

Agriculture Practice

# How digital tools can help transform African agri-food systems

Higher income for farmers, increased output, and improved food security are among the benefits of utilizing digital tools in an agricultural setting.

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**Digital technologies have** the power to transform agri-food systems in emerging markets by accelerating the work of participants across the value chain, including input players, producers, off-takers, and retailers. Governments could assist them by deploying digital tools for important tasks, such as distributing subsidies to farmers or managing the inventories of emergency food-relief stocks in government storage facilities. When used as part of a national agricultural-transformation program, digital tools could help raise the incomes of smallholder farmers, increase crop output, and support food security. For example, an e-wallet can help increase affordability of inputs by efficiently distributing subsidies to farmers.

While governments can play a significant role in helping private-sector players and development partners to invest in digital projects by supporting policy and data infrastructure, they are also developing their own digital solutions to support their stated sector priorities. This article focuses on use cases—projects with a clear beginning and end that apply a digital or advanced analytics solution to achieve a measurable benefit—that governments in Africa can deploy to support agricultural transformation, working with development partners and the private sector.

We first highlight challenges African governments have faced in applying digital agriculture technologies at scale. Second, we offer a set of ten priority use cases for governments to consider as they seek to speed up agri-food system transformation. Finally, we identify important lessons that governments in emerging markets have learned as they launched and scaled digital agriculture use cases.

The COVID-19 crisis has forced many governments in emerging markets to accelerate the use of digital agriculture technologies to support emergency responses, making the issue especially topical—and Africa is no exception. Throughout the crisis, public-sector decision makers have sought more

real-time data more frequently to assess the state of food security and agriculture within their countries, particularly during lockdowns (for example, to better target cash transfers to farmers). This has encouraged more data sharing between the private and public sectors in service of the public good. There is potential to build on this momentum that could support a more systematic transformation of agri-food systems across the continent.

## Challenges to scale

In sub-Saharan Africa alone, more than 400 digital agriculture solutions are in use, including applications in financial services, market linkages, supply-chain management, advisory and information services, and business intelligence.<sup>1</sup> Despite their abundance, many digital solutions struggle to scale and fail to improve the lives of farmers and other end users. For example, in sub-Saharan Africa, most applications have less than 30 percent active users. Twenty applications (about 5 percent) account for more than 80 percent of farmer registrations and have achieved scale of more than one million farmers, including the 8028 Farmer Hotline, a government-run advisory service in Ethiopia.

The availability of a digital agriculture solution does not guarantee smallholder farmer uptake and adoption. To improve participation, three elements are necessary:

- Digital solutions must create value for end users so they have an incentive to adopt. In the case of farmers or growers, that means improving crop yields, boosting profits, or reducing input costs and crop loss.
- Farmers should receive some level of physical, in-person support. The most effective tools allow farmers to supplement access to agricultural knowledge from mobile phones with face-to-face interaction with extension officers, such as those from the Kenya-based

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<sup>1</sup> Benjamin Addom et al., *The digitalisation of Africa agriculture report, 2018–2019*, The Technical Centre for Agricultural and Rural Cooperation, August 2019, cta.int.

agriculture-knowledge-sharing program  
Shamba Shape Up.

- Governments should enable technologies to flourish. Governments, which often play a critical role in providing the core digital and data infrastructure and regulation, may invest in farmer registries, the base data that many digital solutions rely on. Farmer registration is an expensive public good that few want to pay for yet many benefit from.

Beyond low adoption, governments often face broader challenges to scale. These include issues like uneven digital access and digital literacy in their populations, low data accuracy and usability, and limited tailoring of content for local contexts.

Most germane for smallholder farmers is basic access to digital technologies. Half of sub-Saharan Africa does not have access to electric power.<sup>2</sup> The average cost of an entry-level second-generation (2G) or third-generation (3G) wireless device accounts for more than 70 percent of the monthly income of a farmer in sub-Saharan Africa, compared with 17 percent in India. Also, 3G network coverage in rural areas—where most farmers live—is limited: about 70 percent in urban areas versus about 40 percent in rural areas in sub-Saharan Africa.<sup>3</sup> Although non-internet-based approaches (including messaging services) are more widely accessible, internet-based solutions can provide a wealth of additional data that are critical to offering tailored products to farmers, such as geolocation.

