



Unlocking Africa's Agricultural Potential

SCALING AGTECH TO IMPROVE PRODUCTIVITY

BY AUBREY HRUBY, FATIMA EZZAHRA MENGOUB





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Introduction

The extent of food insecurity in Africa is alarming, as approximately 20 percent of the continent's population experienced undernourishment in 2021.¹ Agriculture plays a pivotal role in African economies, providing employment for about half of the workforce, with smallholder farmers contributing to 80 percent of agriculture production in sub-Saharan Africa.² However, the productivity and profitability of smallholder farmers have been limited. Smallholder farmers face challenges stemming from fragmented agricultural supply chains, lack of access to fair markets, affordable inputs, modern equipment, financial services, and essential information like market prices, weather predictions, and pest risk, ultimately resulting in reduced profit margins.

This situation is exacerbated by the impact of macroeconomic inflation—with the average cost of staple foods surging by 24 percent on average between 2020 and 2022, the most since the 2008 global financial crisis.³ Coupled with this, the impacts of climate change contribute to inconsistent agricultural productivity, further intensifying the acute regional obstacles to growth and prosperity. Enhancing current levels of agricultural production is crucial not only to address the high levels of food insecurity across the continent, but also to sustainably feed the rapidly expanding population of Africa. This is especially significant as Africa's population, recognized as the fastest growing globally, is expected to double by 2050. Projected urbanization in Africa is expected to drive substantial growth in urban areas, with the addition of four new megacities—Dar es Salaam, Nairobi, Khartoum, and Luanda—by 2050, alongside the current three megacities of Cairo, Kinshasa, and Lagos.⁴ To effectively provide for this growing population, increasing agricultural productivity is essential.

Despite the extensive, decades-long endeavors to implement technological advancements for industrializing agricultural production, known as the green revolution, numerous African countries have not reaped substantial benefits compared to other regions, contributing to the continent's high rates of poverty and food insecurity. The green revolution's efforts to introduce technologies like high-yielding seed hybrids, agro-chemicals, mechanization, and irrigation were particularly successful in improving agricultural productivity in parts of Asia and Latin America. However, these efforts have been less successful in many African nations, especially those outside Southern Africa where commercial farming is well-established. Challenges related to the accessibility, affordability, and usability of these technologies have hindered widespread adoption by smallholder farms. Despite these efforts, fostering economic growth in Africa's agricultural sector hinges on millions of smallholder farmers effectively implementing these technologies. This entails enhancing productivity and nurturing local innovation to cater to the diverse agro-ecological conditions prevalent across the continent.

The ongoing digital revolution in Africa presents a valuable opportunity to revolutionize the continent's food systems. The COVID-19 pandemic accelerated the digital transformation, propelling much of the world online, and demonstrating the potential that digital solutions hold for spurring improved productivity in all sectors. The accessibility of mobile phones has been a game changer for Africa's digital revolution, enabling countries to leapfrog landline infrastructure and directly adopt mobile technology. Significant investments in connectivity, coupled with the growing affordability of cellular devices, have resulted in approximately 650 million mobile subscriptions, establishing

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- 1 “The State of Food Security and Nutrition in the World 2022: Repurposing Food and Agricultural Policies to Make Healthy Diets More Affordable,” Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, UNICEF, World Food Programme, and World Health Organization, 2022, <https://www.fao.org/3/cc0639en/online/cc0639en.html>.
 - 2 Giacomo Falchetta, “Energy Access Investment, Agricultural Profitability, and Rural Development: Time for an Integrated Approach,” *Environmental Research: Infrastructure and Sustainability* 1, 3 (2021), <https://iopscience.iop.org/article/10.1088/2634-4505/ac3017/pdf>.
 - 3 Cedric Okou, John Spray, and D. Filiz Unsal, “Africa Food Prices Are Soaring Amid High Import Reliance,” International Monetary Fund, September 27, 2022, <https://www.imf.org/en/Blogs/Articles/2022/09/26/africa-food-prices-are-soaring-amid-high-import-reliance>.
 - 4 Anna Fleck, “Africa’s Next Megacities,” Statista, January 19, 2023, <https://www.statista.com/chart/29150/forecast-for-megacities-in-africa-by-2050/>.

an efficient platform for extending access to vital information, markets, and financial services.⁵ However, low literacy rates, the high cost of data, and limited access to smartphone financing limit the potential of widespread digitization.⁶ These obstacles are not unique to African nations; many emerging markets are similarly striving to address rural digital literacy to effectively scale digital solutions.



During the Dakar 2 Food Summit in Senegal, held in January 2023, Akinwumi Adesina, president of the African Development Bank, said, “Today we have the technologies to feed Africa; We need to put them into the hands of the farmers. The technologies are working and we have to deliver them at scale.”⁷ REUTERS/Ngouda Dione.

Global leaders are increasingly focused on ensuring food security, and are making commitments to revamp global food systems. At the United Nations (UN) Food Systems Summit +2 Stocktaking in July, UN Secretary General António Guterres emphasized the need to mend the broken global food system, and advocated for multisectoral solutions to transform agricultural production and distribution.⁸ The United States has also pledged support for efforts to enhance food security. At the US-Africa Leaders Summit last December, the Joe Biden administration announced partnerships with the African Union and African nations to make progress toward achieving food security, building resilient food systems, diversifying supply chains, and expanding access to agricultural markets.⁹

The rise of agriculture technology (AgTech) solutions in Africa has opened significant avenues to transform food systems and tackle long-standing obstacles to enhance smallholder productivity. To effectively expand these promising, yet nascent, AgTech solutions, collaborative efforts involving African governments, development partners, and AgTech innovators are essential. Scaling these solutions requires African governments to establish comprehensive digital-infrastructure and development partners to prioritize investments in digital solutions tailored to alleviate market and financial barriers faced by smallholder farmers.

This issue brief explores the factors that have contributed to scaling prominent AgTech companies in Africa. Additionally, the brief examines a case study from India, where the digital revolution has helped AgTech solutions reach smallholder farmers. Drawing insights from this analysis, the brief provides recommendations to African governments and development partners to establish environments conducive to AgTech companies’ growth, thereby contributing to economic advancement and prosperity.

⁵ Jocelyne Sambira, “Africa’s Mobile Youth Drive Change,” *Africa Renewal*, May 2013, <https://www.un.org/africarenewal/magazine/may-2013/africa%E2%80%99s-mobile-youth-drive-change>. US tech giants are actively investing in the digital transformation in Africa. Google’s \$1-billion Equiano subsea cable arrived in Togo in March 2022, the first of several stops along the west coast of Africa. Once the project is complete, it is expected to result in faster internet speeds and lower retail internet prices. Meta invested \$1 billion in 2Africa to build out the most comprehensive subsea cable to serve Africa and the Middle East, while improving connectivity.

⁶ Aubrey Hruby, *Critical Connectivity: Reducing the Price of Data in African Markets*, Atlantic Council, March 2023, https://www.atlanticcouncil.org/wp-content/uploads/2023/03/Critical_Connectivity_Report_Aubrey_Hruby.pdf.

⁷ “Dakar 2 Summit: Partnership to Deliver Technologies to Farmers to Feed Africa—Says Adesina,” African Development Bank Group, February 1, 2023, <https://www.afdb.org/en/news-and-events/dakar-2-summit-partnership-deliver-technologies-farmers-feed-africa-says-adesina-58689>.

⁸ “Press Release: The UN Secretary General Convenes World Leaders and Key Actors for UN Food Systems Summit +2 Stocktaking Moment in Push to Transform Food Systems and Accelerate Action for the SDGs - United Nations Sustainable Development.” United Nations, July 2023. <https://www.un.org/sustainabledevelopment/blog/2023/07/press-release-the-un-secretary-general-convenes-world-leaders-and-key-actors-for-un-food-systems-summit-2-stocktaking-moment-in-push-to-transform-food-systems-and-accelerate-action-for-the-sdgs/>.

⁹ “Fact Sheet: U.S.- Africa Partnership to Promote Food Security and Resilient Food Systems,” White House, December 15, 2022, <https://www.whitehouse.gov/briefing-room/statements-releases/2022/12/15/fact-sheet-u-s-africa-partnership-to-promote-food-security-and-resilient-food-systems/>.



A farmer at work in Kenya's Mount Kenya region. Photo by Neil Palmer (CIAT).

