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March 2026

# Rethinking Foreign Aid: Driving Local Innovation, R&D, and Capacity Building

# Abstract

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Research and development (R&D) is a central driver of long-term economic growth, technological progress, and institutional capacity. Yet many African countries remain marginal in the global knowledge economy, with limited investment in science, technology, and innovation (STI) and weak research ecosystems. This paper argues that the persistence of Africa's innovation deficit is partly rooted in the design of foreign aid and development policies, which have historically prioritized short-term service delivery over long-term investments in scientific capacity and technological capability. Drawing on economic theory, empirical evidence, and comparative case studies, the paper examines the role of R&D in structural transformation and assesses the structural barriers that limit innovation in Africa, including chronic underfunding, short-term aid cycles, misalignment between donor priorities and national strategies, and weak institutional systems. Evidence from countries such as Ethiopia, Brazil, and China demonstrates how sustained investment in research institutions, human capital, and international knowledge partnerships can generate significant productivity gains and technological upgrading. The paper concludes that development cooperation must shift toward innovation-driven growth. Strengthening universities, financing basic sciences, and fostering university–industry–government collaboration are essential steps for enabling African countries to transition from technology consumers to producers in the global knowledge economy.

**Keywords:** Foreign aid, development policy, knowledge economy, innovation

**JELs:** F35, O30, O32

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*This paper is based on research funded by the Gates Foundation. The findings and conclusions contained within are those of the authors and do not necessarily reflect positions or policies of the Gates Foundation.*

# 1 Introduction

Research and development (R&D) is a cornerstone of sustainable economic transformation and the foundation of modern state capacity. Yet global investment in R&D remains starkly unequal. While high-income countries invest heavily in science, technology, and innovation (STI), many low- and middle-income nations, particularly in Sub-Saharan Africa, remain at the margins of the global knowledge economy. This imbalance is both a cause and a consequence of persistent development gaps. Without strong national R&D systems, countries are less able to raise productivity, diversify their economies, respond to crises, or govern effectively in an increasingly complex and technology-driven world.

The ability to create, adapt, and apply knowledge has become the defining frontier of development in the 21st century. In today's global economy, competitiveness depends less on the abundance of natural resources and more on a country's capacity to generate ideas and transform them into products, processes, and institutions. As the global economy transitions toward digitalization, renewable energy, and artificial intelligence, the divide between technology producers and consumers risks hardening into a new form of economic inequality, one defined not by income, but by innovation capability. For African countries, this shift presents both an existential challenge and a historic opportunity: to leapfrog into new growth trajectories by investing strategically in science, technology, and human capital.

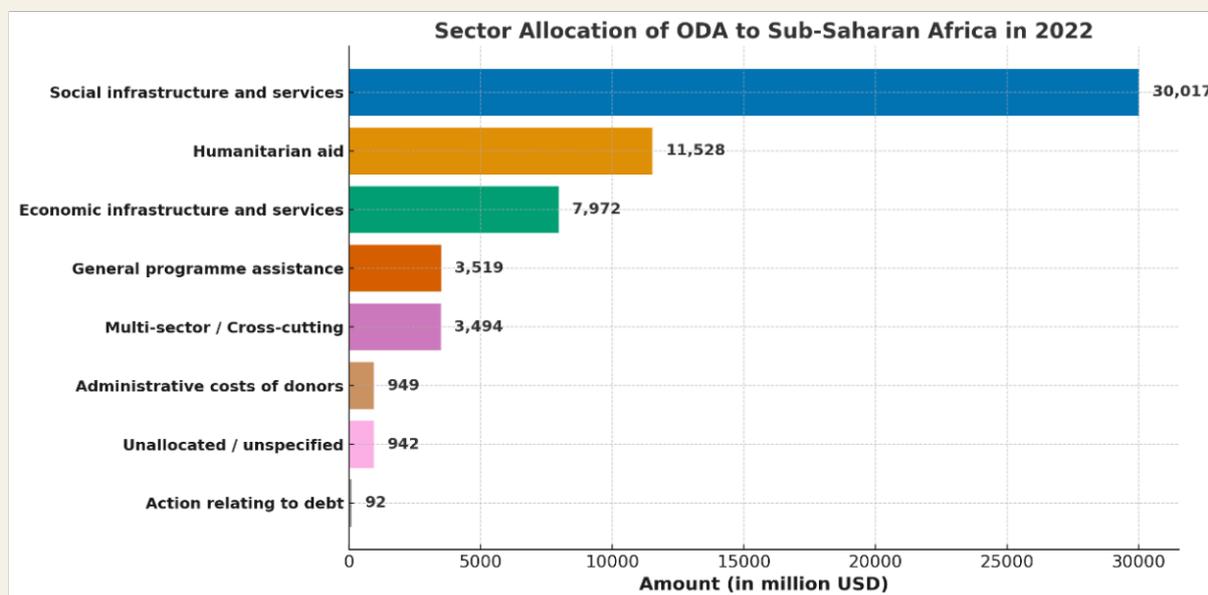
Technology can enter developing economies through multiple channels, most notably technology transfers from more advanced nations and the development of local technological capacities. While international technology transfer has historically played a vital role in accelerating industrialization, especially during the post-war and globalization eras, there is growing evidence that sustainable, innovation-led growth occurs only when external technologies are complemented by domestic research, experimentation, and learning. Imported technologies may ignite progress, but it is locally developed knowledge systems that sustain and multiply it. This relationship between technology transfer and indigenous capability lies at the heart of successful catch-up stories across history.