Finally, it is important to highlight the operational challenges that can be experienced when delivering digital transformations. All transformations are hard—less than 30 percent succeed.<sup>4</sup> Our recent research suggests that digital transformations are even more difficult, and many fail in execution.<sup>5</sup> These transformation hurdles are not unique to Africa, but they are particularly acute in the public sector. They include a shortage of digital talent in the public sector and reconciling sophisticated

digital use cases with legacy manual and digital systems. Also, public-sector procurement processes are designed to carefully control public spending, and while vitally important, this does not always enable more agile digital solutions that can evolve rapidly as user feedback emerges.

Governments cannot address all these challenges at once. Our experience suggests that starting with a handful of well-scoped and targeted use cases can jump-start a broader use of digital technologies to accelerate agricultural transformation. At a macro level, prioritizing a set of digital interventions allows governments to address some of the external barriers described above in a targeted manner, such as focusing on areas where 3G access exists. At a more granular level, prioritizing use cases reduces resource requirements, such as scarce digital talent. Prioritizing use cases to test is a helpful way to articulate the data architecture and underlying data platforms, sort through complex issues of data-sharing policies and guidelines, and ultimately start building the skills and capabilities to manage digital interventions at scale.

## The digital opportunity

To better understand the digital opportunity, we identified ten relevant public-sector use cases based on an analysis of more than 400 digital solutions in sub-Saharan Africa and interviews with more than 70 ag-tech and other private-sector players, government officials, and development partners. We identified gaps in the existing solutions and potential areas for public-sector intervention (Exhibit 1; see sidebar, “Methodology”). We grouped the resulting use cases into four categories:

- increases in farmer income
- increases in agricultural output
- government savings and more effective management of food security and agricultural transformation

<sup>2</sup> Addom et al., *The digitalisation of Africa agriculture report*.

<sup>3</sup> Calum Handforth, *Closing the coverage gap: How innovation can drive rural connectivity*, GSM Association, July 2019, gsma.com.

<sup>4</sup> Hortense de la Boutetière, Alberto Montagner, and Angelika Reich, “Unlocking success in digital transformations,” October 2018, McKinsey.com.

<sup>5</sup> de la Boutetière, Montagner, and Reich, “Unlocking success in digital transformations.”

Exhibit 1

## Ten digital case studies offer examples of how to accelerate the transformation of agri-food systems.

Feasibility based on country composite ● High ● Medium ● Low

Impact	Prioritized use cases	Case examples	Ease of implementation				
			Data	Tech	Execution capacity		
<b>Increase government savings and improve food-security management</b>	<b>1</b> Target eligible farmers with e-vouchers for insured inputs based on a farmer registry, using digital tools and analytics to improve performance	Zambia	Government provided e-vouchers for inputs targeting ~1 million farmers	●	●	●	
		Eastern Europe	Government updated subsidy allocation and e-voucher targeting	●	●	●	
	<b>2</b> Increase the efficiency of government storage facilities through capacity planning and optimization analytics	Colombia	A milk producer conducted an end-to-end supply-chain optimization to reduce logistics costs and optimize storage	●	●	●	
<b>Increase agricultural output</b>	<b>3</b> Manage national food deficit by monitoring countrywide food production and consumption through a digital food balance sheet (FBS)	Kenya	Government developed a digital FBS to facilitate the tracking of the country's food demand and supply	●	●	●	
		<b>4</b> Improve value chain selection for optimal land use with a resource optimization model tailored to specific outcomes (eg, jobs)	Africa	Government built a land-optimization model to identify high-value crops for prioritization	●	●	●
		<b>5</b> Improve farmer practices (eg, input use) by providing farmers with customized e-extension advice on an easily searchable platform	Kenya	Arifu has partnered with Syngenta to provide mobile-based agronomic advice to farmers	●	●	●
	<b>6</b> Provide farmers with regular crop market prices from geo-located markets nearby to reduce market information asymmetries	Nigeria	Esoko provides farmers with SMS-based information on market prices	●	●	●	
<b>Increase farmer income</b>	<b>7</b> Reduce crop losses with an early warning system for pest and disease outbreaks and advice on actions to protect crops	DR Congo, Uganda, South India	Tumaini is an app that uses artificial intelligence (AI) to diagnose diseases from pictures uploaded by farmers	●	●	●	
	<b>8</b> Reduce crop losses with an early warning system for weather fluctuations to help farmers adjust their planting and harvest plans	Ghana	Ignitia sends out regular weather forecasts to farmers to aid in decision making	●	●	●	