Agriculture in Africa Lags in Productivity

In contrast to other developing regions, such as South Asia and Latin America, where agricultural productivity is generally on the rise, the African region has experienced a decline in such productivity since gaining independence. Smallholder farmers, who typically cultivate less than two hectares of land, make up the majority of the farming population but lack global buying power.¹⁰ Consequently, Africa's agricultural gross value added (GVA) is the lowest globally, with an average of less than \$2,000 per worker.¹¹

More than five decades of effort by philanthropies, development-finance institutions, and developed governments have supported Africa's green revolution—with limited results. Fifty years ago, World Bank President Robert

McNamara, speaking in Nairobi, Kenya, acknowledged the shortcomings of the global community's work to make "rapid progress in smallholder agriculture."¹² Unfortunately, little progress has been made since then to increase the productivity of subsistence agriculture. Initiatives such as the Alliance for a Green Revolution (AGRA)—supported by the Bill and Melinda Gates Foundation, the Rockefeller Foundation, and backed by the United Kingdom, United States, and Germany—aim to enhance farm productivity and raise incomes for smallholder farmers, yet the results have shown a range of outcomes. Significant challenges persist among smallholder farmers, who continue to face barriers in accessing improved seeds and fertilizers, leading to limitations in agricultural yields.¹³

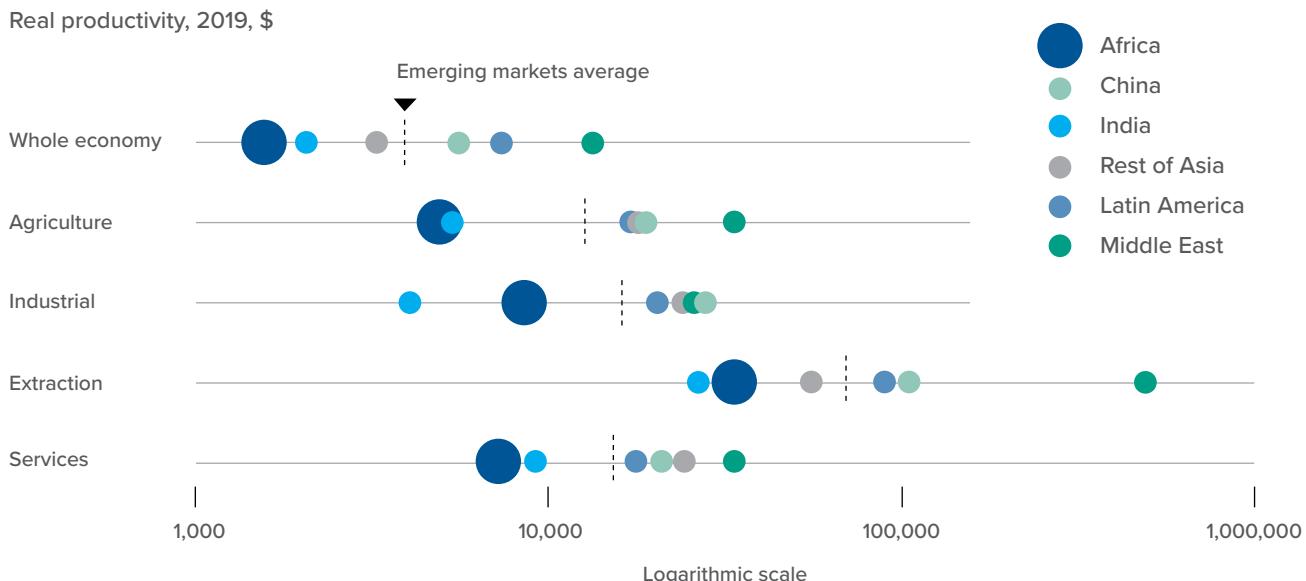
¹⁰ Chania Frost, Kartik Jayaram, and Gillian Pais, "What Climate-Smart Agriculture Means for Smallholder Farmers," McKinsey & Company, February 28, 2023, <https://www.mckinsey.com/industries/agriculture/our-insights/what-climate-smart-agriculture-means-for-smallholder-farmers>.

¹¹ Lutz Goedde, Amandla Ooko-Ombaka, and Gillian Pais, "Winning in Africa's Agricultural Market," McKinsey & Company, February 15, 2019, <https://www.mckinsey.com/industries/agriculture/our-insights/winning-in-africas-agricultural-market>.

¹² Robert S. McNamara, "Address to the Board of Governors," World Bank, September 24, 1973, <https://documents1.worldbank.org/curated/en/930801468315304694/pdf/Address-to-the-Board-of-Governors-by-Robert-S-McNamara.pdf>.

¹³ Randall Blair, et al., "Partnership for Inclusive Agricultural Transformation in Africa," Mathematica, December 8, 2021, https://usrtk.org/wp-content/uploads/2022/03/PIATA_Evaluation_AGRA.pdf.

African sectors are less productive than the average for emerging markets*



*Emerging markets include middle-income countries as defined by the World Bank.

Source: MGI Africa Productivity Model; McKinsey Global Institute analysis.

Mayowa Kuyoro, et al., “Reimagining Economic Growth in Africa: Turning Diversity into Opportunity,” McKinsey Global Institute, June 5, 2023, <https://www.mckinsey.com/mgi/our-research/reimagining-economic-growth-in-africa-turning-diversity-into-opportunity/#/>.

Food markets in African countries, on average, are less competitive than those in other regions due to poor market infrastructure and lack of processing facilities, leading to lower prices for farmers.¹⁴ Inadequate access to harvesting equipment, irrigation systems, cold storage, and agricultural inputs further hampers productivity in the region. Approximately 37 percent of food waste in sub-Saharan Africa is attributed to the absence of cold-storage infrastructure, resulting in large post-harvest losses.¹⁵ Limited access to fertilizers is also a contributing factor to low productivity levels, with sub-Saharan African countries using only twenty-two kilograms per hectare compared to a world average of 146 kilograms per hectare, which is seven

times higher.¹⁶ While the use of fertilizer has increased over the past several decades in sub-Saharan Africa, partly because of the innovative efforts of companies such as OCP and Yara, the usage still trails behind the rest of the world.¹⁷

Climate change poses additional threats to crop productivity due to shortened growing seasons, unpredictable weather patterns, and water stress. Smallholder farmers are incredibly vulnerable to unreliable seasonal weather patterns, as rainfed agriculture makes up 95 percent of the continent’s cultivation, and farmers have little or no access to irrigation infrastructure.¹⁸ The impact of climate change is expected to worsen, with

¹⁴ “Agricultural Productivity Growth, Resilience, and Economic Transformation in Sub-Saharan Africa,” United States Agency for International Development, 2021, https://www.usaid.gov/sites/default/files/2022-05/BIFAD_Agricultural_Productivity_Growth_Resilience_and_Economic_Transformation_in_SSA_Final_Report_4.20.21_2_2.pdf.

¹⁵ Susan Chomba, “3 Ways to Tackle Food Loss and Waste in Africa,” World Resources Institute, January 25, 2022, <https://www.wri.org/insights/3-ways-reduce-food-loss-waste-africa>.

¹⁶ David Malpass, “A Transformed Fertilizer Market Is Needed in Response to the Food Crisis in Africa,” World Bank Blogs, December 21, 2022, <https://blogs.worldbank.org/voices/transformed-fertilizer-market-needed-response-food-crisis-africa#:~:text=Sub%2DSaharan%20Africa%20has%20an,146%20kilograms%20per%20hectare>.

¹⁷ “Fertilizer Consumption (Kilograms per Hectare of Arable Land)—Sub-Saharan Africa,” World Bank Open Data, last visited August 4, 2023, <https://data.worldbank.org/indicator/AG.CON.FERT.ZS?locations=ZG>.

¹⁸ Richard Munang and Jesica Andrews, “Despite Climate Change, Africa Can Feed Africa,” *Africa Renewal*, 2014, <https://www.un.org/africarenewal/magazine/special-edition-agriculture-2014/despite-climate-change-africa-can-feed-africa>.

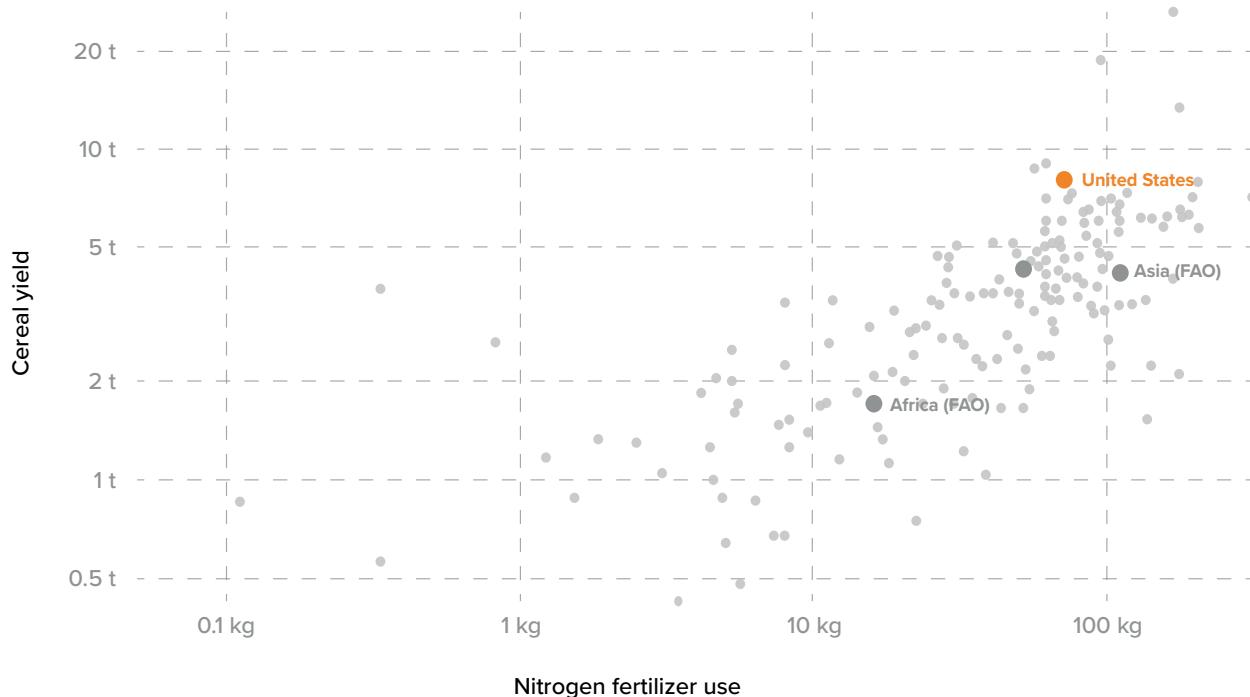
predictions of a 50-percent decrease in crop yields and a 90-percent fall in crop revenue by 2100.¹⁹ The recent drought and locust infestation in the Horn of Africa have put millions of people at risk of food insecurity, highlighting the vulnerability of smallholder farmers to climate change-related shocks.