The global record offers instructive lessons. During the 19th and early 20th centuries, technological flows between Europe and the United States fueled reciprocal industrial growth: The United States absorbed and adapted European innovations, from steel production and electrical engineering to chemical manufacturing, and soon became a leading center of innovation itself. Later, post-war Europe and Japan benefited from American technological diffusion through cooperation, trade, and education. Since the 1980s, China's rapid technological ascent has followed a similar pattern, anchored in strategic partnerships with Western firms and universities, targeted foreign direct investment, and deliberate technology licensing. Crucially, these inflows were coupled

with state-led efforts to internalize and extend knowledge, building domestic research capacity, reforming higher education, and investing massively in science and engineering. The lesson is consistent across regions and eras: Countries that achieve long-term transformation leverage international technology transfers while steadily cultivating indigenous innovation ecosystems.

In the context of global development cooperation, however, foreign aid has not kept pace with this understanding. Over the past several decades, aid flows have financed vital improvements in health, education, and infrastructure across the Global South, saving lives and expanding opportunity. Yet aid directed specifically toward building scientific capacity and research ecosystems has remained limited in scope, fragmented in design, and misaligned with recipient countries' long-term strategies.

In 2022, Sub-Saharan Africa received an estimated USD 60–65 billion in official development assistance (ODA), roughly one-quarter of total global ODA. Yet only a small fraction of these resources supported the development of technological or scientific capabilities. Most aid continues to prioritize short-term service delivery, health programs, social protection, and emergency relief, rather than the foundational investments needed for countries to develop, adapt, and sustain their own technological systems. This persistent underinvestment has left Africa dependent on imported technologies and foreign expertise, constraining its potential to lead in emerging industries.



Source: OECD (2025)

At the same time, African countries face significant institutional, political, and fiscal barriers to expanding domestic R&D. Public R&D spending in most countries remains below 0.5 percent of GDP, far short of the African Union's 1 percent target and dramatically below the 2–3 percent seen in innovation leaders. Coordination among research institutions is limited, and linkages between universities, industry, and government are often weak or nonexistent. The absence of coherent national

innovation strategies has created a landscape where scientific talent is underutilized and fragmented. As a result, despite extraordinary intellectual capital and urgent development challenges, from food insecurity and public health to climate adaptation, Africa continues to lag behind other regions in research output, technological adoption, and innovation-led growth.

This paper argues that reversing this trend requires a fundamental rethinking of how both foreign aid and national policy frameworks approach innovation. R&D should not be viewed as a luxury or an elite pursuit, but as a strategic investment in national resilience, productivity, and autonomy. Building robust innovation systems demands both external and internal transformation: aid must evolve to prioritize long-term capacity-building, and African governments must elevate science and technology to the center of their development agenda. Countries that have successfully done so, such as Brazil, China, and Ethiopia, did not rely solely on market forces or donor initiatives; they built institutions, invested in people, and cultivated a culture of learning and experimentation.

This paper contributes to that agenda by examining how Africa can reshape its innovation ecosystem and how development cooperation can become a catalyst for knowledge creation rather than dependency. It combines empirical evidence, theoretical insights, and comparative case studies to show that R&D is both a means and a measure of sustainable development.

