



Enabling Smallholder Adoption of Agricultural AI in Sub-Saharan Africa (SSA): Lessons from Rwanda and Nigeria

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- More than 60% of the entire SSA population works in agriculture
- Of that, smallholder farmers make up 80% of all farms
- SSA accounts for roughly 25% of the world's arable land, yet generates only 10% of global agricultural output
- This disparity stems from low productivity, lack of infrastructure, limited access to technology, and vulnerability to climate change

Toward an enabling environment - Image generated by AI

Rural Connectivity

Reliable Power Supply

Physical Access

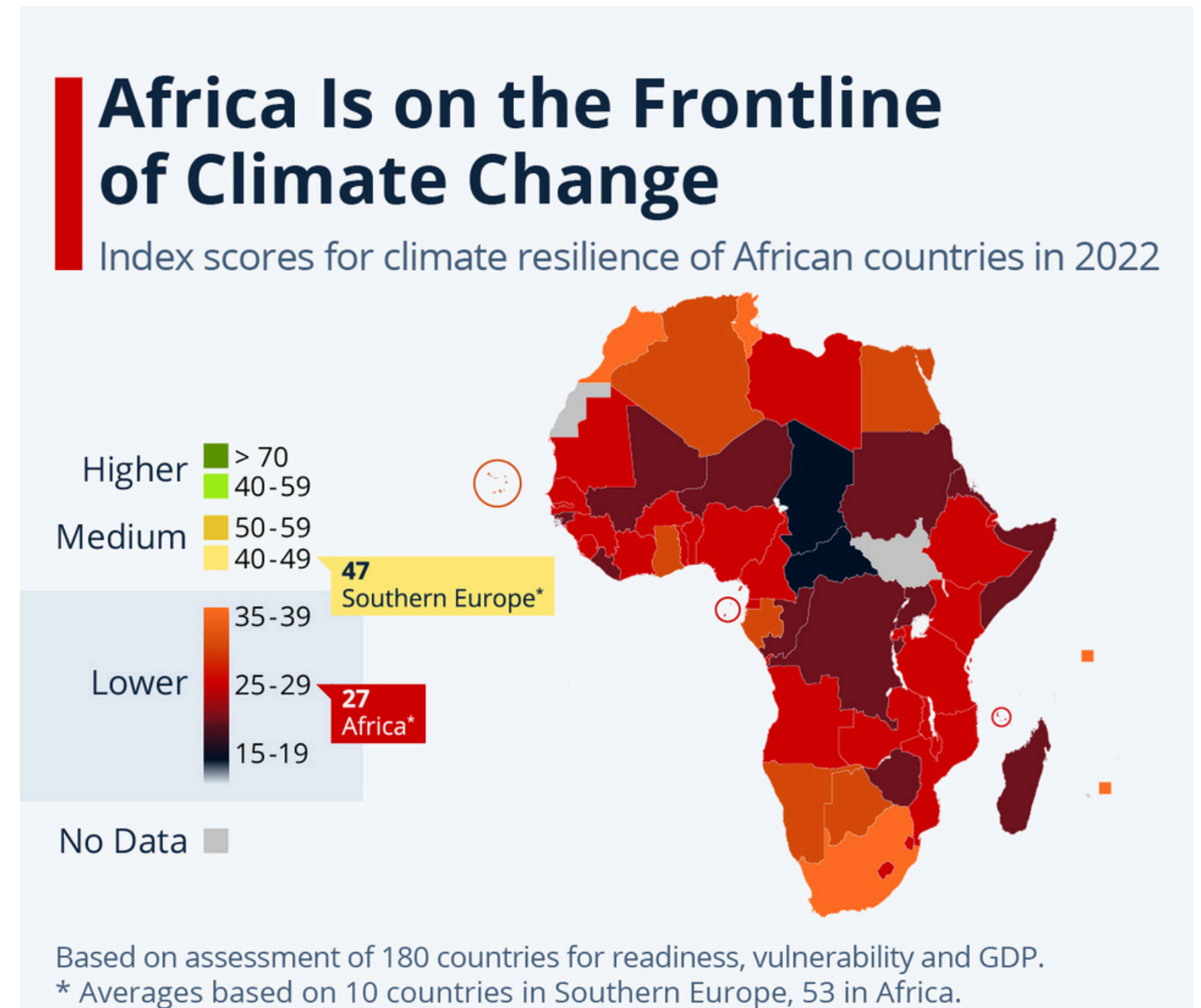
Field Sensors

Mobile/Tablet Access



The Impact of Climate Change on SSA

- In 2024, Malawi, Zambia, and Zimbabwe saw its most severe drought in at least two decades
- The Nigeria floods in May 2025 were described as the worst in 60 years
- WMO reports the continent is warming faster than the global average, with some areas warming up to 1.5 times the global mean



Source: Henley & Partners

AI has emerged as a powerful potential solution in agriculture

- AI adoption is accelerating globally—its application in agriculture can harness technology and data to mitigate climate risks, drive productivity gains, and build long-term resilience across food systems.
- Agricultural AI has been adopted in countries around the world, such as the United States, India, and the Netherlands, and interest across SSA has only been growing.

