costs:** Cross-functional platforms can leverage existing users for new services rather than starting from zero for each offering, significantly lowering customer acquisition costs.
- **Enhanced value proposition:** Farmers benefit from the convenience of a one-stop-shop approach, rather than navigating multiple disconnected applications.
- **Network effects:** With more functions, these platforms attract more users across different value chain roles. This creates powerful network effects that specialized tools cannot match.
- **Risk mitigation:** By diversifying across multiple service areas, multi-function platforms can better weather challenges in any single segment of the value chain.

An example of a digital agricultural application that offers a mix of functions is GeoAgro-MiSR from Egypt (Figure 5.2) (Govind 2023). This app provides users with modules on agronomy, livestock, weather, markets, and bookkeeping. It also allows the user to chat with experts to obtain advice. However, the development and implementation of such cross-functional tools is complex and requires substantial investment to maintain their broad feature sets. Most successful multi-function digital agricultural platforms have emerged from better-funded digital technology ecosystems in countries such as Kenya and Nigeria. In contrast, more specialized tools predominate in less developed digital markets.

The most effective cross-cutting platforms typically begin with a core function that addresses a critical challenge faced by farmers or other actors in agrifood value chains, before

FIGURE 5.2—GEOAGRO-MiSR, AN EXAMPLE OF A MULTI-FUNCTION DIGITAL AGRICULTURAL TECHNOLOGY APPLICATION



strategically expanding to adjacent value chain activities. This phased approach enables the digital agricultural platform developer to establish market traction before undertaking the complexity of designing and implementing multi-functional operations.

When examining the digital agricultural technology landscape in Africa, it is essential to consider not only the number of digital innovations but also the stage of funding and level of commercial development each has achieved. Most such tools in Africa remain at an early funding stage—bootstrap, pre-seed, and seed rounds. Platforms like DigiFarm and iCow in Kenya have secured significant post-seed funding and achieved meaningful scale, largely through strategic partnerships with telecommunications providers (Tsan et al. 2019; Abate et al. 2023b). Mobile money applications, such as M-Pesa (M-Pesa 2025), have reached later funding stages and widespread adoption. However, Parlasca et al. (2022) found that only about one percent of Kenyan farmers use these mobile money platforms for agricultural loans, and just 15 percent use them for agriculture-related payments.

The distribution of digital tools across various stages of the value chain is uneven. E-financial services tools have shown the strongest commercial traction, with several ventures reaching Series A and B sequential venture capital funding rounds. Commercial success is also seen in several market linkage platforms (GSMA 2025; Mercy Corps Agrifin 2021). By contrast, agricultural advisory and agrifood market tools predominantly remain in the pre-seed and seed stages, with fewer examples having secured Series A funding, such as WeFarm, a peer-to-peer knowledge sharing social network that went out of business in 2022. This pattern suggests that business models that directly facilitate financial transactions or establish concrete market connections have more obvious revenue paths than those focused on information provision or data collection (Baumüller 2018; Fabregas et al. 2019). At the same time, the majority of farmers start using such digital tools for advisory purposes (Beanstalk Ag 2023; 60 Decibels 2025). Bundling effective advisory services, along with other features sought by farmers, with features that more easily generate revenue, such as e-finance, is a valuable strategy to achieve both impact and scale. This can be seen, for example, with Apollo Agriculture, which focuses on inputs but also offers agricultural advice (Apollo Agriculture 2023). For policymakers, this insight is critical—investments likely will be most

effective when directed toward bridging the gap between early-stage innovations and commercially viable operations. This is particularly the case for advisory and data collection tools, which, while delivering public benefits, face monetization challenges in rural agricultural contexts (World Bank 2025).

Key Challenges and Opportunities for Digitalization in African Agrifood Systems

Challenges

The digitalization of services in African agrifood sectors presents transformative opportunities for smallholder farmers, agribusinesses, and broader food systems. However, the expansion and effectiveness of these technologies are constrained by several structural and operational challenges. Key barriers include inadequate infrastructure, low digital literacy, limited mobile connectivity, restrictive regulatory environments, and chronic funding shortages. All of these factors limit the scalability and sustainability of digital technologies in agrifood systems across the continent (Abate et al. 2023a; Mulungu et al. 2025; Carvalho do Nascimento and Balsamo 2023; Khan et al. 2025). Social capital plays a crucial role: farmers are more likely to adopt tools introduced by trusted peers or community leaders, underscoring the need to embed social networks in rollout strategies (Dadzie et al. 2022; Beaman et al. 2021). Additionally, issues related to market structure, the growing “platformization” of agricultural technology, and ethical and privacy concerns surrounding the use of technology—especially AI—complicate efforts to digitize agriculture effectively. The failure of digitalization efforts and agricultural technology startups in Africa is often attributed to funding gaps, poor user adoption, a lack of contextual adaptation, and an over-reliance on digital solutions without sufficient physical infrastructure to support them.