Despite the disproportionate burden of climate change, African nations possess promising agricultural potential. With a quarter of the world's arable land, estimates suggest that 480 million to 840 million hectares of untapped agricultural land could be leveraged.²⁰ However, much of this land is heavily forested

or currently unreachable, so balancing land usage with afforestation efforts will need to be considered. If the region intensifies its agricultural productivity, it has the potential to double or even triple its output, adding 20 percent more cereals and grains to the commodity market.²¹ This could save African countries \$75 billion annually that is currently going toward importing food, which could be invested instead in social services or critical infrastructure, helping to address the estimated \$40-billion annual gap in education, the \$66-billion annual gap in healthcare, and the \$68–108-billion annual gap in infrastructure financing.²²

Cereal yield vs. fertilizer use, 2020

Yields are measured in tonnes per hectare. Fertilizer use is measured in kilograms of nitrogenous fertilizer applied per hectare of cropland



Source: Food and Agriculture Organization of the United Nations

Hannah Ritchie, Max Roser and Pablo Rosado, "Fertilizers," Our World in Data, last visited August 4, 2023, <https://ourworldindata.org/fertilizers>.

¹⁹ On the road to COP27: Making Africa's case in the global climate debate, July 2022. https://mo.ibrahim.foundation/sites/default/files/2022-07/en_forum_r_press_release-1.pdf.

²⁰ Goedde, et al., "Winning in Africa's Agricultural Market."

²¹ Ibid.

²² "Africa Needs Up to \$65 Billion in Loans Every Year to Curb Food Imports," Bloomberg, January 2023, <https://www.bloomberg.com/news/articles/2023-01-24/africa-needs-up-to-65-billion-loans-yearly-to-curb-food-imports?rref=a9fBmPFG>; Dhruv Gandhi, "Figures of the Week: Public Spending on Education in Africa," Brookings, March 9, 2022, <https://www.brookings.edu/articles/figures-of-the-week-public-spending-on-education-in-africa/>; Christin Roby, "Africa's \$66B Health Financing Gap Requires Private Sector Power, Experts Say," Devex, February 2019, <https://www.devex.com/news/africa-s-66b-health-financing-gap-requires-private-sector-power-experts-say-94269>; "Africa's Infrastructure: Great Potential but Little Impact on Inclusive Growth," African Development Bank, 2018, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/2018AEO/African_Economic_Outlook_2018_-_EN_Chapter3.pdf?ref=activatorhq.com.

AgTech: Leveraging Digital Solutions to Solve Market Problems

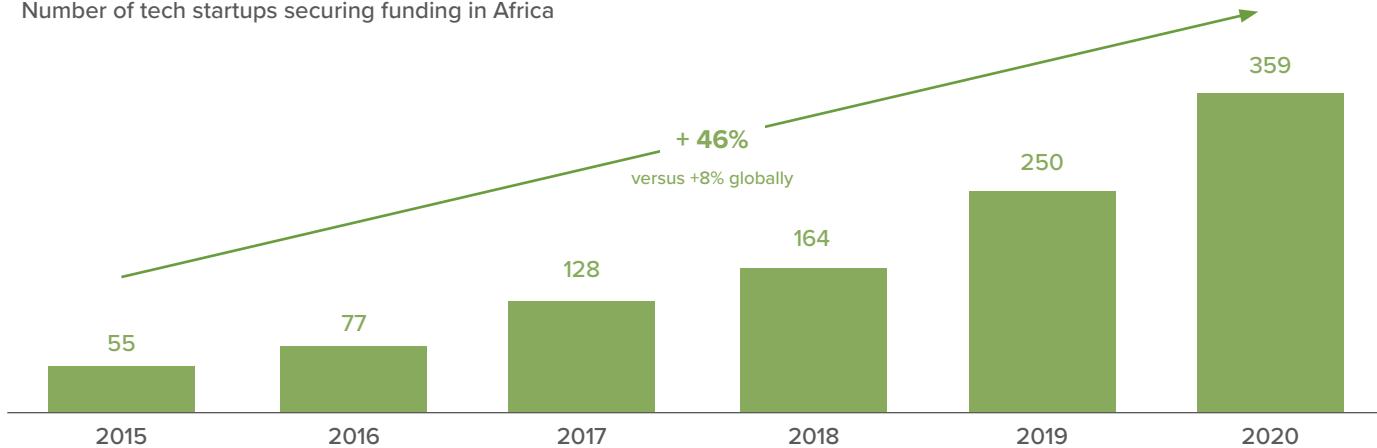
AgTech, as used in this report, is defined as the utilization of digital technologies to overcome market barriers and enhance agricultural productivity and sustainability. This is achieved by improving access to financial services, inputs (such as seeds, fertilizers, and agrochemicals), markets, information, and shared assets. While traditional agricultural technologies—such as fertilizers, mechanization, seed hybrids, infrastructure development, and cold storage—have led to green revolutions in farming regions globally, African nations have yet to fully reap the benefits due to regional fragmentation and prolonged underinvestment in infrastructure. Progress in improving productivity through AgTech does not necessarily

require intricate tech innovation; rather, it requires the utilization of digital solutions to connect farmers to credit, inputs, markets, and information.

Across eighteen African countries, AgTech companies are beginning to break down barriers for smallholder farmers. These companies enable farmers to enhance yield and profitability by facilitating better market access, shortening the value chain, increasing insurance availability, and fostering a shared economy for mechanized equipment.²³ While the number of African tech startups receiving financial backing grew rapidly between 2015–2020, investment in AgTech remains limited.²⁴

Funded Tech Startups Are Growing Six Times Faster in Africa Than Globally

Number of tech startups securing funding in Africa



Source: Partech Partners

Maher, et al., “Overcoming Africa’s Tech Startup Obstacles.”

23 “Products,” Africa: The Big Deal, last visited July 2023, <https://thebigdeal.gumroad.com/>.

24 Hamid Maher, et al., “Overcoming Africa’s Tech Startup Obstacles,” Boston Consulting Group, May 9, 2022, <https://www.bcg.com/publications/2021/new-strategies-needed-to-help-tech-startups-in-africa>.



A farmer in the Kibirichia area of Mount Kenya. Photo by Neil Palmer (CIAT).

Scaling startups on the continent presents challenges, and the AgTech ecosystem is still in its nascent stages, capturing less than 1 percent of global venture capital.²⁵

However, between 2021–2023, the agricultural and food sector in Africa experienced significant growth in investment, with 193 deals involving a minimum investment of \$100,000. While some of these deals were in food-delivery services, restaurant services, fish farming, and niche-food preparation, most of the investment flowed into AgTech companies that utilize digital

platforms to enhance farmers' access to markets, inputs, information, equipment, and credit. The gradual increase in investment, greater attention to food security by development-finance institutions, and pioneering success of several AgTech companies in African markets underscore the growing maturity of the AgTech subsector within the African startup ecosystem.²⁶ The Food and Agriculture Organization (FAO) predicts that the agricultural market in Africa will grow from \$200 million in 2015 to \$1 trillion by 2030, and AgTech companies have been identified as the backbone of the expansion.²⁷

²⁵ Lucy Ngige, "Breaking: Africa Agrifoodtech Startups Raise \$1bn in 5 Years, but Just 1% of Global Investment," AgFunder News, September 20, 2022, <https://agfundernews.com/africa-agrifoodtech-startups-raise-1bn-in-5-years>.

²⁶ "DFC Approves More Than \$655 Million of Investments to Bolster Infrastructure, Energy Security, Food Security, and Healthcare in Q2 of FY2023," Next Billion, press release, April 2023, <https://nextbillion.net/news/press-release-dfc-approves-more-than-655-million-of-investments-to-bolster-infrastructure-energy-security-food-security-and-healthcare-in-q2-of-fy2023/>.

²⁷ "The Future of Africa's Agriculture—An Assessment of the Role of Youth and Technology," Heifer International, July 2021, https://media.heifer.org/About_Us/Africa-Agriculture-Tech-2021.pdf.

AgTech Business Models

The proliferation of mobile phones and the growing availability of connectivity across emerging markets—spanning countries like Cambodia, Colombia, India, and Indonesia—have facilitated cost-effective means for companies to reach smallholder farmers. These developments have enabled companies to offer credit to the unbanked population through nontraditional credit-assessment methods. Smallholder farmers often lack access to essential financial services that would otherwise provide them with credit to purchase seeds and fertilizers, as well as insurance to safeguard their livelihoods. These same farmers often lack direct market access, information related to weather events, advice, and crop monitoring, as well as mechanized farming equipment. Given the plethora of needs, most AgTech companies in emerging markets offer multiple products to farmers, with credit being the most transformative and “sticky.” While most AgTech firms evolve to provide credit in some form, four main business models characterize the subsector: access to finance and inputs; access to market; access to information; and access to shared assets. African AgTech fits into this same typology.

ACCESS TO FINANCE AND INPUTS

- Credit, seed, and fertilizer loans: Less than 4 percent of total commercial-bank lending goes into the agricultural sector, with financial institutions often citing the lack of collateral, high transaction costs, lag between investment and return on revenue, poor infrastructure, and high risk as a result of variable rainfall and price spikes.²⁸ The Kenyan firm Apollo Agriculture helps smallholder farmers maximize profitability, using satellite coordinates of fields to build credit profiles for farmers, which then guide their lending in the form of seeds and fertilizer, which the farmer pays back via a mobile payment after harvest. Similarly, Nigeria’s ThriveAgric calculates and disburses loans to

smallholder farmers in the form of improved seeds, fertilizer, and crop-protection products, based on farm-mapping data and creditworthiness.²⁹ The digital platform also provides the farmers with information and access to local and global markets to sell their commodities.

- Insurance: Overall insurance penetration in African farming is 2.78 percent.³⁰ The Kenyan company Pula is pioneering a solution that uses remote sensing to offer yield-index insurance products to protect farmers from crop and livestock losses due to drought, excessive rainfall, pests and diseases, and other perils that affect agricultural yields negatively.

