SCALING UP DISRUPTIVE AGRICULTURAL TECHNOLOGIES IN AFRICA

Executive Summary

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Introduction

Sub-Saharan Africa’s agri-food system is critical to the region’s economic growth, poverty reduction, food security and nutrition, and employment. Agriculture contributes about one-quarter of gross domestic product (GDP) growth in Sub-Saharan Africa. Evidence shows that a one-percent increase in agricultural GDP reduces poverty, on average, by over one percent, whereas a one-percent increase in industry or services GDP reduces poverty by less than half of one percent. Agri-food systems are also important for food security, as one quarter of the continent’s population is undernourished. By 2030, the continent will have half a billion more people to feed. Finally, agriculture is central to African job growth. There will be over 330 million new entrants into the African labor force over the next 20 years, and the agri-food system could potentially absorb about 70 percent of these new entrants. The agri-food system can — and needs to — play a key role in accelerating growth, ending poverty and hunger, and contributing to job creation in SSA.

The agri-food system is characterized by several challenges which are impeding its ability to achieve a higher growth trajectory and to generate greater agri-food outcomes. First, the agri-food system is large and complex, with many dispersed actors. Africa has 300 million rural inhabitants, many of them are farmers based in remote areas without access to the emerging trillion-dollar agri-food market. Second, there are vast inefficiencies in resource use and market access. Smallholder farmers struggle to connect with input suppliers – whether suppliers of seed, machinery, fertilizer, finance, or advisory services or with farms and farm enterprises. Food production is risky due, in part, to limited information about weather patterns, soil characteristics, future market demand, and other variables. With limited information, farmer’s decisions based on intuition are often less efficient than they could be. Third, Africa’s food system is characterized by inequalities in access to technologies, information, and markets. These inequalities manifest in the form of marginalized groups, such as low-skilled men and women farmers based in rural areas with limited connectivity who lack access to information and markets.

Disruptive technologies have the potential to help address many of the above challenges. Disruptive technologies in agriculture consist of digital and technical innovations that enable farmers and agribusiness entrepreneurs to leapfrog current methods to increase their productivity, efficiency, and competitiveness, thereby facilitating access to markets, improving nutritional outcomes and enhancing resilience to climate change. Agri-tech solutions range from mobile apps to solar applications, to portable agriculture devices, to bio-fortified foods. Disruptive agricultural technologies (DATs) differ from other agri-tech solutions in that they empower farmers by either (i) accelerating agri-food outcomes by multiple folds (3-5x) and/or by (ii) circumventing the conventions of the value chain to achieve the same/better results — but with a more efficient agri-food outcome.

DATs, by addressing the most pressing agricultural challenges, will contribute to improving agricultural outcomes. First, DATs help farmers by reducing the costs of linking various actors of the agri-food system both within and across countries through providing, processing, and analyzing an increasing amount of data faster. Second, DATs help farmers make more precise decisions about resource management through accurate, timely, and location-specific price, weather, and agronomic
data and information that is becoming increasingly important in the context of climate change. Third, DATs can make smallholders and especially marginalized farmers more competitive by leveling the playing field. Even in poorly-connected rural contexts, or with marginalized groups who have lower access to information and markets, sophisticated off-line digital agricultural technologies can provide opportunities to help poor and even illiterate farmers. In short, Disruptive Agricultural Technologies (DATs) are overturning the sector status quo, providing an innovative approach to addressing system-wide challenges (see table 1 for some illustrative examples).