Infrastructure and connectivity barriers

A major challenge for digitalization in Africa’s agricultural technology sector is the persistent infrastructure gap, particularly in rural areas where most smallholder farmers reside. Limited access to electricity, poor mobile network coverage, and unreliable internet connectivity constrain farmers’ ability to use digital advisory services effectively (Khan et al. 2025). Many African countries still struggle with poor rural broadband access, making it difficult for farmers

to engage with mobile-based advisory platforms, smartphone applications, or AI-powered digital tools, especially those that offer multimedia content, which is particularly helpful for learning about complex topics. The uneven distribution of digital infrastructure exacerbates the rural-urban divide, limiting smallholders' access to timely market information, weather forecasts, and agronomic recommendations (Mulungu et al. 2025). Without significant investments in telecommunications, power supply, and rural broadband expansion, digital solutions will remain inaccessible to a substantial portion of the farming population.

Digital literacy and farmer capacity constraints

Even where digital advisory tools are available, many smallholder farmers lack the necessary digital literacy to fully engage with them or are unaware of their existence (60 Decibels 2025). Digital literacy, defined as the ability to use and interpret digital technologies effectively, remains low in many parts of Africa, particularly among older farmers and marginalized groups such as women and rural communities (Khan et al. 2025). Studies show that only 30 percent of smallholder farmers in rural Kenya feel confident using mobile applications for agricultural advice, limiting their ability to take full advantage of digital innovations (Carvalho do Nascimento and Balsamo 2023). Interactive platforms, such as SMS-based advisories or IVR systems, attempt to bridge this gap; however, a lack of training and user support often hinders their impact. Farmers accustomed to traditional face-to-face extension services may struggle to transition to digital platforms without additional assistance. Bridging the digital divide requires targeted training programs, localized content delivery, and hybrid models that combine digital services with in-person support to enhance adoption.

Regulatory and policy challenges

The regulatory environment for digital services in Africa's agrifood systems remains fragmented, with inconsistent policies governing data usage, digital finance, and technology deployment. Many African countries lack clear guidelines for the use of AI, big data, and digital advisory platforms in agriculture, creating uncertainty for businesses and limiting investor confidence (Mulungu et al. 2025). In some cases, restrictive policies on mobile financial transactions hinder the seamless integration of digital advisory services with

credit and input financing. Moreover, taxation and licensing requirements for technology startups can impose additional burdens on small-scale innovators, stifling the growth of new digital solutions tailored for African agriculture and agrifood systems. Addressing these regulatory hurdles requires coordinated policy frameworks that support digital technologies, encourage private sector investment, and establish clear data governance mechanisms.

Funding gaps and sustainability challenges

One of the primary reasons digital technology startups for agrifood system applications struggle in Africa is the lack of sustainable funding models. Many digital innovations require significant upfront investments in software development and hardware, including smartphones, sensors, or drones, as well as ongoing costs for data plans, maintenance, and subscription fees. While many digital agrifood system solutions are introduced through donor-funded projects, they often lack long-term business models to sustain their operations beyond the initial funding cycle (Khan et al. 2025). Researchers note, "The vast majority of digital solutions providers not only rely heavily on public—particularly donor—funding, but actively seek public funding for their projects under the auspices of development assistance, rather than seek private funding based on credible revenue-generating models" (Abate et al. 2023a, 9). Without diversified revenue streams, many promising digital platforms fail once their external funding dries up. Unlike developed markets, where agricultural technology ventures attract substantial venture capital, African startups face difficulties securing investment due to perceived risks, uncertain regulatory frameworks, and market fragmentation (Mulungu et al. 2025). This financial instability limits the scalability of digital advisory services and other agricultural services, preventing them from achieving a widespread impact. Additionally, the recent bankruptcies of African agricultural technology startups that had received venture capital funding further exacerbate the difficulties startups face in attracting financing from international venture capital sources. Developing sustainable financing models—such as public-private partnerships, subscription-based services, or bundled financial products—will be critical for ensuring the long-term viability of digital technology solutions in agriculture.

Ethical and privacy concerns in digital agriculture

As digital technologies in agrifood systems increasingly rely on AI, big data, and precision agriculture technologies, ethical and privacy concerns have become more pressing. Many farmers are unaware of or have no control over how their data is collected, stored, and used by digital platforms, raising questions about consent and data protection (Mulungu et al. 2025). The lack of robust data governance policies in many African countries exacerbates these risks, leaving farmers vulnerable to data exploitation by private companies or governments. Additionally, AI-driven advisory tools may reinforce existing biases if training datasets are not representative of diverse farming conditions and socio-economic contexts. Addressing these ethical challenges requires stronger data privacy regulations, transparent AI development practices, and farmer education on digital rights and data security.

Opportunities and lessons

Bundling of different services

There are strong benefits from bundling different services and helping break siloes of digital solutions (GSMA 2020; Tsan et al. 2019; Mercy Corps AgriFin 2024). Farmers, like most users of digital services, face numerous challenges—from input supplies to agronomic issues to market access—and seek solutions to these problems. Recent research from Kenya indicates that services are being increasingly bundled on digital agricultural technology platforms, which have the potential to create more value for farmers, increase users' willingness to pay, and offer paths to profitability for many companies developing these solutions (60 Decibels 2025). Bundled services providing various benefits for farmers increase farmer adoption and improve outcomes for farmers (GSMA 2020).

