CHAPTER 12

Nurturing Africa's Agricultural Transformation: The Role of Investments in Research and Development (R&D)

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Introduction and Policy Context

Agriculture remains the backbone of Africa's economy, employing nearly two-thirds of the labor force and contributing up to 60 percent of GDP in numerous countries across the continent (FAO 2025; World Bank 2024). Yet the sector's potential remains largely unrealized. Most African farmers are smallholders operating on plots with low productivity, and are further constrained by limited access to inputs, markets, finance, and technology. At the same time, broader pressures – including rapid population growth, environmental degradation, intensifying climate risks, and global shocks such as food price volatility, pandemics, and geopolitical disruptions – are placing increased strains on Africa's food systems and rural livelihoods.

Looking ahead, the urgency for agricultural transformation in Africa is only growing. The continent's working-age population is projected to expand by over 450 million people by 2050 (ILO 2021), intensifying the demand for jobs, food, and inclusive growth. However, the agricultural sector faces persistent challenges in engaging young people, who are often deterred by low returns and limited pathways for innovation and entrepreneurship in agriculture (AGRA 2024). Overcoming this barrier is critical because the agrifood system – spanning both on- and off-farm activities – holds immense potential to absorb a large share of the continent's growing labor force, even as it becomes more productive, sustainable, climate-resilient, and better equipped to meet the demands of rapidly urbanizing economies. Achieving this dual transformation – economic and ecological – requires bold investments in agricultural science, technology, and innovation.

African leaders have long recognized this imperative for transformation. Since the launch of the Comprehensive Africa Agriculture Development Programme (CAADP) in 2003, the continent has set out an ambitious vision to expand the agricultural sector by 6 percent annually, backed by a public expenditure target of at least 10 percent of a country's national budget being directed toward the sector. The 2014 Malabo Declaration reaffirmed these commitments and added a sharper focus on accountability, resilience, and nutrition. Most recently, the CAADP Strategy and Action Plan 2026-2035, adopted in Kampala, signals a new era of action toward climate-resilient, science-led, and inclusive agrifood systems.

Agricultural research and development (R&D) is one of the key policy priorities of this agenda. Various empirical studies provide evidence that agricultural R&D investments in Africa generate high returns relative to public expenditure (Diaz-Bonilla et al. 2014; Mason-D'Croz et al. 2019; Pardey et al. 2016; Goyal and Nash 2017). These investments generate multiple impacts on productivity, food security, environmental sustainability, and social stability.

This is largely because funds are directed toward initiatives and policies that have negligible – or even negative – impacts on agricultural productivity. For example, Benin et al. (2015) argue that the effectiveness of expenditures under the Maputo Declaration was low because CAADP spending is largely focused on subsidy payments, which are not productive in terms of promoting inclusive agricultural growth. The existing literature on the effectiveness of R&D expenditures in African countries' agricultural sectors shows mixed results. Based on Benin et al. (2015), spending on agricultural research and extension has a high impact on agricultural productivity and induced, inclusive economic growth.

Further, as the benefits of R&D often take decades to materialize, sustained and strategic investments are essential. Recognizing this, the African Union's (AU) Science, Technology, and Innovation Strategy for Africa 2024 (STISA-2024) and the Science Agenda for Agriculture in Africa (S3A) have positioned science and innovation as pillars of the continent's transformation. These frameworks complement broader commitments under CAADP and Agenda 2063. They emphasize the importance of strengthening national agricultural R&D systems, fostering regional collaboration, and improving engagements with the private sector.

Tracking, monitoring, and reporting progress made toward achieving the CAADP post-Malabo and Kampala goals and targets are key to measuring development over time. These measures also help in holding countries accountable for delivering on their agricultural growth and transformation commitments. The AU Commission's Biennial Review (BR) process evaluates member states against their agricultural transformation targets, including *total agricultural research spending as a share of agricultural GDP (AgGDP).* The long-standing benchmark – endorsed by the New Partnership for Africa's Development (NEPAD) and in line with the 2007 AU Assembly commitment – calls for countries to allocate at least 1 percent of their AgGDP to agricultural R&D (African Union 2007).

This chapter explores long-term trends in agricultural R&D investments across Africa, drawing on the most recent data and analyses to assess both historical progress and emerging challenges. It assesses how much countries are investing, how strategically those investments are deployed, what outcomes they are producing, and how national R&D systems are equipped to deliver. By framing the analysis around both investment levels and system capacity, this chapter provides a more holistic understanding of the reforms and resources needed to accelerate Africa's agricultural transformation.

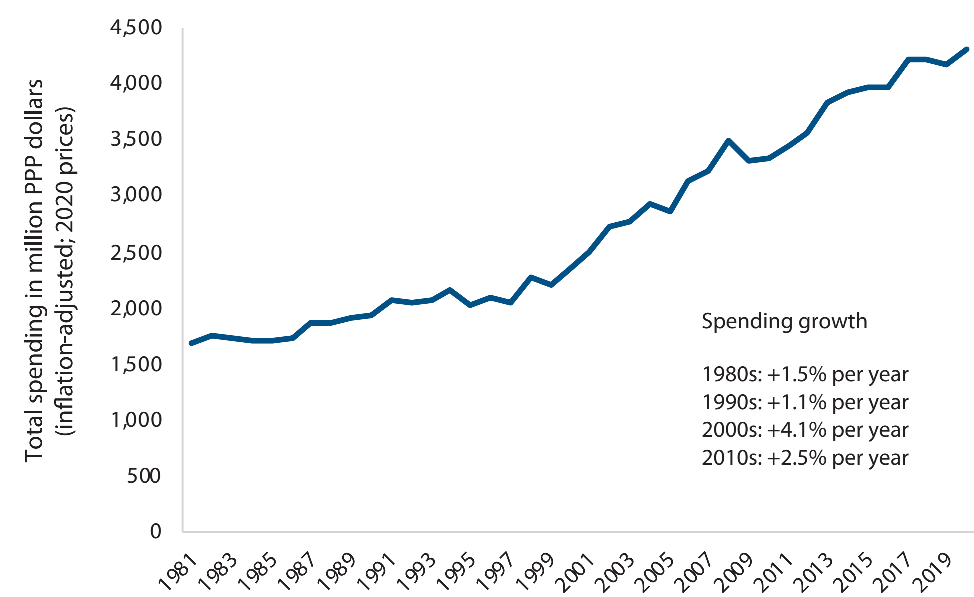
Overview of Agricultural R&D Investment Trends across Africa

Africa's agricultural research spending has grown significantly over the past two decades, but progress has been uneven, and recent trends have raised serious concerns. In 2020, the continent invested $4.3 billion (in 2020 PPP prices) in public agricultural R&D, nearly double the $2.3 billion recorded in 2000 (Figure 12.1).[1] After the sluggish growth of the 1980s (1.5 percent per year) and 1990s (1.1 percent), inflation-adjusted R&D spending accelerated between 2001 and 2010, with an average annual growth rate of 4.1 percent. This acceleration occurred in the context of the 2003 launch of CAADP, which elevated agriculture on Africa's political agenda and helped drive increased domestic and donor-sourced investments during that decade.