Given SSA's evolving agricultural, climate, and development context, this project aimed to understand the enabling environment shaping the deployment, investment, and adoption of agricultural AI in the region

Agricultural AI

AI in agriculture is defined as:

“applying computer or machine learning from data to bring efficiencies and solutions to farming and the food supply. This allows more informed decisions to be made from large and complex data sets than would be possible by a person alone”

AI applications in:

- Crop monitoring
- Pest and disease detection
- Yield prediction
- Weather and climate risk forecasting
- Resource management
- Digital farming advisory
- Agricultural finance and insurance
- Market access
- Supply chain and logistics
- Mechanization and farm automation

AI-Techniques and Technologies Used in Agriculture

Function	Technologies	Techniques
Agricultural data collection	Internet; Cloud computing; Desktops, laptops, tablets, smartphones and mobile apps; Drones; Satellite imagery.	SMS; Sensors and IoT devices; Chatbots.
Analysis of agricultural data and decision-making	Artificial intelligence; Automation; Blockchain.	Machine learning; Deep learning; Computer vision; Generative AI; AI modeling; Predictive analytics.

Source: CEIMIA

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Research Question

What enabling environment is needed for agricultural AI in Sub-Saharan Africa?



Methodology

This study adopted a qualitative research design to assess the enabling environment for agricultural AI in Sub-Saharan Africa, with a focus on policy, investment, infrastructure, and smallholder adoption

