

Discussion Paper:
**The Role of New Technology in
Advancing African Agri-Food Systems**

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This report is part of the preparatory materials for *The Africa Roundtable*, hosted by Global Perspectives Initiative. Future Africa Consulting is supporting Global Perspectives as a knowledge partner and, as such, authored the report at hand. The report outlines ideas that are intended to provide a factual basis for the Roundtable discussions.

BACKGROUND AND CONTEXT

Food systems significantly shape human diets, health outcomes, environmental sustainability, livelihoods, and economic development. African food systems are in turn shaped by national, continental, and global megatrends. These include a burgeoning middle-class; urbanization and related shifts in food demand; dietary preferences and downstream modernization of food systems; a labor-force shift from farm jobs to non-farm jobs; and increasing scarcity in farmland.¹ These food systems have been plagued by uncoordinated measures and contradictory policies resulting in food insecurity, malnutrition, poverty, and environmental degradation. To address this, the African Union established the African Common Position on Food System for the United Nations Food System Summit 2021, with the Comprehensive Africa Agriculture Development Programme (CAADP)¹ Malabo Declaration on "Accelerated Africa Agriculture Growth and Transformation for Shared Prosperity and Improved Livelihoods."² These commitments presented the opportunity to apply an agri-food systems approach to the continent's existing agricultural and food security efforts.

Despite the African agricultural sector accounting for 42.5% of total employment³, the sector is growing slowly at 2.6% a year, which is marginally lower than the global average of 2.7%, but significantly lower than the targeted 6% yearly set under the CAADP Agenda.⁴ In the past few years alone, Africa's agri-food sector has faced numerous challenges, notably, the global pandemic (COVID-19), and conflicts (including the Russia – Ukraine war) that have deteriorated food security and nutrition. Climate change, population growth and changing dietary preferences further compound these challenges. Since 2000, the continent has made the least progress on SDG 2 (zero hunger)⁵ with about 282 million people across the continent currently facing food insecurity and experiencing undernourishment⁶. Despite being a major source of employment, African agriculture suffers from low productivity with poor crop yield, largely attributed to limited use of inputs such as fertilizer. Global cereal yields of 4.15 tons/ha are more than two-and-a-half times the average African cereal yields (1.63 tons/ha). Post-harvest losses are also remarkably high, ranging between 14.97% and 17.37% for maize in sub-Saharan Africa. Consequently, as of 2021, Rwanda was the only country on-track to achieving the CAADP Malabo commitments by 2025.⁷

Africa's overreliance on imports and food-aid makes the continent susceptible to supply and price shocks, threatening food sovereignty. Despite having 65% of the world's unutilized arable land, over 80% of Africa's basic food imports, comprising of basic and processed foods (mainly wheat, edible oil, maize, and rice), are sourced from outside the continent, and cost an estimated USD 50 billion per year.⁸ Moreover, food-aid initiative policies often undermine the continent's initiatives to produce food locally. The impact of increased dependence on imports and food-aid includes free or cheap imports making local food production less competitive, and consequently, shifting consumer preferences away from local to foreign brands.

¹ CAADP - an Agenda 2063 continental initiative that aims to help African countries eliminate hunger and reduce poverty by raising economic growth through agriculture-led development.

This paper highlights the potential of innovative technologies to improve African agricultural resilience, productivity, and livelihoods. The paper provides a snapshot of agricultural innovations adopted in Africa, discusses the requisites for scaling solutions, and concludes by identifying promising opportunities and offering recommendations for cross-sector stakeholders.