Despite this growth, Sub-Saharan Africa accounted for just 3.5 percent of global agrifood R&D spending in 2021 (Pardey et al. 2025). This is despite the region representing nearly one-fifth of the world's population. Furthermore, whereas most African countries have established public institutions dedicated to R&D in the agrifood sector, most governments continue to significantly underinvest in this (Fuglie 2023). Notably, investments in agrifood R&D measured as a share of agricultural GDP, stagnated or even slightly declined in the last two decades in relative terms (see Figure 12.3). This stark imbalance is deeply concerning, especially because more than half of the global population growth between now and 2050 is projected to occur in Africa (United Nations 2024). As a result, the region is likely to remain heavily dependent on technological spillovers from other parts of the world to drive productivity-enhancing agrifood innovations.

While the overall increase in African agricultural R&D spending in recent decades is encouraging, much of this growth has been driven by rising salary costs and the rehabilitation of aging infrastructure at national agricultural research institutes. These investments are undoubtedly essential, but they have not always translated into expanded or more effective research programs. In many countries, the funding available for actual research activities has remained limited and continues to depend heavily on volatile donor funding. Another factor behind the rise in spending is the growing involvement of universities in agricultural R&D, which has occurred in tandem with the creation of numerous new higher education institutions across the continent.

FIGURE 12.1—LONG-TERM PUBLIC AGRICULTURAL RESEARCH INVESTMENT IN AFRICA, 1981-2020



Sources: Pardey et al. (2025), ASTI (multiple years), United Nations (2024), and World Bank (2024).

Notes: Public agrifood R&D expenditures expressed in inflation-adjusted 2020 PPP dollars using United Nations GDP deflators and World Bank currency conversion factor. Includes 46 sub-Saharan and North African countries. Estimates for Angola, Comoros, Djibouti, Equatorial Guinea, Libya, Mayotte, Seychelles, and South Sudan were unavailable and thus excluded from this regional total.

1 These figures exclude private-sector R&D spending, for which estimates are currently less complete and more difficult to develop.

BOX 12.1—THE ROLE OF THE PRIVATE SECTOR IN AFRICAN AGRICULTURAL R&D

While public institutions continue to be the primary source of agricultural R&D investments in Africa, the private sector is playing an increasingly important role, particularly in larger economies such as Kenya, Nigeria, and South Africa. Nevertheless, private R&D activity across the continent remains limited compared to other regions. It continues to be constrained by small and fragmented markets, weak intellectual property protections, and an underdeveloped enabling policy environment.

Most private agricultural R&D in Africa concentrates on near-market innovations further down the value chain, often building on foundational research carried out by public institutions. This highlights the complementary, rather than substitutive, nature of public and private R&D efforts. Continued public investment is therefore essential, particularly in areas where commercial incentives are weak or absent. Cuts in public R&D not only hamper overall innovation but also diminish the effectiveness and reach of private-sector contributions (Pardey et al. 2025).

Agribusiness enterprises, seed companies, agrochemical firms, and startups are increasingly investing in context-specific solutions that complement public-sector research. In South Africa, for instance, both domestic and multinational firms maintain active R&D programs. Pannar Seed, now part of Corteva Agriscience, develops and tests hybrid seed varieties across different agroecological zones. Agricol focuses on high-performance forage and vegetable crops. The South African Sugarcane Research Institute (SASRI), a public-private partnership, supports R&D for the sugar industry with substantial private-sector engagement. In Kenya, firms such as Kenya Seed Company are investing in crop improvement and seed technology, particularly for maize and pasture species. Coopers K-Brands is advancing veterinary diagnostics and products in the livestock sector. Meanwhile, the growth of agritech startups – such as Twiga Foods and iProcure – as well as non-profit ventures like One Acre Fund, reflects rising interest in data-driven, market-oriented innovations across agricultural value chains.

Data on private agricultural R&D in Africa remain scarce and fragmented, hindering a full understanding of its scope and impact. To address this gap, CGIAR and the University of Minnesota's GEMS Informatics Center are developing a system to systematically compile and analyze data on private-sector R&D and scaling capabilities in agriculture across Africa and beyond.

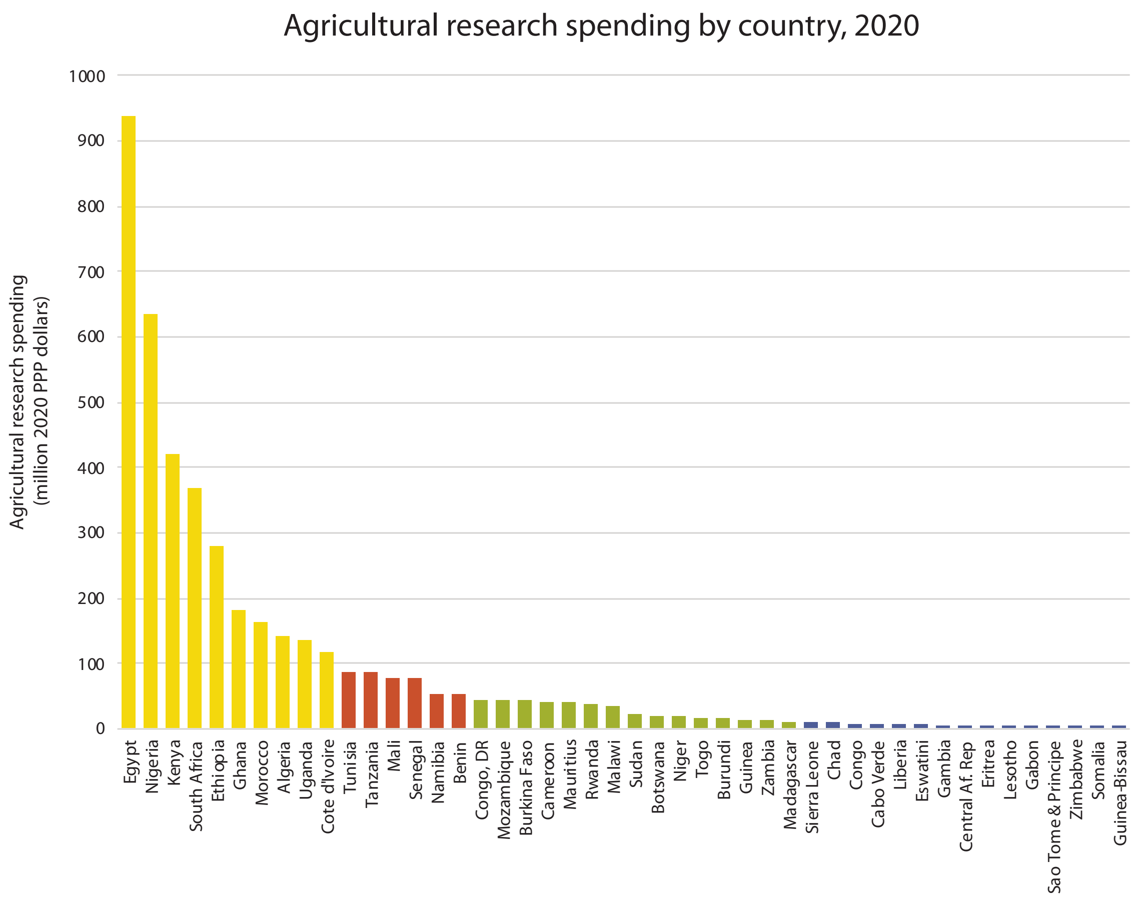
While this trend has helped broaden the research base, it has also contributed to the further fragmentation of Africa's already dispersed agricultural research landscape (African Union 2022).