Feasibility based on country composite ● High ● Medium ● Low

Impact	Prioritized use cases	Case examples	Ease of implementation				
			Data	Tech	Execution capacity		
<b>Enablers</b>	<b>9</b>	Build a digital farmer registry with regularly updated farmer profiles, including farm location, farm size, and crops grown to inform all farmer-facing use cases	Rwanda	Government registered ~1.5 million farmers in partnership with the Bank of Kigali for access to agricultural finance	●	●	●
	<b>10</b>	Create transparency and improve baseline for statistics by building a joint-access national agriculture data platform	Zambia	Zambia launched an integrated agricultural data platform to support its farmer e-subsidy scheme	●	●	●

Source: Arifu; E-soko; Ignitia; UN Food and Agriculture Organization; McKinsey analysis

- enablers that do not generate direct financial impact but are critical to sustainability of use cases

The impact of these use cases varies significantly. Nonetheless, to illustrate the power of digital solutions to support agricultural transformation, let us consider a digital food balance sheet (FBS). This tool measures the consumption, production

and yields, trade levels, commodity prices, and stocks of food in a country. It draws data from stakeholders across the government and the private sector, such as the revenue authority for formal trade and industry associations for informal trade. A well-functioning FBS can support national food security by providing accurate and reliable information to support more-effective policy decisions on trade and food reserve disbursement.

## Methodology

**First, to validate our approach, we selected about 20 countries, six of which are in Africa, that have a strong foundation to support digital agriculture interventions.** This process used three country criteria: classification as low- or lower-middle-income economies with an existing agricultural production base, more than 70 percent of farms are smallholder driven (meaning smaller than two hectares in size), and basic digital infrastructure (such as mobile-phone penetration or internet access) is in place.

**Second, an extensive scoping exercise identified ten use cases relevant to these emerging markets.** The selected use cases needed to have the potential to accelerate national agricultural transformation priorities and have a clear only-government role to implement or scale, even if the public sector will partner with donors and private-sector players to carry them out.

Scoping included a review of more than 400 private-sector digital solutions in sub-Saharan Africa and covered five themes: advisory services, financial services, market linkages, supply-chain management,

and macro agri-sector intelligence. We interviewed more than 70 key stakeholders, including government officials, donors, and ag-tech and other private-sector players, to better understand which of the digital solutions have a government-only role.

**Finally, we reviewed case studies where similar solutions had been implemented to identify impact benchmarks.** For farmer-facing use cases, we considered farmer incomes; for government-facing use cases we considered budget savings, food security improvements, and agricultural output.

It can also inform actions of consumers, farmers, and producers, and aid in the deployment of food relief from development partners.

The Kenyan government recently decided to digitize its FBS to better monitor food deficits and reduce spending on reserves. Within 12 weeks, the government had completed the steps needed to define, design, and build a minimum viable product (MVP). It is now in use. At scale, this digital FBS is expected to reduce spending on food reserves by up to 3 percent annually while improving the ability to report agricultural data.

Such a tool could be used for other purposes as well. For example, it could facilitate improved subsidy allocation by allowing governments to target support initiatives using the tool's outputs for specific local crop production levels, prices, and yield differentials. An FBS could also support investment. Sharing data publicly on local agriculture market statistics (similar to US Department of Agriculture data) would offer to the private sector the transparency it seeks when considering investments in areas such as storage facilities and processing and manufacturing.

A use-case selection framework can help governments to determine what tools are available to achieve particular outcomes (Exhibit 2).

### **Lessons learned: A digital approach to accelerate agricultural transformation**

Applying five lessons can help governments accelerate agricultural transformations using digital approaches.

#### **Grounding the digital agenda in government priorities**

Governments have much to consider when selecting and building digital agriculture solutions. In addition to the impact on core transformation priorities like increasing smallholder farmer incomes, governments may wish to consider who would benefit from a digital solution, and in what part of the country; budgetary constraints;

and availability of talent—in addition to any commitments already made to development partners.

For example, a North African government recently spent several months drafting an agricultural sector transformation policy before launching a digital strategy. Its transformation policy articulated priorities such as food security and export-oriented growth. A digital strategy could then be built from these priorities and—aligned with key government stakeholders such as the Ministry of Information and Communications Technology—ensure that the digital agenda was centered on transformation efforts.

