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Artificial Intelligence in Sub-Saharan Africa

Agriculture Report

Contents

1.

Executive Summary

AI Could Save Sub-Saharan Africa from Food Insecurity

In March 2023, Enipher Jailosi, a 35-year-old farmer from Malawi, stood helpless in the aftermath of **Cyclone Freddy**. The storm's powerful winds and heavy rains had devastated her farmland, washing away her freshly planted maize crop and leaving behind a landscape of mud. Her livelihood had been destroyed, and she had no way to feed her family.

Enipher's story is not unique. In sub-Saharan Africa (SSA), agriculture employs over **52% of the workforce**, around 230 million people. In 2022, agriculture accounted for **17% of the region's GDP**, producing nearly 100 million metric tons of staple crops such as maize, rice, and wheat. Yet, despite these figures, about 237 million people in the region remain chronically undernourished, highlighting deep challenges in food production. Furthermore, 20% of the population faces the threat of hunger, with **868 million people** experiencing moderate to severe food insecurity. In Nigeria, **25% of the population** (some 50 million people) face varying degrees of hunger.

The situation, dire as it already is, threatens to worsen without intervention. **Climate change** is causing havoc, with extreme weather events, like the cyclone that ravaged Enipher's farm, impacting millions of smallholder farmers. Years of poor agricultural practices have degraded the soil, while crop diseases and pests frequently strike without warning, leaving farmers powerless to defend their crops. The average cereal **yield** in Sub-Saharan Africa is around **1,500 kg/hectare**, compared to the world average of about **3,900 kg/hectare**. The best countries in the world exceed 10,000 kg/hectare, almost **7X better**.

The **growing population**, which has increased by over 2.3% annually since 2000, adds further pressure on an already strained agricultural system. By 2050, **1 in 4** people on the planet will live in Africa. If left unchecked, this combination of population growth and agricultural challenges could lead to widespread **hunger and famine** throughout the region.

But there is **hope**, and it comes in the form of **artificial intelligence** ("AI"). AI could be the solution to turning this bleak picture around, providing the tools and information needed to empower millions of smallholder farmers across Africa. **60% of the world's remaining arable land lies in Africa**, so this represents an enormous opportunity. And AI is likely to be extremely transformative to SSA agriculture:

- Huge upside potential since efficiency and yield levels are so low. If SSA just reached the global average yield levels, it would produce **208 million tons** of cereals compared to the **80 million tons** it produced in 2023. It is estimated that approximately **70 million more tons** of cereal crops are required each year to ensure that nobody in the region experiences hunger.

52%

of the workforce are employed by agriculture

17%

of the region's GDP was accounted for by agriculture in 2022

868

million people experience moderate to severe food insecurity

1 in 4

people on the planet will live in Africa by 2050

60%

of the world's remaining arable land lies in Africa

1,500

The average yield (in kgs) per hectare for cereal crops across the region

VS

3,900

The world average (leading countries manage 10,000 kg/ha)

- No entrenched legacy systems that need to be replaced
- Very urgent need for something to avoid disaster

1.1 Key Findings

AI is already revolutionising farming practices in the region by:

- Enabling **precision farming** techniques that can help smallholder farmers boost their yields and efficiency. AI-powered tools are analysing satellite images, sensor data, and weather forecasts and providing real-time, hyper-local recommendations for farmers.

  In Ghana, **Esoko** already uses mobile apps to provide farmers with weather updates, market prices, and farming advice, helping them make informed decisions.

- Using AI models trained on large datasets of crop images to **detect and diagnose plant diseases and pests** with high accuracy, allowing farmers to intervene early and prevent massive crop losses. Early detection is critical for maintaining food security.

  An exciting example of this use case in action is the work of Esther Kimani from Kenya, who, in June 2024, won the Royal Academy of Engineering's Africa Prize for Engineering Innovation. Her invention, a solar-powered device from **Farmer Lifeline Technologies**, detects pests and diseases in crops and sends SMS alerts to farmers and agricultural 4 authorities. Smallholder farmers can rent the device for just $3 a month, which captures images and sends them to an AI engine that recognizes pests or diseases. The AI not only alerts farmers but also advises them via SMS on how to eliminate the threat.

- Optimising **agricultural supply chains** by predicting demand, managing inventory, and improving delivery logistics. This reduces food waste and ensures that produce reaches markets efficiently, helping farmers get the best price for their crops.

  TradeBuza offers a digital platform that enhances the management of out-grower schemes and commodities trade in Nigeria. Amongst other services, TradeBuza's CropGate platform aids exporters and commodity aggregators in streamlining their supply chain operations through efficient tracking and optimization tools.

- Providing far better and wider reaching **credit scoring** models, that are unlocking access to **credit** and **insurance** for a much larger pool of smallholder farmers.

1.2 Key Challenges

Yet, despite the promise of AI, significant **challenges** remain. In many parts of Africa, access to **localised data** is limited, and data collection is inconsistent. **Infrastructure constraints**, such as poor internet connectivity and lack of electricity, further hinder the implementation of AI solutions. The **high cost** of importing technology, coupled with expensive access to the digital platforms required for AI, makes it difficult for smallholder farmers to take advantage of these innovations.

In addition, there is a lack of **digital literacy** in many African countries, with low smartphone penetration and poor cellular coverage in rural areas. AI development itself faces obstacles, as there are few **region-specific models** to address the unique agricultural systems found in Africa, which are often fragmented and dominated by smallholder farmers.

Environmental factors, such as climate unpredictability, and regulatory barriers also present hurdles. Few countries in the region have clear digital agriculture policies, and there is limited funding for local AI initiatives. **Cultural resistance** to technology adoption and difficulty translating AI insights into practical actions for farmers further complicate the situation.

1.3 Recommendations

To overcome these challenges, governments and policymakers must step in to create **supportive AI regulations** and coordinate funding to address infrastructure deficits. While data privacy laws are in place in many countries, more needs to be done to focus on AI. **Coordinated efforts** across the region are essential to **scale** the innovative solutions already in place and ensure that more smallholder farmers can benefit from these incredible advances. Bold and far-thinking **leadership** will be required to guide and stimulate this development.

At this critical juncture, **AI offers a way forward** for African agriculture. By harnessing its power, the region can build a future where farmers like Enipher Jailosi no longer face devastation after every storm but instead are forewarned of impending threats and are **productive** enough to not just feed their families but to sell their excess production for a profit.

2.

The Evolution of Agriculture

2.1 Understanding the Value Chain

The evolution of agriculture has been marked by significant technological advancements that have transformed farming practices over millennia. Initially, agriculture was characterized by subsistence farming, where early humans used rudimentary tools like sticks and stones to plant seeds. The introduction of the plough around 3000 BCE marked a pivotal moment, allowing for more efficient soil cultivation and significantly increasing crop yields. This era laid the foundation for subsequent agricultural innovations, particularly during the Agricultural Revolution in the 18th century, which saw the mechanization of farming with inventions like Jethro Tull's mechanical seed drill and improvements in crop rotation and livestock breeding techniques. These advancements were driven by rising food demand, due to population growth, and the desire for improved living standards, ultimately leading to a more productive agricultural system.

THE AGRICULTURAL VALUE CHAIN

The agricultural value chain consists of the following key steps:

1. Inputs

This stage involves the supply of agricultural inputs like seeds, fertilizers, irrigation systems, and farm equipment. Innovations in inputs are crucial for improving productivity and quality of farm products. Water is vital input and access to regular supplies of it is often an impediment to smallholder farmers.

2. Growing/Production

The production stage includes planting, growing, and harvesting crops or raising livestock. Farmers face both controllable factors (e.g. pest management) and uncontrollable factors (e.g. weather) during this stage.

3. Processing and Packaging

After harvesting, agricultural products may undergo processing, sorting, grading, and packaging to prepare them for consumption or further distribution. Processing can add significant value to raw commodities.

4. Storage and Distribution

Perishable goods need to be stored properly to preserve quality. Storage facilities shield products from deterioration until they are ready for consumption. Efficient transportation infrastructure is critical for delivering goods from farms to markets.

5. End Markets

Agricultural products reach end consumers through various market channels, including:

- Local retail markets
- Wholesale markets
- Exports to international markets
- Direct sales to consumers

> The evolution of agriculture, from subsistence farming to the introduction of key technologies like the plough and irrigation systems, has profoundly shaped the agricultural value chain over time.

These early developments facilitated the domestication of plants and animals, enabling population growth, the establishment of trade networks, and the emergence of specialised roles within the value chain. The surplus production enabled by improved land cultivation and water management fostered trade and the rise of market systems, integrating agricultural producers with consumers and creating more complex value chains. These transformations laid the foundation for modern agricultural practices, emphasising efficiency, specialisation, and trade, which continue to influence modern agricultural value chains.

2.2 Recent technological developments: improvements across the value chain

The 20th century ushered in a new phase known as the **Green Revolution**, characterised by the development of high-yielding crop varieties, synthetic fertilizers, and advanced irrigation techniques. This period dramatically increased food production and helped alleviate hunger in many parts of the world. The advent of **precision agriculture**, or Agriculture 3.0, introduced technologies such as GPS and data analytics, enabling farmers to optimise resource use and improve crop management. Today, we are witnessing **Agriculture 4.0**, which incorporates connected farming technologies like IoT, drones, and autonomous machinery, enhancing decision-making through data-driven insights. As we move into Agriculture 5.0, **digital farming technologies** are set to further revolutionise the sector, focusing on maximising efficiency and sustainability through advanced data collection and analysis methods.

2.3 How has Agriculture in sub-Saharan Africa fared?

Agriculture in sub-Saharan Africa faces significant challenges that have led to low productivity, food insecurity, and rural poverty.

Key issues include:

1. Low Agricultural Productivity

Crop yields are significantly lower compared to other regions due to stagnation in yield improvement and reliance on expanding agricultural land, leading to environmental degradation. It is estimated that this region operates at yields one sixth those of the commercial farms in the Global North.

2. Soil Degradation and Resource Management

Declining soil fertility due to erosion and lack of biomass, exacerbated by high prices and shortages of agricultural inputs, resulting in a drop in productivity.

3. Economic and Policy Constraints

Persistent poverty, urban bias in development programs, and inadequate rural public goods hinder agricultural growth.

4. Climate Change and Environmental Vulnerability

Frequent droughts, floods, and reliance on rain-fed agriculture increase food insecurity, further exacerbated by external factors (like the COVID-19 pandemic).

5. Social and Structural Challenges

Gender inequality, low education levels, and health crises contribute to a lack of investment in agricultural research and extension services.

2.4 Could Artificial Intelligence help?

AI has the potential to revolutionise Agriculture in sub-Saharan Africa by addressing obstacles all along the value chain and bringing advanced technology to bear.