The paper is organized into eight sections. Section 2 explores why R&D is fundamental to long-term development, both theoretically and empirically. Section 3 identifies the main mechanisms through which innovation drives productivity, governance, and state capacity. Section 4 assesses the current state of innovation in Africa and the structural causes of its deficit. Section 5 examines how the design and delivery of foreign aid have contributed to this gap. Section 6 presents case studies, Ethiopia, Brazil, and China, that illustrate successful strategies for building R&D ecosystems. Section 7 distills cross-cutting lessons and proposes the paradigm shifts required to foster innovation at scale. Finally, Section 8 provides detailed policy recommendations for donors, governments, and research institutions committed to closing the innovation gap and positioning Africa as a global actor in science and technology.

## 2 R&D and Development: Theory and Evidence

Research and development (R&D) lies at the heart of long-term economic transformation. For African countries seeking sustained growth, technological progress and institutional modernization are not optional but essential. Across history and theory alike, science and innovation emerge as the true engines of productivity, diversification, and state capacity.

Classical and modern economic theory converge on this idea. From Schumpeter's (1934) concept of innovation-driven "creative destruction" to Romer's (1990) and Aghion and Howitt's (1992) models of endogenous growth, technological progress is not simply a consequence of wealth, it is a driver of it. Economies that generate and apply new knowledge escape diminishing returns, while those that do not remain trapped in low-productivity equilibria. Development economists such as Lewis (1954) and Kuznets (1973) also emphasized that structural transformation, from agriculture to industry and services, depends on technological upgrading. Without investments in research institutions, technical education, and adaptive innovation, such shifts are rarely sustained.

Empirical evidence reinforces these insights. Differences in technological capability explain far more of the global income gap than differences in labor or capital. Abramovitz (1986) and Nelson and Phelps (1966) showed that catching up with frontier economies depends primarily on a country's capacity to absorb and adapt technologies, a "social capability" built through learning and institutional quality. The World Bank (2021) estimates that technological change has accounted for more than half of global productivity growth since the 1990s, while Comin and Hobijn (2010) demonstrate that variations in technology diffusion largely determine differences in income per capita.

The experiences of East Asia confirm these patterns. In the 1960s, South Korea's per capita income was comparable to Ghana's, yet by 2022 it had multiplied more than twentyfold. Sustained investment in R&D, from 0.3 percent of GDP in 1965 to nearly 5 percent by 2020, combined with coordinated industrial policy and higher education reform, transformed the country into a technological powerhouse (Lee, 2013). China followed a similar trajectory, using joint ventures and foreign direct investment to acquire Western technology while steadily building domestic capability through universities and research institutes (Li et al., 2020). Between 1995 and 2019, China's R&D expenditure rose from 0.6 to over 2.4 percent of GDP, propelling it to the world's second-largest investor in science and technology.

The "hockey stick" pattern of global growth illustrates this dynamic vividly: For centuries, per capita income remained stagnant across regions until the institutionalization of scientific research and technological application in Western Europe, North America, and later East Asia triggered exponential takeoff (Mokyr, 2010; Broadberry et al., 2015). These historical lessons highlight a consistent principle, sustained investment in science and innovation produces transformative development momentum, while neglecting it perpetuates structural stagnation.

Universities play a pivotal role in this process. Higher education systems are the primary engines of research and the bridge between knowledge creation and economic application. Countries that achieved rapid growth, such as South Korea and Brazil, built world-class universities that generated new ideas and linked them to industry and policy (Altbach & Salmi, 2011). In Africa, however, most universities remain underfunded, overburdened by teaching, and disconnected from national innovation priorities.

Without significant investment in tertiary education and research infrastructure, Africa's potential for innovation-led growth will remain unrealized.

Ultimately, R&D investment produces broad economic and social dividends. The OECD (2023) finds that each one percent increase in R&D intensity corresponds to a 0.6 percent rise in productivity growth over time. Innovation enables firms to produce more efficiently, adapt to external shocks, and enter new markets. It also generates public goods, new agricultural methods, health technologies, and climate solutions, that improve welfare and resilience. To harness these benefits, countries must establish the basic pillars of innovation: adequate and stable financing, skilled human capital, institutional coordination, and governance frameworks that promote autonomy and accountability. Where these elements are missing, innovation remains sporadic and externally driven; where they exist, transformation follows.

### 3 How R&D Drives Transformation

R&D catalyzes development through mutually reinforcing mechanisms that extend beyond economic growth to encompass governance, social inclusion, and state capacity. Innovation raises productivity, strengthens institutions, and shapes the relationship between knowledge and power.