ACCESS TO MARKET

- Marketplaces: Smallholder farmers often lack access to value-added markets, limiting the profitability of their products. The amount of value added per worker in sub-Saharan Africa is less than half the global average.³¹ Kenyan-based company Twiga delivers a range of services via mobile and web platforms to operate an efficient supply chain, connecting farmers, suppliers, vendors, and customers in a digital marketplace. The platform allows farmers to communicate directly with vendors seeking products, offers last-mile distribution to deliver commodities to vendors, and offers loans to vendors to pay for products over time.

ACCESS TO INFORMATION

- Weather: More than 95 percent of African agriculture is rain fed.³² Providing farmers with timely and precise weather

²⁸ Augustine Langyintuo, “Smallholder Farmers’ Access to Inputs and Finance in Africa,” *Role of Smallholder Farms in Food and Nutrition Security*, 2020, 133–152. <https://link.springer.com/book/10.1007/978-3-030-42148-9>.

²⁹ ThriveAgric, last visited August 2023, <https://www.thriveagric.com/>

³⁰ “Smallholder Farmers Hold the Key to Feeding Africa’s Rising Population,” Intellecap, November 2022, <https://www.intellecap.com/smallholder-farmers-hold-the-key-to-feeding-africas-rising-population/>.

³¹ Hannah Ritchie, “Increasing Agricultural Productivity across Sub-Saharan Africa Is One of the Most Important Problems This Century,” Our World in Data, April 4, 2022, <https://ourworldindata.org/africa-yields-problem>.

³² Len Abrams, “Unlocking the Potential of Enhanced Rainfed Agriculture,” Stockholm International Water Institute, 2018, <https://siwi.org/wp-content/uploads/2018/12/Unlocking-the-potential-of-rainfed-agriculture-2018-FINAL.pdf>.

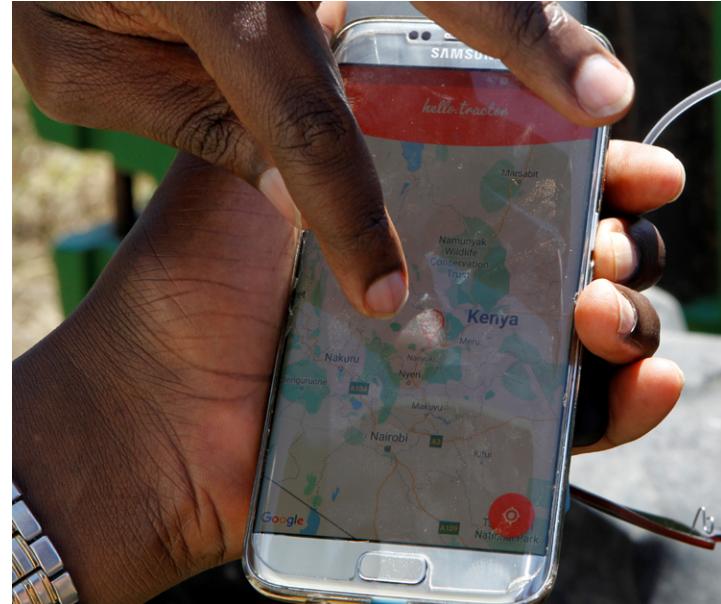
forecasts increases the efficient use of inputs, and reduces the vulnerability to climate change-related risks.³³ Esoko, an agricultural marketing and messaging company based in Ghana, sends weather forecasts and early warnings to its users via short-message service (SMS). The Esoko app also informs farmers of pest-infestation risks and offers advice on how to take preventative action.

- Crop monitoring: In markets with more commercial farming, such as South Africa, Aerobotics uses artificial intelligence, drones, and other technologies to inform farmers about the health of their crops, track pests and diseases, and provide analytics to inform yields.

ACCESS TO SHARED ASSETS

- Equipment rentals: Farming in African markets is characterized by a lack of mechanization. African farmers have fewer than two tractors per thousand hectares of cropland, compared to ten tractors per thousand hectares in South Asia and Latin America.³⁴ The mobile platform Hello Tractor connects tractor owners and operators with farmers in need of tractor services, to make tractor ownership more profitable and tractor use more affordable, thereby advancing productivity-enhancing mechanization.

The integration of artificial intelligence (AI) and big-data technologies will influence, and potentially create, new AgTech business models. For example, Atmo, a US tech company employing AI in weather forecasting, partnered with the Common Market for Eastern and Southern Africa to offer governments meteorology and supercomputing technologies to help make informed decisions based on accurate weather prediction. This aims to enhance access to country-level crop insurance, optimize input allocation, and bolster preparedness for natural disasters.³⁵ OCP, a global phosphate and fertilizer giant, partnered with Microsoft to leverage AI for OCP's digital agriculture platform in Africa. This partnership uses OCP's data on soil



A mobile phone application shows movements of a John Deere 5503 tractor, installed with the Hello Tractor technology that connects farmers with vehicles' owners, in Umande village in Nanyuki, Kenya, February 4, 2020. REUTERS/Njeri Mwangi.

mapping, soil samples, and demonstration trials to customize fertilizer solutions to equip farmers with decision-informing data.³⁶ Similarly, the Google AI Center in Ghana joined forces with InstaDeep and FAO to develop a predictive model for anticipating locust infestations.³⁷

Globally, efforts to coordinate and innovate in AI and big data are emerging to help aggregate agricultural data for the public good. CGIAR, a global partnership for food security, established the Platform for Big Data in Agriculture.³⁸ This platform adheres to open-access and open-data principles, aggregating data from CGIAR's research stations in Kenya, Benin, Nigeria, and elsewhere to increase the impact of agricultural research for development. When AI is applied to this extensive dataset, new opportunities arise for entrepreneurs to unlock untapped potential in African agriculture.

³³ Thomas Peprah Agyekum, Philip Antwi-Agyei, and Andrew J. Dougill, "The Contribution of Weather Forecast Information to Agriculture, Water, and Energy Sectors in East and West Africa: A Systematic Review," *Frontiers in Environmental Science* 10 (2022), <https://www.frontiersin.org/articles/10.3389/fenvs.2022.935696/full>.

³⁴ Busani Bafana, "Mechanizing Agriculture Is Key to Food Security," *Africa Renewal*, April 9, 2019, <https://www.un.org/africarenewal/magazine/april-2019-july-2019/mechanizing-agriculture-key-food-security#:~:text=According%20to%20the%20Food%20and,South%20Asia%20and%20Latin%20America>.

³⁵ "Atmo Partners with 21 African Countries to Build Ai Meteorology Systems," Atmo (via LinkedIn), October 2021, <https://www.linkedin.com/pulse/atmo-partners-21-african-countries-build-ai-meteorology-systems-/>.

³⁶ "Food Security in Africa: Microsoft, OCP Africa Pool Efforts to Support Smallholder Farmers," *North Africa Post*, March 12, 2023, <https://northafricapost.com/65964-food-security-in-africa-microsoft-ocp-africa-pool-efforts-to-support-smallholder-farmers.html>.

³⁷ Perry Nelson and Aisha Walcott-Bryant, "6 Ways Google Is Working with AI in Africa," Google, June 1, 2023, https://blog.google/intl/en-africa/company-news/6-ways-google-is-working-with-ai-in-africa/?utm_source=tw&utm_medium=social&utm_campaign=og&utm_content=&utm_term=.

³⁸ Platform for Big Data in Agriculture, last visited August 2023, <https://bigdata.cgiar.org/about-the-platform/>.

DIGITAL INCLUSION FOR WOMEN AND YOUTH IN AGRICULTURE

Women play a pivotal role in African agriculture, comprising around 50 percent of the agricultural labor force and contributing 60 to 80 percent of total food production. Despite this, they encounter gender-specific challenges that impede their ability to optimize productivity and profitability.¹ Women in smallholder farming communities shoulder the majority of tasks related to production, processing, and market selling, as well as domestic responsibilities. However, they face greater income vulnerabilities due to limited access to extension services, training, decision-making authority, technologies, land ownership, and financial resources. Estimates suggest that reducing these barriers could raise yields on farms by 20 to 30 percent.²

While digital solutions designed specifically to overcome the barriers that female farmers face are limited, progress has



REUTERS/Antony Njuguna.

been made to improve digital literacy for women in Africa. Digital Women Uganda, a civic-tech and digital-rights advocacy organization, offers training and advocacy programs to promote digital literacy among women and girls.³ In 2018, Vodacom Foundation, partnered with UN Women and South African Women in Farming to launch the Women Farmers Programme in rural regions of Limpopo and Kwa-Zulu-Natal in South Africa to teach digital skills and integrate digital knowledge into farm management.⁴ In Nigeria, HerVest provides access to savings, impact investing, and credit for smallholder female farmers, addressing the financial barriers that they have historically experienced.⁵

The inclusion challenge also exists with regard to African youth. The region boasts the youngest population in the world, with more than 60 percent of the population below twenty-five years old and, despite rapid urbanization, many young people still depend on agriculture for their livelihoods.⁶ Young Africans are moving to the cities in pursuit of opportunity and entertainment, resulting in rapid aging of the farming population. Introducing young populations to AgTech solutions can help change the perception of the agricultural sector, and encourage youths to stay in farming communities. Studies have found that productive pathways to engage youths in the sector include technological innovation, government support, and inclusion of youth in agriculture policy formation.⁷

The use of digital solutions in agriculture offers significant potential to empower female farmers and involve young individuals in the sector, leading to transformative outcomes. By targeting the unique obstacles encountered by women farmers and aligning with the preferences of the youth, Africa has the opportunity to foster an inclusive and inventive agricultural environment.