Imagine if:

- AI-powered **precision farming** techniques could help smallholder farmers dramatically increase their yields and efficiency. If AI algorithms could analyse satellite imagery, sensor data, and weather forecasts to provide farmers with real-time, hyper-local recommendations on optimal planting times, fertilizer application, irrigation scheduling, and pest management.

- AI models trained on large datasets of crop images could automatically **detect and diagnose plant diseases and pests** with high accuracy. This would enable early intervention to prevent crop losses. Rapid disease detection is critical for food security.

- AI could help **optimize agricultural supply chains** by predicting demand, managing inventory, and routing deliveries. This would reduce food waste and ensure produce reached markets efficiently.

3.

Exploring the Opportunity Landscape

THE AGRICULTURAL VALUE CHAIN

> Across the Agricultural value chain, start-ups have found ways to reduce costs and increase productivity for both smallholder farmers and commercial agriculture alike.

The challenges facing Agriculture in the region are plentiful and extend right across the value chain. Businesses have found ways to address many of these challenges using AI, but some remain unsolved due to their extremely physical or specific nature, for example, the state of the roads and the infrastructure. Produce still needs to get from farm to market via some form of physical transportation.

These challenges can be explained more fully by looking across each step of the value chain:

3.1 Inputs

1. Limited Access to Improved Seeds and Fertilizers

- Smallholder farmers have limited access to high-yielding crop varieties and hybrid seedsdue to underdeveloped seed systems and distribution networks.
- Fertiliser use in sub-Saharan Africa is the lowest in the world, with only 8-15 kg of nutrients applied per hectare, compared to a global average of 100 kg/ha. High prices, lack of availability, and inadequate infrastructure constrain fertiliser use.

Average fertilizer use in sub-Saharan Africa:

8-15kg/ha

VS

Average fertilizer use globally:

100kg/ha

Irrigated farmland in sub-Saharan Africa:

<4%

VS

Irrigated farmland in South Asia:

37%

2. Inadequate Irrigation and Water Management

- Less than 4% of cultivated land in sub-Saharan Africa is irrigated, compared to 37% in South Asia. Reliance on rainfed agriculture makes farmers vulnerable to climate variability.
- Lack of investment in water storage, distribution systems, and on-farm water management limits irrigation potential.

3. Underdeveloped Input Markets and Supply Chains

- Weak infrastructure, high transaction costs, and lack of competition in input markets reduce availability and increase prices of seeds, fertilisers, and other inputs.
- Inefficient input supply chains, with limited private sector participation, constrain the flow of inputs to farmers.

4. Limited Access to Credit and Finance

- Smallholder farmers have limited access to credit to purchase inputs due to lack of collateral, high transaction costs, and perceived risks by financial institutions.
- Underdeveloped rural financial systems and lack of tailored financial products for agriculture restrict farmers' ability to invest in productivity-enhancing inputs.

5. Weak Agricultural Research and Extension Systems

- Public agricultural research and extension systems are underfunded and have limited capacity to develop and disseminate appropriate technologies for diverse farming systems.
- Weak linkages between research, extension, and farmers limit the relevance and uptake of new technologies.

3.2 Growing / Production

1. Environmental Challenges

- **Climate Change**
  One of the most pressing issues is climate change, which poses a severe threat to agricultural production. Sub-Saharan Africa's agriculture is predominantly rainfed, making it highly susceptible to variations in rainfall patterns, extreme weather events, and rising temperatures. The region's reliance on climatic factors for farming means that any disruption can lead to decreased crop yields and livestock productivity. For instance, higher temperatures and changes in forage availability can adversely affect livestock farmers, while crop farmers face challenges in adapting to these climatic changes due to limited resources and inadequate infrastructure.

- **Land Degradation**
  Land degradation is another critical challenge. Unsustainable farming practices, deforestation, and overgrazing have led to soil erosion and loss of fertility, further exacerbating food insecurity. It is estimated that if current trends continue, more than half of the cultivated agricultural area in Africa could be lost by 2050 due to land degradation. This degradation not only reduces agricultural productivity but also threatens the livelihoods of millions who depend on farming.

1. Social Challenges

- **Smallholder Farmer Support**
  Smallholder farmers, who constitute the majority of agricultural producers in sub-Saharan Africa, often face challenges related to training and support. There is a significant gap in agricultural education and extension services, which are necessary for farmers to adapt to new technologies and practices. Without proper training, farmers struggle to improve their productivity and resilience against climatic shocks.

- **Governance and Institutional Issues**
  Governance and institutional shortcomings also play a role in the challenges facing agriculture in the region. Political instability, corruption, and inadequate policy frameworks can hinder effective agricultural development. Efforts to promote sustainable agricultural practices and support smallholder farmers are often undermined by inconsistent policies and lack of coordination among stakeholders.

3.3 Processing and Packaging

1. Limited Availability and High Cost of Packaging Materials

Often when packaging materials are available in Sub-Saharan Africa, they are of poor quality and/or prohibitively expensive for small and medium-sized agro-enterprises (SMAEs). The limited supply and high costs make it difficult for farmers and processors to package their products effectively to reduce spoilage and extend shelf life.

2. Lack of Knowledge on Packaging Technologies and Standards

There is generally limited knowledge across the region on appropriate packaging technologies, product standards, and certification requirements. This lack of capacity makes it hard for SMAEs to package their products to meet market requirements and consumer expectations.

3. Inadequate Investment in Packaging Systems

There is a dearth of investment in modern packaging systems by both the public and private sectors in Sub-Saharan Africa. Without sufficient capital to upgrade packaging infrastructure and equipment, the region's agro-processing industry remains uncompetitive.

4. Plastic Packaging Bans Without Alternatives

Some countries have banned plastic packaging without ensuring alternative sources of food packaging are available for SMAEs or developing strategies to identify and promote suitable replacements. This has left many agro-processors without affordable and accessible packaging options.

5. Lack of Packaging Expertise and Training

There is a shortage of packaging experts and limited training opportunities for agro-processors in Sub-Saharan Africa on appropriate packaging technologies and best practices. This skills gap constrains the ability of SMAEs to package their products effectively.

6. Inadequate Cold Storage and Transport

Poor cold storage facilities and unreliable transport infrastructure exacerbate the challenges of packaging in Sub-Saharan Africa. Without proper refrigeration and efficient logistics, even wellpackaged perishable products can spoil rapidly.

3.4 Storage and Distribution

1. Infrastructural Challenges

One of the primary obstacles in the storage and distribution of agricultural products in sub-Saharan Africa is the lack of adequate infrastructure. Many rural areas suffer from poor road networks, which complicates the transportation of goods from farms to markets. This results in high transportation costs and delays, leading to increased post-harvest losses. Inadequate storage facilities further exacerbate the situation, as farmers often lack access to modern storage solutions that can help preserve the quality of their produce. As a result, a significant portion of harvested crops is lost due to spoilage and pest infestations before reaching consumers.

2. Economic Constraints

The economic landscape in sub-Saharan Africa presents additional challenges. Many farmers operate on a small scale, with limited capital to invest in necessary storage and distribution technologies. This financial limitation restricts their ability to adopt modern practices that could improve efficiency, such as refrigerated transport or advanced storage systems. Furthermore, the high costs associated with these technologies often deter investment, perpetuating a cycle of inefficiency and loss. The region's agricultural sector is also characterised by low levels of mechanisation, with most farmers relying on manual labour and traditional methods, which are less effective in managing post-harvest processes.

96%

of agricultural land in sub-Saharan Africa is dependent on rainfall

- **Dependence on Rainfed Agriculture**
  The reliance on rainfed agriculture further complicates storage and distribution issues. With 96% of agricultural land in sub-Saharan Africa dependent on rainfall, the variability in weather patterns leads to inconsistent harvests. This unpredictability not only affects the quantity of produce available for storage and distribution but also impacts the farmers' income, making it difficult for them to invest in better storage facilities or distribution networks. The lack of irrigation infrastructure means that many farmers cannot produce surplus crops that could be stored for future sales, leading to a reliance on immediate sales and further losses during peak harvest times.

3. Post-Harvest Losses

Post-harvest losses are a significant concern in sub-Saharan Africa, with estimates suggesting that between 30% to 40% of food produced is lost before it reaches consumers. These losses are attributed to inadequate storage facilities, poor handling practices, and insufficient transportation options. The lack of effective supply chain management exacerbates these issues, as farmers often lack the knowledge and resources to implement best practices in post-harvest management. Consequently, the region remains a net importer of food, despite its agricultural potential, which places additional strain on foreign exchange reserves and food security.

4. Policy and Institutional Support

Lastly, the challenges in storage and distribution are compounded by limited public investment and institutional support. There is often a lack of coherent policies that address the specific needs of the agricultural sector, particularly in enhancing storage and distribution capabilities. Public investment in infrastructure, research, and development is crucial for creating a more robust agricultural system that can withstand the challenges posed by climate change and market fluctuations. Without such support, the potential for agricultural growth in sub-Saharan Africa remains largely untapped.

3.5 End Markets

1. Market Access and Infrastructure

Farmers in sub-Saharan Africa often struggle to access markets due to inadequate infrastructure, such as poor roads and insufficient storage facilities. This leads to high post-harvest losses, which can reach up to 40% for certain crops. The lack of reliable transport systems further exacerbates the issue, making it difficult for farmers to reach urban markets where demand is higher. Consequently, many smallholder farmers are compelled to sell their products at lower prices in local markets, limiting their profitability and ability to invest in better farming practices.

2. Price Volatility and Market Information

Price volatility is a significant concern for farmers, who often lack access to timely market information. This uncertainty can deter investment in production, as farmers may not be able to predict the profitability of their crops. Additionally, the dominance of middlemen in the supply chain often results in farmers receiving a smaller share of the final sale price, further diminishing their income. The absence of organised market structures and cooperatives makes it challenging for farmers to negotiate better prices for their products.

3. Dependence on Traditional Crops

Many farmers in sub-Saharan Africa rely on traditional staple crops, which limits their exposure to more lucrative markets. The focus on subsistence farming often means that farmers do not diversify their production to include high-value crops that could fetch better prices in local and international markets. This lack of diversification can lead to food insecurity, as farmers are vulnerable to crop failures and price shocks in staple foods.

Post-harvest losses for farmers in sub-Saharan Africa can reach up to

40%

4. Gender Disparities

Women play a crucial role in agriculture in sub-Saharan Africa, yet they face numerous barriers in accessing end markets. Cultural norms and limited access to resources such as land, credit, and information hinder their ability to participate fully in agricultural value chains. This gender disparity not only affects women's livelihoods but also limits overall agricultural productivity and economic growth in the region.

5. Global Competition and Trade Policies

Sub-Saharan African farmers often compete with imported agricultural products, which can be cheaper due to subsidies in developed countries. This competition is intensified by trade policies that favour imports over local production, undermining the profitability of local farmers. The influx of cheap agricultural goods can lead to a decline in local production, further exacerbating food insecurity and economic challenges in the region.