AFRICAN INNOVATION ECOSYSTEM AND ADOPTION

Current efforts to bolster food security across the continent are at various stages of adoption and scale. Widely adopted innovations are being commercialized by distributors and retailers:

Drought Resistant/Tolerant Crops: Plant breeders have developed improved crop varieties to address the issues of heat, drought, pests, and diseases. In Zambia, the International Atomic Energy Agency (IAEA) and the Food and Agriculture Organization of the United Nations (FAO) introduced two new varieties of cowpea - Lunghwakwa and Lukusuzi - developed using irradiation. These varieties exhibited higher yields during drought and demonstrated enhanced resistance to disease and pests compared to native breeds.⁹ Furthermore, as of 2019, over 40 million smallholder farmers in sub-Saharan Africa have adopted over 200 drought-resistant maize varieties.¹⁰ Despite promising uptake, unlike traditional seeds, drought-resistant seeds must be purchased annually to maintain their drought-resistant capabilities, posing a financial barrier for farmers. Additionally, the widespread adoption hinges greatly on access to agricultural extension services. Nonetheless, research¹¹ indicates that the benefits and costs associated with adoption outweigh the drawbacks. The global market for drought resistance crops was valued at USD 110.21 million in 2022 and is expected to grow with a CAGR of 6.57% through 2028.¹²

Solar-irrigation: Solar powered irrigation has proven to be transformative for smallholder farmers as a means to increase agricultural productivity and profitability in sub-Saharan Africa, where rainfall pattern is often erratic and unreliable. In Rwanda, the Solar Irrigation Rwanda (SIR) program resulted in smallholder farmers adopting the technology and achieving a third higher yields. Furthermore, many farmers were able to cultivate crops during the dry season.¹³ Despite these benefits, the adoption of solar-powered irrigation systems in sub-Saharan Africa remains minimal, primarily because current initiatives rely on funding from donors such as European countries, non-governmental organizations, World Bank, and other UN agencies.¹⁴ The main obstacle to widespread commercial adoption includes upfront costs, capital costs, and private discount rates.¹⁵ Consequently, both private investment and public-private partnerships are crucial for achieving adoption on a large scale. The Middle East and Africa solar pumps market was valued at USD 0.18 billion in 2023 and is expected to grow at a CAGR of 13.96% to USD 0.39 billion by 2029.¹⁶

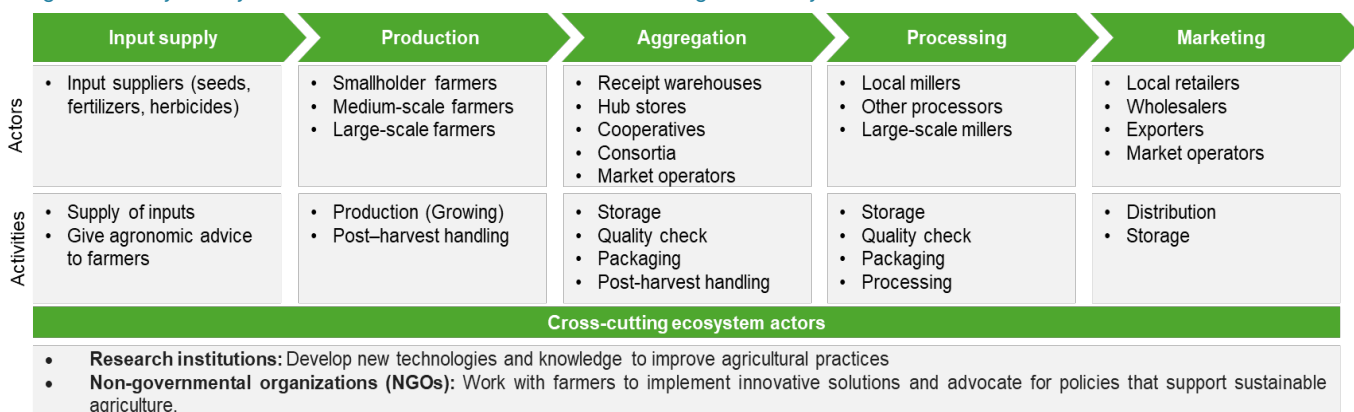
Other innovations gaining traction among early adopters but are currently limited to niche markets and narrow use cases in use by few farmers in Africa:

Hydroponic farming: Hydroponic farming has emerged as an alternative to traditional farming as it reduces water requirements by 80% – 99%. The technique uses a water-based nutrient solution rather than soil to grow plants.¹⁷ In 2018, the World Food Program launched a pilot project for simplified hydroponic crop production in Kenya’s Kakuma refugee camp. The project evidenced hydroponics consumes less water, achieves higher crop yields, and facilitates faster growth rates compared to conventional field agriculture.¹⁸ Hydroponic farming is becoming increasingly popular across numerous African countries, including Kenya, Uganda, Tanzania, Rwanda, Ethiopia, Ghana, and South Africa.¹⁹ However, despite this momentum, the primary obstacle to adoption is the significant initial cost of setting up a hydroponic farming system.²⁰ This includes expenses such as purchasing nutrients, pumps, heating systems, hydroponic drip line, timers, and water systems, among others. Therefore, facilitating patient capital for farmers to secure hydroponic systems and cultivate high-value crops is essential to achieving wide-spread adoption. The Middle East and Africa hydroponics market is estimated to reach USD 91.35 million by 2026 from USD 39.65 million in 2021.²¹

Urban/Vertical farming: Vertical farming practices present farmers with the opportunity to maintain or increase their crop yield by reducing water intensity, thereby conserving resources. This technique stacks crops indoors to monitor climate conditions,²² providing an opportunity to grow crops where land is limited, such as densely populated urban environments.²³ According to a recent study²⁴, countries such as South Africa, Seychelles, Egypt, Mauritius, Morocco, Tunisia, Algeria, Cape Verde, and Nigeria have showed the best prospective for indoor vertical farming implementation. The primary drawbacks of urban/vertical farming are the large investment requirement (infrastructure costs, operational costs, employment of several technologies) and inadequate availability of resources such as energy and water, skilled labor, amongst others.²⁵ Effective collaboration between public and private sector entities is vital for widespread adoption, whereby the public sector sets necessary enabling environment (regulations, incentives, etc.), while the private sector boosts investment into this sector. The vertical farming market size in Middle East and Africa is expected to grow from USD 1.15 billion in 2024 to USD 3.71 billion in 2029.²⁶

Implementation of these innovative technologies depends on the participation of key stakeholders within the agri-food ecosystem. These stakeholders are depicted in the exhibit below:

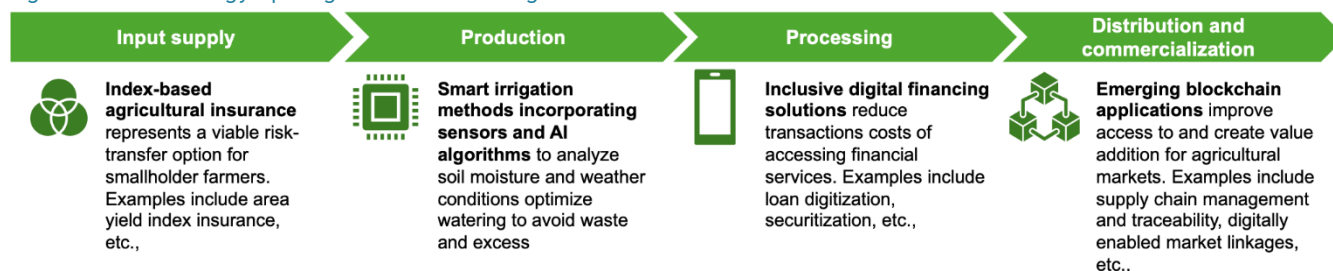
Figure 1: Key ecosystem actors and activities within the agri-food system




TECHNOLOGY SPOTLIGHTS AND USE-CASES

Innovations in climate-resilient production and risk management are transforming African agri-food value chains:


Figure 2: Technology spotlights across the agri-food value chain (non-exhaustive)



 **Index-Based Agricultural (IBA) insurance uses a predefined index to trigger payouts to farmers, enabling a faster and more objective settlement process.**²⁷ The main benefits of IBA are (i) minimization of adverse selection and moral hazard as payout is based on objective indices that neither farmers nor insurers influence, (ii) timeliness of payouts by eliminating the need for individual grower loss assessments, and (iii) reduction of long run administrative costs through standardization and automation of product structures, potentially leading to decreased premiums. The global agricultural insurance market is expected to reach USD 80 billion by 2030, and in 2020, African agricultural insurance premiums were estimated at USD 320 million, representing 1.6% of total African non-life insurance premiums of USD 19,730 million.²⁸

