The Use of Artificial Intelligence in Food and Agricultural Systems

The future of AI in Sub-Saharan Africa's agriculture: opportunities, risks, and governance
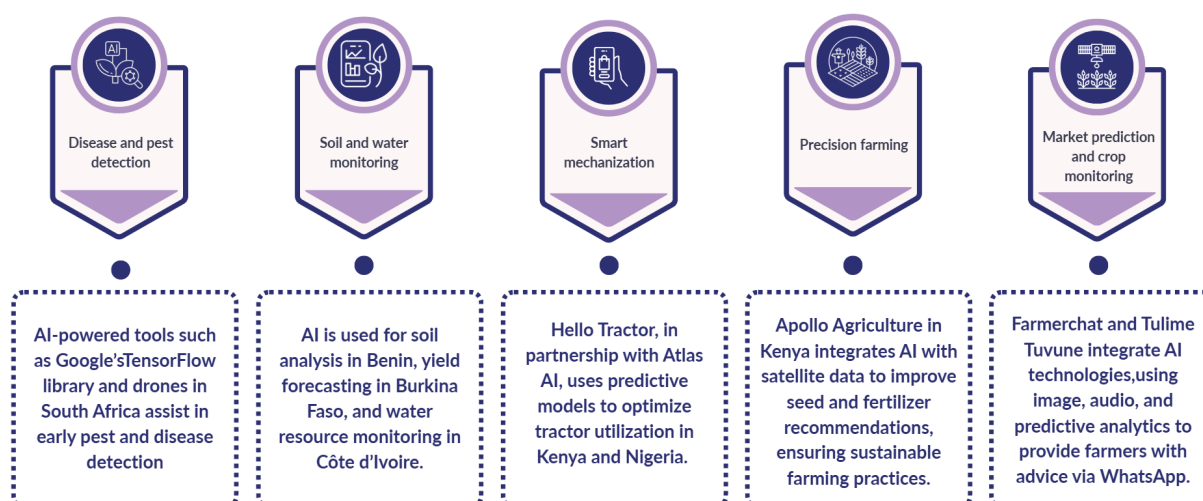
Author: Angella Ndaka

Agriculture remains the backbone of many economies in Sub-Saharan Africa (SSA). Along with education, finance, public service, and health sectors, it plays a vital role in employment, food security, and economic stability. As the continent undergoes rapid technological advancements, artificial intelligence (AI) is proving to be a transformative force in agriculture, offering solutions for increasing productivity, reducing costs, and improving efficiency. The World Bank (2013) estimated that Africa's food and agribusiness sector would reach a value of $1 trillion by 2030, and AI is expected to be instrumental in unlocking this potential. For instance, AI is projected to improve Africa's economy, where agriculture is the biggest contributor, potentially reaching up to $2.9 trillion by 2030 (Jahic 2024). However, challenges such as AI governance, digital and social inequality, and sustainability concerns must be addressed to ensure that AI benefits all stakeholders, especially the smallholder farmers who are the largest contributors in the sector.

AI in agriculture: transforming food systems in SSA

AI is revolutionizing agriculture through applications that range from crop monitoring to

financial services for farmers. AI-driven platforms such as UjuziKilimo, Tula, AGIN, FarmerChat, Hello Tractor, Apollo Agriculture, and Tulime Tuvune, among others, are helping farmers access crucial insights on market trends, disease detection, credit, weather prediction, and input sourcing. Several AI innovations in SSA demonstrate the technology's potential:

Disease and pest detection	Soil and water monitoring	Smart mechanization	Precision farming	Market prediction and crop monitoring
AI-powered tools such as Google'sTensorFlow library and drones in South Africa assist in early pest and disease detection	AI is used for soil analysis in Benin, yield forecasting in Burkina Faso, and water resource monitoring in Côte d'Ivoire.	Hello Tractor, in partnership with Atlas AI, uses predictive models to optimize tractor utilization in Kenya and Nigeria.	Apollo Agriculture in Kenya integrates AI with satellite data to improve seed and fertilizer recommendations, ensuring sustainable farming practices.	Farmerchat and Tulime Tuvune integrate AI technologies,using image, audio, and predictive analytics to provide farmers with advice via WhatsApp.

One locally developed solution, Tulime Tuvune, showcases how AI can support smallholder farmers. Tulime Tuvune operates in 12 counties in Kenya and leverages AI technologies such as Natural Language Processing (NLP), image and audio analysis, and predictive analytics to provide farmers with localized agricultural advice via WhatsApp. By integrating data from Kenya's Integrated Agricultural Management Information System (KIAMIS), FAO, and Kenya's Ministry of Agriculture, Livestock and Fisheries (MOALF), the platform enhances farm-level and post-harvest decision-making for smallholder farmers in rural Kenya.