6. Climate Change and Environmental Factors

Climate change poses a significant threat to agriculture in sub-Saharan Africa, affecting crop yields and market stability. Erratic weather patterns, such as droughts and floods, can devastate harvests, leading to decreased supply and increased prices in the end markets. Farmers often lack the resources and knowledge to adapt to these changes, which further complicates their ability to engage effectively in the market.

4.

Global Innovations in Agricultural AI

The global agricultural sector is experiencing a significant transformation through the integration of innovative AI solutions. These technologies are enhancing productivity, sustainability, and resource management.

Here are some of the most innovative AI solutions currently making an impact in agriculture:

4.1 Innovative AI Solutions in Agriculture

1. Precision Agriculture

OVERVIEW

Precision agriculture employs AI to analyse data from various sources, such as satellites and drones, to monitor crop health and soil conditions.

KEY INNOVATIONS

- **Real-Time Monitoring**
  Sensors collect data on soil moisture, temperature, and nutrient levels, allowing farmers to make informed decisions about irrigation and fertilization.
- **Automated Irrigation Systems**
  AI algorithms optimise water usage by determining the precise amount of water needed, based on real-time data, promoting sustainability and reducing waste.

2. Autonomous Machinery

OVERVIEW

The use of AI-powered autonomous machinery is revolutionising farming operations by automating tasks such as planting, harvesting, and weeding.

KEY INNOVATIONS

- **Weeding Robots**
  Companies like **FarmWise** have developed robots that utilise computer vision to identify and remove weeds without harming crops, significantly reducing the need for chemical herbicides.
- **Drone Technology**
  Drones equipped with AI analyse crop health from above, providing insights into pest infestations and nutrient deficiencies.

3. Predictive Analytics

OVERVIEW

AI systems analyse historical data to predict future agricultural trends, helping farmers anticipate challenges such as pest outbreaks or adverse weather conditions.

KEY INNOVATIONS

- **Crop Threat Detection**
  Start-ups like **Taranis** employ high-resolution imagery combined with AI to detect potential threats to crops early, allowing for timely interventions.
- **Yield Prediction Models**
  AI tools can forecast crop yields based on various factors, enabling better planning and resource allocation.

4. Smart Greenhouses

OVERVIEW

AI is used in smart greenhouses to optimise growing conditions by automatically adjusting environmental factors such as light, humidity, and temperature.

KEY INNOVATIONS

- **Automated Climate Control**
  Systems utilise sensors and AI algorithms to create optimal growing conditions for plants, improving growth rates and resource efficiency.

5. Disease and Pest Management

OVERVIEW

Machine learning algorithms analyse vast amounts of data to identify patterns that indicate disease outbreaks or pest infestations.

KEY INNOVATIONS

- **Early Detection Systems**
  AI can monitor crop health through computer vision technologies that identify symptoms of diseases or pest damage before they become widespread.

6. Supply Chain Optimisation

OVERVIEW

AI enhances agricultural logistics by improving supply chain management from farm to market.

KEY INNOVATIONS

- **Traceability Solutions**
  Digital technologies track produce throughout the supply chain, ensuring quality control and timely delivery.

7 Edge AI for Sustainable Practices

OVERVIEW

Edge AI enables real-time data processing at the source (e.g., on-farm sensors) rather than relying on cloud computing.

KEY INNOVATIONS

- **Resource Efficiency**
  This technology allows for immediate decision-making based on local conditions, improving the efficiency of resource usage while minimising environmental impacts.

5.

What Will It Really Take in Sub-Saharan Africa?

The Roadblocks and Potential Solutions

Many of the global leading edge use cases listed above are already being trialled or rolled out in sub-Saharan Africa. The gaps are not as significant as one might have expected, especially when the comparison is made at the smallholder farmer level. However, that being said, using AI in agriculture in sub-Saharan Africa presents several technical roadblocks, ranging from infrastructure and technological limitations to issues related to data and capacity.

The key technical challenges include:

5.1 Limited Access to Data

- **Lack of localised data**
  AI models require large, accurate datasets for training, but sub-Saharan Africa often lacks extensive agricultural data like soil health, weather patterns, crop types, and yields. Without localised data, it is challenging to develop models suited to local farming conditions.
- **Inconsistent data collection**
  In many rural areas, data collection methods are either outdated or inconsistent, leading to gaps in available information.

SOLUTIONS

- **Invest in Localised Data Collection**
  Governments and private companies can collaborate to build open data platforms where data from local farms, weather stations, and other relevant sources are collected and shared. Crowdsourced data collection from farmers, using mobile apps, could also help gather on-the-ground insights.
- **Satellite and Drone Technology**
  Encouraging investment in satellite imaging and drone technologies can help gather critical data on soil health, crop growth, and pest outbreaks, even in remote regions. Governments can subsidise access to these technologies for smallholder farmers.
- **AI for Data Synthesis**
  Develop AI models that can work with sparse or incomplete datasets by leveraging transfer learning or synthetic data generation to compensate for the lack of extensive historical data.

5.2 Infrastructure Constraints

- **Poor Internet Connectivity**
  Reliable internet access is limited in many rural areas. AI tools often depend on cloud computing or data transmission, which is hindered by slow or unavailable internet connections.
- **Lack of electricity**
  AI tools and platforms require stable power supplies. However, electricity infrastructure in many parts of sub-Saharan Africa is underdeveloped, especially in rural regions where agriculture is most prevalent.

SOLUTIONS

- **Invest in Digital Infrastructure**
  Governments and international development agencies should prioritise improving rural internet access and electricity infrastructure. Public-private partnerships could encourage telecom companies to expand mobile broadband coverage into underserved rural areas.
- **Low-Cost Solar Energy Solutions**
  Solar power solutions could address the electricity gap. Solar-powered AI tools, such as IoT sensors for precision farming, can enable farmers to gather real-time data even in areas with unreliable grid access.

5.3 Cost of Technology

- **High cost of hardware and software**
  AI solutions often require advanced hardware, such as sensors, drones, or sophisticated computing infrastructure. The cost of this technology is often prohibitive for smallholder farmers.
- **Expensive access to digital platforms**
  Many AI-driven solutions are subscription-

based or require purchasing licences, which can be costly in regions where farmers operate on tight margins.

SOLUTIONS

- **Subsidies and Grants**
  Governments can provide subsidies for the purchase of AI-driven agricultural tools such as drones, sensors, or precision farming equipment. International organisations like the FAO and World Bank could offer grants to farmers for acquiring technology.
- **Shared Resources and Cooperatives**
  Encourage the development of farming cooperatives that pool resources for AI tools. This could involve the collective purchase of expensive hardware, such as AI-equipped tractors or drones, allowing individual farmers to access advanced technology without bearing the full cost.
- **Open-Source AI Models**
  Promoting open-source AI platforms tailored to agriculture can lower costs for developers and farmers. Local AI researchers could build and adapt these tools to regional needs without the licencing costs of proprietary software.

5.4 Limited Digital Literacy

- **Lack of technical knowledge**
  Many farmers in sub-Saharan Africa lack the technical expertise to utilise AI-powered tools. Even if AI tools are available, adoption is hindered by the absence of relevant skills and training.
- **Language barriers**
  Many AI tools are designed in global languages like English or French, but many rural farmers speak indigenous languages, creating a usability barrier.

SOLUTIONS

- **Farmer Training Programs**
  Develop large-scale digital literacy programs for farmers to help them understand and use AI tools effectively. Extension services should incorporate AI and digital tools training to build farmer capacity for using these technologies.

- **User-Friendly Interfaces**
  AI platforms should be designed with intuitive, simple interfaces. This ensures that even farmers with limited digital literacy can understand and utilise the tools. Multilingual interfaces and voice-activated AI services in local languages can further help bridge the language gap.
- **Farmer Field Schools**
  Set up technology demonstration farms or "smart farming centres" where farmers can see the benefits of AI in practice, participate in hands-on learning, and gain confidence in adopting new technologies.

5.5 Inadequate Digital Infrastructure

- **Low smartphone penetration**
  While mobile technology is widespread, smartphones, which are necessary for advanced AI applications, are less common. Many farmers still rely on basic mobile phones, limiting access to AI-driven mobile apps.
- **Poor cellular network coverage**
  Many rural areas have insufficient 3G or 4G network coverage, making it difficult to access digital services required by AI tools.

SOLUTIONS

- **Focus on Mobile-Friendly AI Applications**
  Given the prevalence of mobile phones, developers should focus on creating AI tools optimised for basic mobile phones or SMS-based platforms. This can help bypass the need for advanced digital infrastructure, allowing AI adoption through more accessible technologies.

5.6 Challenges in Model Development

- **Lack of region-specific AI models**
  Most AI models are developed in more advanced agricultural economies, where farming conditions are vastly different. Transferring these models to sub-Saharan Africa without adaptation often leads to poor outcomes.
- **Complexity of local ecosystems**
  Sub-Saharan Africa is home to diverse climates, crops, and farming practices, which require highly specialised and localised AI models. This adds to the complexity of developing accurate AI solutions.

SOLUTIONS

- **Localised AI Model Development**
  Research centres in sub-Saharan Africa need support to develop region-specific AI models. These institutions can collaborate with international AI experts and local agronomists to create AI systems that account for unique climate conditions, crop varieties, and soil types.
- **Collaboration with Farmers**
  Farmers should be involved in the development of AI tools, ensuring that these technologies are adapted to local farming practices and traditions. Participatory design approaches ensure AI recommendations are relevant to the actual challenges farmers face.
- **Training and Partnerships with Research Institutions**
  Universities and research centres can partner with global technology companies to develop AI models that are trained on local datasets. Agricultural extension workers could be trained to use these tools and help farmers adopt them

5.7 Fragmented Agricultural Systems

- **Smallholder farm dominance**
  Agriculture in sub-Saharan Africa is dominated by smallholder farmers, which creates a fragmented system. Developing scalable AI solutions that cater to a wide range of farm sizes, crops, and practices is challenging.
- **Lack of organised cooperatives**
  Agricultural data collection and AI

adoption can be easier when farmers are organised into cooperatives or groups, but such frameworks are often lacking, making scaling AI solutions difficult.

SOLUTIONS

- **Strengthening Farmer Cooperatives**
  Organising farmers into cooperatives helps in the pooling of resources for AI adoption and scaling initiatives. Cooperatives can collectively invest in AI solutions, share best practices, and facilitate more efficient use of agricultural data.
- **Value Chain Development**
  AI systems should not only focus on production but the entire agricultural value chain—from planting to post-harvest activities, market access, and pricing. AI platforms that provide market information can help farmers secure better prices and reduce food waste.
- **AI-Powered Market Platforms**
  AI-based platforms could connect farmers directly to buyers, offering insights on demand, market trends, and pricing in real-time. This helps reduce market fragmentation and enables farmers to make informed decisions on when and where to sell their crops.