Pula Advisors is an example of an IBA insurance technology company that has successfully insured over 15 million farmers enabling them to protect their livelihoods. In 2022, Pula and APA insurance paid out nearly USD 750,000 in claims to over 13,000 farmers in Kenya who had been affected by drought that had lasted over 4 months. Each farmer received an average of USD 57 having paid less than USD 11 in premiums at the beginning of the agricultural season.²⁹


By focusing on scalability (access or coverage, participation, and operation costs) and sustainability (long-term participation of farmers and long-term management of program), IBA insurance has a significant potential to protect farmers agricultural output and enhance overall resilience.³⁰

 **Smart Irrigation Methods help farmers monitor and optimize their yields through** predictive analytics capabilities for weather conditions and water needs. AI (Artificial Intelligence) algorithms leverage historical data to accurately forecast weather patterns, irrigation requirements, and water availability, aiding farmers in planning planting and harvesting activities and irrigation schedules. AI-driven smart sensors that continuously monitor soil moisture levels enable farmers to establish optimal watering schedules and adapt their irrigation strategies based on crop types, reducing water wastage, and promoting plant

health.³¹ The smart irrigation market for Africa and the Middle East was USD 61.12 million in 2021, and estimated to grow at a CAGR of 16.9%, to reach USD 162.52 million by 2027.³²

SunCulture is an example of a solar water pumping solutions provider for smallholder farmers. A survey of over 150 customers revealed that 76% experienced income growth, primarily from increased crop yields. The improved water management also resulted in reduced costs and the ability to cultivate a wider variety of cash crops. Beyond financial gains, 93% reported an enhanced quality of life, with reliable water supply enabling activities such as home lighting and sanitation improvements. This contributed to improved health and access to nutritious food.³³

Focusing on renewable energy sources, affordability, and user-friendly design can unlock wider adoption and empower a larger base of farmers to improve their agricultural productivity and environmental sustainability.

 **Inclusive Digital Financing Solutions reduce the cost and risk associated with agricultural lending.** For lenders, one-stop digital lending provides the necessary speed to launch digital products by minimizing the proliferation of Application Programming Interfaces (API) at each stage of development.³⁴ This enables lenders to expand their loan portfolio beyond traditional offerings (such as personal loans) and broaden their client base (to include vehicle loans, business loans, etc.). For borrowers in the agricultural sector, a digital loan origination system reduces the cost per application, shortens turnaround time and enhances transparency. Moreover, for the entire ecosystem, it decreases the risk of fraud, such as data misuse or misinterpretation, by incorporating additional layers of verification such as face matches and liveness checks. Unlocking inclusive digital financing solutions could help reduce the annual financing gap of USD 74.5 billion for agricultural SMEs in Sub-Saharan Africa.³⁵

Apollo Agriculture is an agricultural technology company that offers farmers access to agricultural inputs, financing, and advice. In Kenya and Zambia, it has reached over 350,000 farmers,³⁶ improving their livelihoods by facilitating their access to quality inputs and recovering the loans once the produce is harvested. A survey indicates that 89% of sampled Apollo farmers report increased productivity, with 71% expressing significant enhancements since partnering with Apollo.³⁷

The effectiveness of inclusive digital finance relies on a digitally accessible platform that reaches remote farmers via mobile money. Data-driven decision-making enables tailored loan packages, while a farmer-centric approach with harvest-linked repayments enhances impact. Partnerships with input suppliers further strengthen these efforts. Broader implementation also includes the importance of robust digital infrastructure such as mobile money access, coupled with data security and transparency.