1 Bongiwe Njobe, "Women and Agriculture: The Untapped Opportunity in the Wave of Transformation," African Development Bank, 2015, https://www.afdb.org/fileadmin/uploads/afdb/Documents/Events/DakAgri2015/Women_and_Agriculture_The_Untapped_Opportunity_in_the_Wave_of_Transformation.pdf; "Food Security and Gender," US Agency for International Development, last visited August 8, 2023, <https://www.oecd.org/dac/gender-development/46460857.pdf>.

2 Henry Adlam, "Supporting Female Farming Cooperatives: The Smart Choice for the African Development Bank," *Journal of Public and International Affairs*, Princeton University, May 2023, <https://jpia.princeton.edu/news/supporting-female-farming-cooperatives-smart-choice-african-development-bank>.

3 Digital Woman Uganda, last visited August 8, 2023, <https://www.digitalwomanuganda.org/>.

4 "Women Farmers: Using Tech to Boost Business in Africa," Vodafone, January 2021, <https://www.vodafone.com/news/technology/women-farmers-tech-africa>.

5 HerVest, last visited August 8, 2023, <https://learn.hervest.ng/>.

6 Weny, Kathrin, Rachel Snow, and Sainan Zhang. "The Demographic Dividend Atlas for Africa: Tracking the Potential for a Demographic Dividend." United Nations Population Fund, September 2017. <https://www.unfpa.org/resources/demographic-dividend-atlas-africa-tracking-potential-demographic-dividend>.

7 "The Future of Africa's Agriculture."

Africa's Top Venture Capital-Backed AgTech Companies

Although the AgTech landscape in African markets is witnessing a surge in activity due to the greater geopolitical focus on food security, only a small number of companies have managed to scale and raise substantial funding (defined as approximately \$5 million raised in the most recent funding cycle

and around fifty employees). This indicates that while the digital transformation is evident, with more than five thousand startups in the ecosystem in 2021, many startups face challenges when it comes to transitioning beyond the seed stage. The chart below gives a snapshot of the top ten AgTech companies.³⁹

Name	Service	Core Market	Total Funding to Date	Number of Employees	Type of Digital Solutions	Farmers/CUSTOMERS Reached
Twiga Foods	Business-to-business (B2B) marketplace connecting farmers and urban retailers.	Kenya	\$157.1 million	789	Access to market	Increased incomes for over 17,000 farmers and more than 8,000 produce vendors.
Apollo Agriculture	Provides credit to farmers based on digital crop assessment, bundled with insurance.	Kenya	\$67.1 million	570	Access to finance and inputs	Financed around 100,000 farmers
ThriveAgric	Provides input financing and data-led advisory, and enhances supply-chain efficiency.	Nigeria	\$60 million	242	Access to finance and inputs; access to market; access to information	500,000 registered farmers
Vendease	Provides a marketplace for restaurants to buy directly from farms and food manufacturers.	Nigeria	\$46.5 million	182	Access to market	Moved approximately 400,000 metric tonnes of food to its 2,000 customers
Babban Gona	Provides farm inputs, credit, marketing, and training services to franchised farmer groups.	Nigeria	\$34.2 million	441	Access to market; access to credit; access to information	Reached over 200,000 smallholder farmers and increased their net incomes to twice the national average
Aerobotics	Provides farm monitoring and management services through satellite imagery and drones.	South Africa	\$26.8 million	69	Access to information	Serves more than 350 farming groups cultivating 600,000 acres of land annually (in Africa & the US)
iProcure	Connects agricultural manufacturers and distributors to local retailers.	Kenya	\$16.5 million	155	Access to market	Connects 5,000 agro-dealers to different manufacturers.
Farmerline	Facilitates farmer profiling, financing, digital payments, and messaging.	Ghana	\$15.2 million	73	Access to market; access to information	Through its digital platform, Mergdata, reached one million farmers across 26 countries and financed \$18 million worth of inputs and crops in partnerships with agribusinesses and dealers.
Pula	Provides digital and agricultural insurance for smallholder farmers.	Kenya	\$9.7 million	245	Access to finance and inputs	Insured over 4.3 million farmers
Hello Tractor	Provides shared access to tractors.	Nigeria	\$4.4 million	46	Access to shared assets	Platform has 3,000 fleet owners, providing access to 500,000 farmers

³⁹ Africa: The Big Deal, last visited July 2023, <https://thebigdeal.gumroad.com/>.

Attracting greater AgTech investment will be crucial for African countries to cost-effectively advance productivity. Success by the leading ten AgTech firms in achieving profitability will be key to generating additional global venture-capital (VC) interest as they scale.

KEY COMPONENTS TO SCALE

A basic analysis of the top ten African AgTech companies shows that there are three common strategies that prove critical to scaling. Leading firms have: developed a proprietary way of establishing the creditworthiness of smallholder farmers and informal agribusinesses; created partnerships that allow for access to cheap capital for onlending and efficient distribution; and forged global networks that support global fundraising.

Establish Creditworthiness of Smallholder Farmers

Apollo Agriculture, ThriveAgric, and Pula provide financial services to farmers in the form of agricultural inputs or insurance. Given that most smallholder farmers lack a traditional credit history, and often fear pledging their land as collateral, these companies utilize AI and geographic information services to predict a farm's yield.⁴⁰ This information is then used to assess a farmer's credit risk, enabling these companies to offer tailored financial services to regions and customer segments ignored by mainstream African banks, and at rates better than those of microfinance institutions.

Access to Cheap Capital for Onlending and Distribution

Once companies have the models to assess farmer creditworthiness, they need access to cheap debt to scale. The average interest rate direct from banks in Africa is around 15 percent, and rates can be as high as 40 percent.⁴¹ Interest rates are even higher for rural farmers, as they borrow from a constellation of individuals, microfinance institutions, and community organizations—often at interest rates as high as 47 percent, which reflects the high cost of reaching them, and the challenges in assessing creditworthiness and collections.⁴² Companies such as Apollo need to find ways to access credit at concessionary

rates (below 10 percent) so that they can onlend to farmers sustainably. Development finance institutions (DFIs) are playing a critical role in providing this affordable capital. For example,

- Apollo Agriculture received debt financing from the US Development Finance Corporation (DFC), Agri-Business Capital Fund, and FMO, Rabobank;
- TwigaFoods received debt financing from the DFC and the International Finance Corporation (IFC);
- iProcure received debt financing from Investisseurs & Partenaires, which is backed by Proparco, FMO, and the DFC; and
- FarmerLine received debt financing from DEG, Rabobank, Ceniarth, Rippleworks, Mulago Foundation, Whole Planet Foundation, Netri Foundation, and Kiva.

These partnerships can also be with agricultural-input producers, as farmers take loans to purchase fertilizer and seed for the growing season. Therefore, if companies can access inputs on favorable terms, onlending can also be sustainable.

While ensuring access to affordable debt, AgTech companies must develop a cost-effective way to reach a large number of smallholder farmers in rural areas. This last-mile challenge can be addressed by creating partnerships with established industry players and intermediaries, such as cooperatives and agro-dealers. Agro-dealers—small-scale independent distributors of agricultural products—have played a critical role in reaching the last mile in the agricultural supply chain, as they possess valuable local knowledge and are often trusted and well-connected members of farming communities.⁴³ Their role extends beyond distributing agricultural inputs; they also offer agronomic advice, provide credit, and facilitate the movement of goods to and from the marketplace. This human, and often informal, infrastructure can be leveraged for building the distribution for digital products.

⁴⁰ Bedru B. Balana and Motunrayo A. Oyeyemi, "Agricultural Credit Constraints in Smallholder Farming in Developing Countries: Evidence from Nigeria," *World Development Sustainability* 1 (2022), <https://www.sciencedirect.com/science/article/pii/S2772655X2200012X?via%3Dihub>

⁴¹ "Lending Interest Rate in Africa," Global Economy, 2022, https://www.theglobaleconomy.com/rankings/lending_interest_rate/Africa/.

⁴² Evan Girvetz, "De-Risking Agricultural Investment in Africa," *Financial Times*, August 14, 2018, <https://www.ft.com/content/4ee682ec-9fd6-11e8-85da-eeb7a9ce36e4>.

⁴³ Goedde, et al., "Winning in Africa's Agricultural Market."

HARVESTING GROWTH: THE ROLE OF OCP AFRICA IN SUPPLYING AGRICULTURAL INPUTS

Agricultural productivity in Africa is hindered by soil degradation and nutrient depletion. The United Nations Environment Program projects that Africa may lose approximately 4.74 million tons of nitrogen, phosphorus, and potassium annually, valued at more than \$5 billion per year, if action against soil erosion is not taken.¹ The Agribooster program, launched by OCP Africa to promote soil health in 2016, provides farmers with customized fertilizers and offers extension services throughout the entire agricultural value chain. The program ensures farmers have access to vital farm inputs, including fertilizers, seeds, and crop-protection products.² Local extension agents guide farmers on the best practices for utilizing inputs effectively. Agribooster also facilitates access to financing and insurance, strengthening farmer resilience, and connects farm-

ers to competitive markets, enabling them to obtain better prices for their produce. Finally, Agribooster offers training in business and good agricultural practices, empowering farmers to make informed decisions and improve their overall efficiency.

The Agribooster program has already made a significant impact on the lives of 850,000 smallholder farmers involved in maize, rice, millet, and sorghum value chains across Ghana, Tanzania, Côte d'Ivoire, Senegal, Nigeria, and Kenya.³ The average crop yields on the participating farms have witnessed an impressive increase of 33 percent. This demonstrates the effectiveness of such initiatives in tackling the challenges of low agricultural productivity in Africa.

1 “The Economics of Land Degradation in Africa: Benefits of Action Outweigh the Costs,” United Nations Environment Programme, October 2015, <https://www.unep.org/resources/report/economics-land-degradation-africa-benefits-action-outweigh-costs-a-complementary>.