5.8 Improving Financial Access

SOLUTIONS

- **Innovative Financing Models**
  Encourage micro-financing, leasing, or pay-as-you-go models for AI technology acquisition. Smallholder farmers could access AI-powered tools on a subscription basis, spreading the cost over time rather than requiring upfront capital.
- **Digital Financial Inclusion**
  Promote the integration of AI in agricultural credit scoring systems to offer more accurate credit assessments for farmers, which could improve their access to loans and investments for AI tools.

5.9 Environmental Factors

- **Unpredictable climate**
  The region's agriculture is heavily affected by climate change, which makes it harder to develop AI models that can accurately predict crop outcomes, disease spread, or weather patterns.

- **Low availability of remote sensing data**
  While satellite imagery is critical for AI in agriculture, many parts of sub-Saharan Africa are under-mapped, and obtaining high-resolution imagery is expensive.

SOLUTIONS

- **Climate-Resilient AI Models**
  AI models can be designed to incorporate real-time climate data, helping farmers adjust to the increasing variability in weather patterns. Climate-smart agriculture initiatives, coupled with AI, can assist farmers in choosing drought-resistant crops or optimise irrigation schedules.
- **Remote Sensing and Early Warning Systems**
  AI-based remote sensing technologies (such as satellite imagery and drones) can be used to detect early signs of crop diseases, pest outbreaks, or environmental changes. These systems can send real-time alerts to farmers, allowing them to take preventive action.

5.10 Regulatory and Policy Barriers

- **Lack of digital agriculture policies**
  In many countries, there is no clear regulatory framework to support the deployment of AI in agriculture. This creates uncertainty around data privacy, digital infrastructure development, and government support.
- **Limited funding for AI initiatives**
  Governments and private entities may not prioritise investment in AI for agriculture, slowing the development and adoption of such technologies.

SOLUTIONS

- **Government Support for AI in Agriculture**
  Governments should develop national digital agriculture strategies that focus on improving data availability, supporting research and innovation, and investing in infrastructure. Clear policies around data use, privacy, and security can encourage greater adoption of AI.
- **Public-Private Partnerships**
  Governments can partner with private technology companies, international organisations, and NGOs to create favourable conditions for AI development and deployment in agriculture. These partnerships can help fund infrastructure development, provide access to AI tools, and offer training to farmers.

5.11 Integration with Traditional Practices

- **Cultural barriers to technology adoption**
  Many smallholder farmers rely on traditional farming knowledge passed down through generations, which may conflict with AI-recommended practices, making farmers hesitant to adopt AI tools.
- **Difficulty in translating AI insights into actionable practices**
  Even when AI tools provide recommendations, farmers may not have the resources or infrastructure to implement them effectively.

SOLUTIONS

- **Localised AI Recommendations**
  AI tools should deliver personalised, culturally relevant recommendations that respect traditional farming knowledge. By validating AI outputs through local farmer experience, the technology can be seen as an enhancement to traditional methods rather than a replacement.
- **Incremental Adoption**
  Promote gradual AI adoption, starting with simple tools like weather prediction apps or pest detection systems. As farmers see the value of these tools, they may become more open to using advanced AI solutions in their broader farming practices.
- **Combining AI with Traditional Knowledge**
  AI models can be developed to integrate indigenous knowledge and practices with modern data science techniques. By complementing local knowledge with AI-driven insights, farmers will be more likely to adopt AI tools.

6.

The AI Landscape: A Deep Dive into Six African Nations

The AI landscape in the selected six countries has been mapped along the Agricultural value chain. For each country a selection of companies or organisations have been highlighted describing their key activities and which segment(s) of the value chain they operate in. Although this analysis has not been conducted using a statistically significant methodology, it is interesting to note that most AI organisations are operational in the "Growing & Production" segment of the value chain. This is true in most of the six countries and is a reflection that the early market entrants are focused on yield improvement and betterment of actual farming operations. The least populated segments are "Processing & Packaging" and "Storage & Distribution", which probably reflects the harsh realities of agriculture in this region, namely that the road and supporting infrastructure is sub-standard. AI will have to be applied extremely creatively to make improvements in this area.

Rwanda

RTI International

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

RTI International has been active in Rwanda for over 35 years, providing a range of services including technical assistance, institutional strengthening, and research to support various sectors. Their initiatives focus on enhancing water resource management, developing agricultural exports, and promoting job growth through programs like the USAID-funded Feed the Future Hanga Akazi activity, which aims to improve workforce skills and create equitable employment opportunities. Additionally, RTI engages in projects that address climate resilience and environmental sustainability, contributing to the overall development goals of Rwanda.

Charis Unmanned Aerial Solutions

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Charis Unmanned Aerial Solutions (Charis UAS) is a pioneering drone service provider in Rwanda, specializing in commercial drone operations and advanced data analytics. The company offers a wide range of services, including UAS consulting, UAV system integration, pilot training, and maintenance, aimed at enhancing decision-making across various sectors such as agriculture, health, and infrastructure. Charis UAS has notably implemented drone technologies to support farmers with precision agriculture, assist the Ministry of Health in malaria control efforts, and provide critical geospatial data for environmental management.

Shambapro

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓		✓			

What they do

Shambapro offers a digital platform that empowers small-scale farmers in Rwanda to manage their farm resources efficiently, enhancing productivity and profitability. Through its app, farmers can maintain accurate records, access financial services, and receive advisory support on crop management, weather predictions, and market opportunities. The integration of artificial intelligence allows Shambapro to provide data-driven insights and analytics, helping farmers make informed decisions that lead to sustainable agricultural practices and improved yields.

Centre for Fourth Industrial Revolution

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

The Centre for the Fourth Industrial Revolution (C4IR) in Rwanda does engage in work related to agriculture. They are involved in developing innovative agricultural advisory tools aimed at enhancing farming practices and improving productivity. Additionally, C4IR collaborates with various stakeholders to integrate artificial intelligence and data governance into agricultural initiatives, which can help farmers optimize their operations through better data utilization and technology adoption.

Feed the Future Initiative

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			✓

What they do

Feed the Future Initiative in Rwanda, particularly through its programs like Kungahara Wagura Amasoko and Hinga Weze, focuses on enhancing agricultural productivity, improving market access, and boosting nutrition among smallholder farmers. These initiatives aim to increase high-value agricultural exports, facilitate investments, and empower marginalized groups such as women and youth to participate effectively in the agricultural economy. By leveraging artificial intelligence, they analyze market trends and optimize agricultural practices, thereby enhancing decision-making processes and increasing the overall efficiency of agricultural production

Ghana

Farmerline

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓		✓			

What they do

Farmerline is a social enterprise in Ghana that empowers smallholder farmers by providing access to quality agricultural inputs, financial services, and training. Through its innovative Mergdata platform, Farmerline delivers critical information via mobile technology, including market prices and weather forecasts, in local languages to enhance farmers' decision-making. Additionally, Farmerline offers input credit support programs that allow farmers to acquire necessary resources like fertilizers on credit, thereby improving their productivity and livelihoods while promoting sustainable agricultural practices.

Amaati Group

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
	✓				✓

What they do

Amaati Group is a Ghanaian social enterprise that focuses on the revival and processing of Fonio, an indigenous grain, while empowering women farmers. The organization provides essential services such as access to land, seeds, and machinery, along with training in sustainable agricultural practices to enhance productivity among smallholder farmers, particularly women. Additionally, Amaati promotes food security and sustainable livelihoods by purchasing the harvested Fonio at guaranteed prices, thus supporting local economies and improving household nutrition

Cowtribe

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Cowtribe is a Ghana-based startup that provides on-demand veterinary services and vaccines to smallholder farmers through a mobile platform. By leveraging technology, Cowtribe connects farmers with certified veterinarians, ensuring timely access to essential animal healthcare, which significantly reduces livestock mortality rates. Additionally, the company offers agricultural support services, including best practices and alerts on disease outbreaks and weather patterns, aimed at improving the livelihoods of farmers across Ghana

Grow for Me

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Grow For Me is a web-based agricultural crowdfunding platform based in Ghana that connects micro-investors with smallholder farmers to facilitate crop production. The platform utilizes drone and satellite imagery to monitor farming activities, providing real-time updates and agronomic advice to ensure optimal crop yields. Upon harvest, profits are distributed among the farmers (35%), sponsors (50%), and Grow For Me (15%), thereby addressing food security and economic empowerment in the region.

Ignitia

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Ignitia, a Ghanaian company, specializes in providing weather information services tailored for smallholder farmers. Their offerings include daily and seasonal weather forecasts delivered via mobile platforms, which help farmers make informed decisions regarding planting and harvesting. Additionally, Ignitia collaborates with local mobile service providers to enhance accessibility and ensure that critical agricultural information reaches farmers effectively.

Legendary Foods

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Legendary Foods in Ghana specializes in producing sustainable and nutritious animal protein through the farming of palm larvae, a traditional food source in West Africa. Utilizing a proprietary vertical farming system, the company aims to provide high-quality protein that is both affordable and environmentally friendly, addressing food security challenges in the region. Additionally, Legendary Foods focuses on creating value-added products from palm larvae, contributing to a circular economy by integrating farming by-products into other agricultural supply chains

Nigeria

Kitovu

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
	✓	✓			

What they do

Kitovu in Nigeria offers a range of services aimed at improving the livelihoods of smallholder farmers. Through a multi-platform mobile application, Kitovu connects farmers with manufacturers, retailers, and consumers, enhancing market access and reducing cultivation costs by up to 70%. Additionally, Kitovu focuses on training young people in agricultural skills, creating job opportunities that contribute to economic growth and food security within the communities it serves

FarmCrowdy

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓	✓				

What they do

FarmCrowdy is Nigeria's first digital agriculture platform, designed to empower small-scale farmers by providing them with essential resources such as improved seeds, farm inputs, and training in modern farming techniques. The platform connects these farmers with investors who provide capital in exchange for a share of the profits, thereby enhancing productivity and efficiency in agriculture. Since its inception in 2016, FarmCrowdy has positively impacted over 11,000 farmers, contributing to increased food production and security in Nigeria

Nigeria AI Research Scheme

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓					

What they do

The Nigeria Artificial Intelligence Research Scheme (NAIRS) aims to cultivate a robust AI ecosystem by providing financial support and fostering collaboration among researchers and startups. This initiative offers grants of up to N5,000,000 to 45 successful applicants, targeting critical sectors such as health, agriculture, and education to enhance the application of AI technologies. By leveraging AI, the scheme seeks to drive economic growth and innovation while addressing socio-economic challenges through responsible and ethical AI practices

Releaf

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
			✓		✓

What they do

Releaf is an agritech startup based in Nigeria focused on transforming the food processing sector, particularly in the oil palm industry. Established in 2017 by Ikenna Nzewi and Uzoma Ayogu, Releaf aims to industrialize agricultural practices by leveraging technology to enhance efficiency and productivity among smallholder farmers.