Governance and policy landscape for AI in agriculture

African governments, tech companies, and AgTech startups are actively exploring opportunities in big data and AI solutions to address food security, climate change, and poverty in the continent. Regional initiatives highlight the potential for AI to drive development. These include the African Union's AI Continental Strategy (2024) (Continental Artificial intelligence Strategy 2024), Africa Agenda 2063 (African Union 2025) , and the Africa Digital Transformation Strategy 2020-2030 (African Union 2020). Agricultural innovation for food security and climate action is positioned as a main policy priority. Other supporting policies like African Union Malabo Convention on Cybersecurity and personal data protection in Africa set data protection guidelines in the region. Nationally, Mauritius, Rwanda, Senegal, Kenya, Zambia, Ethiopia, and Benin have recently formulated and launched

AI policies. These are aimed at leveraging AI innovations to enhance agricultural productivity and food security, along with developing key sectors like education, finance, health, and public service delivery.

However, many of these policies remain anticipatory, adopting a techno-optimistic and techno-centric approach. They overly emphasise AI's potential to improve different sectors, while narrowly attending to the risks related to data sovereignty, data access and value, social and digital inclusion, and ethical AI use. This is particularly concerning for smallholder farmers and rural communities, as emphasised by Akintuyi (Olabimpe Banke Akintuyi 2024) Without clear farmer-centric AI governance frameworks, smallholder farmers may be left vulnerable to exploitative practices from global and local tech firms controlling AI-driven agribusiness solutions.

Governance and policy landscape for AI in agriculture

Despite AI's promise, several challenges hinder its widespread adoption in SSA, including but not limited to:

Data bias and poor data quality

Digital inequality and access barriers

Gender and social inclusion disparities

Environmental and ethical concerns

Power imbalances in AI governance

- **Data bias and poor data quality**

AI systems require vast datasets for accurate predictions, but SSA lacks representative agricultural data. Poor-quality data, systemic and cultural inequality, and algorithmic bias can lead to inaccurate insights. This disadvantages smallholder farmers, especially women and marginalized groups. Solutions like Tulime Tuvune, while promising, struggle with accessing region-specific data limitations, reducing their effectiveness.

- **Digital inequality and access barriers**

Many AI-driven agricultural platforms are designed without considering the realities of smallholder farmers. Limited digital literacy, high smartphone costs, and internet connectivity issues create barriers to AI adoption. For instance, Tulime Tuvune's solution relies on WhatsApp as the farmer engagement channel, making it accessible for those with smartphones. However, many rural farmers lack smartphones or the digital skills to fully utilize the platform.

- **Gender and social inclusion disparities**

Women, who form a significant portion of Africa's agricultural workforce, are often excluded from AI-driven agricultural innovations. Many AI Agtech start-ups prioritise outreach through Savings and Credit Cooperative Societies (SACCOS), which are male-dominated, rather than informal networks such as Chamas, where women actively participate. Youth engagement is also low, due to limited access to productive assets. Many young people lack land and financial capital, which limits their interest in digital farming solutions.

- **Environmental and ethical concerns**

AI development requires high energy consumption and water usage and has a significant environmental footprint. Climate-conscious AI strategies must balance innovation with sustainability to prevent ecological damage.

- **Power imbalances in AI governance**

AI policies in SSA are often influenced by bureaucrats, multinational corporations, and foreign entities rather than local grassroots stakeholders like smallholder farmers. This top-down governance approach risks prioritising profit-driven AI solutions over the needs of smallholder farmers and rural communities.

Solutions: building inclusive and sustainable AI for agriculture

For AI to truly benefit SSA's agricultural sector, a farmer-first approach is essential. Here are key strategies to enhance AI adoption:
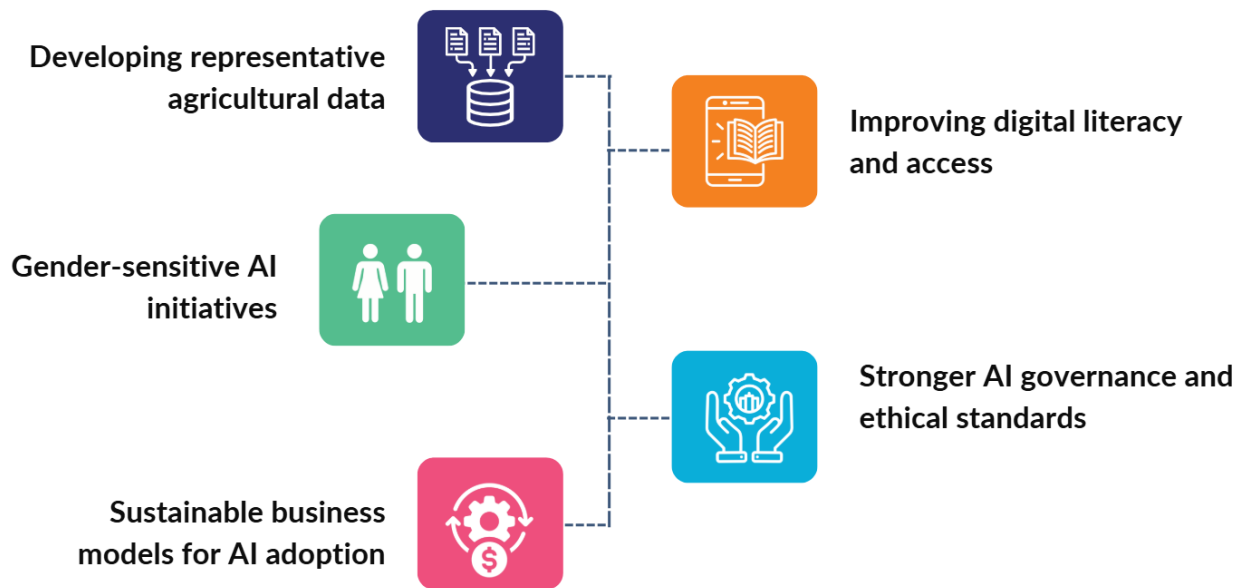
- **Developing representative agricultural data**