#### **Demonstrating quick wins**

Quick wins are important in early digital interventions. They can help lay a strong foundation for subsequent scale-up efforts and provide momentum to address some of the competing priorities articulated above.

In one East African country, the Ministry of Agriculture had been planning to build a tool to track production of key commodities nationwide as part of a broader effort to digitize manual data. However, the plan to build the tracker did not immediately gain support, because the use case for the data was not clear. The COVID-19 pandemic brought into acute focus the importance of a tool that could monitor food supply across the country in near real time. The government conducted a series of workshops that included more than 60 private-sector and development-partner actors. In only six weeks, the government developed a food production tracking tool and expanded it to track indicators such as food prices. The tool permitted data to be visualized in real time by senior ministry officials and catalyzed efforts to build more real-time visualizations for decision making.

#### **Choosing partnerships carefully**

Governments may seek to partner with private-sector and development partners when incentives align, including commercial terms, data privacy, and ownership rights. The default answer for

Exhibit 2

Each use case is defined by a clear key beneficiary, outcome, and digital tool.

**1 Key beneficiary**



- Smallholder farmers
- Governments

**2 Outcome**



- Increase farmer incomes
- Enablers
- Increase agricultural output
- Government budget savings
- Boost food security

**3 Tools**



- Smallholder farmers
- Governments

● **Pests and disease early warning system**

Reduce crop losses with an early warning system for pest and disease outbreaks and advice on actions to protect crops

● **Weather early warning system**

Reduce crop losses with an early warning system for weather fluctuations to help farmers adjust their planting and harvest plans

● **Farmer registry**

Build a digital farmer registry with regularly updated farmer profiles, including farm location, farm size, and crops grown to inform all the farmer-facing use cases

● **Agriculture data platform**

Create transparency and improve baseline for statistics by building a joint-access national agriculture data platform

● **Land optimization model**

Improve value-chain selection for optimal land use with a resource-optimization model tailored to specific outcomes (eg, jobs)

● **E-extension platform**

Improve farmer practices (eg, input use) by providing farmers with customized e-extension advice on an easily searchable platform

● **Market information system**

Provide farmers with regular crop market prices from geo-located markets nearby to reduce market information asymmetries

● **E-subsidy or e-wallet**

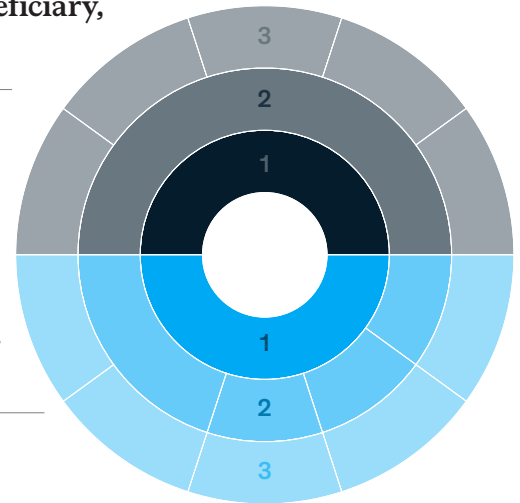
Target eligible farmers with e-subsidies for inputs and mechanization based on a farmer registry, using digital tools and analytics to improve performance of the subsidy program

● **Digitized storage and logistics facilities**

Increase the efficiency of government storage facilities through capacity planning and inventory-optimization analytics

● **Digital food balance sheet (FBS)**

Manage national food deficit by monitoring countrywide food production and consumption through a digital FBS



digital agriculture use cases is not always to partner with private-sector players, many of whom are still figuring out how to make digital agriculture solutions commercially viable. Nonetheless, governments may benefit from addressing early questions on data privacy and ownership. Partners may have a commercial interest in maintaining ownership of the data, but this could inhibit development of a government or public digital tool, which may require a more open level of access, such as a farmer registry.

One example that emphasizes the importance of choosing partnerships carefully is a not-for-profit innovation called OPAL (“Open Algorithms”) from a group of data for development pioneers including the MIT Media Lab, Imperial College London, Orange, the World Economic Forum, and Data-Pop Alliance.<sup>6</sup> OPAL aims to create systems and standards to mitigate associated privacy risks and capacity gaps so that data can be used for the greater good and in a sustainable, scalable manner. The OPAL ecosystem is designed to work through

<sup>6</sup> “OPAL 4-pager,” OPAL, Opalproject.org.