Governments in Africa, including Kenya, Ethiopia, Côte d'Ivoire, Benin, and Cameroon, as well as at the global level—most notably India—are increasingly providing the digital public goods and data infrastructure needed to power platforms and bundled services (FAO and ITU 2022; World Bank 2023a, 2025). The underlying logic is that if data infrastructure and

digital public infrastructures do not exist, companies must create the enabling conditions for each feature and area in which they want to operate, whether in agricultural finance or output markets for agricultural commodities. Having a strong digital public infrastructure in place across sectors enables companies, whether working in the agrifood sector or elsewhere, to offer such digital services with less investment. The development of such digital public goods as well as basic digital infrastructure by governments and international organizations should be further advanced and promoted.

Inclusive design for targeting hard-to-reach farmers

If designed correctly, digital tools can help bridge social divides, including those due to gender or wealth. In a recent paper focused on Kenya, 60 Decibels (2025) found no significant difference between genders in accessing digital services. However, the research revealed a divide between subsistence and commercial farmers in their degree of access to agricultural digital

BOX 5.1—CASE STUDY: INTERACTIVE VOICE RECORDING (IVR)-BASED TRAINING IN MALI

Grovermann et al. (2024) outline the results of their research on the effectiveness of a digital advisory platform for farmers in Mali that made use of IVR—essentially voice-message-based training content that was made available through phone calls to farmers—to train farmers on agroecological farming. The impact assessment employed a randomized control trial.

Their results show significant positive impacts from such telephone-based training. The impacts included increased farmer awareness and knowledge and the implementation of agroecological farming practices. The researchers concluded that purely telephone-based training can lead farmers to adopt new sustainable farming practices in a context where security concerns make the in-person delivery of agricultural advisory services difficult.

technologies. Digital tools can be particularly beneficial where physical infrastructure is lacking or security concerns make in-person interactions challenging (Text Box 5.1).

However, to ensure that digital technologies for agrifood systems are inclusively designed, developers and providers need to build upon the principles of human-centered design and ensure that their tools are accessible across multiple channels, both offline and online (IDEO 2016; Norman 2013). The Principles for Digital Development (PDD) is a framework of nine principles that guides the design of digital products and platforms to ensure they are inclusive and effective (PDD 2025), as shown in Figure 5.3.

FIGURE 5.3—THE NINE PRINCIPLES FOR DIGITAL DEVELOPMENT



Source: PDD (2025).

Combining in-person and digital approaches

Scalable digital approaches that have led to higher user adoption usually rely on trust-building measures. These almost always include some in-person components alongside the digital solutions, whether related to training, management, or market access. The need for in-person engagement as part of the deployment of digital technologies in agrifood systems has been well documented both globally and specifically in Africa (Tsan et al. 2019; GSMA 2020). The consensus is that to build trust, in-person interactions or building on existing trusting relationships, such as with extension agents or input sellers, are crucial. Trust is a necessary precondition for the adoption of new digital services.

That in-person interactions are often necessary for digital tools to be adopted has implications for both the design of digital products and the costs of their deployment. Empowering existing actors to become more effective will usually be a more successful strategy than one that aims to fully substitute in-person service provision with digital content alone, whether the services being provided are advisory in nature, involve the sale of inputs, or offer users access to markets. This combining of in-person and digital approaches creates a more complex picture for solution providers working in agrifood systems. Digital solution creators will not only need to create value for their end customers but also enhance the operations of existing physical solution providers, thereby creating efficiency gains for all parties involved.

Digitalization for Food Security and Sustainable Agriculture

The proliferation of digital tools across Africa's agrifood value chains has generated considerable optimism about their potential to enhance food security and nutrition outcomes, as well as expand the adoption of sustainable agricultural practices. However, empirical evidence documenting actual impacts and the magnitude of the changes the digital technologies foster in the agrifood sector remains surprisingly limited. There remain significant gaps in our understanding—for example, of how digital interventions translate into improved nutritional status. Questions also persist regarding the contributions digital tools might make to supporting transformations toward sustainable agriculture.

Evidence on food security impacts

Studies examining the direct link between digital agricultural tools and food security outcomes have shown emerging, albeit incomplete, positive evidence. There is evidence (Kikulwe et al. 2014) that mobile money users in Kenya marketed a higher proportion of their produce and experienced increased household income compared to non-users, thereby indirectly improving their food security status through enhanced purchasing power. Similarly, Mdemu and colleagues (2020) found in Tanzania that soil water monitoring tools supported by digital platforms contributed to improved food security by optimizing irrigation practices and increasing yields.

The most compelling evidence comes from digital financial services, where Suri and Jack (2016) documented how M-Pesa improved household resilience to shocks in Kenya, allowing families to maintain food consumption during periods of stress. Riley (2018) similarly found that mobile money provided effective insurance against rainfall shocks in Tanzania, resulting in smoother consumption patterns during drought periods.

However, most studies focus primarily on intermediate outcomes, such as increased productivity, higher incomes, or improved market access, rather than directly measuring food security — “Few studies systematically examine market-level impacts, including impacts on input market channels, supply chain and network performance, or effects on costs, prices, and returns,” (Abate et al. 2023a, 7).