**TABLE 1. Agricultural Challenges and Relevant Examples of DATs in Africa**

<table>
<thead>
<tr>
<th>Challenge Framework</th>
<th>Agricultural Challenges</th>
<th>Standard agricultural solutions</th>
<th>DAT solutions</th>
<th>Illustrative DAT Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Productivity</td>
<td>Insufficient Advisory and climate smart services</td>
<td>Producer organizations, extension agents, radio, TV</td>
<td>Agricultural extension and advisory delivered through videos and platforms linking experts</td>
<td>Digital Green in Ethiopia, and Precision Agriculture for Development in Kenya</td>
</tr>
<tr>
<td></td>
<td>Not enough access to inputs (tractors) for land preparation</td>
<td>Manual, animal-aided, mechanized</td>
<td>Digitally enabled tractor hiring services</td>
<td>Hello Tractor in Nigeria</td>
</tr>
<tr>
<td>Market Linkages</td>
<td>Poor market access</td>
<td>Farmer cooperatives, intermediaries</td>
<td>Real-time alert systems</td>
<td>Waterwatch Cooperative in Kenya</td>
</tr>
<tr>
<td></td>
<td>Poor market access</td>
<td>Moneylenders, family and friends</td>
<td>Platforms for input credit, e-wallets, and insurance products</td>
<td>Tulaa in Kenya, Maano in Zambia, Farmshine in Kenya, Zowasel in Nigeria</td>
</tr>
<tr>
<td>Farmer Financial Inclusion</td>
<td>Insufficient/unfair access to credit and financial products</td>
<td>Moneylenders, family and friends</td>
<td>Platforms for input credit, e-wallets, and insurance products</td>
<td>Agri-wallet in Kenya</td>
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<tr>
<td>Data Analytics and Agricultural Intelligence</td>
<td>No/inadequate access to data for informed decision making</td>
<td>Intuition based on observation, no solution</td>
<td>Portable soil testers, satellite images, remote sensing</td>
<td>Agrocares based in Netherlands operating in Kenya and UjuziKilimo in Kenya</td>
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<td>Energy for Agriculture</td>
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<td>Solar-powered irrigation pumps</td>
<td>SunCulture in Kenya</td>
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</table>

Source: authors

**Nowhere is the potential of disruptive technologies in agriculture more promising than in Sub-Saharan Africa, where agriculture employs nearly 70 percent of the region’s entire population.** Recognizing the potential of DATs to accelerate the efficiency, equity and sustainability of agri-food systems, African governments are seeking to understand the nature of these technologies, their impact, and their constraints. The key questions are: How are DATs impacting the agri-food system outcomes? What does it take to create and foster conducive ecosystems for scaling up disruptive agriculture technologies? How can governments and partners, such as the World Bank, help local entrepreneurs, innovators, youth, and agribusinesses to confront institutional challenges in the
industry? To answer these questions, it is important to study the supply-side dynamics of disruptive agricultural technologies.

This study — including a pilot intervention in Kenya — aims to further the state of knowledge about the emerging trend of disruptive agricultural technologies in Africa, with a focus on supply-side dynamics. Three activities contributed to the report’s findings. The first activity was a ‘stocktaking analysis’ to assess the number, scope, trend, and characteristics of scalable disruptive technology innovators in agriculture in Africa. The analysis is based on a database that focused explicitly on the scale of existing DAT operations, and thus all 194 DATs in the database are identified as scalable DATs. The second activity was a comparative case study of Africa’s two most successful DAT ecosystems in Kenya and Nigeria, which together account for half of SSA’s active DATs. The third activity was an Innovation Knowledge and Challenge Conference in Nairobi, Kenya that brought together over 300 key stakeholders from large technology companies, agribusiness companies, public agencies, government representatives (such as Governors and Country Agriculture Ministers), experts from research and academic institutions, representatives from financial institutions, foundations, donors, and venture capitalists. The conference, aimed at jump-starting Kenya’s DAT innovation ecosystem through knowledge sharing, culminated in the selection of 14 DAT innovators to participate in a new ‘Million Farmer Initiative’ platform that will leverage the Bank’s existing agriculture engagements in Kenya to scale up the adoption and development of disruptive agricultural technologies.