1

Literature Review

2

**Legal, Regulatory, &
Policy Analysis**

3

**Comparative Case
Studies**

4

Expert Interviews



Main Agricultural AI Use Cases in SSA

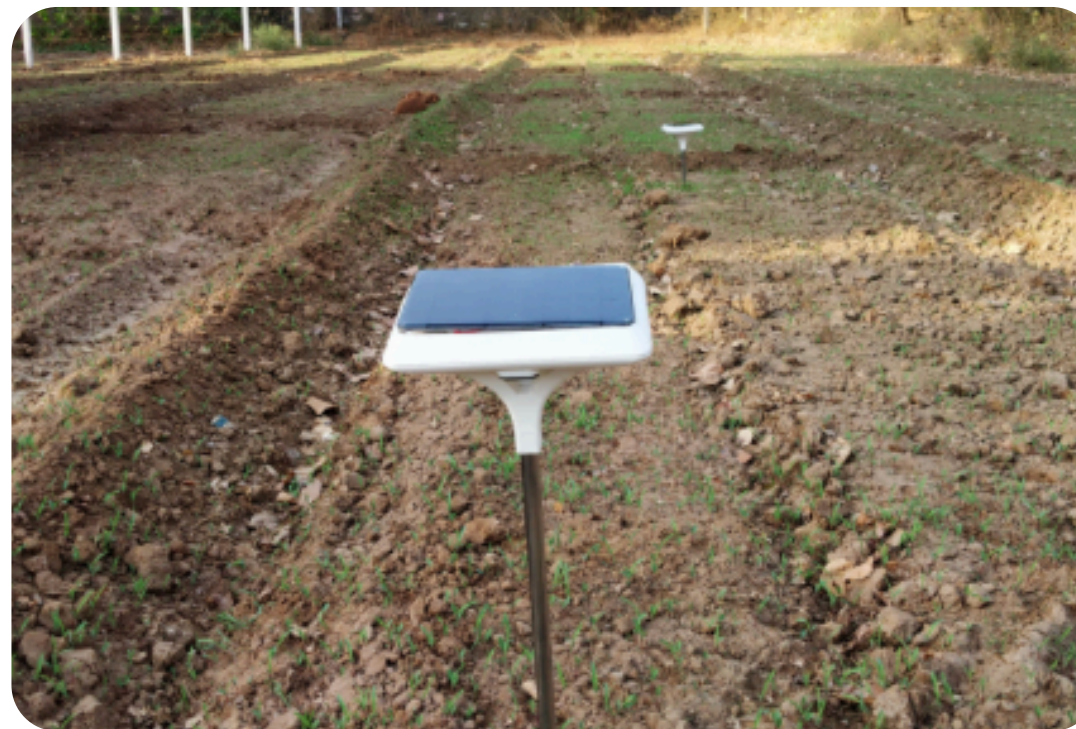
Weather Forecasting



Source: AgriPredict

AgriPredict - Zambia

Resource Management



Source: Zenvus

Zenvus - Nigeria

Digital Advisory



Source: DigitalGreen

FarmerChat - Multiple Countries

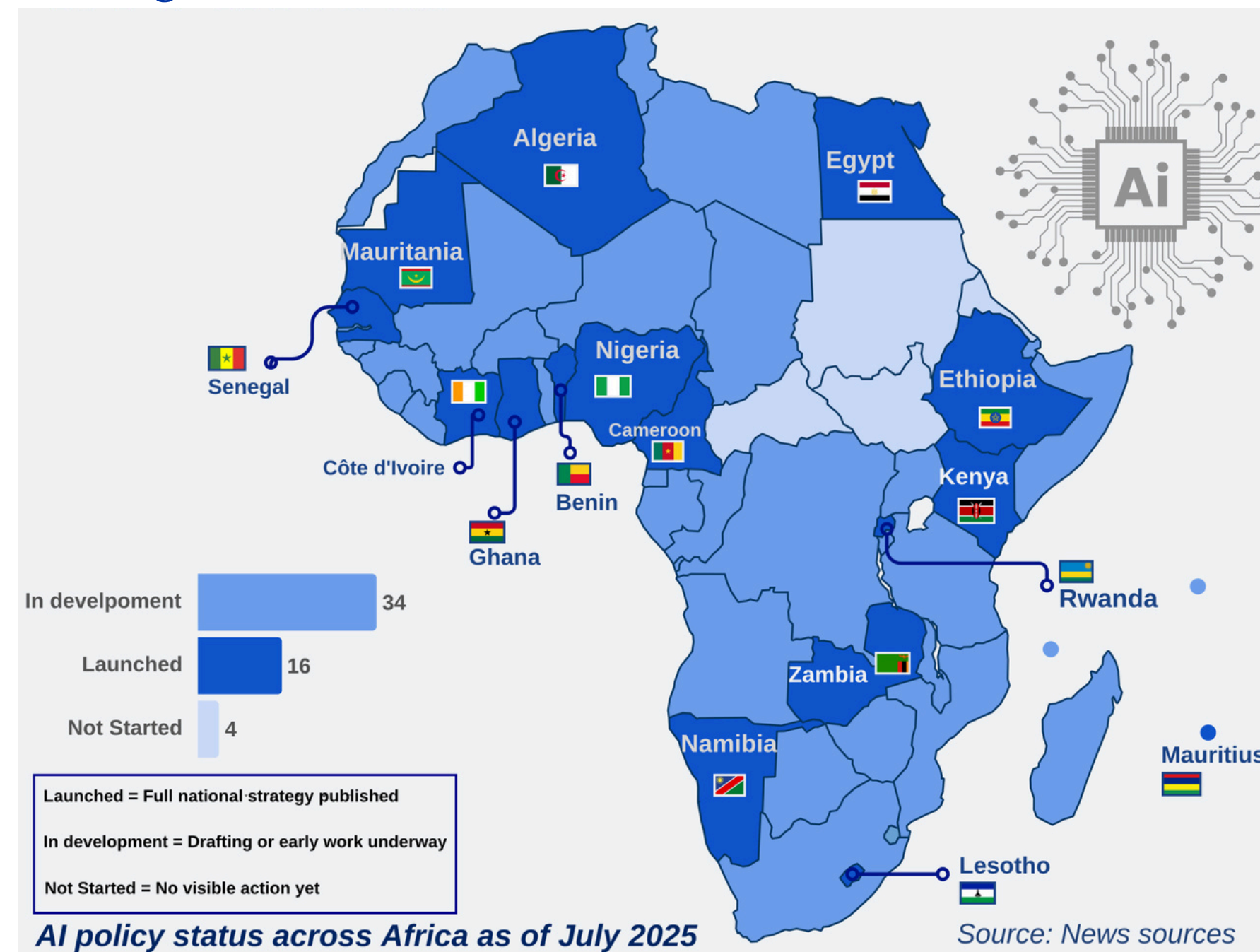
Yet, AI technologies do not equal farmer adoption