The nutrition evidence gap

The evidence gap is even more pronounced regarding the impacts of the adoption of digital technologies in the agrifood sector on nutrition. Despite the growing emphasis on nutrition-sensitive agriculture, remarkably few studies have evaluated whether digital agricultural tools translate into improved dietary diversity, micronutrient intake, or nutritional status of vulnerable populations. This represents a critical gap in the literature.

Most evaluations of digital technologies in agriculture focus on economic and productivity outcomes, with nutrition rarely appearing as a primary consideration or measured outcome (Choruma et al. 2024). The few studies that do consider nutrition tend to make assumptions about the nutrition impact

pathway rather than directly measuring nutritional indicators. For example, while improved income from digital market access may theoretically enhance household nutrition, researchers rarely verify whether income gains actually translate into better diets or nutritional status.

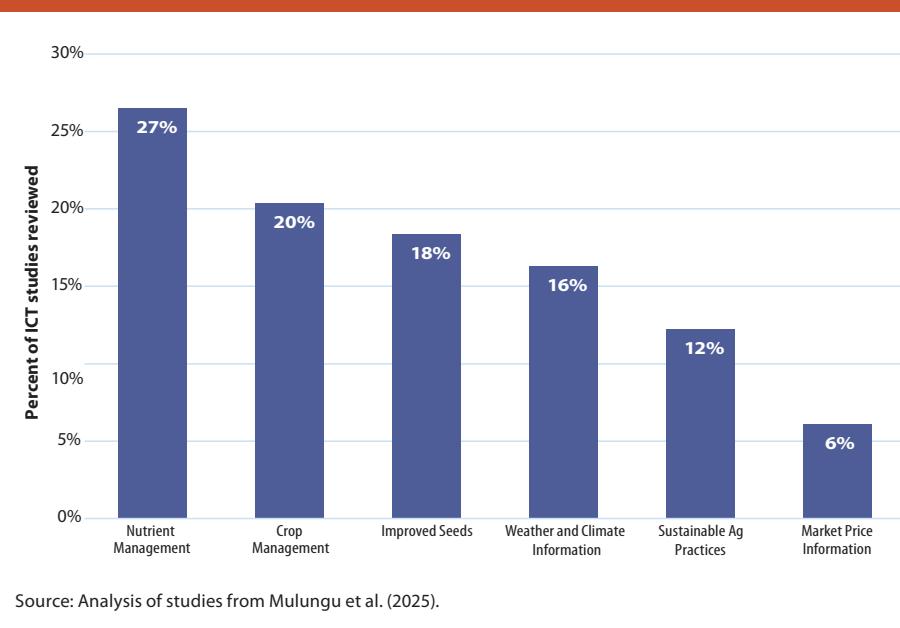
A systematic review by Tata and McNamara (2018) highlighted that, while information and communication technology (ICT) interventions in agriculture show promise for improving productivity and incomes, evidence of their impact on nutrition outcomes remains “extremely limited.” Similarly, the extensive mapping of digital solutions in agrifood systems (Tsan et al. 2019) found that nutrition outcomes were rarely incorporated into digital tool design or evaluation frameworks. The review by Beanstalk AgTech (2023) also found that existing empirical evidence on the impacts of digital tools on nutrition in agriculture was limited. The authors found that the few studies that have directly examined nutritional outcomes have mainly focused on the impacts of digital agricultural advisory tools. However, studies on explicit nutritional outcomes are far fewer than those examining intermediate nutritional measures.

Digital tools and the transition to sustainable agriculture

To better understand the transformative potential of digital tools in sustainable agriculture, synergies and potential drawbacks need to be identified. An essential human factor in digital agriculture is the need to align the digital advice provided to users with farmers’ cultural practices and ecological knowledge. Ignoring this dimension risks alienating communities and undermining the adoption of sustainable agricultural practices (Ingram et al. 2022; Finger 2023; Yeo and Keske 2024).

The potential for digital tools to facilitate transitions toward more sustainable agricultural practices remains one of the most promising yet underexplored applications of agrifood system digitalization in Africa. Despite growing recognition of the need for environmentally sustainable farming practices, evidence on how digital technologies specifically contribute to their adoption is surprisingly limited. While digital agriculture has the potential to contribute to environmental sustainability through more efficient resource use, there remains a significant gap between this theoretical potential and the documented impacts on sustainable agriculture adoption

FIGURE 5.4—ASSESSMENT OF THE IMPACT OF DIGITAL AGRICULTURAL EXTENSION TOOLS ON FARMER PRACTICES, SHARE OF ALL STUDIES BY TOPIC



(Abbasi et al. 2022). While reviews frequently mention precision agriculture and resource optimization as benefits, few studies have rigorously evaluated actual environmental outcomes or transitions to more sustainable farming practices associated with the use of digital technologies in agriculture.

Most digital tools in agriculture focus primarily on productivity enhancement, market access, or financial inclusion rather than explicitly promoting sustainable agricultural practices, such as integrated pest management, agroecological approaches, or climate-smart agriculture. Re-analyzing the data from Mulungu and colleagues (2025) shows that sustainable agriculture practices are among the least-studied topics involving the use of digital tools (Figure 5.4).

When we examine the few studies that have focused on the use of digital tools to promote the adoption of sustainable agricultural practices, several themes emerge.