2 OCP Africa, last visited August 8, 2023, <https://www.ocpafrica.com/>.

3 “OCP Africa: From Subsistence Agriculture to Agribusiness through Agribooster Program,” World Business Council for Sustainable Development, last visited August 8, 2023, <https://www.wbcsd.org/Programs/Food-and-Nature/Food-Land-Use/Programs-Food-and-Nature-Food-Land-Use-Global-Agribusiness-Action-on-Equitable-Livelihoods/Resources/Supplier-empowerment-for-an-equitable-food-systems-transformation/OCP-Africa-From-subsistence-agriculture-to-agribusiness-through-Agribooster-program>.

Apollo Agriculture’s partnership with agro-dealers exemplifies this approach.⁴⁴ After a loan is approved, the farmer receives a voucher via M-Pesa’s mobile app, which they can redeem at a partner agro-dealer shop.⁴⁵ Apollo Agriculture also employs field agents who visit smallholder farmers on their farms, educating them about how the input loan works and collecting farmer data. IProcure also connects agro-dealers with seed and fertilizer producers in Kenya and Uganda. With plans to double its distribution hubs, IProcure has recently expanded to Tanzania through a partnership with the Farm to Market Alliance, a consortium of public and private institutions that aims to increase farmer income through Farmer Service Centers, a network of last-mile service hubs for in-

puts, information, financing, and storage solutions.⁴⁶ Similarly, Farmerline employs agro-dealers as key partners to ensure that farmers have access to inputs using its AI technology platform called Mergdata. These agro-dealers can also act as an online/offline interface, helping farmers, who struggle with digital literacy, navigate the products and services being offered by AgTech firms over their mobile phones.

Forge Global Networks that Support Global Fundraising

Once the fundamentals of the business—cost-effective ways to reach and assess farmers so as to provide credit—are in place, AgTech firms need to raise capital to scale. Given the small size of the homegrown African VC industry, global sources of capital

44 “Drivers and Barriers of a Platform-Based Business Model in Agriculture: The case of Apollo Agriculture,” International Institute of Social Studies, May 25, 2022, https://issuu.com/devissues/docs/devissues_spring_2022/s/15890690.

45 M-Pesa, last visited August 2023, <https://www.vodafone.com/about-vodafone/what-we-do/consumer-products-and-services/m-pesa>.

46 “IProcure Expands to Tanzania, Partners with Farm to Market Alliance to Reach 125K+ Farmers,” Farm to Market Alliance, press release, May 2023, <https://ftma.org/iprocure-expands-to-tanzania-partners-with-farm-to-market-alliance-to-reach-125k-farmers/>.

must be tapped. Comparative analysis on startup ecosystems globally shows that founders with strong global networks grow their early-stage companies 2.1 times faster than founders without international connections.⁴⁷ Of the ten African AgTech companies analyzed, all were founded or are led by chief executive officers (CEOs) who have received an undergraduate or advanced degree from universities in the United States or Europe and have experience working outside the core market.⁴⁸

Global networks can become even more critical as a company scales to new markets and needs to raise larger and larger fund-

ing rounds. Twiga Foods' co-founder Peter Njonjo, who worked at Coca-Cola for more than twenty years, took over as CEO from Grant Brooke in 2019 to scale the company by building out a logistics platform, opening operations in Uganda, and leading a team of three thousand in supplying twelve thousand customers daily. Apollo Agriculture's three co-founders—Eli Pollak, Benjamin Njenga, and Earl St Sauver—have backgrounds in Silicon Valley and in agricultural insurance in Africa, making for a local and global mix of fundraising and operational expertise that is showing success in these early days of the African AgTech space.

⁴⁷ “Global Connectedness: The Key to Fast-Growing Startups and Ecosystems,” Startup Genome, 2018, <https://startupgenome.com/articles/global-connectedness-the-key-to-fast-growing-startups-and-ecosystems>.

⁴⁸ Uka Eje, founder and CEO of Thrive Agric, Covenant University; Peter Njonjo, CEO and co-founder of Twiga Foods, Harvard Business School; Yebeltal Getachew, CEO, East Africa, Twiga Foods, Harvard Business School; Eli Pollak, founder and CEO, Apollo Agriculture, Stanford; Benjamin Njenga, co-founder, Apollo Agriculture, Jomo Kenyatta University of Agriculture and Technology; Earl St Sauver, co-founder, Apollo Agriculture, Tufts University; Tunde Kara, co-founder and CEO, Vendlease, Stanford University; Kola Masha, co-founder and managing director, Babban Gona, Harvard Business School; James Paterson, CEO, Aerobotics, Massachusetts Institute of Technology; Paul Maira, CEO, iProcure, University of Nairobi; Nicole Galletta, co-founder, iProcure, University of Rome; Stefano Carcoforo, co-founder, iProcure, Oxford Brooks University; Alloysius Attah, co-founder and CEO, Farmerline, Stanford University.

The Indian Example

Given the relatively underdeveloped state of the African startup ecosystem, and the lag in agricultural productivity compared to other emerging markets, it is valuable to look at similar countries to identify drivers of successful AgTech development. India serves as a particularly instructive example. With a population of nearly 1.5 billion, similar to that of the entire African continent, India offers insights into the development trajectory of African nations.⁴⁹ Unlike China's highly centralized structure, India's large, messy, federal democracy shares similarities with countries like Nigeria, Ethiopia, and the Democratic Republic of the Congo.

Structurally, strong parallels exist. Nearly half of Indians depend on agriculture for their livelihoods, and 82 percent of Indian farmers are smallholders.⁵⁰ India's agricultural sector faces comparable challenges to Africa's, including rising input costs, climate change risks, limited mechanization, an aging farm labor force, and fragmented markets affecting crop profitability. However, India's green-revolution initiative in the 1960s yielded some progress in improving productivity.⁵¹ If African countries were to match the productivity growth experienced by India's agricultural sector between 1980 and 1990, they would collectively add \$200 billion to their economies by 2030.⁵²

The progress India made in agriculture decades ago is quickly being overtaken by an AgTech revolution fueled by India's vibrant venture ecosystem. With approximately 2,500 AgTech startups, funding for the subsector has increased sixfold in the past seven years.⁵³ In 2022, AgTech and food tech companies in India raised more than \$4.5 billion, nearly equivalent to the

total startup ecosystem in African markets.⁵⁴ Just as in other emerging markets, Indian AgTech companies are providing farmers access to markets, credit, information, and efficient logistics networks—a full-stack solution for farming. As these companies have scaled, many have evolved into two-way platforms, both sourcing from farmers and selling to farmers. They have integrated fintech throughout the value-creation process, focusing on working-capital provision, asset financing, and insurance. Moving forward, a large share of all agricultural lending will occur through digital channels, and a new wave of startups focused on capturing the \$500 billion per year fintech opportunity in agriculture is expected to emerge.⁵⁵

There are lessons that African countries can learn from India's experience to advance digital transformation and unlock opportunities to improve agricultural productivity. Two main learnings stand out—one from top-down initiatives by the central government and another from the bottom-up efforts of startups. These lessons can be readily applied in African markets, without necessitating massive investments in physical infrastructure.

GOVERNMENT PRIORITIZATION OF THE DIGITAL BACKBONE

In India, the government has implemented policies aimed at technology and innovation in agriculture, which build on the progress made in areas such as fintech.⁵⁶ India Stack is a comprehensive set of digital public-infrastructure systems that includes digital identity, payment mechanisms, and data man-

49 “India Population (Live),” Worldometer, 2023, <https://www.worldometers.info/world-population/india-population/>.

50 Harish Damodaran, “What India’s Labour Force and National Income Data Tell Us about Jobs Shifting from Agriculture,” *Indian Express*, March 7, 2023, <https://indianexpress.com/article/explained/explained-economics/explained-economics-agriculture-and-employment-8480945/>; “India at a Glance,” Food and Agriculture Organization of the United Nations, last visited August 4, 2023, <https://www.fao.org/india/fao-in-india/india-at-a-glance/en/#:~:text=Agriculture%2C20with%20its%20allied%20sectors,farmers%20being%20small%20and%20marginal>.

51 While India's green revolution yielded some progress by introducing high-yield seed varieties, improving irrigation techniques, and enhancing fertilizers and pesticides, it created a chemical-intensive agricultural system and widened the gap between more prosperous and marginalized farming communities. “The Green Revolution: Transforming Agriculture in India: Science-Environment,” Devdiscourse, June 29, 2023, <https://www.devdiscourse.com/article/science-environment/2501298-the-green-revolution-transforming-agriculture-in-india>.

52 Kuyoro, et. al., “Reimagining Economic Growth in Africa: Turning Diversity into Opportunity.”

53 “Agritech Startups in India,” Tracxn, July 2023, <https://tracxn.com/explore/AgriTech-Startups-in-India>.

54 “Investment in Agri Tech Startups Jumps 2-Fold to \$4.6 Billion in FY22,” *Business Standard*, November 2022. https://www.business-standard.com/article/companies/investment-in-agri-tech-startups-jumps-2-fold-to-4-6-billion-in-fy22-122113000675_1.html.

55 Hemendra Mathur, “Agritech Startups Have Arrived. What Will It Take to Scale Impact and Profits?” *Forbes India*, September 2022, <https://www.forbesindia.com/article/agritech-special-2022/agritech-startups-have-arrived-what-will-it-take-to-scale-impact-and-profits/79619/1>.

56 Namrata Dubashi, et al., “How Agtech Is Poised to Transform India into a Farming Powerhouse,” McKinsey & Company, May 10, 2023, <https://www.mckinsey.com/industries/agriculture/our-insights/how-agtech-is-poised-to-transform-india-into-a-farming-powerhouse>.

agement upon which third parties can build software.⁵⁷ These are known as application programming interfaces (APIs), and open APIs have been proven to encourage innovation.