At the economic level, R&D increases productivity by generating new technologies, improving production processes, and diffusing knowledge across sectors. In agriculture, innovations such as drought-resistant seeds, soil mapping, and precision irrigation have dramatically boosted yields and reduced exposure to climate shocks (Fuglie, 2018). In manufacturing and services, investments in research support automation, quality control, and digital transformation, enabling firms to compete globally (Cirera & Maloney, 2017). These gains compound over time:

Innovation in one sector creates spillovers in others, driving diversification into higher value-added activities such as pharmaceuticals, renewable energy, and information technology.

R&D also enhances **state capacity** by enabling governments to design and implement policies grounded in evidence. Scientific research underpins public service delivery, from health surveillance and education reform to infrastructure maintenance and climate adaptation (Evans, 1995; Besley & Persson, 2011). Investments in research institutions and data systems strengthen bureaucratic performance, improve transparency, and increase public trust. In East Africa, for example, expanded meteorological and hydrological research has improved disaster preparedness and resource allocation (World Bank, 2020). As knowledge systems mature, states gain both technical capability and political legitimacy.

Beyond institutions, technology transforms **social life**. The spread of digital infrastructure, mobile technology, and broadband connectivity has revolutionized

communication, education, and market access across Africa. Empirical work by Wantchekon and Riaz (2019) shows that mobile technology has significantly improved food access and security by lowering transaction costs and improving price information in rural areas. Similar studies by Aker (2010) and Jack and Suri (2014) find that digital tools enhance agricultural efficiency and financial inclusion. Technology diffusion also expands access to education through e-learning and to healthcare through telemedicine, strengthening social resilience and inclusion (Acemoglu & Robinson, 2019).

Finally, the co-evolution of knowledge and power underscores the political dimension of R&D. Countries that produce their own knowledge gain autonomy over their development trajectories, while dependence on imported expertise limits sovereignty. In a world shaped by data and artificial intelligence, control over knowledge systems translates directly into strategic influence. As scientific communities expand, they foster informed public debate and accountability, creating a virtuous cycle where innovation reinforces governance and governance sustains innovation.

In sum, R&D is not merely an economic input but a structural force that shapes how societies grow, govern, and adapt. For Africa, strengthening research and innovation capacity is not just about catching up, it is about securing the intellectual and institutional foundations of sustainable, self-determined development.

## 4 Africa's Innovation Deficit

Despite increasing recognition of the importance of science, technology, and innovation (STI) for sustainable development, Africa remains significantly behind other regions in research investment, scientific output, and innovation infrastructure. This persistent deficit limits the continent's ability to accelerate productivity growth, improve service delivery, and achieve structural transformation.

While the African Union's Agenda 2063 and the Science, Technology and Innovation Strategy for Africa (STISA 2024) underscore the centrality of innovation for inclusive growth, implementation remains slow and uneven. Africa's weak performance in global innovation metrics reflects deep-rooted challenges in financing, higher education, governance, and integration into international research networks.

### 4.1 A Global Lag in Science and Innovation

Africa's contribution to global research and innovation remains marginal. The continent accounts for less than 1 percent of global R&D expenditure and produces roughly the same share of the world's scientific publications and patents. In contrast, East Asia and the Pacific account for over 45 percent of total R&D spending, and even individual economies such as South Korea or Japan spend more on research each year than the entire African continent combined (OECD, 2023).

Several structural channels explain this gap:

**Financing constraints:** Public R&D budgets in most African countries remain below 0.5 percent of GDP, well under the African Union target of 1 percent and far behind the 2–3 percent typically invested by innovation leaders. Private-sector investment is even scarcer, as domestic firms face limited credit, weak venture-capital ecosystems, and low absorptive capacity for new technologies. According to the **World Bank (2022)**, fewer than one in five African firms engages in any form of technological innovation.

**Weak higher education systems:** The continent's tertiary education institutions lack the scale and resources to serve as engines of scientific progress. Average enrollment in higher education stands at only 9 percent, compared to over 60 percent in OECD countries (UNESCO, 2023). Many universities remain primarily teaching-oriented, with inadequate laboratories, limited research funding, and weak linkages with industry or government. The resulting shortage of skilled researchers, fewer than 100 researchers per million inhabitants compared to 4,500 in high-income countries, severely constrains Africa's innovation potential.