- Climate-smart agricultural practices are often promoted through mobile-based weather and climate information services, which facilitate adaptive water management and diversified cropping systems (Djido et al. 2021).
- Integrated pest management is another critical focus for digital tools in agriculture, with SMS-based systems, hotlines, and interactive media reducing reliance on pesticides by improving disease and pest control strategies (Subramanian 2021; Larochele et al. 2019; Tambo et al. 2020).
- Soil health and nutrient management are often addressed through precision agriculture tools, such as mobile apps and IVR systems. For example, these apps often seek to optimize fertilizer use by the farmer by balancing organic and inorganic inputs (van Campenhout et al. 2021; Naik and Krishna 2021).
- Knowledge dissemination on regenerative agriculture practices, including legume intercropping and soil conservation, is often enhanced by digital extension platforms (Lasdun et al. 2025).
- The System of Rice Intensification (SRI) has been promoted through mobile telephone-based training videos. As SRI has been found to improve water and input use efficiency, this use case demonstrates how ICTs can support the sustainable intensification of farming systems (Baul et al. 2024).

Collectively, these studies highlight how digital technologies can serve as vital tools for advancing agroecological transitions, reducing agrochemical dependence, and improving resilience to climate and pest pressures (Table 5.1). However, successful implementation requires context-specific adaptations to ensure accessibility and farmer adoption. Future research should explore long-term impacts and scalability across diverse agroecosystems.

Despite these examples, the integration of sustainability principles into digital agricultural technology remains the exception rather than the rule. This represents a significant missed opportunity, particularly given that conventional agricultural extension systems throughout Africa continue to predominantly promote high-input, resource-intensive farming practices that may not be environmentally sustainable in the long term or financially accessible for a large proportion of farmers.

TABLE 5.1—FOCUS OF STUDIES THAT USE DIGITAL TOOLS FOR SUSTAINABLE AGRICULTURE

Study	Country	Aspect of sustainable agriculture	Digital technology
Djido et al. (2021)	Ghana	Adoption of climate-smart practices (water management, multiple cropping)	Weather/climate info services (SMS/call)
Subramanian (2021)	India	Integrated pest management (IPM) to reduce pesticide use	SMS/hotline for disease control
Larochelle et al. (2019)	Ecuador	Integrated pest management (IPM) to reduce pesticide reliance	Text reminders for IPM adoption
Tambo et al. (2020)	Uganda	Fall armyworm management (reducing pesticide overuse)	Interactive radio/SMS/video
van Campenhout et al. (2021)	Uganda	Soil health (organic/inorganic fertilizer balance) and weed management	IVR/SMS/video for maize cultivation
Naik and Krishna (2021)	India	Reduced chemical inputs (N/P fertilizers) and organic alternatives	Mobile app for pest/nutrient management
Lasdun et al. (2025)	Tanzania	Regenerative agriculture (intercropping with legumes, soil conservation)	Digital extension platform
Bual et al. (2024)	India	System of Rice Intensification (SRI) for water/input efficiency	Mediated training videos

Source: Authors' compilation.

TABLE 5.2—CO-BENEFITS AND TRADE-OFFS ASSOCIATED WITH THE USE OF DIGITAL TECHNOLOGIES TO ACHIEVE SDG 2, ZERO HUNGER

Interaction	Explanation	Example	Related SDGs
+3—Indivisible	Inextricably linked to the achievement of another goal	Increased agricultural production or access to agricultural markets increases incomes and reduces rural poverty	SDG 1 - End poverty
+2—Reinforcing	Aids the achievement of another goal	Adoption of sustainable practices aids the achievement of improved biodiversity and regeneration of land	SDG 15 - Life on land
+1—Enabling	Creates conditions that further another goal	Greater economic output from rural areas can stimulate economic growth	SDG 8 - Decent work and economic growth
0—Consistent	No significant positive or negative interactions	Digitization for food and agriculture does not interact significantly with improved governance and fostering peace	SDG 16 - Peace, justice, and strong institutions
-1—Constraining	Limits options on another goal	Greater access to digital tools can perpetuate uneven access to agricultural resources from a gender perspective, due to their lower ownership of mobile phones.	SDG 5 - Gender equality
-2—Counteracting	Clashes with another goal	Digital tools that are not inclusive, focusing solely on commercial farmers, will clash with efforts to reduce inequalities in rural areas.	SDG 10 - Reduced inequalities
-3—Canceling	Makes it impossible to reach another goal	Increased use of AI in digital tools can push demand for non-renewable energy sources, jeopardizing our ability to tackle climate change.	SDG 7 - Affordable and clean energy

Source: Adapted by authors from Nilsson et al. (2016).

The disconnect between digital agriculture and sustainable farming practices is particularly unfortunate because digital tools have unique capabilities that could support sustainability transitions. Digital agriculture can potentially contribute to environmental sustainability by employing precision agriculture technologies to reduce agrochemical input use (Shepherd et al. 2020). Additionally, given that many of the sustainable approaches are knowledge-intensive, as compared to conventional input-based agricultural approaches, the increased availability of locally-adapted advice through digital technologies provides these digital agricultural tools with a comparative advantage when it comes to the promotion of sustainable agricultural production. Increased policy support to prioritize the increased development and adoption of digital innovations in agriculture that demonstrate clear pathways to more sustainable farming systems could go a long way.