ThriveAgric

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓	✓				✓

What they do

ThriveAgric is an agricultural technology company based in Nigeria, focused on empowering smallholder farmers and enhancing food security across Africa. Founded in 2017 by Uka Eje and Ayodeji Arikawe, the company has developed a comprehensive approach to address the challenges faced by farmers, including access to finance, quality inputs, and market opportunities

Vendease

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
					✓

What they do

Vendease is a Nigerian digital platform designed to streamline the procurement process for restaurants and food businesses across Africa. Founded in 2020, it enables these businesses to purchase supplies directly from farms and manufacturers, bypassing traditional middlemen. This approach not only reduces costs but also ensures faster delivery, typically within 12 to 24 hours

Extension Africa

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓	✓				

What they do

Extension Africa (EXAF) is a research-based agritech platform operating in Nigeria that focuses on providing private extension services to agricultural value chain actors. The organization aims to address the challenges of availability, reliability, and sustainability in agricultural extension service delivery across Africa.

AirSmat

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
	✓	✓			

What they do

AirSmat in Nigeria offers a range of services focused on drone technology and aerial solutions. Their offerings include aerial surveillance, mapping, and inspection services tailored for various industries such as agriculture, construction, and logistics. Additionally, AirSmat provides training and consultancy services to help businesses integrate drone technology into their operations effectively.

FarmKart Foods

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓	✓	✓	

What they do

FarmKart Foods is an agri-tech company in Nigeria that provides affordable and high-quality poultry and fish products directly to consumers' doorsteps. They operate a comprehensive aquaculture supply chain, which includes everything from production to packaging and logistics, ensuring sustainability and accessibility for low to mid-income earners. In addition to selling fresh produce, FarmKart also offers consulting services for poultry and fish farming, aiming to modernize agriculture and support local farmers

So Fresh

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
					✓

What they do

So Fresh is Nigeria's leading healthy food Quick Service Restaurant, specializing in a variety of nutritious offerings such as salads, juices, smoothies, sandwiches, and parfaits. Founded in 2010 and evolving from selling whole fruits and vegetables, the company now operates 15 outlets across Lagos and Abuja, providing delivery services to select communities through its online platforms. In addition to promoting healthy eating, So Fresh sources over 90% of its ingredients from local suppliers, reinforcing its commitment to community support and sustainability

TradeBuza

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓					✓

What they do

TradeBuza offers a digital platform that enhances the management of outgrower schemes and commodities trade in Nigeria. Their services include farm management solutions, agricultural credit risk assessment, and data infrastructure that connects smallholder farmers with financial institutions, improving access to financing. Additionally, TradeBuza's CropGate platform aids exporters and commodity aggregators in streamlining their supply chain operations through efficient tracking and optimization tools

Farm Monitor Africa

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Farm Monitor Africa offers a range of services aimed at enhancing agricultural efficiency and productivity for smallholder farmers in Nigeria. Their platform utilizes AI and machine learning to provide real-time data on crop health, weather forecasts, and soil conditions, enabling farmers to make informed decisions that optimize yields and minimize risks. Additionally, Farm Monitor provides training and support through on-site workshops and continuous assistance, ensuring that farmers can effectively utilize their technology for sustainable farming practices

Zowasel

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
	✓				✓

What they do

Zowasel is an agritech startup in Nigeria that offers a comprehensive platform to support smallholder farmers through various services. These include a marketplace for buying and selling agricultural products, education on crop cultivation, access to farm machinery, credit scoring for financial assistance, and traceability of products throughout the supply chain. By eliminating middlemen and providing resources like fertilizers and logistics, Zowasel aims to enhance farmers' productivity and profitability, significantly improving their livelihoods

Togo

BaoBaby

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓					✓

What they do

BaoBaby in Togo focuses on combating malnutrition among infants by transforming local organic crops into affordable, nutritious alt- protein formulas. They empower rural female farmers through mobile payment systems, ensuring a sustainable supply chain that minimizes costs and environmental impact. Utilizing innovative technology, BaoBaby incorporates artificial intelligence to optimize the processing of these crops, enhancing the nutritional quality and efficiency of their products while contributing to community development and food security

AquaRoots

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

AquaRoots in Togo offers innovative agricultural services focused on sustainable food production through aquaponics systems, which combine fish farming and hydroponics to enhance crop yields and nutritional diversity. Their mission addresses food insecurity by empowering local farmers, creating reliable food supply chains, and providing training and employment opportunities within the community. Additionally, AquaRoots leverages artificial intelligence to optimize their farming practices, enhance resource utilization, and improve the efficiency of their operations, ensuring a continuous supply of fresh produce year-round

Yatoo

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓					

What they do

Yatoo in Togo is focused on providing social protection services through its flagship program, Novissi, which offers unconditional cash transfers to vulnerable populations. Leveraging artificial intelligence, Yatoo utilizes machine learning algorithms and mobile phone data to accurately identify the most impoverished individuals, ensuring that aid reaches those in greatest need more effectively than traditional methods. This innovative approach has allowed the Togolese government to enhance the precision of targeting for cash transfers, significantly increasing the number of beneficiaries during the COVID-19 pandemic

Kenya

Victory Farms

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			✓

What they do

Victory Farms, established in 2015 in Homa Bay, Kenya, is a leading aquaculture company specializing in the sustainable production of tilapia. The farm operates a vertically integrated model that includes breeding facilities, processing plants, and a distribution network, enabling it to supply over 1.5 million fresh fish monthly to low-income neighborhoods across Kenya. Committed to sustainability, Victory Farms aims to become the world's first carbon-negative fish farm while addressing food security challenges by providing affordable and nutritious protein to millions in East Africa

Elloe AI

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets

What they do

Elloe AI does work in agriculture. The company is involved in revolutionizing various industries, including agriculture, by utilizing artificial intelligence to enhance business operations and optimize processes within the sector. Their AI solutions aim to empower agricultural businesses through improved efficiency and innovative practices, which can significantly benefit smallholder farmers and the agricultural ecosystem overall.

Synnefa

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Synnefa in Kenya offers innovative farming solutions designed to enhance productivity and efficiency for smallholder farmers. Their services include the installation of smart greenhouses equipped with FarmShieldTM IoT sensors and drip irrigation kits, which optimize water usage and improve crop yields while also providing remote management capabilities through their FarmCloudTM platform. By leveraging these technologies, Synnefa aims to help farmers increase their incomes, reduce climate risks, and simplify farm management processes, ultimately supporting over 17,000 farmers across Africa

Apollo Agriculture

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
	✓				

What they do

Apollo Agriculture offers a comprehensive suite of services designed to support smallholder farmers in Kenya. These services include access to high-quality agricultural inputs, such as seeds and fertilizers, provided on credit, alongside crop insurance and tailored training programs to enhance farming practices. Utilizing innovative technology, Apollo Agriculture also delivers digital information services that help farmers optimize their operations and improve their yields, thereby fostering sustainable agricultural practices and increasing profitability

Aquarech

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
	✓				✓

What they do

Aquarech is Kenya's pioneering fish farming platform that connects fish farmers, feed manufacturers, and buyers to facilitate trade and build trust within the aquaculture sector. The platform offers high-quality fish feed, enables farmers to sell their harvests for stable incomes, and provides training to enhance farming operations. Additionally, Aquarech promotes sustainable practices that improve the livelihoods of small and medium-scale fish farming communities while reducing reliance on wild fish

Digicow Africa

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Digicow Africa LTD, a leading agritech company in Kenya, offers innovative mobile-based technologies designed to enhance the agricultural sector. Their flagship product, the DigiCow dairy app, enables farmers to digitize farm records, access training resources, and receive real-time alerts on key farming activities. Additionally, Digicow provides digital veterinary services, data-driven decision- making tools, and digital extension services to support over 230,000 farmers in improving productivity and profitability in their farming practices

Farmshine

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
	✓				✓

What they do

Farmshine in Kenya offers a digital platform that connects smallholder farmers directly with reliable retail and export buyers, enabling them to aggregate their harvests for better pricing. The company provides technical support through field agents who assist farmers throughout the growing season, helping them to maximize productivity and minimize costs through access to essential resources like seeds, loans, and crop insurance. Additionally, Farmshine promotes climate-smart agricultural practices, ensuring sustainability while enhancing farmers' incomes and market access for high-value crops

Lentera Africa

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
	✓	✓			✓

What they do

Lentera Africa, based in Kiambu, Kenya, is an agriculture technology company focused on empowering farmers through innovative solutions. They provide a comprehensive range of services including climate-smart inputs, digital advisory services via their mobile app CropHQ, and access to markets for their produce. By leveraging technology, Lentera enhances agricultural productivity and sustainability, helping farmers adapt to climate change while improving their yields and income

MyFugo

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

MyFugo provides a range of services aimed at enhancing the productivity of smallholder dairy farmers in Kenya. These include financing options like the Leta Ngombe program, which helps farmers acquire high-quality cows through loans, and micro-loans that serve as working capital for farming activities. Additionally, MyFugo employs IoT technology with smart cow collars to monitor animal health and behavior, while also offering training and consultancy to improve farming practices

Soko Fresh

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
				✓	✓

What they do

Soko Fresh is a Kenyan social enterprise that provides essential services to smallholder farmers, primarily focusing on avocado production. They offer cold storage rental solutions, utilizing solar-powered refrigeration units to minimize post-harvest losses and ensure the quality of produce. Additionally, Soko Fresh facilitates market linkages, connecting farmers directly to buyers and enhancing their income through a streamlined aggregation and sales process. SokoFresh utilizes artificial intelligence (AI) in its operations. The Soko-App, which is part of their service offerings, employs AI and machine learning algorithms to create tailored nutritional health diets, interpret user feeding data, and simplify nutrition planning based on individual needs. Additionally, the app provides food waste management tips and connects users with food waste collectors, enhancing overall efficiency and sustainability in agricultural practices

Hello Tractor

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Hello Tractor provides a digital marketplace that connects smallholder farmers in Kenya with tractor owners, facilitating access to essential agricultural machinery at affordable rates. Through their app, farmers can book tractor services for tasks like planting and harvesting, significantly increasing efficiency and productivity while reducing costs. The company leverages artificial intelligence (AI) and machine learning to predict demand for tractor services, optimizing resource allocation and ensuring that farmers receive timely assistance based on weather patterns and regional agricultural needs

Adventa Seeds

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
	✓				

What they do

Adventa Seeds in Kenya specializes in providing high-quality hybrid seeds tailored for various crops, focusing on enhancing agricultural productivity and resilience in the face of climate change. They offer innovative training programs for smallholder farmers, equipping them with knowledge on best practices for crop management and sustainable farming techniques. Additionally, Advanta Seeds utilizes AI technology through partnerships, such as with Seed-X, to improve seed processing and quality by employing advanced sorting systems that enhance germination rates and reduce waste