- Key enabling conditions include the legal, regulatory, and policy context, infrastructure readiness, relevant data, financing conditions, and delivery channels
- These conditions determine whether AI can be implemented, trusted, financed, and used in practice



Understanding the Regional Picture

Countries on the African Continent with National AI Strategies or Policies



- As of today, 14 SSA countries have national AI strategies or policies, with many identifying agriculture as a priority sector, but no laws or regulations for AI
- Development finance is central, backed by governments, donors, and philanthropies. Initiatives like AI4D Africa and the AfDB's Feed Africa strategy support digital agriculture, though private investment is limited despite interest from tech firms like Google and Microsoft

Case Studies: Nigeria and Rwanda



To examine how enabling conditions shape agricultural AI adoption, this project compares two SSA countries with different national contexts, with Rwanda and Nigeria selected for the following reasons:

- **Market context:** Nigeria is a large, populous economy with significant market scale, while Rwanda is a smaller, fast-growing economy and population
- **Infrastructure contrast:** Nigeria has 28 data centers, compared with 3 in Rwanda

Together, they provide a useful comparison of how agricultural AI may develop across markets that differ significantly in scale, economic size, infrastructure, and national context

Challenge 1: AI Governance Gaps and Regulatory Uncertainty



- National AI Policy sets a cross-sector vision for AI development and adoption
- PSTA 5 embeds digitization and AI within agricultural transformation
- Clearer budgets, institutional roles, and implementation pathways support more coordinated delivery



- National AI Strategy still awaiting full parliamentary approval
- NATIP 2022–2027 emphasizes agricultural modernization and digital agriculture
- No budgets or implementation plans; broader institutional base, but responsibilities are more diffuse

Across Countries,

- Neither country currently has legally binding AI laws or regulations, cross-sector or in agriculture
- Key issues remain underdefined, including data ownership, farmer consent, liability for incorrect AI advice, fairness, accountability, and deployment standards

Challenge 2: Weak Digital and Physical Infrastructure



- Reached approximately 95% 4G coverage and invested in national fibre optic backbone expansion to improve connectivity across the country
- Established a national data center, supporting digital public systems and AI deployment



- 4G coverage remains lower at approximately 53%, limiting access outside major urban areas
- Broadband expansion has been slowed by high right-of-way costs and uneven state-level implementation

Across Countries,

- Infrastructure constraints limit the practical reach of agricultural AI
- Where connectivity, electricity, and digital systems are weak, AI tools become less usable for farmers, harder to scale for developers, and riskier for investors because the addressable market remains smaller and more uneven

Challenge 3: Fragmented Data Foundations



- Treats data as a national asset, with emphasis on public data systems that can connect and share information
- Digital Public Infrastructure (DPI) strategy aims to support data exchange, service delivery, and cross-institutional coordination



- Stronger emphasis on legal protection and data subject rights
- Less clearly linked to an operational system for agricultural data sharing across institutions
- Data remains more fragmented across agencies, platforms, and private-sector actors

Across Countries,

- Neither country has clear, standardized requirements for how agricultural data should be collected, formatted, shared, and integrated
- Data is often stored across different agencies, platforms, and databases, making it harder to combine and use at scale

Challenge 4: Investment Remains Limited and Does not Reliably Reach Smallholders



- More government-led and public-sector oriented agricultural AI model, with tools built in-house
- Rwanda AI Scaling Hub received around US\$17.5M in Gates Foundation support
- National AI Policy faces a funding gap of US\$76.5M needed vs. ~US\$1.2M mobilized



- Active startup ecosystem and initiatives like NAIRS and the NCAIR AI Fund with Google support AI technology development
- Nigeria AI Scaling Hub received up to US\$7.5M in Gates Foundation support
- Funding remains concentrated around R&D and pilots

Across Countries,

- Investment remains limited, uneven, and not consistently aligned with smallholder adoption
- Public financing can support inclusion but may face sustainability challenges
- Private investment can drive innovation but prioritize more commercially attractive users

Challenge 5: Farmer Realities and Last-Mile Delivery Barriers



- Farmers aged 16–30 make up only 14% of the agricultural workforce, while younger users generally have higher digital literacy
- Rwanda addresses this by routing AI insights through extension agents, who translate tools like crop forecasting into farmer-facing advice



- Around 70% of the population is under 30, creating more potential for direct farmer engagement with AI tools
- Startup-led models allow more experimentation, but may face last-mile reach, affordability, and accessibility barriers among smallholders