Emerging Blockchain Applications improve access to and create value addition for agricultural markets.³⁸

Blockchain technology merges distributed system and cryptography to create a tamper-proof distributed database, ensuring secure and transparent record keeping. Blockchain facilitates commodity tracking along the supply chain, providing traceability. This benefits African farmers, who often face challenges obtaining fair prices for their produce to the complex and opaque nature of commodity supply chains in Africa. Beyond traceability, blockchain advantages include: (i) reduction of overall costs by eliminating the need for third party intermediaries, (ii) enhancing security by storing information across a decentralized network, making hacking extremely challenging, and (iii) streamlining transactions without the requirement for third-party approval.³⁹ The global blockchain in agriculture and food supply chain market was calculated to be USD 133 million in 2020 and is expected to reach USD 948 million in 2027.⁴⁰

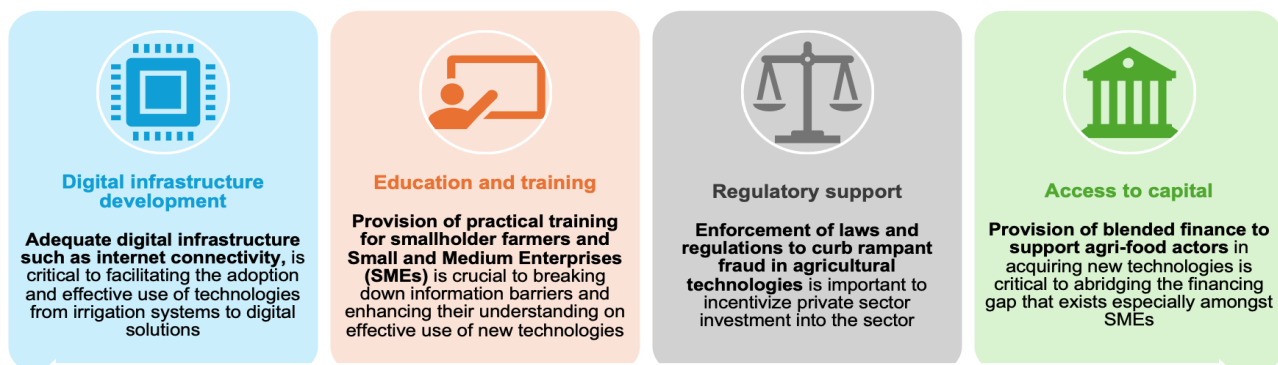
The Food and Agriculture Organization (FAO) and the Ministry of Agriculture, Animal Industry and Fisheries of the Republic of Uganda (MAAIF) led a project aimed at developing knowledge on different potential applications of blockchain and other digital technologies to improve access to and create value addition for agriculture markets. At least 35 examples of applications of blockchain technologies were developed in support of value chains, including digitally enabled market linkages, supply chain management and traceability targeting coffee, tea, and fisheries value chains. For example, the project investigated the application of blockchain technologies to create traceability for off takers within the coffee value chain. During phase 2 of the project, blockchain will be piloted in two value chains, including aquaculture.⁴¹

Effective adoption of blockchain technology is dependent on adequate legal and physical infrastructure. Identifying key governing principles such as regulatory requirements, key stakeholders, legal framework, interoperability with existing systems, amongst others, is crucial.⁴² Determining the appropriate technology or architecture to address these challenges is essential for the uptake of blockchain technology in agriculture.

SCALING SOLUTIONS

Pre-conditions and practices for scaling uptake and application of technologies in the agri-food value chain are depicted in the figure below and detailed in the subsequent paragraphs.

Figure 3: Pre-conditions and practices to scaling solutions



Digital infrastructure development is critical in facilitating the adoption and effective use of agricultural technologies. The availability and use of digital technologies is strongly linked to economic growth, innovation, job creation, and inclusion, and sub-Saharan Africa trails significantly behind other regions in digital infrastructure coverage, access, and quality.⁴³ This is particularly evident in the agri-food sector, where inadequate connectivity to last mile rural areas hinders access to agricultural technologies such as smart irrigation and digital financing solutions. Private sector driven cost-effective solutions are essential to stimulate innovation in this areas.

Increasing awareness of agricultural technologies through education and training to smallholder farmers and SMEs is crucial in scaling solutions. Information barriers prevent the uptake of agricultural technologies. Training programs offer insights into the technology's existence, benefits, effective utilization, and address behavioral barriers that might create resistance.⁴⁴ This knowledge enables smallholder farmers and SMEs to make informed decisions about which smart agricultural technologies to adopt, ensuring agricultural productivity and promoting food security. In addition to this, training programs that focus on upskilling and reskilling help bridge the skills gap for adoption.