**Fragmented innovation ecosystems:** National innovation systems are often poorly coordinated across ministries and agencies. Research institutions frequently operate in isolation, and intellectual property regimes are underdeveloped. Collaboration with the private sector is rare, while cross-border cooperation within Africa remains minimal.

As a result, Africa's **Knowledge Economy Index** and **Global Innovation Index** scores have improved only modestly over the past decade. Even countries considered regional leaders, such as South Africa, Kenya, Egypt, and Senegal, still fall below the global median in indicators of technological readiness, R&D intensity, and innovation outputs.

## 4.2 International Cooperation and National Development Innovation (NDI)

One way to address this persistent gap is through national development innovation (NDI) strategies that leverage international cooperation. Partnerships with multilateral institutions, development agencies, and research networks can facilitate the transfer of technology, skills, and institutional know-how.

However, such cooperation must move beyond traditional aid paradigms toward mutual learning and co-creation of knowledge. Countries such as China and South Korea illustrate how deliberate engagement with global scientific communities, through joint ventures, technology licensing, and education exchanges, can accelerate technological catch-up (Lee, 2013; Li et al., 2020).

For African nations, international partnerships under frameworks such as the African Research Initiative for Scientific Excellence (ARISE) and the EU–Africa Global Gateway provide opportunities to build local R&D capacity. Yet the impact of these programs depends on domestic ownership and alignment with national priorities.

Without parallel investment in local human capital and research infrastructure, technology transfer risks remaining superficial.

In short, Africa's innovation gap cannot be bridged by external flows alone. It requires synergistic strategies that combine foreign cooperation with strong NDI policies, anchored in long-term national planning, financing, and institution-building.

### 4.3 Modest Foreign Aid for R&D

Foreign aid has not meaningfully filled this gap. Official Development Assistance (ODA) to Sub-Saharan Africa has been substantial in aggregate, amounting to over USD 60 billion annually, but only a small fraction is directed toward building scientific capacity or strengthening R&D systems.

OECD analyses show that less than 6 percent of global concessional finance is dedicated to STI-related activities, and the share allocated to Africa is even lower (OECD, 2019; 2024). In contrast, the "Asian Tigers" during their industrialization phase benefited from targeted investments in technical education, science institutions, and industrial R&D, often supported by development partners such as Japan, the United States, and the World Bank.

African countries have received relatively little comparable support for STI, despite recurring affirmations of its importance by international agencies. This imbalance has limited the continent's ability to build the scientific foundations needed for sustained transformation.

### 4.4 Misalignment and Fragmentation of Aid

Even when R&D-related aid is delivered, it often suffers from misalignment with national priorities and fragmentation across projects and donors. Many research programs are externally designed, short-term, or narrowly sectoral, focusing on donor interests, such as agriculture or climate, rather than on comprehensive innovation system development (Mouton, Gaillard, & van Lill, 2014).

The lack of coordination between donors and recipient ministries leads to duplication, inefficiencies, and institutional dependence. Aid projects may fund isolated research centers or short-term consultancies without contributing to national STI strategies. Without a systems approach, one that integrates research, education, and industrial policy, such interventions fail to generate lasting outcomes

### 4.5 A Stalled Paradigm of Development Assistance

The persistence of Africa's innovation deficit points to a deeper problem in the development paradigm itself. Although donors and governments increasingly emphasize "evidence-based policymaking" and "capacity building," these goals are

rarely matched with serious investment in the institutions that produce and manage knowledge.

Instead, aid continues to prioritize service delivery and crisis response, often at the expense of long-term development drivers like innovation and research. This imbalance perpetuates dependency on external technology and limits Africa's ability to generate homegrown solutions.

Without stronger innovation ecosystems, African countries will remain vulnerable to external shocks, reliant on imported expertise, and unable to fully participate in the global knowledge economy. A new approach, centered on co-investment, national ownership, and continental collaboration, is therefore essential to unlock Africa's innovation potential.