Assessing co-benefits and trade-offs for sustainable agriculture

Nilsson et al. (2016) introduced a framework for assessing co-benefits and trade-offs mapped against the SDGs. As summarized in Table 5.2, they range from -3, or ‘canceling’, meaning it is impossible to reach a set SDG due to a trade-off, and +3, ‘indivisible’, meaning the achievement of the target SDG is linked to the achievement of another goal. Using SDG 2 on zero hunger as our entry point, we consider the potential of digital tools to enable the transformations in food security and sustainable agriculture required to achieve the SDG.

To start with, the co-benefits — increased agricultural production and access to agricultural markets — are inextricably linked to achieving SDG 1 on ending poverty. Adoption of more sustainable practices through digital tools aids the achievement of improved biodiversity and regeneration of land, as captured under SDG 15. Greater economic output from rural areas furthers the achievement of SDG 8 on decent work and economic growth.

Regarding trade-offs that need to be managed, greater access to digital tools can perpetuate gender-based digital divides, negatively impacting SDG 5 on gender equality. Beyond gender, digital tools adopted primarily by wealthier, more endowed farmers will clash with efforts to reduce inequality, as laid out in SDG 10. Given the significant energy required to operate AI systems, the increased use of AI in digital advisory services may cancel out progress in reducing emissions and in shifting towards cleaner energy (SDGs 7 and 13). To effectively leverage the potential of digital technologies for transforming agrifood systems, these trade-offs need to be accounted for and managed.

BOX 5.2—CASE STUDY: AGRIPATH—EMPOWERING SMALLHOLDERS THROUGH DIGITAL ADVISORY SERVICES

The AgriPath project (2021-2026) is a five-country, action-oriented research initiative funded by the Swiss and German governments that aims to empower 150,000 smallholder farmers in Uganda, India, Burkina Faso, Tanzania, and Nepal to adopt sustainable agricultural practices through inclusive, evidence-based digital advisory services (Kassie et al. 2024). At the heart of AgriPath is the farmbetter platform, a mobile platform that delivers tailored, context-specific recommendations on more than 1,500 sustainable land management practices (farmbetter 2025). The platform uses geolocation and the World Overview of Conservation Approaches and Technologies (WOCAT) global database to match users with actionable, locally relevant advice on sustainable land management. Its design accommodates self-service access by farmers, agent-facilitated interactions, and a hybrid model combining both, allowing flexibility in delivery based on local needs and digital capacity.

AgriPath systematically tests and compares three digital advisory service delivery mechanisms: (i) the self-service model, through which farmers independently interact with an app; (ii) the agent-facilitated model, involving trained community-based agents using the app to deliver guidance; and (iii) the hybrid model, which combines a WhatsApp chatbot with an agpp for extension agents to maximize engagement and learning. These models are being evaluated through randomized controlled trials in Uganda and India to generate rigorous evidence on effectiveness, adoption dynamics, and gender-specific outcomes. The delivery mechanisms are designed to overcome contextual barriers such as digital literacy, gender norms, and infrastructural limitations, while promoting equitable access to tailored advisory services.

AgriPath’s innovation lies not only in technology but also in its human-centered and gender-sensitive approach. The project addresses trade-offs and critical barriers to digital advisory service adoption by embedding inclusive design principles and localized capacity development strategies. Special attention is given to women and youth, who often are underserved by conventional extension systems. AgriPath seeks to demonstrate how interdisciplinary collaboration, digital innovation, and inclusive design using a scalable digital advisory service models and robust evidence base can democratize agricultural knowledge, enhance adoption of sustainable practices, and support resilient, climate-smart smallholder farming systems.

Artificial intelligence (AI) innovations

The primary challenge of any development venture in agriculture is the inherently contextual nature of agricultural production. The advantage of traditional, human advisory services is the ability for sufficiently trained extension professionals to adapt and translate knowledge and best practices to a novel or unique farming context. Innovations in AI, including leveraging large language models (LLMs) and predictive analytics, offer pathways to overcome some of these challenges. Trained on an extensive repository of existing knowledge, they are able to approximate the challenges experienced at a local level by drawing from a large pool of past data. One example of the use of localized knowledge in agricultural extension is the AgriPath project being implemented in five countries in Africa and Asia (Box 5.2).

However, two inherent biases to AI systems need to be overcome if they are to be effective in assisting smallholder farmers in Africa:

- First, the LLMs that are the foundation of most AI systems are biased toward the dominant language, typically English, reducing accessibility to and the potential applicability of AI-driven tools. Given the low-input-intensive nature of farming across Africa south of the Sahara, training AIs based on LLMs that predominantly reflect experiences from the global North will fail to effectively guide localized practices in the global South.
- Second, local languages are effectively omitted from LLM efforts, given the bias within existing AI research and development toward major languages. Interventions are now underway, such as GIZ FAIR Forward - Artificial Intelligence for All, which seek to address these gaps by integrating local languages into LLMs and building local programming expertise (GIZ 2025). LLMs, by design, also omit traditional knowledge or practices that are not captured in written form—such as oral histories or practices passed down through generations. This limits what solutions are available to farmers through AI-generated tools.