Crucially, the pace of R&D spending has slowed since 2011, which is a matter of grave concern with long-term consequences. Between 2011 and 2020, agricultural R&D spending grew by only 2.5 percent per year. This slowdown is troubling as agricultural research underpins long-term productivity growth and resilience. Without sustained and substantially greater investment, the continent risks falling further behind in terms of boosting agricultural productivity and tackling mounting challenges such as climate change, resource degradation, and food insecurity. Agrifood R&D investments are sorely needed for inclusive agricultural and economic growth, given the unique features of Africa's agrifood systems, such as the diverse set of commodities produced, the prevalence and geographic distribution of smallholder producers, as well as the localized nature of technology (Fuglie 2023).

These continental trends, however, mask a considerable degree of cross-country differences. In 2020, just four countries – Egypt, Kenya, Nigeria, and South Africa – accounted for more than half of Africa's total agricultural R&D investments, as they collectively spent $2.4 billion out of the total $4.3 billion spent on the continent (Figure 12.2). Their dominance reflects not only their economic size but also the relatively stronger capacity and institutional support underpinning their national research systems.

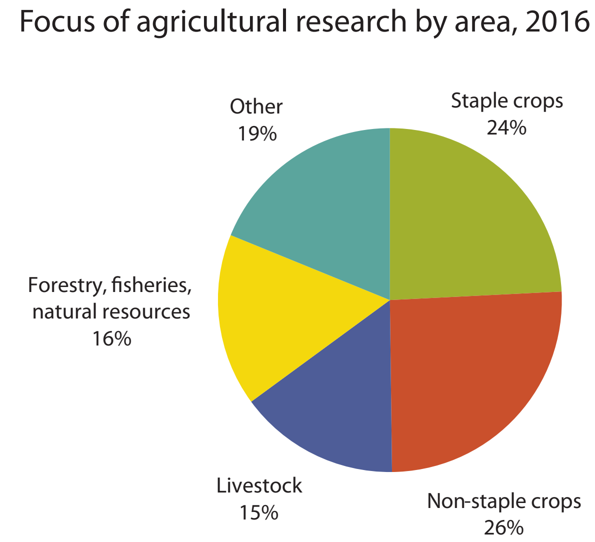
A second tier of countries, including Algeria, Côte d'Ivoire, Ethiopia, Ghana, Morocco, and Uganda, made annual investments between $100 million and $300 million each. Another six countries spent between $50 million and $100 million, while another 30 countries with available data invested less than $50 million each. This long tail reflects the broader structural reality that many African economies are still small and lack the necessary (public) resources to independently sustain strong, diversified R&D systems. While it is natural for larger economies to invest more in absolute terms, the persistent disparities across the continent pose a strategic challenge. Narrowing these gaps will require more than increased funding alone. It calls for stronger cooperation and integration of research at the (sub-)regional level, more efficient resource sharing, and differentiated strategies tailored to country-specific capacities and development goals.

FIGURE 12.2—AGRICULTURAL RESEARCH SPENDING BY COUNTRY, 2020 AND FOCUS OF AGRICULTURAL RESEARCH BY AREA, 2016



Sources: Pardey et al. (2025), ASTI (multiple years), OECD (2024), and World Bank (2024).

Notes: Totals exclude the private for-profit sector. Benin, Burkina Faso, Cabo Verde, Cameroon, Central African Republic, Chad, Congo, Côte d'Ivoire, Gabon, Gambia, Ghana, Liberia, Niger, Nigeria, Sierra Leone, and Togo from ASTI; South Africa from OECD (2024); all other estimates from Pardey et al. (2025) based on ASTI data for earlier years.



Source: African Union (2022), based on ASTI (various years).

Notes: Based on the total number of researchers (measured in full-time equivalents). *Staple crops* include cereals, pulses, and roots and tubers; *non-staple crops* include other crop types such as oil-bearing crops, horticultural crops, and non-food crops. *Other* refers to non-commodity research areas, including socioeconomic, postharvest, and agricultural engineering research.

Underinvestment in Agricultural Research: A Threat to Africa's Growth

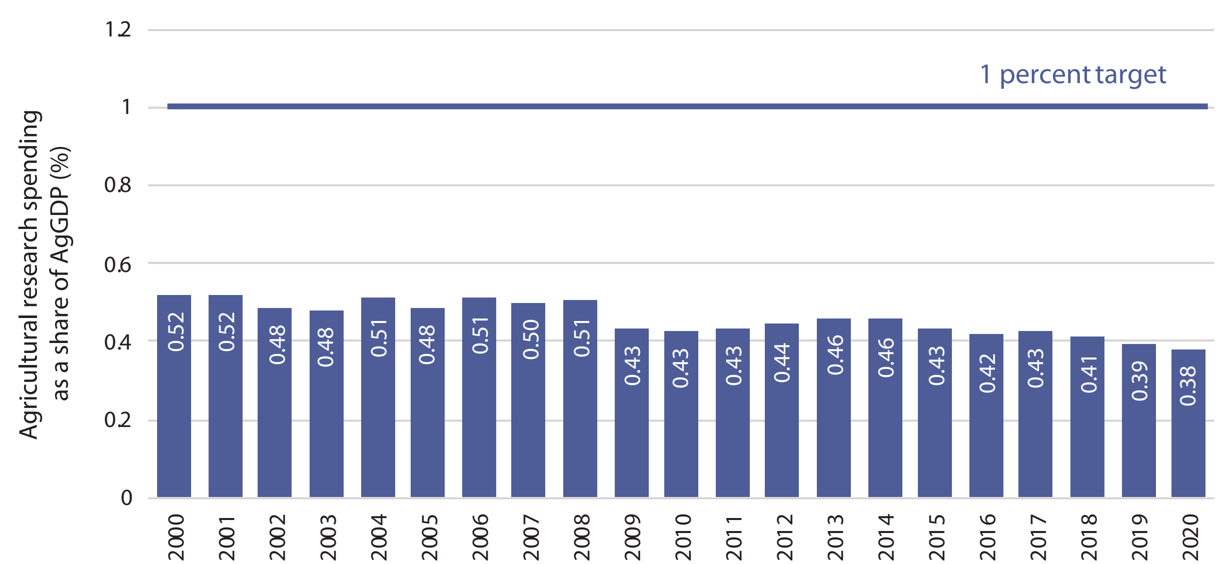
The launch of CAADP in 2003 marked a turning point for agricultural investments in Africa as it triggered a surge in spending that reversed decades of underfunding. Between 2000 and 2020, total agricultural expenditure across the continent rose by 75 percent in inflation-adjusted terms (ReSAKSS 2025), while agricultural R&D spending grew by 85 percent over the same period. At first glance, these figures may suggest a strategic shift toward knowledge-based growth in African agriculture. However, a closer examination of agricultural R&D expenditure as a share of AgGDP reveals a more sobering reality. Despite the overall increases in spending, public research investments have not kept pace with growth in agricultural output. Consequently, Africa's research intensity ratio – measured as spending on agricultural R&D relative to agricultural GDP – declined considerably from 0.52 percent in 2000 to just 0.38 percent in 2020 (Figure 12.3).