This study is the first in a series of analytical studies and operations on Disruptive Agriculture Technology in sub-Saharan Africa which will contribute to regional integration through knowledge sharing and collective policies / investments to transform agriculture. If governments and development partners come together to drive this agenda in Sub-Saharan Africa, there is potential to create multiplier effects through trade, market access and a regional innovation ecosystem. This study also forms part of the World Bank Group’s support for the African Union’s ‘Digital Moonshot for Africa’, which aims to digitally enable every African individual, business and government by 2030. This study also aligns with the Digital Economy for Africa Initiative (DE4A) by the Digital Development team at the World Bank. Aligned with the World Bank Group’s overall strategy, this study contributes a unique, distinctive and complementary perspective.

The stocktaking analysis in this report is based on a novel, non-exhaustive database of scalable DATs in Sub-Saharan Africa which has been curated through secondary research. This database of 194 DATs forms the basis of the landscape analysis given the selected DATs’ proven products and growth potential. Therefore, this database is a unique snapshot of a dynamic sector and it is not meant to be exhaustive. The data was collected from a variety of secondary research sources (including company profile sources such as Tracxn, Pitchbook, Crunchbase, Google searches, literature reviews etc.). A total of 434 for-profits/non-profit organizations were reviewed. From 434, 194 organizations were identified as scalable DATs based on the inclusion criteria. Since the database primarily comes from company profile sources and these company profile sources focus on for-profit companies, over 95 percent of the identified DATs in the database are for-profit organizations with operations in SSA.
Key Findings

Disruptive Agri-tech is an emerging sector in Sub-Saharan Africa. There has been a spike in the number of scalable DATs in SSA founded in the last decade. Indeed, according to the database of DATs compiled, over 70 percent of the DATs in the database were founded in the last 10 years. There are four key drivers of DATs in SSA: (i) low-cost and pervasive connectivity means; (ii) adaptable and more affordable tools; (iii) advances in data analytics and exchange; and (iv) increasing demand for contextualized agricultural solutions. In this regard, some African governments are driving the disruptive agri-tech agenda in their countries to improve agri-food outcomes. These drivers have provided a conducive ecosystem and are expected to continue shaping the prospects of DATs throughout the region.

Over 75 percent of scalable DATs in the database are digital. The remaining 25 percent of non-digital DATs are either focused on energy (solar), are producers/suppliers of bio-products for agriculture or are aquaponics/hydroponics producers; thus, their primary technology is not digital. Although 75 percent of the scalable DATs are digital, the agriculture sector is still the slowest sector to digitize. Thus, it is vitally important to proactively invest in the digital ecosystem for agriculture. SSA’s digital ecosystem has progressed in the last few years such that most countries now have intermediate mobile penetration and internet connectivity. In these intermediate connectivity scenarios, DATs are using technology adaptations tailored to the agriculture sector.

Many of the digital technologies applicable to the agriculture sector can be deployed even in low-connectivity, rural environments. DATs operate across a continuum, from low internet penetration and mobile connectivity to high digital connectivity. Most African countries have intermediate-level mobile and internet penetration (Figure 1). However, digital accessibility is much lower in rural areas and varies greatly according to age, gender, and income. As such, reaching all African farmers with disruptive agricultural technologies will require a range of tools that can operate in different connectivity scenarios even within a country, for instance low connectivity scenarios require nascent technologies, intermediate connectivity scenarios require transitional technologies whereas high connectivity scenarios can leverage advanced technologies. Examples of DATs adapted to low-connectivity environments include portable soil testers, short message service (SMS)-based farmer education tools, interactive voice recordings, and off-line functioning platforms that can upload or receive data when a connection becomes available. Over 83 percent of the DATs operate as e-marketplace or basic precision agriculture tools which do not require high connectivity and can operate with intermediate connectivity.

Thirty-two percent of the scalable DATs in the database aim to enhance agricultural productivity, 26 percent are working to improve market linkages, 23 percent are engaged in data analytics, and another 15 percent are working on financial inclusion. Those DATs addressing market linkages, data and financial inclusion are all digital DATs. There are also DATs that address more than one agricultural challenge. However, their proportion remains small, indicating a scope for moving from point-based solutions (addressing only one challenge) to bundled solutions (addressing multiple challenges). Indeed, bundled services such as digital platforms combining input supply with extension services, or linking farmers to buyers complemented by credit, may help to increase adoption.