Delta40

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓					

What they do

Delta40 is a venture studio based in Kenya that focuses on building and investing in technology-driven ventures in energy, agriculture, and mobility. They provide hands-on support to entrepreneurs, including fast product testing, technology brokering, and early-stage commercialization, aiming to increase incomes and address climate change challenges across Africa. Delta40 incorporates artificial intelligence to enhance its operations by leveraging data analytics for venture development and scaling, ensuring that the startups they support can effectively tackle pressing social and environmental issues

Fairoils

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
	✓				✓

What they do

Fairoils in Kenya focuses on improving the livelihoods of small-scale farmers by providing them with essential oils and vegetable oil production opportunities. Their services include supplying seedlings, offering agronomy expertise through field officers, and ensuring a reliable market for farmers' produce, which helps create a second income stream for these communities. Fairoils utilizes AI technology, specifically farmforceTM, to collect data on crop yields and biomass, enabling them to offer tailored support and optimize agricultural productivity for local farmers

Simlaw Seeds

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
	✓				

What they do

Simlaw Seeds, a subsidiary of the Kenya Seed Company, specializes in the production and marketing of high-quality seeds for various crops, including maize, beans, and vegetables. The company is committed to enhancing agricultural productivity in Kenya by providing farmers with access to superior seed varieties and agricultural resources. Additionally, Simlaw Seeds utilizes artificial intelligence to optimize seed development processes and improve supply chain efficiencies, ensuring that farmers receive the best possible products and support for their agricultural needs

South Africa

Aerobotics

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Aerobotics, based in South Africa, offers innovative agricultural solutions that leverage drone technology and artificial intelligence to enhance crop management for fruit and nut farmers. Their services include AI-powered fruit sizing, which allows growers to quickly and accurately assess the size of their crops, improving yield monitoring and decision-making processes. By analyzing aerial imagery and utilizing machine learning algorithms, Aerobotics provides insights into tree health, pest detection, and irrigation issues, ultimately helping farmers optimize their resources and increase product

Grain Pulse

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			✓

What they do

Grain Pulse in South Africa offers a range of services focused on enhancing the efficiency and quality of grain production and trading. Their solutions include advanced grain classification systems that utilize artificial intelligence (AI) to provide objective and consistent assessments of pulse samples, which helps growers and marketers make informed decisions about their products. By leveraging AI technologies, Grain Pulse optimizes logistics, predicts market trends, and ensures quality control throughout the supply chain, ultimately improving operational efficiency and reducing waste

Khula

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓	✓				✓

What they do

Khula is a South African agritech startup focused on empowering farmers by providing a digital platform that connects them with suppliers, buyers, and financing options. The platform addresses key challenges such as limited market access and financial constraints, enhancing the overall agricultural ecosystem. Khula leverages AI technologies to optimize farming practices through precision agriculture, enabling farmers to make data-driven decisions that increase productivity and sustainability

Livestock Wealth

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
✓					

What they do

Livestock Wealth is a South African crowdfunding platform that connects investors with farmers, allowing individuals to invest in livestock such as cattle and macadamia trees. The company offers a unique investment model called CrowdfarmingTM, where investors can own real farm assets and earn profits as these assets grow and are harvested. Livestock Wealth utilizes AI technology, developed in collaboration with Huawei, to enhance their mobile app, enabling efficient management of investments and providing farmers with integrated AgriTech solutions for better asset tracking and decision-making

Mogale Meat

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Mogale Meat is a South African cellular agriculture company focused on producing affordable, nutritious cell-based meat products, including Africa's first cultivated chicken. Their innovative approach utilizes biotechnologies to grow meat without harming animals, aiming to address food security and environmental sustainability while conserving wildlife. The company employs artificial intelligence to optimize production processes, reduce costs, and analyze consumer behavior, enhancing their ability to meet market demands effectively

TerraClim

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
		✓			

What they do

Terraclim is an innovative online platform designed to support the agricultural sector in South Africa, particularly focusing on providing detailed climate and terrain data to enhance decision-making for farmers. It integrates over 40 environmental variables, including rainfall and temperature, enabling users to optimize planting, harvesting, and resource management while adapting to climate change challenges. Utilizing advanced AI techniques, Terraclim automates the collection and analysis of climate data, allowing for high-resolution spatial modeling that empowers farmers to make informed decisions tailored to their specific land conditions

SwiftVee

Finance	Inputs	Growing & Production	Processing & Packaging	Storage & Distribution	End Markets
					✓

What they do

SwiftVEE is a South African AgriTech startup that provides a comprehensive online livestock auction platform, enabling farmers and buyers to engage in live webcasts, silent auctions, and timed sales. The platform streamlines the buying and selling process by allowing users to view livestock auctions, request quotes, and bid online through a mobile app. SwiftVEE leverages artificial intelligence to optimize market efficiency by matching buyers and sellers in real-time, enhancing pricing strategies, and expanding market access for farmers facing challenges such as climate change and water scarcity

7.

Policy Recommendations: Paving the Way for AI-Enhanced Agriculture

The importance of policy initiatives in establishing safe and effective AI practices cannot be overstated. As AI technologies evolve, robust policies are essential for addressing ethical, legal, and operational challenges, ensuring that AI systems serve the public good while mitigating risks.

The following is a brief overview of the primary AI initiatives in the six countries:

Nigeria

Nigeria has been proactive in developing its AI landscape through the **National Digital Economy Policy and Strategy (NDEPS)**, which emphasises the integration of AI in various sectors. The government is fostering an ecosystem that supports startups and innovation hubs. Initiatives like the **Nigerian AI and Robotics Competition** aim to encourage youth engagement in AI technologies. Additionally, partnerships with international organisations are being formed to enhance local capabilities in AI research and application.

Ghana

Ghana's **National Artificial Intelligence Strategy (2023-2033)** aims to leverage AI for inclusive social and economic transformation. The strategy focuses on enhancing human potential and improving quality of life through AI applications across sectors such as healthcare, agriculture, and finance. The establishment of **Google's first African AI lab** in Accra highlights the country's commitment to becoming a regional tech hub. Moreover, various initiatives are underway to improve digital skills among the youth, including mentorship programs and coding workshops.

Togo

Togo has initiated efforts to develop its AI framework through partnerships with organisations like **Smart Africa**. The government is working on a national digital strategy that includes AI as a key component for economic development. Togo's focus is on building infrastructure and regulatory frameworks that support innovation while addressing ethical concerns related to AI deployment.

Kenya

Kenya is recognised for its vibrant tech ecosystem, often referred to as "**Silicon Savannah**." The government has launched several initiatives aimed at integrating AI into public services, including healthcare and agriculture. The **Kenya National Innovation Agency** is spearheading efforts to promote research and development in AI technologies. Additionally, the country has seen significant investment from private sector players in AI startups focused on solving local challenges.

Rwanda

Rwanda's **National Artificial Intelligence Policy** was enacted in 2023, aiming to harness AI for socio- economic development while adhering to ethical standards. The policy emphasizes stakeholder engagement and capacity building within the local workforce. Rwanda has also established itself as a leader in **drone technology for medical supply delivery**, showcasing practical applications of AI in improving health outcomes. The government promotes partnerships with international organisations to bolster its AI capabilities.

South Africa

South Africa is advancing its AI initiatives through the **National Strategy on Artificial Intelligence**, which focuses on promoting ethical use of AI while enhancing economic growth. The country has established several research institutions dedicated to AI studies and applications. Initiatives like **Data Science for Social Impact** aim to leverage data analytics and AI to address societal challenges such as poverty and health disparities. Furthermore, South Africa is actively participating in international discussions on AI governance and ethics.

There are several policy recommendations for policymakers in sub-Saharan Africa to increase opportunities for using AI in agriculture:

Invest in Digital Infrastructure

Governments should prioritise investments in digital infrastructure, including high-speed internet access, cloud computing resources, and data centres. This will enable the collection, storage, and processing of large volumes of agricultural data required for AI applications.

Promote Data Sharing and Governance

Policymakers should create incentives for public and private sector entities to share agricultural data. This could include establishing data trusts and developing data governance frameworks to ensure fair and ethical use of data.

Support AI Research and Development

Governments should allocate funding for AI research and development in agriculture, focusing on adapting AI solutions to local contexts. This can be done by partnering with universities, research institutions, and private sector players.

Develop AI-Focused Education and Training Programs

Policymakers should invest in education and training programs to build AI skills and knowledge among farmers, extension workers, and agricultural professionals. This will enable them to effectively utilise AI-powered tools and make data-driven decisions.

Establish AI Regulatory Frameworks

Governments should develop regulatory frameworks to ensure the responsible and ethical development and deployment of AI in agriculture. This includes addressing issues such as data privacy, algorithmic bias, and transparency.

Provide Financial Incentives for AI Adoption

Policymakers should consider providing financial incentives, such as subsidies or tax credits, to encourage the adoption of AI technologies by smallholder farmers and agribusinesses. This will help overcome the initial cost barriers associated with AI implementation.

8.

Where to Focus Our Attention in Agriculture

We have used a prioritisation matrix to rank the use case opportunities in Agriculture across the region:

CRITERIA	HIGH (5)	MODERATE (3)	LOW (1)

The Value Chain	Challenges	Strategic Alignment	Impact	Urgency	Inclusivity	Complexity	Feasibility	Total
Growing and Production - precision agriculture apps	Lack of information on weather, soil and irrigation	5	5	5	4	3	4	**26**
Growing and Production - AI pest / disease identification and solution	Lack of identification/ remedy for pests and diseases	5	5	5	4	4	4	**27**
End Markets - AI advice on crop selection and timing	Knowledge of commodity prices, demand, volumes	5	5	5	4	3	4	**26**
Storage and Distribution - supply chain management software	Inability to optimise supply chain – aggregating distribution, managing inputs.	5	5	4	4	3	3	**24**
Growing and Production - weather forecasting services	Ability to know what weather conditions are coming up before planting, harvesting etc	4	4	5	5	3	4	**25**
Finance - AI-driven credit scoring	Inability to get credit for buying inputs or expanding operations due to lack of formal data	5	5	4	5	3	4	**26**
Growing and Production - resource management	Inability to know which crop to plant given current conditions – supply, demand, pricing, weather	4	4	4	4	3	3	**22**
Growing and Production - AI advice bots	Lack of availability of extension officers to provide specific farming advice	5	5	3	5	3	3	**24**
Growing and Production - AI-generated soil testing	Lack of knowledge about soil types, current soil conditions and what the nutrients are required	4	4	4	5	3	3	**23**
Entire Value Chain - data-driven crop insurance	Inability to protect crops through crop insurance, due to lack of data	4	4	3	3	3	3	**20**

The prioritisation rankings indicate that the following use cases should be preferred due to their high potential impact and feasibility:

1. Precision agriculture, including soil management
2. Disease and pest identification and prevention advice
3. Supply chain optimisation along the value chain
4. Access to credit scoring and therefore credit

9.

