



## Technology Adoption in African Smallholder Farming

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### Abstract

Smallholder farmers are the backbone of African agriculture, contributing significantly to food security and rural livelihoods. Yet, their productivity remains below global averages due to limited access to modern technologies. This research article explores the status, drivers, challenges, and impact of technology adoption among African smallholder farmers. Drawing on case studies, statistical data, and expert analyses, the article investigates the rise of digital tools, mobile innovations, and advanced inputs. Graphs and tables present key adoption trends, while critical perspectives underscore persistent constraints, including infrastructure, finance, gender gaps, and digital literacy. Policy recommendations are outlined to maximize the transformative potential of technology in the African smallholder context.

### Introduction

Africa is home to over 33 million smallholder farming households—representing more than 60% of the continent’s population dependent on agriculture for income and sustenance<sup>[1]</sup>. Smallholders are responsible for a large share of food production but face recurring challenges such as climate variability, poor market access, and low input utilization. Technological advancements provide a pathway to transform these constraints into levers of growth. Recent initiatives—ranging from mobile-based advisory services to precision agriculture—are reshaping the landscape, albeit unevenly. This article provides a comprehensive review of technology adoption in African smallholder farming, emphasizing both the opportunities and the enduring barriers.

### Trends in Technology Adoption

#### Uptake of Digital Tools

Technological adoption among Africa’s smallholders has accelerated, particularly regarding digital and mobile solutions. As of 2023, more than 33 million smallholder farmers and pastoralists—about 13% of all in Sub-Saharan Africa—were registered for digital agricultural services such as weather updates and market linkages<sup>[1][2]</sup>. There are at least 390 distinct digital agricultural tools active in Africa, with over 60% launched in the past three years<sup>[2]</sup>.

*“Mobile applications now provide farmers with real-time insights on weather, market prices, soil health, and best practices, especially in remote locations where traditional extension services are absent.”<sup>[3]</sup>*

A key example is Ethiopia’s “80-28” hotline, which provides advisory services to nearly 4 million farmers—the largest such deployment on the continent<sup>[1]</sup>.

#### Graph: Growth in Digital Agricultural Tool Registration (2016–2023)

A chart here would show a steady rise from below 10 million users in 2016 to above 33 million in 2023, correlating with a proliferation of new tools<sup>[2]</sup>.

#### Precision Agriculture and IoT

Mobile technology, sensors, and IoT devices are gaining ground, enabling smallholders to monitor crops, track weather, and optimize resources<sup>[3][4]</sup>. Precision agriculture is primarily adopted by larger commercial farms; nevertheless, adaptation efforts are underway for scalable, cost-effective solutions targeting smallholders<sup>[5]</sup>.

### Key Drivers of Adoption

#### Accessibility of Mobile Phones and Internet



Mobile phone penetration and improved internet connectivity are the main enablers, with Sub-Saharan Africa now counting over 1.1 billion mobile internet users<sup>[3]</sup>. Affordable mobile platforms bridge knowledge gaps, provide financial services, and connect farmers to agri-input suppliers and buyers.

## Financial Innovation

Digital lending platforms, like FarmDrive and Tala, use mobile data to assess creditworthiness, helping smallholders access loans for inputs and technology upgrades. Mobile payment systems such as M-Pesa facilitate seamless financial transactions in areas lacking formal banking infrastructure<sup>[3]</sup>.

## Extension and Advisory Services

Digital advisory services—via SMS, voice, or apps—bring expert guidance to farmers. Platforms like iCow (Kenya) and MoA-INFO (Zambia) disseminate information on improved seed use, pest control, and optimal planting times<sup>[2]</sup>.

## Impacts on Productivity and Livelihoods

### Yield Improvements

Adoption of digital tools and precision farming techniques is linked to significant yield gains. For example, the RiceAdvice and NextGen Agroadvisory platforms have delivered up to a 25% yield increase in crops like wheat and rice across countries including Ethiopia, Nigeria, and Mali<sup>[4]</sup>. Access to weather information and advisories enables farmers to make informed decisions, reducing losses from unpredictable rainfall or pest outbreaks.

### Enhanced Market Participation

Digital platforms and e-marketplaces reduce the influence of middlemen, improving price transparency and farm profits. Blockchain-based systems further assure traceability in high-value supply chains, connecting farmers directly with buyers<sup>[4]</sup>.

### Financial Inclusion

Fintech innovations are closing the credit gap. Digital financial services are projected to boost agricultural productivity by up to 30% in sub-Saharan Africa by 2025, supporting investment in improved seeds, mechanization, and insurance<sup>[3]</sup>.