Governments should invest in data collection initiatives such as KIAMIS, ensuring open-source access for AI developers to build accurate, localized solutions.

- **Improving digital literacy and access**

Grassroot organisations can collaborate with the international development sector and AI developers to implement capacity-building and AI literacy programs. These programs can help farmers navigate different digital platforms, while protecting their rights to privacy and flourishing.

- **Gender-sensitive AI initiatives**

  o AI developers should engage with women's farmer groups and Chamas to increase female participation
  o Providing AI-based advisory services in local languages can make digital tools more accessible
  o Enforcing gender equity laws on a larger scale will improve gender-responsive AI scoring, and ensure meaningful benefits of AI for women and girls in farming

- **Stronger AI governance and ethical standards**

African governments must establish clear AI in agriculture policies, prioritizing data protection, transparency, data value tracking, and farmer participation in agricultural data governance.

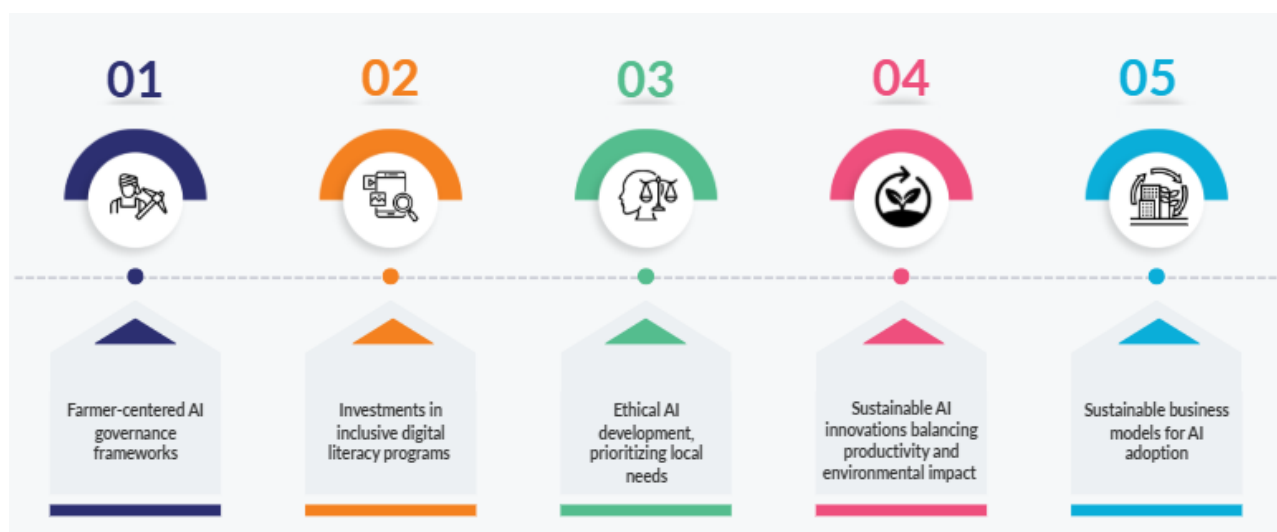- **Sustainable business models for AI adoption**

Instead of relying on subscription-based models, which may be inaccessible to smallholder farmers, AI initiatives should explore freemium models (where basic products or services are free, with optional paid features or services available for premium customers), NGO partnerships, and government subsidies. This helps in attracting a large user base of smallholder farmers who, in turn, help in refining the AI tools.

Conclusion: a call for equitable AI in African agriculture

AI has the potential to revolutionize SSA's agriculture, improve food security, and drive economic growth. However, without inclusive governance, ethical AI policies, and farmer-centric solutions, AI adoption may widen existing inequalities.

To ensure AI benefits all farmers, SSA must prioritize:

01	02	03	04	05
Farmer-centered AI governance frameworks	Investments in inclusive digital literacy programs	Ethical AI development, prioritizing local needs	Sustainable AI innovations balancing productivity and environmental impact	Sustainable business models for AI adoption

By fostering inclusive and responsible AI ecosystems, SSA can create a resilient, tech-driven agricultural sector that empowers smallholder farmers and ensures long-term food security for the continent. As AI continues to shape the future of farming, policymakers, tech innovators, and agricultural stakeholders must collaborate to design solutions that work for the many, not just a few.

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