Conclusion:
AI is the Only Way to Save Agriculture in Sub-Saharan Africa

We have seen in this report that Agriculture in Sub-Saharan Africa is conducted primarily by smallholder farmers (with South Africa being the notable exception). It is characterised by **low levels of productivity** compared to the developed world and **extreme fragility** in respect of disasters brought about by climate change, pest infestations or rampant disease.

This, when combined with a relentlessly **growing population**, is a recipe for growing levels of **food insecurity**, and even famine, across the region. Due to the widespread involvement of the population in Agriculture, such a squeeze will have serious knock-on effects on economic growth, employment, forced migration and instability.

AI, properly **deployed along all segments of the agricultural value chain**, has the power to increase access to inputs and credit, dramatically improve yields and productivity, allow for optimised aggregation and distribution of product, and increase the bargaining power of smallholders when selling to their end markets.

If AI could bring about a **6-fold increase** in productivity in the region (which would still be below the level of the commercial agriculture sector), the problem of **feeding** the region's population would be solved and there would be enough left over to export for a profit, thus enabling increased re-investment in agricultural operations and **growth** in the region's economies.

10.

Case Studies

10.1 Africa Agriculture Watch (AAgWa)

10

The number of crops the Africa Crop Production Model (AfCP) predicts annual production output for in over 40 African countries

INTRODUCTION AND MISSION STATEMENT OF THE PROGRAM

The **Africa Agriculture Watch (AAgWa)** is a web-based platform that was launched by AKADEMIYA2063 in 2021. The mission statement of the program is "A web-based platform that combines remote sensing data and machine learning techniques for informed decision-making in African food production systems" (AKADEMIYA2063, 2021). AKADEMIYA2063 view themselves as mobilizers of the **African Union's Agenda 2063** aspiration for "A prosperous Africa based on inclusive growth and sustainable development", one of whose subgoals is to "radically [transform] African agriculture to enable the continent to feed itself and be a major player as a net food exporter" (African Union, 2015).

AAgWa is driven by an Artificial Intelligence (AI) model known as the Africa Crop Production Model (AfCP). This model employs remotely sensed data and machine learning techniques to predict annual crop production output for 10 crops in over 40 African countries, at the beginning of each growing season. The primary mission of AAgWa is to help countries monitor climate forecasts using real-time data and insulate themselves against climatic shocks (e.g. floods and droughts) and the devastating impact these can have on the food security of a country. It was driven by the realisation that Africa cannot handle both a health crisis (that came from COVID-19) and a food crisis, hence this web application was the solution to help decision-makers be more proactive in ensuring food security on the continent (Ly, 2024).

USE CASES

- **Governments, Policy Makers and Researchers**
  One of the main challenges local and national governments face is anticipating food supply and planning for how much food they need to import or export to ensure food security. One of the big advantages of AAgWa is that it helps governments predict how many metric tons of a particular crop will be harvested in a particular growing season. This helps them know whether there will be a shortfall or a surplus in that season. If there is an anticipated shortfall, governments can put budgets in place to import more food, and if there is an anticipated surplus, governments can export the surplus produce to generate extra revenue (and prevent surplus food going to waste) (Ly, 2024). This is particularly useful during periods of climatic shocks, such as droughts or floods, where yields are much poorer than expected. AAgWa can help governments plan and put interventions in place to maintain the food security of their citizens.

AAgWa is also being used by international policy makers such as the **Global Alliance for Food Security (GAFS)** to monitor food availability on the African continent and plan for harvest shortfalls to ensure food security on the continent (Ly, 2024). There is also a lot of scientific interest in the impact of climate change on the African continent. Scientific researchers across the world can use the data in AAgWa to model and monitor the impact of changing climatic conditions on food production and advise policymakers on interventions they can take to ensure food security (Ly, 2024).

- **Private sector**
  AAgWa has also been used by businesses to gain prospective customers. For example, if a particular growing season is predicted to have poor harvests, businesses have used this information to market fertilisers to improve farmers' crop yields for that season (Ly, 2024). Furthermore, banks can use AAgWa's crop suitability maps, which identify which crops are more suitable for which areas (AKADEMIYA2063, 2021). Banks can use this information to determine whether to extend a loan to a farmer for a particular crop, based on the suitability of that crop for that region, as well as the predicted yield for that growing season (Ly, 2024). In addition to this, crop insurance companies can also use the predicted crop production yields on AAgWa to revise the risk of claims likely to come from farmers during poor harvests, as well as revise their premiums or reserves accordingly to meet the claims.

- **Small-holder farmers**
  Farmers want a high return on investment on their crops. They have invested in fertiliser, seeds, farm implements, and need to be able to recoup these costs. If they have a poor harvest due to e.g. drought or a pest outbreak, this can lead to significant losses which affects livelihoods. For subsistence farmers, this could also lead to food insecurity. AKADEMIYA2063 is working with local partners in five African countries - Senegal, Benin, Ghana, Uganda and Malawi - to bring this information on predicted crop outputs to local communities via radio stations (Ly, 2024). This information can help farmers decide to plant the crops that will be the most productive in a particular growing season. In turn, this will help them to maximise their return on investment and secure their livelihoods for their families. This information can also help farmers see where there are crops that have consistently performed well or poorly in recent years, and strategically plan on which crops to plant and what farm implements they need to invest in to improve their crop yields in future years. It also allows commercial farmers to be proactive and take out insurance to indemnify themselves against poor harvests.

DETAIL AND OUTCOMES OF THE SOLUTION

The **AfCP model** is an artificial neural network machine learning model, which is a supervised machine learning model that uses labels to train a dataset to predict correct outcomes (AKADEMIYA2063, 2021). In this case, the labels (or the outcome variable) are actual historical crop output values (measured in metric tons), while the input parameters are land surface temperature (LST), rainfall, Normalised Difference Vegetation Index (NDVI), evapotranspiration rate, crop masks and the crop calendar. AKADEMIYA2063 uses remotely sensed data to collect real-time, granular data, ensuring the predictions are as accurate as possible.

The output of the model are the predictions of annual crop production output for 10 crops in over 40 African countries. These are published in country briefs on the AAgWa website, at both a country and district level (AKADEMIYA2063, 2021). The validation process for the model is repeated every year before the country briefs are published (AKADEMIYA2063, 2021), to make sure that the models are still accurate and thus protect the reputation of AKADEMIYA2063. AKADEMIYA2063 shares its predictions with the country partners to compare with actual data, before the predictions are published (Ly, 2024). This test is 'blind' to the researchers at AKADEMIYA2063.

The result of these comparisons is an accuracy score that helps the researchers refine the model further before it is published.

The publication of forecasted yields is then done in a 3-step approach:

- The first predictions are made before the planting season even begins. This uses biophysical parameters for the last 4 - 5 months to predict crop yields.
- The second predictions are made when the planting begins, updating it with the biophysical parameters of the first few months of the planting season.
- The final predictions are published in the middle of the growing season. These are the most accurate as they have also been updated with rainfall, growing conditions (NDVI) and temperature parameters from the growing season (Ly, 2024).

The advantage of this 3-step approach is that it ensures that the model accounts for any anomalous trends in weather conditions during the growing season and adjusts accordingly. AAgWa also sense-check the model themselves, by looking at available data online on rainfall forecasts, for example, and aligning their models accordingly (Ly, 2024).

CHALLENGES AND HOW THESE WERE OVERCOME

- **Bureaucracy of Data Accessibility**
  In the process of training the machine learning models, a significant challenge emerged related to the release of data. A prevalent atmosphere of bureaucracy hindered collaboration between data custodians and AKADEMIYA2063. Many data custodians expressed concerns that their data would be misappropriated, fearing that AKADEMIYA2063 might not utilize the data for its intended purpose in data science initiatives. Furthermore, there was an insufficient understanding of the underlying data science principles guiding its initiatives.This lack of trust not only slowed down the data-sharing process but also posed a barrier to the successful development of machine learning models for the project. However, one of the ways in which AKADEMIYA2063 overcame this was by appointing local champions such as ReSAKSS and AGRODEP to help them build relationships with data custodians (AKADEMIYA2063, 2016). These local champions in turn convinced governments of the value this AAgWa Platform would bring to them, building trust and making it easier for data custodians to release the required data to AKADEMIYA2063 (Ly, 2024).

WHAT IS NEXT?

- **Recommendations and Opportunities for Wider Applications**
  According to AKADEMIYA2063, there is a big opportunity for cross-collaboration on the continent. In particular, the intersection of the agricultural, geospatial and AI domains leaves a small subset of experts, many of whom are working in silos, yet they face many similar challenges when it comes to AI in the agricultural space (Ly, 2024). If institutions worked together, they would be able to arrive at solutions faster, for the benefit of all. Creating spaces such as conferences where researchers, governments, NGOs and the private sector can come together and brainstorm solutions, particularly when it comes to artificial intelligence applications to agriculture, would be highly beneficial (Ly, 2024).

  The African continent also has a large talent pool, especially when it comes to theoretical mathematics and statistics, which are crucial driving forces in the AI revolution. For example, AKADEMIYA2063 is made up of scientists from the **African Institute of Mathematical Sciences**. Instead of losing talent to developed countries, Africa can exploit and tap into the talent we have, to drive AI solutions for the benefit of the continent (Ly, 2024).

  Furthermore, countries like Senegal and Rwanda are investing heavily in large data centres (Ly, 2024), which platforms like AAgWa are testing and can tap into to gain access to real-time data and train machine learning models. There is still much more that can be done in this regard on the continent to set Africa apart when it comes to solving problems using artificial intelligence.

  In the near-future AAgWa is looking to scale up the AAgWa platform, to make it more accessible to small-holder farmers via cell phone devices (Ly, 2024).

CONCLUSION

AAgWa allows governments to understand what the crop production levels are likely to be for a particular year. They can then put proactive measures in place to ensure that there is sufficient, affordable food available for all citizens, all-year round. It can also allow small-holder farmers to see which crops do well in which regions and/or seasons and focus on planting the crops that will yield a good harvest. It gives private sector businesses the information they need to make data-driven decisions when it comes to extending loans to farmers and crop insurance risk mitigation. Finally, it gives international researchers and policy makers the information they require to assess and monitor the impact of climate change on food security on the continent. The AfCP is based on a robust scientific model. It is an excellent example of 'AI for Real Impact', which is a core part of SAND Technologies' and Google's mission.