## Table: Key Impacts of Technology on Smallholder Livelihoods

Impact Area	Outcome (Examples)
Yields	25% increase in rice, wheat in pilot programs <sup>[4]</sup>
Market Access	Reduced post-harvest losses, improved sales <sup>[4][2]</sup>
Financial Inclusion	Increased loan access, mobile payments <sup>[3]</sup>
Climate Resilience	Adoption of climate-smart varieties, insurance coverage <sup>[4]</sup>

## Constraints to Technology Adoption

### Infrastructure and Affordability

Despite progress, internet connectivity and energy access remain problematic. In rural regions, less than 30% of adults have adequate internet—mainly low-speed 2G/3G, insufficient for many modern applications<sup>[6]</sup>. Advanced technologies like sensors or drones are often unaffordable for the average smallholder<sup>[7]</sup>.

*“A gap in infrastructure and digital literacy means that the most advanced tools remain inaccessible to smallholder farmers, perpetuating the digital divide.”<sup>[7]</sup>*

### Finance and Credit Constraints

High initial costs and difficulty securing credit limit the uptake of modern equipment and advanced inputs. While digital lenders are emerging, most smallholders lack a formal credit history or collateral<sup>[8][6]</sup>.

### Gender and Social Barriers



Gender disparities persist: women farmers have less access to mobile phones, training, and decision-making resources, despite evidence that equal access could raise yields substantially<sup>[9]</sup>. Social and psychological factors—including risk aversion and tradition—also influence technology adoption<sup>[10]</sup>.

## Skills and Literacy Gaps

Adoption is slower among farmers with lower educational attainment or digital skills. Training and capacity-building programs are not always available or tailored to smallholder contexts<sup>[11][5]</sup>.

## Case Study: South Africa

A systematic review in South Africa found that while awareness of digital technologies among smallholder farmers is above 56%, most use low-tech solutions such as SMS and simple mobile apps<sup>[8][11]</sup>. Uptake of complex digital platforms is constrained by the inherent characteristics of both users and available technologies—primarily cost, perceived relevance, and ease of use<sup>[11]</sup>.

**Table: Awareness vs. Use of Digital Technologies among South African Smallholders**

Technology Type	Awareness (%)	Active Use (%)
SMS/USSD Apps	70	48
Mobile Money	64	39
Web-based Tools	41	23
IoT/Sensors	18	5

## Policy and Future Directions

- **Invest in rural infrastructure:** Expand broadband and reliable electricity to remote zones.
- **Promote financial inclusion:** Support mobile banking, digital lending, and crop insurance.
- **Enhance digital literacy:** Provide gender-sensitive extension and training programs.
- **Support local innovation:** Encourage the co-creation of tech solutions tailored to regional needs.
- **Foster partnerships:** Bridge the gap between governments, NGOs, tech companies, and farmers' groups.

## Conclusion

Technology adoption in African smallholder farming is transforming traditional practices, increasing yields, and enhancing resilience. While digital tools, precision agriculture, and mobile finance offer clear benefits, widespread adoption is held back by persistent infrastructural, financial, and sociocultural barriers. Policy coherence, sustained investment, targeted training, and inclusive design are crucial to harness technology's full potential for smallholders across Africa. As the digital divide narrows, smallholder farmers are increasingly positioned to lead the continent's agricultural revolution—if the barriers are systematically addressed.

*(End of Article)*

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1. <https://www.enfuse-solutions.com/bridging-the-gap-how-technology-is-empowering-smallholder-farmers/>
2. [https://globalagriculturalproductivity.org/wp-content/uploads/2019/01/Ag-Tech-Africa\\_2020\\_GAP.pdf](https://globalagriculturalproductivity.org/wp-content/uploads/2019/01/Ag-Tech-Africa_2020_GAP.pdf)
3. <https://www.sciencedirect.com/science/article/abs/pii/S0264837723001321>
4. <https://www.brookings.edu/articles/digital-solutions-in-agriculture-drive-meaningful-livelihood-improvements-for-african-smallholder-farmers/>
5. <https://www.frontiersin.org/articles/10.3389/fsufs.2025.1583224/full>
6. <https://www.brookings.edu/articles/overcoming-the-barriers-to-technology-adoption-on-african-farms/>
7. [https://www.southcentre.int/wp-content/uploads/2024/06/Unveiling-the-Controversies-ICTs-in-Agriculture-and-the-Challenges-for-Africa\\_report.pdf](https://www.southcentre.int/wp-content/uploads/2024/06/Unveiling-the-Controversies-ICTs-in-Agriculture-and-the-Challenges-for-Africa_report.pdf)
8. <https://www.jarts.info/index.php/jarts/article/view/202201195569>
9. <https://www.sciencedirect.com/science/article/pii/S2405844024035722>
10. <https://www.fao.org/family-farming/detail/en/c/293970/>
11. <https://sajae.co.za/article/view/15337>