## 5 Diagnosing the Innovation Gap: Four Structural Causes

The failure of foreign aid to close Africa's innovation deficit is not simply a matter of insufficient funding. It stems from deeper structural flaws in how aid is conceptualized, allocated, and implemented, as well as limitations within recipient-country systems. This paper identifies four interrelated structural causes of the persistent innovation gap: underfunding, short-termism, misalignment, and institutional weakness. Together, these factors have produced a fragmented and ineffective approach to supporting science, technology, and innovation in the region

### 5.1 Underfunding

The most immediate and visible barrier is the chronic underfunding of R&D in Africa. Public budgets for science and innovation remain minimal across most countries in the region. While African governments have committed, at least rhetorically, to increasing their R&D spending, actual allocations often fall far short. In many cases, R&D receives less than 0.3 percent of GDP, well below the African Union's target of 1 percent and the levels required to build globally competitive research systems.

Foreign aid, which could in theory help close this gap, has similarly failed to prioritize science. Data on official development assistance show that less than 3 percent is directed toward STI-related efforts. This reflects a broader donor preference for visible, short-term investments in service delivery over the slow, complex work of building knowledge systems. The result is a funding landscape in which neither domestic nor international sources provide sufficient or sustained resources for innovation to flourish.

## 5.2 Short-Termism

A second barrier is short-termism in both aid programs and national policy cycles. R&D is by nature a long-term endeavor. Breakthroughs often require years of experimentation, institutional learning, and gradual accumulation of expertise. Yet the dominant approach to aid emphasizes short-term results and rapid disbursement, favoring projects that deliver easily measurable outputs over investments with deferred, systemic returns.

Many donor-funded initiatives are structured around two- or three-year funding windows that are ill-suited to building enduring research institutions or training future generations of scientists. Similarly, frequent changes in government priorities or leadership within recipient countries can lead to policy discontinuity, weakening the institutional memory and strategic focus needed to sustain innovation systems.

This short-term orientation also discourages risk-taking and experimentation, core attributes of any vibrant R&D environment. Without patient capital and policy stability, innovation remains marginal to the development agenda.

## 5.3 Misalignment Between Donor and National Priorities

A third structural cause is the misalignment between donor priorities and the actual developmental needs of recipient countries. While many donors express support for capacity building and evidence-based policy, aid for STI often reflects the strategic interests of the donor country rather than the national development strategies of the recipient.

Research funding may be concentrated in areas that align with the donor's foreign policy, commercial interests, or preferred sectors (e.g., climate, health), leaving critical gaps in other domains such as industrial research, basic science, or technological upgrading. This issue is compounded when donors bypass national institutions, such as ministries of science or local universities, in favor of international NGOs or consultancy firms.

Such misalignment undermines the ownership and effectiveness of aid. When local stakeholders are not meaningfully involved in setting research agendas, managing programs, or evaluating outcomes, the likelihood of institutional learning and sustainability is low.

## 5.4 Weak National Systems and Institutions

Even when funding is available and priorities are nominally aligned, many African countries lack the institutional infrastructure needed to translate resources into innovation outcomes. This includes deficits in technical human capital, ineffective

coordination between research and policymaking agencies, and fragile or outdated institutional frameworks.

Innovation systems in Africa are often fragmented across ministries, agencies, and academic institutions, with limited cooperation or data-sharing. In some countries, national science councils or STI ministries exist on paper but have weak mandates and limited budgets. Universities are frequently under-resourced, overly bureaucratic, and disconnected from industry or government needs.

This institutional weakness impairs not only research productivity but also the ability to absorb, adapt, and scale technologies developed elsewhere. It also contributes to a cycle of donor dependency, in which external actors continue to fill gaps that domestic institutions are unable to address.

Together, these four structural barriers amount to a systemic failure in the way innovation is supported in Africa. The underfunding of science, the dominance of short-term projects, the mismatch between donor intent and national need, and the fragility of local institutions have created a broken system. This system is not merely inefficient, it is actively preventing the emergence of the scientific capabilities needed to drive long-term development.

Reversing this trend requires more than marginal increases in aid or policy tweaks. It calls for a strategic overhaul of how both donors and national governments approach the challenge of innovation.

## 6 Success Stories and Lessons learned

Although Africa continues to face a substantial innovation gap, examples from the Global South demonstrate that significant progress is possible under the right institutional and strategic conditions. This section explores three success stories, **Ethiopia**, **Brazil**, and **China**, that provide useful lessons for designing effective, locally grounded, and scalable innovation systems. Each illustrates how political commitment, international cooperation, and targeted institutional investment can yield transformative outcomes.