Seventy-five percent of scalable DATs in the database are operating in Kenya, South Africa, and Nigeria (Figure 2). Kenya is a leading agri-tech hub with approximately 60 scalable DATs operational in the country (as per the stocktaking database), followed by South Africa and Nigeria. Indeed, Kenya is one of the top-rated digital ecosystems on the continent. The country has the third largest technology incubation and acceleration hub in the region. Kenya’s financial sector is also characterized by a robust mobile money ecosystem, with over 70 percent of the population using mobile money on a regular basis.
Major barriers in scaling up DATs include limited access to finance; low technology adoption among smallholder farmers; and a lack of role models and mentoring for new entrepreneurs.

Innovators highlighted the lack of appropriate growth capital to help them build operations to reach a significant number of users. Affordable debt capital is a major gap, particularly for DATs with significant working capital needs. A lack of a historical track record of successful DATs that have achieved scale or that have been acquired by larger firms hampers motivation and interest among potential DAT entrepreneurs and/or investors. Finally, despite the progress made regarding mobile penetration and internet connectivity, Kenya and Nigeria — Sub-Saharan Africa’s leading DAT countries — still ranked low on technology use, especially among smallholder farmers (Figure 3).

Bringing together governments, entrepreneurs, investors, and other ecosystem actors is a powerful catalyst for scaling up disruptive agricultural technologies. There is immense scope in supporting the DATs to turn them into successful large-scale innovation enterprises for transforming food systems. Timely support and catalytic funding can send a strong signal to private investors to take on the residual risks in investing in DATs. One such example is Kenya’s Twiga foods. Launched in 2014, the company uses a technology platform to improve the supply chain from farmers to markets. Twiga Foods serves around 2,000 outlets a day through a network of 13,000 farmers and 6,000 vendors. The company has reduced typical post-harvest losses in Kenya from 30 percent to 4 percent for produce brought to market on the Twiga network. In 2018, Twiga further scaled up and secured a series funding of over $10M from IFC and TLcom Capital. This is a result of timely support from USAID in the form of a grant and different mentorship programs (Google Launchpad and GSMA Ecosystem).
Innovation, Knowledge and Challenge Conference organized as part of this ASA generated knowledge and momentum within Kenya’s public sector and innovation ecosystem to lead the agri-tech agenda. In this context, it provided an important venue for participants to identify new areas of partnership and new partners. Indeed, 14 innovators were selected for inclusion in the first cohort for
the One Million Farmer Initiative\(^1\). Overall, the conference provided an interface for DAT players and ecosystem enablers and served as a model for providing training, mentorship, finance and collaboration incentives across key stakeholder groups.

Conclusions and Recommendations

Whereas first-order challenges in agriculture (for example, irrigation, access to inputs, and so on) remain pressing, the adoption of DATs (especially digital DATs) which can offer innovative solutions to the challenges remains low in SSA. However, evidence exists that DATs can amplify the impact of ‘analog’ investments. In terms of the scale of operations (number of farmers), DATs operate on a wide range from 1,000 farmers to over 600,000 farmers, depending on the model of delivery. This is also a positive indication about the successful adoption of DATs within the agri-food system. In this regard, DAT ecosystems appear to be at an inflection point where several trends are emerging:

- A profusion of small companies is starting to bundle their services together (e.g. input supply with extension) to achieve a wider scale and deeper/stronger viability.
- Emerging DATs can operate successfully off-line at the farm level, updating only when connected in urban areas.
- Farmer databases support DAT development and uptake; these databases are a major investment cost for startups.
- Well-developed mobile payment systems are an essential ingredient for most DAT enterprises to function effectively.
- Financial technology (Fintech) solutions are bridging liquidity gaps for farmers to the benefit of the entire supply chain, from input-suppliers to off-takers. Examples include installment payment systems, very short-term loans, and insurance products.
- The biggest challenge is not the existence of solutions, but rather the enabling framework within which these DAT solutions would operate. Leading Ministries of Agriculture are seeking to systematically invest in knowledge, innovation and the incubation ecosystem for digital, women and youth entrepreneurship.