At the core of the India Stack is the world's largest biometric-identification program. Aadhaar, launched in 2009, provides Indian citizens with unique identification numbers, through which India created the foundation for the formalization and modernization of the economy. By providing 90 percent of India's population with digital IDs, Aadhaar serves as a master database for implementing various government schemes related to farmers, including soil health cards, credit cards that can be used for agricultural inputs, crop insurance, and income transfer.⁵⁸ The India Stack's multilayered features provide governments, banks, and other companies with vital information about individual farms and farmers, enabling informed decisions on insurance, fertilizers, and credit-to-cash transfers.

With a verifiable and digitized identification system, the government turned its attention to the millions of unbanked. The government's efforts to encourage the opening of zero-balance bank accounts have significantly expanded banking services to hundreds of millions of Indians, with more than 450 million accounts opened by 2022.⁵⁹ The Unified Payments Interface, a part of the India Stack, has further enhanced financial inclusion by enabling instant payments through collaboration with the Reserve Bank of India, public and private banks, and government agencies. This open API architecture has allowed private entities to leverage the platform for innovation and new services.⁶⁰

The government has worked to increase farmers' access to credit by establishing regional rural banks, creating the National Bank for Agricultural and Rural Development (NBARD), introducing special agricultural credit plans, and establishing the agricultural debt waiver and debt-relief program. The NBARD introduced the Kisan Credit Card (KCC) scheme in 1998. The KCC offers short-term credit to farmers, allowing them to purchase various inputs such as seeds, fertilizers, and pesticides, and to access cash for immediate production needs. The State Bank of India has also developed the YONO Krishi app to meet farmers' finance, inputs, and advisory needs.⁶¹ By demonstrating that farmer creditworthiness can be cost-effectively assessed, the government paved the way for banks to expand services into more rural areas. Private institutions such as the HDFC Bank have also significantly increased agricultural lending, from \$1.2 billion in 2015 to \$7.5 billion.⁶²

To build on this success in digital infrastructure, India's 2022–2023 federal budget includes plans to set up a dedicated AgTech fund to help in early-stage growth for companies working in drone crop assessment, land-record digitization, and other areas.⁶³ This allocation of funding demonstrates the government's commitment to create an enabling environment for AgTech solutions to scale and deliver technological solutions to rural farmers. While these advancements have facilitated improved access to credit, information, and markets for smallholder farmers, persistent challenges such as land fragmentation, insufficient investment in research and development, rural-urban migration, and resource scarcity remain. India continues to grapple with a high rate of farmer suicides, which is

⁵⁷ India Stack, last visited August 2023, <https://indiastack.org/>.

⁵⁸ Yan Carrière-Swallow, Manasa Patham, and Vikram Haksar, "The India Stack Is Revolutionizing Access to Finance—IMF F&D," International Monetary Fund, July 2021, <https://www.imf.org/external/pubs/ft/fandd/2021/07/india-stack-financial-access-and-digital-inclusion.htm>. Billy Perrigo, "What to Know about Aadhaar, India's Biometric Identity System," *Time*, September 28, 2018, <https://time.com/5409604/india-aadhaar-supreme-court/>.

⁵⁹ Cristian Alonso, et al., "Stacking up the Benefits: Lessons from India's Digital Journey," International Monetary Fund, March 31, 2023, <https://www.imf.org/en/Publications/WP/Issues/2023/03/31/Stacking-up-the-Benefits-Lessons-from-Indias-Digital-Journey-531692>; Siddharth Dixit, "India's Digital Transformation Could Be a Game-Changer for Economic Development," World Bank Blogs, June 20, 2023, <https://blogs.worldbank.org/developmenttalk/indias-digital-transformation-could-be-game-changer-economic-development>.

⁶⁰ India Stack has been met with criticism by activists in India, with concerns about privacy, data breaches, and surveillance. "India's Government Denies Report of Mass Leak of Citizens' Data," *Financial Times*, July 14, 2023, <https://www.ft.com/content/88c0e926-901f-4dd7-bb42-76ff18d62cac>.

⁶¹ Dubashi, et al., "How Agtech Is Poised to Transform India into a Farming Powerhouse."

⁶² The development of the government of India's digital backbone coincided with efforts to increase investments in rural roads and a significant drop in data prices, enabling increased smartphone and internet penetration. These initiatives collectively contributed to improving access to information, markets, financial services, and agricultural inputs for farmers in rural areas. Hruby, *Critical Connectivity*; "India: Rural Roads Sector II Investment Program (Project 5 and Multitranche Financing Facility)," Asian Development Bank, <https://www.adb.org/documents/india-rural-roads-sector-ii-investment-program-project-5-and-multitranche-financing>; "India's Journey from Agricultural Basket Case to Breadbasket," *Economist*, June 2023. <https://www.economist.com/finance-and-economics/2023/06/22/indias-journey-from-agricultural-basket-case-to-breadbasket>.

⁶³ Shobhaa De, "Dedicated Fund to Benefit Agriculture & Related Business in Madhya Pradesh," *Times of India*, February 2, 2023, <https://timesofindia.indiatimes.com/city/indore/dedicated-fund-to-benefit-agriculture-related-business-in-madhya-pradesh/articleshow/97543678.cms?from=mdr>.

attributed to the overwhelming debt faced by farmers and their families, and exacerbated by the volatile nature of the agricultural sector.⁶⁴

STARTUP INNOVATION IN BRIDGING THE OFFLINE/ONLINE GAP

While many farmers have access to mobile devices capable of accessing AgTech applications, they often prefer physical touchpoints, such as in-person tutorials.⁶⁵ Successful AgTech companies have built-in offline/online interfaces to reach remote farming communities in a cost-efficient manner. Leveraging agro-dealers and partners in local micro markets or rural bank branches is proving to be an effective strategy for AgTech companies to reach farmers more cost-effectively. ITC, an Indian conglomerate with a diverse presence in agribusiness, packaging, software, and more, is bridging the offline/online gap through its e-Choupal ecosystem.⁶⁶ This platform uses extension services as physical touchpoints for farmers, providing valuable advice, facilitating direct-from-

farm procurement, and offering access to modern tools, quality inputs, and finance. Other examples in India, such as DeHaat and Agrostar, demonstrate how AgTech companies can aggregate demand and deliver commodities through networks of intermediaries in larger volumes, improving efficiency and cost-effectiveness.⁶⁷

As Indian AgTech companies grow and mature, they will need to compete to deliver value to the smallholder farmer and at multiple levels of the agricultural supply chain. In doing so, they will help increase rural incomes and add tens of millions to the Indian consumer class. For this virtuous cycle to be replicated and unleashed in African markets, African governments can look to the Indian model of investing in core digital infrastructure, promoting open APIs, and de-risking lending to farmers. At the same time, African AgTech companies can find and build networks with supply-chain intermediaries to fast track the adoption of digital solutions in farming communities. Combined, these top-down and bottom-up approaches will help to mainstream AgTech, thereby improving agricultural productivity and profitability.

⁶⁴ Runisha Kaur, "The Country Where 30 Farmers Die Each Day," CNN, March 17, 2022, <https://www.cnn.com/2022/03/17/opinions/india-farmer-suicide-agriculture-reform-kaur/index.html>.

⁶⁵ Dubashi, et al., "How Agtech Is Poised to Transform India into a Farming Powerhouse."

⁶⁶ Ibid.

⁶⁷ Manish Singh, "Indian Agritech DeHaat Tops \$700 Million Valuation in \$60 Million Funding," *TechCrunch*, December 1, 2022, <https://techcrunch.com/2022/11/30/indian-agritech-dehaat-tops-700-million-valuation-in-60-million-funding/>; Agrostar, <https://www.corporate.agrostar.in/>, last visited August 6, 2023.

Policy Recommendations

Given the sustained challenges of trying to close the infrastructure financing gap in African markets, supporting the growth of AgTech companies is the most cost-effective way to improve farmer incomes in the near term for both African governments and their development partners.

RECOMMENDATIONS TO AFRICAN GOVERNMENTS

Invest in a cross-cutting digital backbone and prioritize digitization in agriculture. The India case shows the powerful impact of digitized identification programs that feed into open APIs on expanding access to financial services, including those within agriculture. African governments are making progress on this front, though the record is mixed. Tech-enhanced agricultural productivity can be accelerated by prioritizing four efforts.

- Achieving universal coverage for ID programs. Nigeria, Africa's most populous nation, should double down on its program to give all its citizens unique digital identity numbers. Supported by the World Bank's Identification for Development (ID4D) initiative, Nigeria has recorded one hundred million registrations for the National Identity Card (NIN), more than halfway to the goal of 148 million registered Nigerians including sixty-five million women and fifty million children.⁶⁸ The program has been innovative, allowing commercial banks to issue debit cards that double as NIN cards. This innovation could be enhanced and expanded through regular government engagement with leading Nigerian fintech and AgTech startups on how the NIN can drive financial inclusion, particularly expanding access to credit for farmers and developing products that speak to the specific needs of women and youth in agriculture. Co-creating an open API infrastructure can also support broader startup ecosystem growth and deepening.

In Liberia, the Ministry of Agriculture has partnered with the World Bank to register thirty thousand farmers with the National Identification Registry (NIR), so as to more effectively provide training, inputs, and financing.⁶⁹ These practical and targeted World Bank programs—including the ID4D Initiative, which is expected to run until June 2024—should be extended and expanded to additional countries.