Across Countries,

- Low digital literacy, limited trust, shared smartphone access, and weak connectivity constrain direct use
- Some smallholders lack formal land rights, IDs, or farming records, making it harder to access verified digital services
- Land and documentation gaps can reduce farmer confidence and exclude users from AI-enabled platforms

Cross-Case Findings



1 Policy & Governance
Policy context:
National Agricultural Technology &
Innovation Policy + draft National AI Strategy



2 Investment & Financing
More private capital;
mature startup ecosystem



3 Physical & Digital Infrastructure
Weaker physical and
digital infrastructure



4 Data Systems & Sharing
Rights-based data protection;
less data sharing



5 AI Tools & Technologies
Local startup-led AI tools



6 Delivery Pathways
Direct access by farmers



Farmer Context
Smallholder + commercial



1 Policy & Governance
Policy context:
5th Strategic Plan for Agriculture
Transformation + National AI Policy



2 Investment & Financing
Mainly public and philanthropic
finance; low private capital



3 Physical & Digital Infrastructure
Stronger physical and
digital infrastructure



4 Data Systems & Sharing
Government-led public
data systems



5 AI Tools & Technologies
Government-built local AI tools



6 Delivery Pathways
Extension agent-led delivery



Farmer Context
Older smallholders

Recommendation 1: Governments Should Establish Clearer Governance Frameworks for Agricultural AI

What to clarify

- Agriculture-specific guidance from national AI strategies
- Responsible agencies for implementation and oversight
- Rules on data ownership, access, consent, standards, and liability

What this unlocks

- Lower uncertainty for farmers, developers, and investors
- Clearer participation rules for farmers and public agencies
- Greater trust for wider scale deployment



Recommendation 2: The Foundations for AI should be Built Before Pushing AI Itself

What is needed

- Rural connectivity
- Cloud & local data centers
- Mobile ecosystems
- Reliable power
- Physical access & last mile logistics

What this enables

- 4G/5G to transmit real-time farm data
- Powers AI models, analytics, and computer vision
- Mobile networks and smartphones enable access
- Keeps sensors, drones, and devices operational
- Roads, service hubs, and extension networks help deploy, maintain, and act on AI tools



Recommendation 3: Public and Private Finance should be Combined More Deliberately Around Smallholder Adoption

What public finance can support

- Infrastructure
- Extension and training
- Early deployment
- Shared data systems
- Risk reduction

What private capital should scale

- Tool development
- Service expansion
- Market scaling
- Distribution models where demand exists



Recommendation 4: Incentivize Delivery, Not Just Innovation

Innovation incentives → new tools, R&D, pilots, local relevance

Inclusion incentives → affordability, accessibility, farmer reach

What policy levers can do

- Procurement rules: require proof of rural usability
- Grant/funding conditions: prioritize reach, usability, and scale
- Licensing requirements: set standards for data, transparency, and accountability
- Affordability/accessibility criteria: ensure tools are realistic for smallholders
- Farmer-reach metrics: track adoption, repeat use, and action taken



Recommendation 5: Match Delivery Models to Farmer Realities

Extension-led model → suited for older, less digitally connected, or lower-literacy farmers

Direct delivery model → suited for younger, well-connected farmers with device access

What delivery design must account for

- Age and digital literacy
- Device and smartphone access
- Trust in digital tools
- Language and accessibility
- Infrastructure constraints
- Existing extension networks



Future Research

1. Further investigate farmer adoption and trust

Examine how farmers actually use, trust, adapt, or reject AI tools in practice, including the role of digital literacy, language, device access, and trusted intermediaries such as extension agents or cooperatives.

2. Further investigate business model viability

Assess which financing and delivery models can sustainably reach smallholders, including whether costs are best carried by farmers, governments, donors, agribusinesses, insurers, or blended models.

3. Further investigate tool usefulness and impact

Compare different agricultural AI use cases to understand which tools create the most value for farmers, and measure their effects on productivity, income, resilience, input efficiency, and decision-making.

Conclusion

- Agricultural AI has real potential to support productivity, climate resilience, and decision-making in SSA.
- But Rwanda and Nigeria show that tools alone do not guarantee adoption.
- Adoption depends on the systems around AI: governance, infrastructure, data, finance, delivery channels, and farmer trust.
- Rwanda and Nigeria suggest different pathways — public/state-led and private/startup-led — but both face shared enabling-environment gaps.
- The priority should be to build the foundations and enabling environment that AI needs to succeed



Thank you

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