CHAPTER 1

Introduction

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Africa stands at a pivotal moment in the transformation of its agrifood systems. Despite important progress in agricultural development and growing regional policy coherence (AGRA 2025), the continent continues to grapple with persistent and interlinked challenges: food and nutrition insecurity, recurrent climate shocks, demographic pressures, low levels of value addition, and underdeveloped innovation ecosystems (FAO 2022; World Bank 2023; AUC and AUDA-NEPAD 2025). Rapid population growth, urbanization, and shifting dietary preferences are increasing the demand for nutritious, affordable, and processed foods. Meeting this demand requires expanding production, raising productivity, and strengthening intra-African trade. At the same time, these pressures create an opportunity for African countries to leverage advances in science, technology, and innovation (STI) to improve sustainability, competitiveness, and resilience (FAO 2022; Alexandrova-Stefanova et al. 2023).

For more than half a century, development economics has emphasized the centrality of agricultural productivity for broad-based economic transformation. Following Johnston and Mellor (1961), productivity growth contributes to poverty reduction and structural transformation through multiple pathways: increasing farm incomes, lowering food prices, stimulating agro-industry, and releasing labor for nonfarm sectors. These dynamics drove the remarkable progress in Asia and Latin America, where the Green Revolution and substantial public investment generated decades of total factor productivity (TFP) growth, rising rural incomes, and dramatic reductions in poverty and hunger. Importantly, this growth was based on technological change and intensification rather than land expansion, supported by investments in research, extension, irrigation, market development, and enabling policy reforms.

Sub-Saharan Africa (SSA) has not yet experienced a comparable trajectory of inclusive agricultural transformation. The region still houses nearly two-thirds of the global poor, the majority of whom live in rural areas. While African governments committed to raising agricultural investment under the Maputo (2003) and Malabo (2014) Declarations, actual spending has remained well below that of Asia and Latin America. Where investments increased, they often favored subsidies and short-term programs with limited productivity impact rather than research, extension, rural infrastructure, or institutional strengthening. As a result, agricultural growth in SSA has been driven largely by area expansion rather than TFP gains. Micro-level evidence confirms that productivity growth among smallholders has been stagnant or negative, contributing to only modest reductions in extreme poverty and hunger since 1990.

Notwithstanding these trends, Africa's agronomic potential remains substantial. Agronomic studies reveal large yield gaps—often 40–60 percent for major cereals—while microeconomic frontier analyses show that most TFP gains come from improvements in technical efficiency rather than technological progress. This underscores the need to address systemic constraints, including high transaction costs, limited market access, and heightened climate risks, which prevent farmers from adopting and benefiting from productivity-enhancing innovations.

Thus, Africa's productivity challenge is **not primarily technical but deeply institutional and socio-political**. Scientific and technological innovations must be embedded within supportive institutions, effective governance, and coherent policies to ensure their widespread adoption and equitable impact.

In this regard, emerging technological paradigms offer new opportunities. Digital farming, precision agriculture, remote sensing, artificial intelligence (AI), biotechnology, and organizational innovations cannot only reduce transaction costs, strengthen efficiency, and support climate-smart productivity gains, but also enable innovative complementary institutions and governmental processes that enable these technologies to scale.

Hence, Africa now stands at a decisive juncture. The continent possesses substantial agronomic potential, a rapidly growing population, and accelerating technological opportunities. Realizing this potential will require a new generation of investments, institutional reforms, and innovation strategies grounded in evidence, systems thinking, and innovative (digital) governance.

The Annual Trends and Outlook Report 2025 (ATOR 2025), ***"Moving the Technology Frontiers in African Agrifood Systems,"*** aims to contribute to this agenda. It explores pathways for advancing Africa's agrifood technology frontier in ways that promote sustainable, resilient, and inclusive development. The report is guided by several cross-cutting questions:

Understanding Africa's Productivity Lag: Why has Sub-Saharan Africa struggled to translate agricultural growth into substantial poverty and hunger reduction? How do structural conditions, transaction costs, and institutional weaknesses limit innovation and productivity?

Technological Pathways for Transformation: What roles can digital agriculture, biotechnology, AI, and climate-smart agriculture play alongside

conventional agronomy? How can these technologies close yield gaps, strengthen resilience, and ensure equitable growth? How can they be adapted and scaled across diverse agroecological and socio-economic settings?

Institutions, Governance, and Policy Strategy: What institutional barriers hinder technology adoption and scaling? How should public spending be allocated to maximize inclusive and sustainable growth? What reforms are needed to attract private investment, improve markets, and lower transaction costs? How can participatory and evidence-based policy processes be institutionalized under uncertainty?

Systems, Actors, and Measurement: What data and metrics are needed to track innovation, scaling, and system-wide impacts? What roles should governments, the private sector, farmer organizations, cooperatives, and development partners play in strengthening innovation systems?

The ATOR 2025 is organized into 19 chapters across four thematic clusters: (i) conceptual and analytical framing; (ii) clusters of emerging agrifood technologies; (iii) governance of innovation; and (iv) CAADP monitoring and accountability.

Chapter 2 develops a conceptual framework for understanding technology frontiers and diffusion pathways. **Chapters 3–11** examine frontier technologies—AI and geospatial tools; biotechnology; digital agriculture; mechanization; value addition; irrigation; livestock; insect-based systems; and aquaponics. **Chapters 12–14** analyze enabling systems such as R&D investment, seed policy, and regulatory frameworks, as well as digitally enabled producer organizations. **Chapters 15–17** provide global comparative perspectives from Europe, China, and Latin America. **Chapter 18** reviews CAADP results and implementation progress.

Produced annually by AKADEMIYA2063 in collaboration with continent-wide, regional, and international partners, the ATOR is a flagship analytical publication that supports evidence generation, policy dialogue, investment planning, and progress monitoring under the Comprehensive Africa Agriculture Development Programme (CAADP). The 2025 edition comes at a critical policy moment following the endorsement of the Kampala Declaration and the associated CAADP Strategy and Action Plan (2026–2035), which set ambitious targets for agrifood output, value addition, trade, investment, and innovation (AUC and AUDA-NEPAD 2025).

Achieving these commitments requires addressing structural and institutional bottlenecks: low productivity, climate vulnerability, limited R&D investment, fragmented markets, slow technology diffusion, and weak commercialization pathways. While evidence increasingly shows the potential of frontier technologies—such as digital agriculture, AI, biotechnology, aquaponics, mechanization, precision irrigation, water recycling, and processing innovations—adoption remains slow (FAO 2022; Ahmad et al. 2025). The Kampala Declaration identifies these technologies as essential tools for reshaping Africa's agrifood systems.

By examining the drivers, constraints, and opportunities for moving Africa's technology frontiers, ATOR 2025 seeks to help policymakers, researchers, investors, and practitioners design strategies that unlock innovation-led, sustainable, and inclusive growth. In doing so, it supports the vision of a more productive, resilient, and equitable continental agrifood system aligned with the Kampala Declaration and the CAADP 2026–2035 Strategy and Action Plan.