Digital Green has been a pioneer in innovative knowledge sharing for sustainable farming practices, often among the first to utilize emerging digital technologies. The NGO is now using an AI chatbot, FarmerChat, for extension providers (Box 5.3).

BOX 5.3—CASE STUDY: FARMERCHAT: AI-DRIVEN REAL-TIME FARMER SUPPORT

One of Digital Green's strengths is its collaboration with public agricultural extension service providers, as opposed to creating competing ventures that undermine existing service offerings. Similar to farmbetter's offering under AgriPath (Box 2), Digital Green leverages location-based data to improve the relevance of the advice that it generates in response to queries made to its AI-chatbot, FarmerChat (Digital Green 2023). The platform aims to cut the extension cost per farmer from an estimated US\$ 35.00 to US\$ 0.35. In addition to cost-savings, Digital Green's objective is to boost the confidence of extension officers in the process, including in their own ability to offer relevant insights for adapting to climate change.

However, it is recognized that Digital Green's AI chatbot fails to fully overcome barriers in access to extension, reinforcing the importance of extending the reach of public extension offerings in the first place. Additionally, the FarmerChat service, as yet, does not offer a functioning business model that will generate sustainable revenue, so the commercial viability of the tool is uncertain.

Digital platforms to connect farmers to inputs and markets.

One of the best use cases for digital tools—even as low-tech as SMS—is to create greater transparency on market pricing and improve access for even less commercially oriented smallholder farmers. Digital platforms can successfully connect farmers directly to markets, cut out market intermediaries, and thereby increase farmers' profits (Shrader et al. 2018). If operated at sufficient scale, they can also reduce transaction costs for buyers. This results in more reliable markets for both sellers and buyers. Operating at scale also allows them to offer discounted input prices. In 2022, One Acre Fund launched Tupande, a digital input marketing service that allows farmers to compare and purchase inputs via a mobile app (One Acre Fund 2025).

However, an important challenge with such market platforms is that, at least in their initial stages, they tend to be focused on a single crop or value chain.

Given the current agricultural development focus in Africa on agricultural commercialization and cash crops, agricultural marketing apps do not support a transformation of agriculture that focuses on diversification and resilience. More knowledge-intensive digital agricultural tools, such as those focused on sustainable land management practices, are missing in the deployment of digital tools for agricultural marketing, whether for inputs or outputs.

Summary

In summary, the potential for digitalization to foster sustainable agrifood systems and food security in Africa is undisputed. However, the progress achieved has primarily involved a process of trial and error. There is currently limited systematic research on how digitalization directly impacts positively or negatively on larger rural economic transformation. In a world of declining funding for extension services, there is a significant risk that digital innovations in agrifood systems will increase inequalities in rural communities across Africa, widening gender, income, and spatial gaps (Ledermann et al. 2024). Digital and sustainable transformations need to be embedded in one another, rather than viewing technology as a quick fix to address a larger policy problem temporarily. Understanding and subsequently leveraging the co-benefits, while addressing

the trade-offs in the use of digital technologies in agrifood systems to achieve sustainable development, would represent a first step towards more sustained efforts that create local, longer-lasting impact. Creating incentive structures for the dissemination of more knowledge-intensive agriculture, embedded within digital tools that empower existing users, including government agencies and farmer cooperatives, offers a potent avenue to support more sustained, systemic efforts at agrifood system transformation.

Key Lessons on What Works in Digital Agriculture in Africa

Building on the analysis presented, it is clear that digitalization offers transformative potential for Africa's agrifood systems—but only if persistent constraints are addressed through coordinated, equity-focused, and evidence-based interventions. The following recommendations chart a way forward for unlocking impact and enabling digital solutions to serve as catalysts for sustainable and inclusive agricultural growth (Table 5.3).

De-risk and catalyze investment. Africa only attracts a small fraction of global investment in digital agricultural technologies—just 1.6 percent in 2024. De-risking investment through blended finance, insurance mechanisms, and

TABLE 5.3—RECOMMENDATIONS FOR THE DIGITALIZATION OF AFRICA'S AGRIFOOD SYSTEMS

Dimension of digitalization	Key lessons	Recommendation
Bundling and integration	Multi-service platforms have higher impact and scalability	Incentivize bundled solution development via challenge grants and public-private partnerships (PPP)
Institutional ecosystem	Weak collaboration between public agencies, private firms, and non-governmental organizations limits scale	African Union, governments, and donors need to formalize digital technology ecosystems in agrifood systems with increased investment or funding windows
Inclusion	Gender and youth inclusion are mixed; most tools miss marginalized smallholders	Mandate human-centered design, user co design, and the Principles for Digital Development.
Sustainability alignment	Digital tools often reinforce existing production practices, rather than transform them	Continue to provide funding for tracking sustainability indicators and transformative outcomes associated with the use of digital tools
Policy environment	Regulatory and data governance gaps hold back the use of digital tools in agrifood sectors	Introduce open data, interoperability, and digital literacy mandates regionally
Impact evidence	Gaps in direct nutrition, food security, and sustainability metrics. Focus has been more on intermediate and process outcomes	Prioritize evaluation funding for impact metrics beyond productivity and income alone

Source: Authors' compilation.

targeted challenge funds is essential. Public and private capital should be strategically directed toward high-impact areas underserved by commercial investment, such as digital advisory tools for marginalized farmers, especially in early value chain segments.