# Digital solutions can be a powerful way to accelerate agricultural transformation if they are designed to directly support outcomes such as increasing farmer incomes.

a four-step process to ensure private data are accessed and used ethically:

- Partner companies allow OPAL to securely access their servers via a dedicated platform.
- Certified open algorithms are run on the servers of partner companies behind their firewalls.
- A governance system verifies the integrity of the algorithms and use cases.
- Key indicators are derived from the data—for example, population density, poverty levels, and mobility patterns—and fed into use cases to support decision making.

## **Applying agile thinking to design digital products**

The digital agriculture space is quickly evolving. Gathering market intelligence is critical to improve solution designs, ensure farmers have sufficiently detailed data that are useful to them, and align the sector around a “single truth” on the final output from the digital product. For example, an e-incentives tool for farmer-inputs subsidies may require the integration of several data sources,

including a farmer registry and agro-dealer prices for the inputs that farmers might purchase from a network of providers. The best tool would produce a single answer: a specific subsidy amount allocated to specific farmers.

One way to facilitate the development of such tools is through the application of agile ways of working, including fast decision making, early user engagement, and rapid iterations or sprints. The agile approach is increasingly popular in the private sector, but governments can also employ it to engage users early in the design of a digital product and start testing early. For example, data sources do not need to be perfect. Start with sufficient data to build a working product and a plan to improve data sources over time. It may require investing in broader agricultural statistics improvements, but this could be done in parallel as an MVP is being iterated.

The Ministry of Agriculture of one Southern African country observed that its crops were generating low revenue. To change course, the ministry commissioned a project to rapidly build a land optimization model to identify crops with the highest economic potential across the country’s major agro-ecological zones. In four months and several design



sprints, the model identified 18 crops suitable for investment across the country's five regions and made suggestions for which crops might be grown in a particular region. Each design sprint improved the selections.

### **Building for the long term**

While the design and test phases should work toward an MVP, governments should build with a longer time frame in mind. An MVP version is never complete; governments should continue to iterate their digital products with user feedback. As a result, officials should anticipate a program that runs for three or more years. Implementation at scale will likely extend beyond a single government administration.

This is particularly true when considering funding digital talent. The number of data scientists, engineers, product owners, and other digital talent required at scale can differ by orders of magnitude depending on the MVP under development. Recruiting and training these people can take years, and securing financing for this undertaking early in the process is key to building for sustainability.

An East African government partnered with the largest bank in the country to launch a product aimed at providing loans to farmers while collecting data to reduce their risk profiles. The bank registered all of the country's approximately 1.5 million farmers and provided a platform for them to receive subsidies from the government and to pay for inputs at agro-dealers.

To ensure sustainability of the tool, the government took three steps. First, it aligned the new data architecture with existing databases and used extension officers to verify all the registrations. Second, the product was embedded within the bank

to provide institutional stability separate from the government administration. Third, the government invested from the start in developing digital talent rather than outsourcing its needs. It took nearly a year to build an MVP and ensure that the bank's staff was fully trained to manage the system and make fixes. Outsourcing this work to third parties could have accelerated time to completion, but it would have made it more difficult to manage the tool in the future as it scaled and the requirement for digital talent grew.

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Employing digital solutions can be a powerful way to accelerate agricultural transformation if they are designed to directly support outcomes such as increasing smallholder farmer incomes and are not seen as add-ons or isolated digitization efforts. Governments that are committed to digital agricultural solutions have seen or expect to see distinctive results in their agricultural transformation outcomes.

These governments understand that both digital and nondigital aspects of the ecosystem must be considered to accelerate agricultural transformation—from digital and data infrastructure to regulation, financing, and in-person support for smallholder farmers and agribusinesses using digital tools. But successfully implementing digital projects and transformations is hard—and most of them fail in execution. Governments cannot tackle all these challenges at once. Carrying out a handful of well-scoped and targeted use cases can allow them to address these challenges in manageable sprints to accelerate their agricultural transformations and improve food and nutrition security for all.

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The authors wish to thank Sara Boettiger, Jean Nyaguthii Edwards, Chania Frost, Sian Kiri, Rahmet Mohamed, Caroline Mutuku, Brenda Odhingo, and Romain Paniagua for their contributions to this article.

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