### **Ethiopia: Agricultural Productivity through Local Capacity and Global Partnerships**

Ethiopia's development strategy has long placed agriculture at the center of economic transformation, and its progress owes much to deliberate investment in research and innovation systems. The government's establishment of the Ethiopian Institute of Agricultural Research (EIAR) and a network of regional research centers has allowed the country to generate technologies tailored to its diverse agro-ecological zones,

ranging from improved teff and maize varieties to pest-resistant crops and climate-adaptive soil management techniques (Spielman et al., 2010).

What distinguishes Ethiopia's experience is its combination of domestic institution-building and international cooperation. Through programs such as the Ethiopia Agricultural Transformation

Agency (ATA) and partnerships with international organizations, including the International

Maize and Wheat Improvement Center (CIMMYT), the International Livestock Research Institute (ILRI), and U.S. universities, Ethiopia has successfully embedded foreign expertise into local systems. These collaborations have strengthened local research capacity while ensuring that innovations respond to domestic needs.

The country's extension system, which deploys over 60,000 agricultural agents nationwide, creates a continuous feedback loop between scientists and farmers, enhancing the adoption and refinement of innovations (Davis et al., 2010). Although funding and infrastructure remain constraints, Ethiopia demonstrates that even resource-limited countries can achieve high returns when they align R&D with national priorities and leverage targeted international cooperation.

### **Brazil: Embrapa and the Power of Institutionalized and Internationalized Innovation**

Brazil's transformation into an agricultural powerhouse is inseparable from the rise of Embrapa, the Brazilian Agricultural Research Corporation, founded in 1973. Embrapa embodies how sustained investment in a public research institution, combined with strong international linkages, can drive technological breakthroughs and inclusive development.

Embrapa's strategy relied on a unique blend of localized research and international academic cooperation. In the 1970s and 1980s, the Brazilian government funded hundreds of Embrapa scientists to pursue graduate training abroad, notably through partnerships with U.S. universities such as Purdue University, Cornell University, and Texas A&M. This "train-abroad-return-home" model cultivated a generation of Brazilian scientists equipped with global expertise who went on to lead domestic research programs.

These human-capital investments were paired with robust institutional frameworks and stable public funding. Embrapa's integrated approach, linking ecology, agronomy, and technology, generated world-class innovations in tropical agriculture, including nitrogen-fixing soybeans, no-till farming, and new seed varieties adapted to the Cerrado region. Such technologies transformed previously infertile lands into highly productive zones, accounting for between 42 and 78 percent of Brazil's total factor productivity (TFP) growth in agriculture (Vieira Filho & Fornazier, 2016).

Equally important, Embrapa forged strong partnerships with private firms, rural cooperatives, and international donors, ensuring that research outputs translated into

commercial applications and social benefits. Its success underscores the importance of institutional stability, international learning networks, and the localization of global knowledge.

### **Technocratic Leadership, Overseas Training, and Strategic Innovation**

China's ascent from a manufacturing follower to an innovation leader reflects decades of state-led investment, education reform, and international integration. Since the 1980s, Chinese leaders have explicitly linked national modernization to scientific advancement. The government prioritized the recruitment and overseas training of the country's top talent, sending tens of thousands of students and researchers to the United States, Europe, and Japan for advanced studies in science and engineering. Many of these scholars returned to build world-class universities, research parks, and technology firms, a model encapsulated in China's "study abroad, serve the nation" policy.

This global learning strategy was complemented by massive domestic investment. China's R&D expenditure rose from 0.6 percent of GDP in 1995 to over 2.4 percent in 2022, making it the world's second-largest spender on research after the United States (OECD, 2023). Technocratic governance, where many senior policymakers hold engineering and scientific degrees, has ensured consistent, long-term support for innovation.

Universities such as Tsinghua, Peking, and the University of Science and Technology of China established joint programs with Western institutions (e.g., Stanford, MIT, and Oxford) while creating national laboratories and patent offices to institutionalize domestic research. As a result, China now accounts for nearly one-third of global patent filings and leads in fields such as renewable energy, telecommunications, and biotechnology.

China's experience illustrates the power of strategic international engagement coupled with strong domestic coordination. By combining external learning with internal capacity-building, it has achieved technological self-reliance while remaining embedded in global knowledge networks.

The experiences of Ethiopia, Brazil, and China demonstrate that innovation-driven transformation is not the exclusive privilege of high-income countries. It is the product of intentional state action, consistent financing, and strong linkages between universities, industries, and international research networks.

However, replicating these successes in Africa requires more than rhetorical commitment, it demands structural reforms in how knowledge is produced, funded, and governed.