By 2020, 41 out of 46 African countries for which data were available were investing less than the AU's recommended target of 1 percent of AgGDP in agricultural research. Of these, 32 countries allocated less than 0.5 percent, with only a handful – Botswana, Cabo Verde, Mauritius, Namibia, and South Africa – exceeding the 1 percent benchmark (Figure 12.4).

This widespread underinvestment is particularly concerning given extensive evidence of consistently high returns from agricultural research (Dias Avila & Evenson 2010; Fuglie et al. 2012; Alston et al. 2009). One of the key reasons for this underinvestment is the long time lag between research investment and its resultant outputs – such as new crop varieties and improved soil management techniques – which can take decades to develop, test, disseminate, and adopt at scale (Alston et al. 2023). The long time period needed for research outcomes offers limited short-term political payoffs, which makes it harder to attract government support in comparison to infrastructure projects or subsidies, which yield more immediate and tangible results (Pardey and Smith 2017). Consequently, agricultural research is frequently undervalued by policymakers, especially when competing against more urgent fiscal priorities such as health, education, and security (Mogues 2015).

Agricultural R&D is a well-documented driver of productivity growth, poverty reduction, and long-term food system resilience. Africa's underinvestment and declining agricultural R&D investment ratios are therefore particularly alarming (Mason D'Croz et al., 2019; Mogues 2015). With the continent's population expected to nearly double by 2050 (World Bank 2024), food demand will surge, placing enormous strain on already fragile agricultural systems. Yet the region has not fully tapped into one of its most important assets:

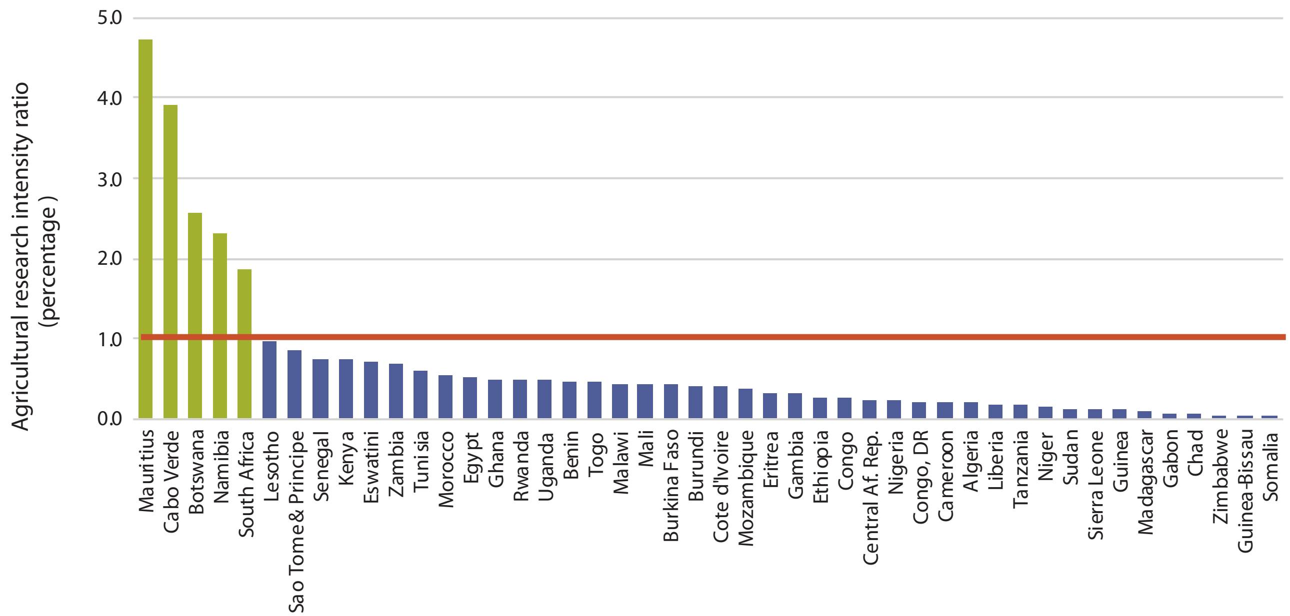
FIGURE 12.3—AFRICAN AGRICULTURAL RESEARCH SPENDING AS A SHARE OF AGRICULTURAL GDP, 2000-2020



Sources: Pardey et al. (2025), ASTI (multiple years), United Nations (2024), and World Bank (2024).

Notes: Research intensity ratio represents public agrifood R&D expenditures from Pardey (2025) and ASTI (multiple years) relative to agricultural GDP from United Nations (2024). Totals exclude the private for-profit sector. Data for Angola, Comoros, Djibouti, Equatorial Guinea, Libya, Mayotte, Seychelles, and South Sudan were unavailable and excluded from the regional average intensity ratio.

FIGURE 12.4—COUNTRY-LEVEL AGRICULTURAL RESEARCH SPENDING AS A SHARE OF AGRICULTURAL GDP, 2020



Sources: See Figure 12.3.
Notes: See Figure 12.3.

its youth. Africa's young people are not yet playing a transformative role in the sector due to limited educational opportunities, poor access to land and finance, and prevailing negative perceptions of agriculture. At the same time, climate change is expected to disproportionately affect African agriculture through higher temperatures, increasingly erratic rainfall, and greater prevalence of pests and diseases. These pressures demand urgent innovation in climate-resilient crops, sustainable land and water management practices, and adaptive agronomic systems. Without increased investments in agricultural R&D, African food systems will struggle to respond to these converging challenges, potentially exacerbating food insecurity and rural poverty.