- Forging partnerships with India and adopting the India Stack. Morocco and Sierra Leone have already begun to receive assistance from India to build similar API systems using India Stack's open-source technology architecture for services such as Aadhaar and Unified Payments Interface (UPI).⁷⁰ The interoperability of the India Stack enables its adoption in many different countries, and allows transactions to be carried out with local banks and partners. In the lead-up to the Group of Twenty (G20) Summit, the Indian presidency has been using the Digital Economy Working Group to showcase the India Stack, capturing the early interest of several other African nations. Rapid adoption can cut the costs of learning and implementation in African markets.
- Expanding mobile money usage and financial inclusion. While Kenya, Nigeria, Egypt, and South Africa collectively secure more than 90 percent of the capital entering the continent for AgTech startups, Kenya has emerged as the top destination because of its position as a world leader in mobile money.⁷¹ M-Pesa, launched in 2007, covers more than 98 percent of Kenya's population, and creates an almost ubiquitous transactional identification platform that has been unmatched on the continent.⁷² For other countries that have seen more uneven use of mobile money, governments should partner with savings startups such as Piggyvest in Nigeria and neobanks (e.g., Tyme, Kuda, Fairmoney, Lucky, Bettr) to enable the opening of ze-

⁶⁸ “The Role of Digital Identification in Agriculture: Emerging Applications,” World Bank, 2018, <https://id4d.worldbank.org/sites/id4d/files/ID4D-Agriculture-Emerging-Applicaitons-Summary.pdf>; Michael Akuchie, “Nigeria Has Recorded 100 Million NIN Registrations but Could Still Fall Short of the World Bank's Target,” Technext, May 26, 2023, <https://technext24.com/2023/05/26/nigeria-100-million-registrations-nin/>.

⁶⁹ Judoemue M. Kollie, “Liberia: Farmer Moa-Piu, National Registry Sign Agreement to Register 30,000 Smallholder Farmers,” *Liberian Observer*, October 6, 2022, <https://www.libermanobserver.com/liberia-farmer-moa-piu-national-registry-sign-agreement-register-30000-smallholder-farmers>.

⁷⁰ “India Stack Goes Global, to Be Adopted by Sierra Leone to Develop Aadhar-like Digital ID Pilot Project,” *Economic Times*, February 16, 2023, <https://government.economictimes.indiatimes.com/news/digital-india/india-stack-goes-global-to-be-adopted-by-sierra-leone-to-develop-aadhar-like-digital-id-pilot-project/97973141>; Benjamin Parkin, et al., “The India Stack: Opening the Digital Marketplace to the Masses,” *Financial Times*, April 20, 2023, <https://www.ft.com/content/cf75a136-c6c7-49d0-8c1c-89e046b8a170>.

⁷¹ Ngige, “Breaking: Africa Agrifoodtech Startups Raise \$1bn in 5 Years, but Just 1% of Global Investment.”

⁷² Paula Gilbert, “M-Pesa Has Almost 99% Market Share in Kenya,” Connecting Africa, July 2020, https://www.connectingafrica.com/author.asp?doc_id=762180.



Residents perform a mobile phone transaction at a stall within the trading centre of the U.S. President Barack Obama's ancestral village of Nyang'oma Kogelo, west of Kenya's capital Nairobi, July 15, 2015. REUTERS/Thomas Mukoya.

re-balance bank accounts tied to mobile payments in rural areas. To date, most African neobanks have focused on urban areas because of the high cost of customer acquisition at the last mile. Governments can help offset this cost by giving millions a digital financial identity.

regulation, from incentives for innovation in rural accessibility to competition policy—around data-cost reduction. Tracking and regularly publishing results will help to keep governments accountable and measure success over time.

RECOMMENDATIONS TO DEVELOPMENT PARTNERS

In addition to supporting African governments in building the digital backbone, advancing financial inclusion, and reducing the cost of data, development partners should do the following.

- Reducing the cost of mobile data. Rural farmers are often the last to come online. Mobile connectivity at the last mile is expensive, and Africans already spend 3.3 percent of monthly income on data—the highest percentage of any region in the world, and above the 2-percent figure the United Nations deems affordable.⁷³ India's high mobile connectivity was enabled by India's 95-percent drop in mobile data from 2014 to 2018, and supported the rapid growth of digital services in agriculture.⁷⁴ African governments should align policy—from taxes and tariffs to right-of-way
- Transform the Hiroshima Action Statement for Resilient Global Food Security into real progress. In May, Group of Seven (G7) leaders issued the Hiroshima Action Statement, which included the promotion of innovation and technol-

⁷³ Hruby, *Critical Connectivity*.

⁷⁴ Ibid.

ogy at every stage of the food system.⁷⁵ The Partnership for Global Infrastructure and Investment—the G7's flagship infrastructure initiative—will need to ensure that research and development and technology innovations for food systems are prioritized and adequately funded. This collaboration could be expanded in the G20, building off of the momentum of the African Union becoming a permanent member during the September Summit held in New Delhi. The government of India can continue to leverage its leadership shown under its recent G20 presidency to further promote digital solutions and global partnerships around the India Stack.

- Mandate DFIs to take more risks. DFIs play a critical role in reducing the risks of investing in new geographies and sectors. Agriculture in emerging markets—with its ties to basic human survival, climate dependencies, fragmentation, trade distortions, and concentration of women—clearly fits this bill. In trying to balance the political pressure to return taxpayer money to national treasuries, DFIs often act more conservatively than their mission or rhetoric suggest. Governments—the United States, United Kingdom, the Netherlands, Germany, etc.—should explicitly mandate that their DFIs take more risks, and potentially even lose money, in order to prove business models and support the sustainable growth of companies in difficult sectors. In this way, DFIs can be truly catalytic.

Within their existing portfolios, DFIs should create more debt facilities with AgTech firms, as the DFC has done in the cases of Apollo and Iprocure.⁷⁶ Simply onlending to traditional banks with the intent that they expand access to credit in agriculture has proven, time and again, not to be transformative. The concentration of bank branches in urban areas, old systems for assessing credit risk, and bias toward large companies stymie progress in bank-based

financial inclusion. Betting on the nimble, asset-light, and innovation mindset of AgTech and fintech startups will yield better development results.

- Leverage existing US-Africa initiatives to enhance the AgTech sector. The United States, home to Silicon Valley and globally competitive in agribusiness, has a special role to play in supporting the growth of AgTech in African markets. Three immediate actions are suggested.
 - Prosper Africa should prioritize agribusiness. To realize Prosper Africa's vision to strengthen US national security through strategic and economic partnerships between the United States and African nations, the initiative should establish agribusiness as a priority sector. US agribusinesses such as Cargill, Mars, Dole, ADM, Pioneer, John Deere, and Coca-Cola have long been active in African markets and are making investments in farming value chains. These investments can be enhanced and expanded through innovative partnerships with US commercial agencies and local AgTech players.
 - Digital Africa should advance the digital backbone required for enhanced agricultural productivity. At the 2022 US-Africa Leaders Summit, the Biden administration announced the Digital Transformation with Africa initiative to expand digital access, promote literacy, and strengthen enabling environments across the continent.⁷⁷ Recognizing the barriers that smallholder farmers in Africa experience when integrating into the digital economy, the administration should support projects that expand digital identification, build digital land registries, create open APIs, and reduce the cost of data.⁷⁸ Digital Africa should coordinate with the White House and State Department on how AgTech solutions can advance US global efforts to enhance overall food security.

⁷⁵ “Hiroshima Action Statement for Resilient Global Food Security,” *White House*, May 20, 2023, <https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/20/hiroshima-action-statement-for-resilient-global-food-security/>.

⁷⁶ “DFC Approves 21 New Investments, Mobilizing More than \$1.1 Billion to Tackle Development Challenges Worldwide,” US Development Finance Corporation, December 8, 2021, <https://www.dfc.gov/media/press-releases/dfc-approves-21-new-investments-mobilizing-more-11-billion-tackle-development>; “DFC Approves More than \$3 Billion across Priority Sectors in the Third Quarter of FY23,” US Development Finance Corporation, June 30, 2023, <https://www.dfc.gov/media/press-releases/dfc-approves-more-3-billion-across-priority-sectors-third-quarter-fy23>.

⁷⁷ “Fact Sheet: New Initiative on Digital Transformation with Africa (DTA),” *White House*, December 14, 2022, <https://www.whitehouse.gov/briefing-room/statements-releases/2022/12/14/fact-sheet-new-initiative-on-digital-transformation-with-africa-dta/>.

⁷⁸ Hruby, *Critical Connectivity*.

- The Department of Agriculture should include scholarships for African students in budgetary support of land-grant universities. The administration should accept Senator Sherrod Brown and Senator Raphael Warnock's request to expand support for land-grant colleges and universities as part of the fiscal year 2024 budget, and should include scholarships for African students in the process.⁷⁹ Both higher education and agribusiness are sectors of US global competitiveness that should be shored up and exported in the face of increasing competition with China. Land-grant institutions can provide higher-education opportunities for African students to learn the latest in agricultural innovation. This opportunity, combined with internships at leading US Agtech and agribusinesses, will provide African students with global networks and tech skills that can be used to improve agricultural outcomes on the continent.

In order to realize the potential of Africa's agricultural sector, the productivity and profitability of African smallholder farmers will need to increase. Africa's nonlinear growth trajectory, the impacts of climate change, and an already high prevalence of food-insecure populations only heighten the urgency to leverage innovative solutions to improve the productivity and profitability of Africa's agricultural sectors. Harnessing the digital transformation already under way on the continent and accelerating it with AI presents an opportunity to cost-effectively improve the livelihoods of hundreds of millions of Africans.

⁷⁹ "Brown, Warnock Urge Administration to Fund 1890 Land-Grant Colleges and Universities in Budget: U.S. Senator Sherrod Brown of Ohio," Senator Sherrod Brown, press release, February 9, 2023, <https://www.brown.senate.gov/newsroom/press/release/sherrod-brown-warnock-urge-administration-fund-1890-land-grant-colleges-universities-budget>.

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