Supportive policies can promote integrity in agricultural technologies. Fraud in agricultural technology occurs through unauthorized use of IP technology and sale of counterfeit products such as fertilizer and pesticides, diluted chemicals, etc.⁴⁵ Government enforcement of laws and regulations is crucial in curbing fraud as it incentivizes private sector investment into commercialization.

There is significant potential for increased investment in food systems across Africa. African governments allocated less than 10% of their budgets in the agricultural sector, and in most countries, agricultural investment represented less than 5 percent of the total credit portfolio volumes.⁴⁶ This underinvestment leaves many food systems actors, particularly smallholder farmers and SMEs unable to access finance, limiting their capacity to adopt new technologies and hindering their growth and contribution to sustainable food systems. To address these dynamics, African governments need to strategically use development and public finance (blended finance) for the mobilization of additional finance towards the agricultural sector using various instruments such as credit facilities, guarantees, and grants.

OPPORTUNITIES TO SUPPORT INNOVATION AND APPLICATION

The agricultural technologies discussed in this paper offer numerous opportunities to capitalize on transformative trends in the sector:

Index-based insurance products: The chance that farmers with insurance will suffer losses but not receive any compensation is a primary obstacle to the successful commercialization of index insurance. Many agricultural insurance indices are based on satellite measurements of average vegetation cover across pixels of 250 square meters. However, in developing nations,

where the average farm spans about only 2ha and is more dispersed, these low-resolution measurements could fail to distinguish between different vegetation types or non-farmland. **AI-powered drone technology** has the potential to provide more accurate measurements/images of crops, decreasing the margin of error associated with basis risk. Relevant actors in this innovation area include: [Pula Advisors](#), [Acre Africa](#), and [Oko Finance](#).

Smart irrigation: The absence of basic infrastructure - reliable electricity supply, connectivity, and adequate communication networks hampers the seamless functioning of irrigation systems in rural areas. Public-private partnerships (PPPs) provide an opportunity to bring the additional investment needed to build public infrastructure and serve as a mechanism for improving planning, implementation, operation, and maintenance. Relevant actors in this innovation area include [SunCulture](#), [Agrico](#), and [Solargen](#).

Inclusive Digital financing: Identifying the key attributes of target populations and designing specifically for their needs has **high capital costs** for digital companies building inclusive user-centered products. Investment in early-stage **Research and Development (R&D)**, customer profiling, and initial design is critical for segmentation and customer-focused design. Relevant actors in this innovation area include [Apollo Agriculture](#), [SunCulture](#), [Emata](#), and [EzyAgric](#).

Blockchain technologies: Technical complexity in integrating blockchain technologies into agricultural technology solutions limits scalability and adoption. Investment in R&D and creating awareness of these technologies can explore effective ways to integrate blockchain and assess the feasibility and impact of the solutions. Relevant actors in this innovation area include [Dimitra](#), [Farmshine](#), and [AgUnity](#).

Weather prediction: Data scarcity and quality pose a challenge in developing tools that provide accurate and reliable weather forecasting. Integrating AI into weather forecasting can be valuable as AI systems can make precise and accurate predictions leveraging large data sets and making inferences from them.⁴⁷ Collaboration with governments, research institutions and NGOs can also foster sharing of resources and expertise to develop and scale these tools. Relevant actors in this innovation area include [Ignitia](#) and [Salient Predictions](#).

Artificial Intelligence: Data quality and quantity as well as data privacy concerns limit the accuracy and granularity of data from AI and slow the uptake of these solutions. Investing in data collection networks and data quality, as well as enforcing regulations protecting data privacy is essential in furthering the use of AI in agricultural technology solutions. Relevant actors in this innovation area include [Dimitra](#), [MkulimaSasa](#), and [Re-basket](#).