Despite this urgent need, the pace of innovation and productivity growth in Africa remains slow. In recent decades, growth in agricultural output has largely come from extensification, i.e., expanding the area under cultivation, rather than from intensification through the adoption of improved technologies and practices (Fuglie et al. 2020). As a result, Africa's agricultural total factor productivity (TFP) – a measure of output relative to all inputs – lags behind those of other developing regions (Fuglie 2023). Africa's estimated average annual TFP growth is markedly lower than that of Asia or Latin America, and the productivity gap has continued to widen (USDA-ERS 2025). Whereas Asia has seen transformative gains through expanded and sustained investments in R&D, mechanization, and improved seed systems, much of African agriculture remains dependent on labor-intensive, low-input systems.[2] Chronic underinvestment in research has hampered innovation, commercialization, and the diversification needed to modernize and transform the sector (Fuglie 2023). Building on these insights, this chapter outlines complementary metrics, such as the Agricultural R&D System Capacity Index (ARDSCI). It also emphasizes the benefits of leveraging regional public research systems to address the challenges of fragmentation and scaling innovation, as scale and system capacity are central to research performance.

Improving Metrics to Track Agricultural R&D Performance

As outlined in the previous sections, Africa's agricultural research systems face

2 The digitalization of agriculture—including AI-driven tools, precision farming, and data platforms—offers promising avenues for transformation. Africa's youth, who are more digitally literate and open to technology adoption than older generations, are well positioned to lead this shift. However, realizing this potential will require targeted investment in skills, connectivity, and access to innovation ecosystems (Walisha Foundation 2024).

the twin challenges of persistent underinvestment and a fragmented institutional and geographic architecture that constrains the translation of research into development outcomes. While some countries are making progress, most NARS remain under-resourced, structurally fragile, and poorly equipped to drive innovation at scale.

In this context, the 2025 Kampala Declaration marks an important milestone. It renews the AU's political commitment to position agricultural R&D at the heart of food systems transformation in the post-Malabo agenda. But declarations, however ambitious, must be matched by operational mechanisms that ensure accountability and track progress. To achieve meaningful reform, countries must not only be encouraged to increase investments in agricultural R&D, but also be evaluated on how effectively their NARS deliver results.

Historically, CAADP monitoring has leaned heavily on a single, limited metric, i.e., the R&D intensity ratio, defined as public agricultural R&D spending as a percentage of agricultural GDP. While this indicator can be useful in tracking a single country's investment trajectory over time, it has limitations as a cross-country comparative or diagnostic tool. Worse, it risks generating misleading conclusions as countries with small or shrinking agricultural sectors may appear to be high performers due to a favorable intensity ratio, even though the absolute levels of R&D investment are modest or stagnant.

The use of a rigid 1 percent AgGDP target as a benchmark, though politically convenient, is an oversimplification of a more complex landscape and can be misleading if used in isolation. It masks a complex reality, conceals structural bottlenecks, and creates perverse incentives. For instance, the use of the benchmark may potentially encourage cosmetic increases in reported spending without actually improving system quality or productivity (Nin Pratt 2016). In fact, many globally competitive R&D systems – notably those of China (0.5 percent) and India (0.3 percent) – fall well below this 1 percent threshold even as they continue to deliver strong results due to their scale, institutional depth, and sustained capacity development (ASTI, multiple years). Although the 1 percent target is an appealingly simple benchmark, it fails to account for the significant differences in country size, economic development, and agro-climatic conditions, making this one-size-fits-all approach largely ineffective (see Chapter 2 in this volume).

Understanding the performance of agricultural R&D systems requires looking beyond investment levels to see how well these systems convert resources into tangible results. In response to this challenge, CGIAR, in partnership with the AU and the Food and Agriculture Organization (FAO), developed the Agricultural R&D System Capacity Index (ARDSCI). This is a composite measure designed to provide a broader, more practical perspective on R&D capacity across the continent (based on previous work by the African Union (2022) and Nin Pratt et al. (2023). The ARDSCI is built to accommodate existing data constraints in African contexts. It combines multiple dimensions of system strength into a single tool that supports more informed monitoring and decision-making. It is currently being considered for inclusion in the Kampala phase of the CAADP biennial review reporting cycle from 2027.

The ARDSCI consists of four sub-indicators:

- *Quality of Human Resources (QHR):* Assesses the proportion of PhD-qualified researchers relative to MSc and BSc researchers. A higher share signals stronger technical capacity and leadership potential within the NARS.
- *Expenditure per FTE Researcher (EXPppp$ / RESTOTfte):* Measures public R&D spending per full-time equivalent (FTE) researcher, indicating the level of financial support and enabling environment for research activities.
- *Five-Year Intensity Growth (AAIGR):* Captures the average annual rate of change in R&D spending intensity over five years, which serves as a proxy for medium-term political and fiscal commitment to research investments.
- *Publications per 100 FTE Researchers (PUBag / RESTOTfte x 100):* Reflects scientific productivity using peer-reviewed scientific output as a standardized and quantifiable benchmark.

The index is calculated as follows:

$$ARDSCI_t = (0.30 \times HR_t) + (0.25 \times EXP_t) + (0.15 \times AAIGR_t) + (0.30 \times PUB_t)$$

Where:

- HR_t = Human Resource score at time t
- EXP_t = Expenditure per FTE researcher score at time t
- PUB_t = Publications per 100 FTE Researchers score at time t

TABLE 12.1—AGRICULTURAL R&D SYSTEM CAPACITY INDEX (ARDSCI) CALCULATION AND PARAMETER SCORES FOR SELECTED WEST AFRICAN COUNTRIES, 2016

A. Input data for ARDSCI calculation

Country	PhD Researchers (FTEs)	MSc + BSc Researchers (FTEs)	Total Spending (Million PPP$)	Total Researchers (FTEs)	5-year Intensity Growth (%)	Peer-reviewed Articles
Benin	125.1	76.4	30.5	201.5	-2.7	135
Ghana	266.0	330.9	215.8	596.9	8.0	300
Sierra Leone	18.4	120.8	11.8	139.2	0.1	8

B. ARDSCI parameter scores and final index values

Country	PhD / (MSc+BSc)	Score	Expenditure per FTE (PPP$)	Score	5-year Growth (%)	Score	Articles per 100 FTEs	Score	ARDSCI score
Benin	1.64	5	0.151	3	-2.7	0	67.0	3	**3.15**
Ghana	0.80	4	0.361	5	8.0	5	50.2	2	**3.80**
Sierra Leone	0.15	0	0.084	1	0.1	1	5.7	0	**0.40**

Sources: Calculated by authors based on ASTI (www.asti.cgiar.org) and SCImago (www.scimagojr.com) coun-try-level data for 2016.
Note: The year 2016 was chosen as an indicative reference due to the availability of data for all parameters.

Each sub-component is transformed into a score on a scale of zero to five (0–5) using performance banding based on percentile thresholds across a reference dataset. This results in a final composite index score ranging from 0 to 5.[3] The weights reflect a pragmatic judgment about the relative contribution of each dimension to overall R&D system performance, drawing on insights from existing literature (e.g., Guan and Chen 2012; Nin Pratt et al. 2023; Nin Pratt and Stads 2023) and expert input. While not empirically derived, the weights are designed to be transparent and adaptable as new evidence becomes available.