DATs have demonstrated early signs of creating an impact by leapfrogging the conventions. As such, they hold the potential for accelerating the outcomes of the agri-food system. The pace at which DATs will accentuate these positive outcomes depends upon the innovation ecosystem in SSA. Further areas of research for agri-technology include coverage and adoption of DATs, such as an Enterprise Survey measuring technology adoption across agricultural sectors.

Policy opportunities to promote digital innovation include policies to promote competition; effective intellectual property protections; incentives for technology diffusion; innovation in public service provision related to e-vouchers or e-extension; investments related to digital skills; open science initiatives; research infrastructure; and ongoing dialogue with the private sector to adapt to evolving needs. Public investments to promote DAT development are most effective when they follow the ‘cascade’ approach to ensure that they crowd in, rather than crowd out, private investments.

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\(^1\) The One Million Farmer Initiative is a three-year partnership that will link one million Kenyan farmers across 14 different agricultural value chains and 45 counties in Kenya to a digitally-enabled platform. The platform will integrate and coordinate the activities of leading Kenyan-focused DATs. The One Million Farmer Initiative will build on and link to existing World Bank projects in Kenya, most notably the Kenya Climate Smart Agriculture Project and the National Agricultural and Rural Inclusive Growth Project.
Governments can support DATs as follows (See figure 4):

- Invest in policy and platforms for data collection and access from public and private sources. This will enable the development of appropriate products and services for smallholders. It will also develop a foundation for data and evidence-based policymaking. Digitizing farmer data would enable the development of data-based and digitally-enabled products and services. Access to good quality data will aid in the development of innovative service delivery and products.

- Invest in an e-agriculture strategy, which includes policy for pluralistic extension and service delivery approaches to enable digital innovations and solutions to be tested and tried for smallholders. Most of these solutions require a partnership between input suppliers, service providers, and digital innovators. Many existing agricultural policies have some scope for trying alternative and pluralistic approaches. It is difficult to develop these solutions in the absence of an enabling agriculture policy environment.

- Invest in e-governance systems for all public services and resources being administered through Ministries of Agriculture. Channeling input subsidies and other incentives through digital services is also critical to the development of products and services.

- Invest in enabling policies for telecommunications infrastructure and payment systems in rural and remote areas to ensure good quality and predictable rural connectivity. Access to connectivity for smallholder farmers and service providers would enable better access to services and digital solutions.

- Invest in an Agriculture Technology (AG Tech) start-up policy to enable innovators in the digital space to operate and grow. In parallel, invest in the enabling ecosystem for AG Tech innovations to enable country-level, regional and international innovators to invest.

**FIGURE 4. Potential Entry Points to Facilitate the Broader Adoption of Digital Technologies and Improve Food System Outcomes**

- **E-Agriculture Strategy**
  - Develop an e-agriculture strategy to be integrated into the overall agricultural sector development strategy

- **Agricultural Data Policy**
  - Develop data policies that clarify data privacy, ownership, and sharing rules, as well as those mandating data collection and protections

- **Policy and Regulatory Reforms**
  - Adopt pluralistic extension and service delivery approaches to enable digital innovations and solutions to be tested and tried for smallholders.
  - Enable telecommunications infrastructure and payment systems in rural and remote areas to ensure good quality and predictable rural connectivity.
  - Invest in agricultural research, including partnerships between academic programs and industry tailored for digital agriculture technologies and innovations

- **Public investment can be made in the areas of collecting foundational data and developing platforms**
  - Digital farmer IDs
  - National digital soil maps
  - E-government systems including smart subsidy programs
  - Real-time agricultural weather observatory and early warning systems (satellite, geospatial)
  - Digital surveillance system

- **Supporting Infrastructure**
  - Support rural broadband access and last-mile internet delivery programs.
  - Develop rural road networks, power, and irrigation infrastructure

Source: Authors
Disruptive Agricultural Technology