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10.2 Farm Monitor

INTRODUCTION AND MISSION STATEMENT

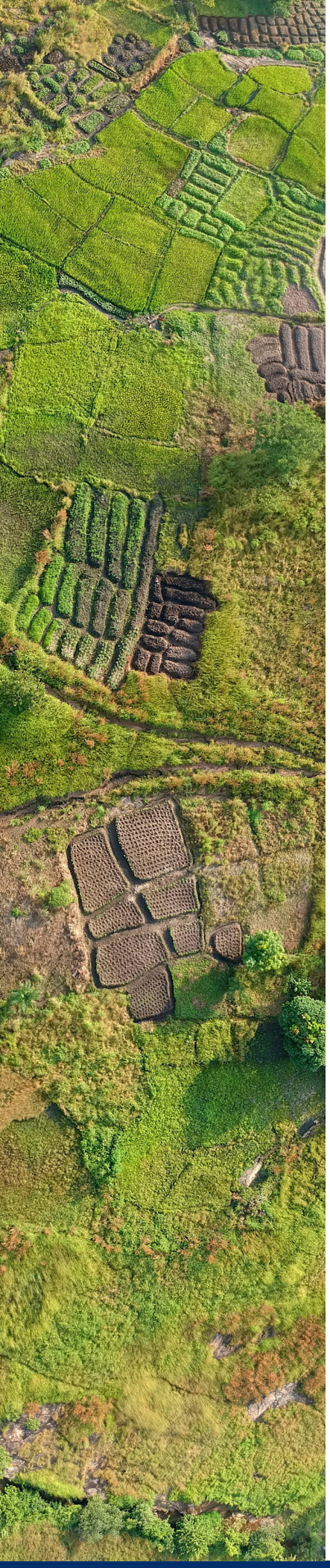
- **Mission and Vision of Farm Monitor**
  Farm Monitor's primary goal is twofold: to assist farmers in optimizing their farming operations for increased profitability and to provide financiers with the necessary data to confidently invest in farming operations. By leveraging AI and data-driven insights, the app helps farmers make better-informed decisions while simultaneously offering transparency and trust to potential investors. Farm Monitor was founded with a vision of improving agricultural practices and promoting agricultural investments.

- **How the App Fits the Company's Mission**
  Farm Monitor embodies the company's mission by providing farmers with actionable insights that enhance productivity and sustainability, while also empowering financiers with reliable farm data. Through this dual focus, the app aims to create a symbiotic relationship between farmers and investors, fostering a more robust and efficient agricultural ecosystem. The app illustrates the company's commitment to using technology and data to support farmers, making farming more efficient, scalable, and economically viable.

THE JOURNEY TO NOW

- **Founding Story of the App**
  Farm Monitor was born out of the CEO's personal frustration with managing his own large-scale farm. Daniel Udeme-Joseph, a Nigerian farmer and entrepreneur, initially outsourced the development of a farm management tool to monitor his farm remotely. However, after two unsuccessful attempts with external development teams, he met Victor Ogunshola, who joined as the CTO. Together, they formed an internal team to build a robust solution to address not only Joseph's farm management needs but also the broader agricultural industry's data challenges. Initially intended for personal use, the app evolved into a commercial product, addressing common problems in farm management.

- **Key Milestones**
  Development of the app began in August 2022, with an internal team built by Ogunshola. Within 3.5 months, a minimum viable product (MVP) was delivered. After a short break, further development resumed in early 2023, integrating AI capabilities like FarmPal, an AI-powered assistant that responds to farmers' questions based on real-time farm data and conditions. By 2024, Farm Monitor had expanded its offerings and entered discussions to launch in Uganda and Kenya.



- **Challenges Faced**
  Some challenges included Ogunshola's initial unfamiliarity with agricultural processes, which required him to invest significant time learning about the industry. There were also technical obstacles, such as attempting to develop an AI feature for pest and disease identification through image recognition, which was shelved due to data limitations. Another challenge was the Nigerian market itself—many farmers were unaware of the potential value of data in farming, making adoption difficult.

- **Initial Pilot and Lessons Learned**
  The initial version of Farm Monitor was launched for farmers in late 2022. From the pilot, the team learned the importance of designing a solution that catered not just to farmers but also to financiers. This realization led to the split of the platform into two distinct sections—one focused on farming operations and the other on financial oversight.

- **Recognition**
  The government of Nigeria, through the Central Bank, recognized the platform's potential by signing an MOU to use it for managing agricultural risks. This partnership, though slowed by a lack of government funding in 2024, highlights the growing impact and recognition of the app.

DETAILED SOLUTION

- **Technology**
  Farm Monitor employs a range of technologies, including satellite imagery (from Sentinel-2), AI, and machine learning models to gather and process farm data. The app tracks metrics like soil moisture (NDMI), vegetation health (NDVI), and weather conditions to provide farmers with actionable recommendations. Additionally, it uses an AI-powered assistant, FarmPal, which relies on a language model (OpenAI, enhanced with local agricultural data) to answer farmers' queries about irrigation, planting, and farm management.

- **Core Components and Features**
  Key features include a dynamic farm calendar that adjusts recommendations based on weather patterns, satellite imagery, and user inputs. FarmPal, the AI assistant, allows farmers to ask farm-specific questions and receive tailored advice. On the financier side, the app offers insights into farm performance, cost tracking, and risk management metrics, providing data-driven transparency for investment decisions.

- **App Workflow**
  Farm Monitor works by aggregating data from multiple sources—weather forecasts, satellite imagery, and farmer inputs—into a unified platform. Farmers log activities like planting and irrigation, while the app analyzes these inputs and generates actionable recommendations. The app delivers these recommendations via SMS, ensuring that even farmers with limited internet access can benefit. Financiers can monitor farmers' progress and access detailed data to support their investment decisions.

- **Data Sources**
  Farm Monitor integrates multiple data streams: satellite imagery for land analysis, weather data, soil composition data from partners, and user-generated data on farm activities. This combination allows the app to generate precise, farm-specific advice. In addition, the AI assistant, FarmPal, is fed with local agronomic knowledge and data collected from users to maintain accuracy and contextual relevance.

- **User Interaction/Interface**
  The app is available as both a mobile and web application, although connectivity issues and low-end Android devices pose challenges for adoption. As a workaround, the app sends vital information via SMS, and the team is exploring WhatsApp integration for easier farmer interaction. The design thinking prioritizes simplicity, ensuring that farmers with limited technical knowledge can easily input data and receive recommendations.

- **Scalability and Expansion**
  The platform is designed to scale, both in terms of user numbers and geography. While currently operational in Nigeria, Farm Monitor plans to expand into Uganda and Kenya, adapting to local agricultural contexts through partnerships with agronomists in those regions. Expansion into related sectors like carbon accounting and crop insurance profiling is also under consideration.

- **Compliance and Guardrails**
  As a data processor, Farm Monitor complies with Nigerian data privacy regulations, ensuring proper handling and protection of user data. The app's AI recommendations are stored for internal review to ensure accuracy and reduce the risk of providing erroneous advice that could harm crop yields. Custom-built agronomic datasets also serve as guardrails, ensuring that OpenAI's general model is appropriately fine-tuned for local contexts.

- **Limitations**
  The app's limitations include challenges in scaling AI-based features due to limited training data and the reluctance of some farmers to adopt technology. Furthermore, the lack of high-end smartphones among many farmers hinders full utilization of the mobile app, which has prompted the exploration of alternative communication channels like WhatsApp.

- **Support and Training Provided**
  Farm Monitor provides training materials, including video tutorials, and recommends the use of extension workers who serve as intermediaries between the farmers and the app. These workers help farmers input data and explain recommendations, thereby easing the adoption of the platform.

- **Ethical Considerations**
  Farm Monitor ensures that its data-driven recommendations are unbiased and supports farmers' autonomy by allowing them to make informed decisions. The platform also respects privacy through its data protection measures, ensuring that farmers' information is only shared with financiers under mutual agreement.

10.3 Ask Viamo

BACKGROUND

In Tanzania, many rural farmers rely on radio broadcasts for agricultural advice, weather updates, and market information. However, these farmers often lack a way to provide feedback or ask questions in real time, limiting the effectiveness of the information shared. Viamo aims to bridge this gap by using interactive voice response (IVR) technology, allowing farmers to engage directly with radio broadcasts.

ACTORS

1. **Farmers**
   Rural individuals involved in agriculture who listen to radio broadcasts for important information.
2. **Radio Broadcasters**
   Local radio stations that provide agricultural content, weather forecasts, and market news.
3. **Viamo**
   Technology provider that offers IVR solutions to facilitate two-way communication.
4. **Agricultural Experts**
   Specialists who provide information and answer questions regarding farming practices.

PRECONDITIONS

- Farmers have access to mobile phones and reliable network coverage.
- Radio stations are equipped with Viamo's IVR technology.
- Farmers are familiar with how to use the IVR system.

MAIN FLOW:

1. **Listening to Broadcasts**
   Farmers tune in to local radio stations to listen to agricultural broadcast segments.
2. **Engaging via IVR**
   During or following the broadcast, farmers are prompted to call a specific number to ask questions or provide feedback related to the broadcast content.
3. **Submitting Questions**
   Farmers use the IVR system to submit their questions regarding farming practices, weather, or market conditions in a simple menu-driven interface.

4. **Expert Response**
   Questions submitted by farmers are collected and routed to agricultural experts. The experts provide tailored responses which are then broadcasted in subsequent radio segments.
5. **Feedback Loop**
   The answers provided can lead to further engagement. Farmers are encouraged to continue discussing the answers through the IVR system, creating an ongoing conversation.
6. **Community Impact**
   The two-way interaction leads to a better understanding of farmers' needs, enabling radio broadcasters and agricultural experts to tailor future broadcasts to address prevalent issues.

POSTCONDITIONS

- Farmers feel more empowered as their questions are acknowledged and answered.
- Radio broadcasters enhance their programming based on farmer feedback and queries.
- Agricultural experts gain insights into the concerns and needs of farmers, improving resource delivery.

EXTENSIONS

- **Limitations in Technology**
  In regions with poor mobile coverage, alternative communication methods (e.g., community meeting discussions) may be explored to ensure those farmers also have a voice.
- **Training Sessions**
  Viamo could facilitate training sessions to educate farmers on how to use the IVR system effectively.

BENEFITS

- Enhanced communication between farmers and information providers leads to better farming practices and enhanced crop yields.
- Farmers feel more connected to the information they receive, leading to increased trust in broadcasters.
- Improved agricultural outcomes can contribute to local economic growth.

USER EXPERIENCE

> **ONE FARMER REFLECTED ON THE EASE OF USING THE IVR SYSTEM:**
>
> **"I can call 667 anytime, even if I'm in the field. It's much easier than trying to find information online, especially when I don't always have internet access or when there's no electricity for TV or radio. For example, I had a question about early marriage and health topics, so I just called. I pressed 1 for 'Ask Any Question,' and they helped me right away. It's so simple and accessible! I find the information really useful for my studies, and I plan to share it with my sister and friends."**

This use case illustrates how Viamo's IVR technology can create a meaningful dialogue between farmers and information providers, ultimately leading to better agricultural practices in Tanzania.