Table 12.1 presents the application of the ARDSCI using relevant data from Benin, Ghana, and Sierra Leone for illustrative purposes. Ghana scores highest (3.80) among the three countries, reflecting strong performance across multiple dimensions: a high proportion of PhD-qualified researchers; substantial investment per researcher; and sustained growth in research intensity. Benin also performs relatively well, with an ARDSCI score of 3.15, demonstrating that well-structured, mid-sized systems can deliver meaningful outcomes even in resource-constrained environments. In contrast, Sierra Leone (0.40) records consistently low scores across all four dimensions, reflecting limited numbers of highly qualified staff, low and stagnant investment levels, and weak research outputs. It is important to note that ARDSCI scores tend to be relatively stable over time, so using one benchmark year instead of another does not substantially change the picture, at least not more than traditional intensity ratios.

While the ARDSCI is intentionally kept straightforward given current data limitations across countries, it nonetheless marks a meaningful advance toward a more nuanced assessment of the capacity of African agricultural R&D systems to produce knowledge and drive food system transformation over time. However, the ARDSCI is not without its limitations. It does not yet capture the broader landscape of innovation, such as cross-country spillovers – where one country benefits from the research investments or breakthroughs made in another – nor does it measure other critical NARS outputs such as the development and release of new crop varieties or improved

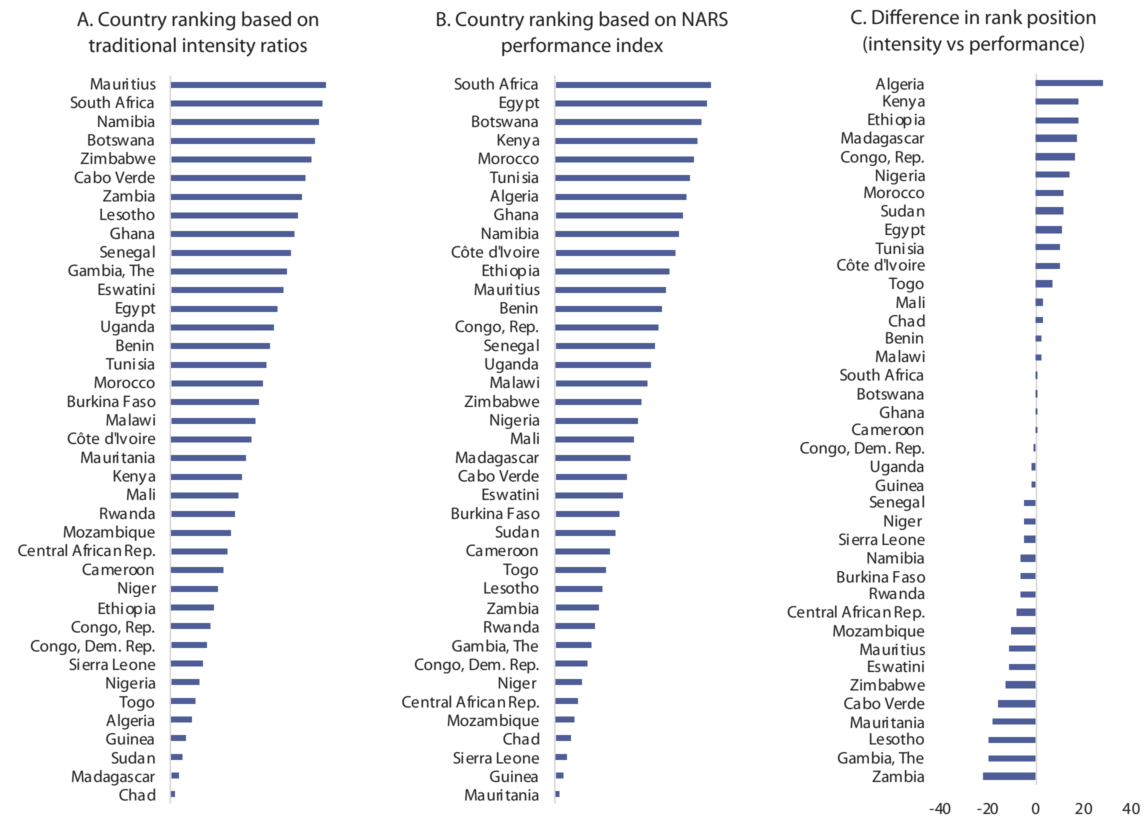
3 Each ARDSCI sub-indicator is scored separately on a 0-5 scale based on the thresholds below. These thresholds were set to reflect meaningful performance distinctions based on the distribution of values observed across African countries in recent years. The final ARDSCI score is a weighted average of these individual scores.

- Human Resources (QHR): 0.0-0.2 = 0; 0.2-0.4 = 1; 0.4-0.6 = 2; 0.6-0.8 = 3; 0.8-1.0 = 4; >1.0 = 5.
- Expenditure per FTE Researcher (EXPppp$ / RESTOTfte): < $50k = 0; $50k-$100k = 1; $100k-$150k = 2; $150k-$200k = 3; $200k-$250k = 4; > $250k = 5.
- Five-Year Intensity Growth (AAIGR): Negative = 0; 0%-1% = 1; 1%-2% = 2; 2%-3% = 3; 3%-4% = 4; > 4% = 5.
- Publications per 100 FTE Researchers (PUBag / RESTOTfte x 100): < 20 = 0; 20-40 = 1; 40-60 = 2; 60-80 = 3; 80-100 = 4; > 100 = 5.

livestock breeds, farmer-oriented technologies, capacity-building initiatives, or policy innovations. These outputs are often difficult to measure due to limited statistical standardization, challenges in attribution, and a lack of internationally comparable data. However, as data availability and quality improve, additional dimensions could be integrated into the ARDSCI to reflect the evolving scope and complexity of agricultural innovation systems. Despite its constraints, the ARDSCI already offers a more informative and context-sensitive benchmark than the existing 1 percent investment target. It shifts the focus from how much is spent to how effectively national systems are positioned to deliver results. This is an important step toward enabling the AU to promote R&D-driven agricultural transformation.

To further demonstrate how different measurement frameworks can shape perceptions of performance, Figure 12.5 compares the rankings of African countries under the traditional intensity ratio (Panel A) and the multidimensional ARDSCI (Panel B). [4] Panel C of this figure emphasizes the divergence between the two by showing the absolute difference in rank position between the ARDSCI and the intensity ratio ranking for each country. The results are striking. Some of Africa's smallest NARS, including those from Cabo Verde, Eswatini, Gambia, Lesotho, Mauritania, and Mauritius, score relatively high on the intensity ratio, largely because their modest R&D budgets appear large when measured against small agricultural GDPs. However, their position in the ranking falls sharply under the ARDSCI, which, in addition to investments, also accounts for research capacity and scientific outputs. The latter two areas are points of weakness for these countries' R&D systems.

FIGURE 12.5—CONTRASTING AGRICULTURAL R&D RANKINGS FOR AFRICAN COUNTRIES – INTENSITY VS. ARDSCI



Sources: See Table 1.
Notes: See Table 1.