Foster enabling ecosystems. Governments, in collaboration with the African Union and regional bodies, must formalize digital agriculture ecosystems by creating regulatory frameworks for open data, digital public goods, and secure data governance. Prioritizing rural infrastructure—particularly electricity and broadband services—and interoperability standards will underpin the scalability and long-term sustainability of digital solutions.

Drive inclusion and human-centered design. Require all digital interventions to adopt human-centered design and follow the Principles for Digital Development (Figure 5.3), while mandating gender, youth, and literacy considerations in the design process and ensuring that the platforms developed can be accessed through low-tech channels, such as voice calling and SMS. Invest in digital literacy training and co-design with farmer organizations, as these efforts can close current access gaps to digital tools and boost adoption. Associated with this is a continuing need to favor hybrid physical and digital approaches in many contexts over purely digital interventions. Maintaining a physical element in the design of these tools has been shown to lead to higher adoption and increased impact.

Advance bundled and integrated solutions. Support the development and scaling of multi-service platforms, such as the bundling of market access, agricultural advisory services, finance, and e learning functions in the tools. Such integrated approaches offer higher impact, lower user-acquisition costs, and greater platform sustainability.

Align digitalization with agroecological and SDG goals. Encourage and ring-fence funding for digital innovations that track sustainability outcomes, contribute to equity, and enable agroecological transitions. Evaluation efforts must go beyond productivity to capture the impact such tools have on nutrition, food security, sustainability, welfare, and climate resilience.

Through these coordinated measures, digitalization can fulfill its promise for Africa's agrifood systems—supporting a more resilient, productive, and equitable agricultural transformation.

Conclusion

Digitalization in African agrifood systems presents an unprecedented opportunity to transform them by enhancing market access, improving farm management, and expanding learning opportunities for the most underserved. As demonstrated throughout this chapter, digital tools have the potential to bridge critical gaps in agricultural productivity, sustainability, and resilience. From AI-driven advisory services to digital marketplaces to precision agriculture, digital technologies are reshaping the sector. However, the extent of this transformation remains limited by persistent challenges, including inadequate infrastructure, digital literacy barriers, and underinvestment in agricultural technology solutions.

While in-person training and support may be superior to remote support, few of the 500 million smallholders worldwide can readily access such in-person services. The evidence shows that a combination of in-person and digital training and support might be optimal. Recognizing the significant lack of in-person extension services in the agriculture sector, some form of remote training will be required in the near future. Combining this limitation with changing climates, invasive pests, and volatile markets, farmers and pastoralists can use as much support as possible. Digital services provide an opportunity to complement in-person support for advisory services and have the potential to unlock numerous new markets and opportunities to improve agricultural livelihoods and the sustainability of farming.

The evidence reviewed underscores that, while advancing globally, digital agriculture in Africa lags in investment, adoption, and regulatory support. Despite the rapid proliferation of mobile-based advisory services and digital platforms, most innovations struggle to achieve sufficient scale due to fragmented ecosystems, a lack of integration with physical infrastructure, and weak institutional support. As a result, most have not been financially successful. The continent's digitalization efforts must therefore be accompanied by targeted policies and investments that promote inclusivity, address infrastructure deficits, and create enabling environments for innovation and competition.

Key lessons from successful models indicate that bundled services—integrating advisory services, finance, market access, and training—yield a greater impact than standalone digital interventions and also may be more financially viable. Similarly, hybrid approaches that blend digital and in-person engagement

have proven more effective at fostering trust and adoption among smallholder farmers. The importance of designing for inclusivity cannot be overstated: gender-sensitive and literacy-conscious digital solutions are essential to ensuring equitable access and benefits.

Moving forward, stakeholders across the public and private sectors, along with development partners, must prioritize strategic investments to de-risk digital agriculture in Africa. Expanding financial access for agricultural technology startups, strengthening regulatory frameworks, and fostering cross-sector collaborations are essential steps toward scaling digital innovations. Furthermore, leveraging emerging technologies such as AI, blockchain, and the Internet of Things (IoT) can enhance efficiency and transparency within agricultural value chains, contributing to long-term sustainability and resilience. We have already seen innovative examples of these and expect many more to emerge in the near future.

While significant hurdles remain, digitalization holds immense promise for African agrifood systems. By addressing existing challenges and scaling successful interventions, digital tools can drive a more productive, sustainable, and equitable agricultural transformation. A concerted effort is needed to channel investments, shape policies, and foster innovation to ensure that digital agricultural technologies fulfill their potential to enhance food security and promote climate-resilient farming systems. The time to act is now—digitalization must be harnessed as a key driver of Africa's agricultural future to reduce costs and risks and create sustainable, broader prosperity. A holistic approach requires integrating ethics, equity, and sustainability as core pillars of digital agriculture. However, technology alone cannot solve systemic issues, so participatory governance is essential.