RECOMMENDATIONS FOR STAKEHOLDERS

Distinct responsibilities for the public, private and development sectors could facilitate the adoption of these promising opportunities:

The public sector plays the critical role of creating an enabling environment that fosters innovation in agricultural technology and enhances accessibility for a more productive and sustainable agricultural future. Concrete actions for the public sector include:

- **Facilitating digital transformation:** The digital agricultural revolution in Africa holds promise for boosting productivity, lowering transition costs, and mitigating information asymmetries across Africa's food systems. However, the intentional creation and maintenance of an enabling environment is needed to accelerate the pace of investment in communication infrastructure.⁴⁸ This can be achieved through lowering the barriers of entry for agricultural technology entrepreneurs, digital financial service providers, telecommunication service providers, etc., thereby boosting the number of innovators, creating jobs, and lowering end-user costs.
- **Easing access to finance:** Governments have a significant role to play in shaping the financial market system and making sure it works for everyone. Governments worldwide are increasingly adopting financial inclusion as a policy objective, recognizing its capacity for fostering economic growth and reducing poverty, and acknowledging supply- and demand-side barriers, along with inadequate regulatory frameworks as key challenges.⁴⁹ African governments can emulate this approach by fostering a conducive financial market, encouraging (i) agri-food innovations through incentives for product pioneers, and (ii) end-users with subsidies to boost adoption rates.
- **Stimulating demand through education:** African agriculture is dominated by SMEs. To realize their potential as suppliers, investors, and employees while effectively managing risks, SMEs need to be equipped with entrepreneurial knowledge and skills that enhance their capability to adopt agricultural technologies. African governments can enhance education and training for this demographic by partnering with the development and private sector to tailor courses, establish networks, and stimulate demand for agricultural technologies.
- **Enforcing consumer protection laws:** Establishing a conducive environment for agricultural technology innovation, while simultaneously enforcing regulatory measures to safeguard end-users necessitates a delicate equilibrium. African governments bear the duty of safeguarding the intellectual property rights of innovators, while also protecting farmers and enterprises from exploitation.

The Private Sector is the driving force behind agricultural technology. Private funding accounts for nearly 90% of financial flows into developing nations, while concurrently generating nine out of every ten jobs within these economies.⁵⁰ The primary initiatives that the private sector should pursue include:

- **Technology transformation:** The primary obstacle to widespread adoption of agricultural advancements aimed at sustainable productivity enhancement remains

affordability. Hence, it is imperative for the private sector to persistently allocate resources to R&D focused on reducing the cost barriers associated with these innovations, thereby rendering them accessible to smallholder farmers and SMEs. This not only increases innovation access but also generates job opportunities for skilled African labor.

- **Establishing partnerships:** While innovation forms the basis for agricultural technologies, building strategic partnerships with a diverse range of stakeholders transforms these solutions from mere concepts and tools to widespread adoption within the industry. Private organizations play crucial roles in forging strategic partnerships to enhance impact. This includes collaborating with Savings and Credit Co-operatives (SACCOs) and cooperatives for digitalization, partnering with the public sector for research and infrastructure development, engaging with development institutions for capacity building and financial services provision.
- **Knowledge sharing:** Implementation of agricultural technology requires a collaborative environment where knowledge flows freely between stakeholders, thereby fueling innovation and widespread adoption. Private companies have the potential to significantly contribute to knowledge dissemination by establishing platforms where farmers can exchange best practices and troubleshoot issues.

The Development Sector supports the implementation and uptake of initiatives by farmers.

Activities that development organizations can undertake include:

- **Capacity building:** For successful implementation of solutions, farmers and other stakeholders require training and upskilling on efficient usage of innovative technologies. The development sector can facilitate capacity building by offering training programs on digital tools, financial management, and risk assessment. Enhancing the skills of current actors in the ecosystem is vital for them to meet the demands of an increasingly technology-driven sector.
- **Policy Advocacy:** Policy advocacy contributes to the creation of a conducive environment for the development and adoption of agricultural technology. Development organizations can advocate for policies that establish an inclusive regulatory landscape, promoting the development of new innovations, constructing digital and physical infrastructure, and fostering sustainability and equity within the industry.
- **Easing access to finance:** Financial institutions often avoid lending to smallholder farmers due to the perceived high risks associated with their business. Development institutions can mitigate this by providing grants and guarantees to expand funding opportunities. For example, they can offer credit facilities through collaboration with banks to reduce their risk and increase lending to farmers considered risky otherwise.

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