In contrast, larger and more mature systems – including those in Algeria, Egypt, Ethiopia, Kenya, Morocco, Nigeria, and Sudan – perform much better in the ARDSCI ranking than the intensity ranking. These countries benefit from economies of scale, more robust institutional frameworks, and sustained investments in human capital and infrastructure. Their intensity ratios may appear modest due to the size of their agricultural sectors, but this does not necessarily reflect a lack of effort or effectiveness in their R&D systems.

This comparison surfaces a key insight: scale and institutional quality are critical determinants of system performance. While intensity ratios offer a

4 It is important to note that the underlying data refer to 2016, which explains the discrepancy with the intensity-based rankings shown in Figure 12.4, which draw on 2020 data. Some of the data required for calculating the ARDSCI were not available for later years. Nevertheless, the overall message remains consistent, and the differences between the two rankings are striking.

BOX 12.2—SECTORAL BREAKDOWN OF AGRICULTURAL RESEARCH INVESTMENTS

Governments across Africa, particularly in smaller countries, often face tough decisions when allocating limited research resources. Despite these constraints, it is crucial to direct sufficient investments toward research areas and commodities that align most closely with national agricultural priorities and development goals. In many African countries, crop research is the dominant focus of agricultural R&D. In 2016, the most recent year for which continent-wide data were available, half of all agricultural researchers in 44 countries were dedicated to crop research, with efforts fairly evenly split between staple and non-staple crops (see Figure 2.1). Livestock research, on the other hand, accounted for 15 percent of the agricultural research workforce, while the remainder was spread across areas such as fisheries, forestry, natural resources, and socioeconomics.

Research priorities vary widely from country to country. In Benin, Burundi, Malawi, and Togo, crop research dominates, employing over 70 percent of agricultural research staff. Conversely, livestock research is a more significant focus in countries like the Central African Republic and Sudan. Fisheries research is especially prominent in Mauritania, Morocco, and Namibia, where it accounts for more than 30 percent of total agricultural research.

Admittedly, so far we have only demonstrated that measuring the performance of national R&D systems in African countries using the ARDSCI yields country rankings that are partly or significantly different from those produced by classical intensity ratios, i.e., the ratio of public expenditure on agricultural R&D systems to agricultural GDP.

BOX 12.3—WHY PURCHASING POWER MATTERS IN COMPARING AGRICULTURAL R&D SPENDING

Comparing agricultural research expenditures across countries is a complex undertaking due to major differences in local price levels. The bulk of research spending typically goes toward staff salaries and local operational costs, rather than internationally traded goods. For example, the wages of a field laborer or lab assistant are significantly lower in Ethiopia than in Europe, and office furniture produced locally in Senegal costs far less than similar items in the United States. While market exchange rates are appropriate for tracking international financial flows, they do not account for these cost differences and are therefore inadequate when comparing research investments across countries.

Purchasing power parity (PPP) offers a more accurate method by adjusting for national price level differences. PPP reflects the relative purchasing power of currencies by comparing the cost of a standardized (across countries) basket of goods and services designated in local purchasing prices. This makes PPP especially useful for converting agricultural research spending into a common metric. PPP-adjusted values also benefit from greater stability over time, avoiding the volatility often seen in exchange rates.

A crucial research gap is demonstrating that the ARDSCI measure has a greater positive correlation with inclusive sustainable development of agrifood systems vis-à-vis other metrics. This is an important question that should be investigated in future research. It may be particularly interesting to test a combination of the ARDSCI and classical intensity ratio to predict the performance of R&D systems.

narrow view focused on relative investment levels, they obscure the broader realities of research capacity and impact. Smaller countries may appear to "overperform" on paper, but without corresponding outputs or institutional depth, such metrics risk misrepresenting real system strength. In contrast, the ARDSCI captures a fuller picture as it highlights where investments are translating into real research capabilities and scientific outcomes. If African countries are to deliver on the Kampala Declaration's vision and build the next generation of dynamic, impactful R&D systems, they will have to reframe how performance is measured and understood. A multidimensional index helps reveal critical disparities and may offer a more useful basis for decision-making and reform. It is important to note that the ARDSCI is not intended to function as a scorecard or a tool to name-and-shame countries.

Rather, it is a diagnostic instrument that can help identify where innovation leadership might emerge and where support is most needed. This way, it enables a more deliberate, collaborative approach to organizing R&D efforts across the continent.

Size Matters: National Agricultural Research Systems (NARS) and Innovation Capacity in Africa

The divergent rankings revealed by a comparison of the ARDSCI and the intensity ratio underscore a structural reality – scale and system capacity are central to research performance. Africa's agricultural research landscape is highly uneven. A handful of relatively well-resourced systems – notably those of Egypt, Kenya, Nigeria, and South Africa – coexist with a large number of much smaller systems which lack the critical mass needed to sustain innovation.

As shown by Nin Pratt and Stads (2023), the size, structure, and resource base of a NARS are key determinants of scientific output. Larger systems enjoy greater disciplinary breadth, more diversified talent pools, stronger institutions, and better infrastructure. This enables them to produce a larger number of publications and improved technologies, as well as to engage more credibly in policy dialogues and extension services. In contrast, many smaller NARS lack capacity in critical and emerging disciplines, leading to lower volume, quality, and relevance of research outputs. This, in turn, hampers their ability to address pressing agricultural challenges such as pest outbreaks, shifting market demands, or the growing impacts of climate change. The reliance on short-term, donor-driven, project-based funding often further exacerbates the problem, undermining strategic continuity and potentially misaligning research efforts with national priorities.

Historically, many African countries have depended on international knowledge spillovers to fill their R&D gaps. Contributions from CGIAR centers, South-South cooperation, and the private sector have driven innovation in areas such as staple crop breeding and natural resource management. However, while such external innovations have accelerated progress, their successful adoption often depends on local adaptation and testing by national research systems to ensure they are technically viable, economically relevant, and well-suited to local agrifood contexts.

Africa's fragmented and under-resourced agricultural R&D landscape also has broader regional implications. While larger NARS and CGIAR centers can serve as innovation hubs, smaller systems risk falling permanently behind. Cross-border collaborations, shared infrastructure, and pooled scientific expertise are therefore essential to narrowing the capacity gap. Without such mechanisms, the agricultural research efforts of many smaller systems will remain fragmented, inefficient, and vulnerable to costly duplication. This raises a fundamental question: should agricultural research continue to be organized primarily along national lines?

Many of Africa's most urgent agricultural challenges – such as drought resilience in the Sahel or improving sustainable intensification in the humid tropics – cut across borders. There is a strong case for organizing research around shared production systems and agroecological zones. Regional approaches, such as those piloted by the West and Central African Council for Agricultural Research and Development (CORAF) and the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), offer promising models. These regional models are increasingly essential in promoting innovative solutions such as digital farming platforms, biotechnology applications for climate-resilient crops, and innovative farmer organizations like e-cooperatives. For example, the Accelerating Impacts of CGIAR Climate Research for Africa (AICCRA) initiative piloted innovative approaches to scaling up climate-smart agriculture technologies and innovations in West Africa and Central Africa. This way, the initiative generated impacts beyond the six countries – Ethiopia, Ghana, Kenya, Mali, Senegal, and Zambia – that were the focus of AICCRA (Segnon et al. 2022).

Furthermore, integrating e-markets and e-learning systems across borders can amplify knowledge diffusion and adoption. Digital tools, often combining voice, text, video, and the internet, have the potential to deliver tailored information to farmers at lower cost. These tools also enable access to precision farming methods tailored for local, national, and regional levels involving remote sensing data and satellite imagery to provide precise and real-time crop management advice that is more commonly applied on technologically advanced farms (Fuglie 2023).

Beyond agricultural production, supranational innovation hubs could also pioneer digital governance mechanisms such as regional platforms for agricultural statistics, policy simulations, and administrative planning.

Such tools can help harmonize regulations, strengthen accountability, and reduce duplication across member states. For example, ASARECA, in collaboration with the International Water Management Institute (IWMI), on behalf of the CGIAR initiative on Diversification in East and Southern Africa (Ukama Ustawi), has supported Uganda through a joint analysis of the National Agricultural Extension Policy (NAEP). This was done using a Policy Manager Tool (Barungi et al. 2024), a digital framework designed to transform policy formulation, analysis, and monitoring through a structured, data-driven approach to evaluating agricultural policies.

Regional collaboration could transform Africa's agricultural research capacity if it is carefully implemented. Realizing the full potential of regional approaches will require sustained intergovernmental coordination, long-term investments in supranational or regional infrastructure, and equitable benefit-sharing mechanisms. By pooling expertise, achieving economies of scale, and targeting shared challenges, a regional approach can unlock more efficient, relevant, and impactful innovations – accelerating the continent's progress toward a more resilient and sustainable agricultural future.

Policy Recommendations and Practical Steps

Africa stands at a critical juncture. The continent's ability to achieve sustainable food systems, adapt to climate shocks, and seize new market opportunities hinges on the strength of its agricultural research and innovation capacity. Yet, widespread underinvestment and persistent disparities in the size, structure, and funding of research systems threaten to entrench inequality and limit progress. A future defined by fragmentation, inefficiency, and squandered potential is not inevitable, but changing course requires decisive and coordinated action.

First, **Africa must increase investment in agricultural R&D**. Without reliable, multi-year financing, research institutions cannot operate strategically, attract and retain talent, or adapt to fast-evolving challenges like climate change and emerging pests. While the targeted 1 percent of agricultural GDP may not fit every context, the direction is clear – investments must increase significantly. Further, these investments must be delivered through financing mechanisms that build institutional resilience, reduce dependence on short-term donor cycles, and align with long-term national and regional priorities.

BOX 12.4—TOTAL FACTOR PRODUCTIVITY – A KEY DRIVER OF LONG-TERM AGRICULTURAL GROWTH

Improving agricultural productivity, for instance, by producing greater output with the same or fewer inputs, is essential for enhancing food security, raising farm incomes, and reducing rural poverty. One of the most important indicators of productivity is Total Factor Productivity (TFP). Ostensibly, TFP measures the ratio of total quantity of agricultural outputs (such as crops and livestock) to the total quantity of inputs used in production (including land, labor, capital, seed, fertilizer, and other resources). When agricultural output rises without a proportional increase in input use, TFP increases, indicating greater productivity in the sector.

Long-term growth in TFP is driven by a range of factors. Agricultural R&D is central, as it generates improved crop varieties, livestock breeds, and new technologies. Other elements may also play a vital role in increasing TFP. These include knowledge spillovers from international innovation, a more skilled agricultural workforce, better-functioning markets, and investments in infrastructure such as roads and communications. Sound public policies and strong institutions that promote competition and facilitate market access further amplify these effects.

Sustaining and accelerating TFP growth will be critical for meeting future food demand, especially as climate change and population growth place increasing pressures on natural resources. Because the impacts of agricultural R&D can take years, decades, or even longer to materialize, investment decisions made today will shape productivity outcomes well into the future. It is therefore essential that countries prioritize long-term R&D strategies and target innovation efforts toward high-potential crop and livestock systems where gains can be most transformative.

Source: Fuglie (2023).

Second, Africa needs **not just more investment, but smarter investment**. Many smaller NARS lack the capacity to tackle complex, transboundary challenges independently. Supranational research institutes and regional approaches rooted in agroecological zones, supported by harmonized policy environments, and strengthened through shared infrastructure and centers of excellence, can build the critical mass needed to generate meaningful impact across borders. Pan-African frameworks like CAADP, alongside Regional Economic Communities (RECs), have a vital role to play in driving this shift.

Third, Africa must **invest in the next generation of scientists and innovators**. A future-ready research system requires more than just technical knowledge; it demands diversity, interdisciplinarity, and innovation capacity across emerging fields such as data science, synthetic biology, and climate adaptation. This means scaling up graduate education, incentivizing retention, addressing gender and generational gaps, and creating career pathways that keep young talent within African institutions. Equally important is fostering youth creativity and entrepreneurship within their own communities, ensuring that innovation is grounded in local realities and responsive to on-the-ground needs. Moreover, tapping into cross-country and inter-institutional (e.g., academic, government, and private sector) cooperation, in addition to leveraging the global African diaspora, will be vital to developing this next generation of experts.

Fourth, **innovation should be viewed through an agrifood systems lens, not reduced to an exclusive focus on (public) research**. While R&D is essential, it is only one part of a broader innovation ecosystem that includes policies, markets, finance, infrastructure, and, critically, the private sector. Driving real impact requires connecting researchers with entrepreneurs, investors, policymakers, farmers, and young people to co-develop and scale inclusive solutions. This means creating an enabling environment that fosters collaboration, aligns incentives, and ensures innovation is driven by practical challenges and opportunities on the ground.

Finally, **the role of R&D in Africa's agrifood transformation must be measured through more meaningful performance metrics**. The current 1 percent R&D investment target in the CAADP biennial review, while symbolically important, oversimplifies a complex challenge. What is needed is a broader portfolio of R&D and related innovation indicators, including those featured in the ARDSCI. Steps are already being taken to integrate these into future CAADP biennial reviews, supporting more accountable, learning-oriented, and evidence-informed policy decisions with long-term impacts. Strengthening in-country data collection and analytical capacity will be essential to ensure that such tools are used to guide future investments and policy reforms.

Looking ahead, these five priority actions offer a roadmap for positioning agricultural R&D as a cornerstone of Africa's long-term development strategy. If pursued with urgency, ambition, and regional coherence, they can unlock a new era of African-led innovation; one that delivers food security, economic opportunity, and climate resilience for future generations. This is not a call for incremental change. It is a call to transform the way African countries think about, invest in, and govern agricultural innovation. The time to act is now.