Africa's current innovation architecture remains fragmented: universities often lack professional research management; funding is concentrated in short-term social programs rather than long-term scientific capacity; and foreign aid rarely targets basic sciences or technology creation. The result is an ecosystem rich in talent but poor in structure and continuity.

To reverse this pattern, both foreign aid frameworks and national innovation policies must be reimagined around five central shifts: sustained funding, inter-university cooperation, systemic connectivity, innovation-driven finance, and sovereignty through scientific capacity.

### **From Short-Term Projects to Structural Commitments**

African innovation cannot thrive on projectized interventions. Donor programs typically operate on two-to-three-year cycles, producing fragmented outcomes that disappear once funding ends. By contrast, the enduring success of Embrapa in Brazil or KIST in Korea rested on decades of patient capital and political continuity.

Foreign aid to Africa must therefore transition toward multi-decade endowments and regional innovation funds. These should finance long-term assets, laboratories, data centers, and R&D institutes, rather than ephemeral consultancies. Similarly, African governments must institutionalize R&D financing within national budgets, insulating it from political turnover and embedding science policy within development and industrial strategies.

### **From Imported Models to Locally Embedded Cooperation**

Innovation flourishes when global knowledge networks are locally anchored. Instead of importing foreign research models wholesale, African universities should pursue reciprocal partnerships that combine international exposure with domestic relevance.

A prime example is the African School of Economics (ASE), which operates as a research and training network connecting African scholars with global universities. ASE's collaboration with Princeton University culminated in the creation of the Princeton–African School of Economics Research (PASER) Hub, a model of decentralized cooperation that strengthens African research ecosystems while promoting joint inquiry and mentorship.

Replicating this approach across the continent would enable African universities to professionalize research administration, establish competitive grant offices, and train faculty in global publication standards. By fostering inter-university cooperation, Africa can build a distributed network of excellence rather than a few isolated centers.

### **From Fragmentation to Systemic Connectivity**

Innovation is a networked process, not a single-sector effort. Its success depends on strong linkages between universities, industries, and government agencies. Yet, in many African countries, these actors operate in silos, ministries design policy without research input, universities publish without commercial application, and firms innovate without academic collaboration.

To change this, governments should adopt national innovation systems (NIS) frameworks that integrate education, finance, and industry. Universities must host innovation clusters, technology parks, and industrial research consortia that link academic research to market needs.

Regional models already exist. Morocco's Mohammed VI Polytechnic University and South Africa's Council for Scientific and Industrial Research (CSIR) have successfully bridged academia and industry. Continental networks such as PASER Hub can serve as catalysts, connecting African-based scientists with diaspora and global researchers to facilitate collaborative projects and shared infrastructure.

### **From Consumption to Creation: Financing Innovation and Basic Sciences**

A defining weakness of Africa's innovation landscape is the underfunding of basic sciences, physics, mathematics, chemistry, and biology, the intellectual bedrock of all applied technologies. Current donor and government spending overwhelmingly favors social or humanitarian programs, leaving the laboratories that generate technological breakthroughs chronically neglected.

Foreign aid must be rebalanced toward technical capacity and foundational research. Development finance institutions should create dedicated Basic Science and Innovation Windows, supporting graduate fellowships, laboratory equipment, and scientific journals. Aid conditionality should also reward governments and firms that allocate a defined share of their budgets to R&D.

This approach, known as innovation conditionality, would mirror earlier experiences in South Korea and China, where international financing and foreign investment were explicitly tied to technological upgrading. Similarly, donors should incentivize innovation-driven foreign direct investment (FDI), ensuring that multinational corporations investing in Africa contribute to local R&D through joint ventures, technology transfer, and on-the-job training.

### **From Dependency to Sovereignty**

At its core, Africa's innovation challenge is about autonomy over knowledge. Countries that can generate, adapt, and govern their own technologies possess strategic sovereignty. Achieving this requires both local investment and a new kind of international partnership, one that emphasizes co-creation rather than dependency.

Donors can reinforce sovereignty by channeling funds directly through African universities and regional research networks instead of external contractors. Governments must, in turn, elevate scientific leadership, protect research independence, and integrate innovation into the heart of state planning.

Scientific sovereignty is not isolationism, it is the ability to engage globally from a position of competence and equality.

## **7 Returns to Investments**

A large body of economic literature shows that investments in technology transfer, skills, and institutional capacity in developing countries generate substantial returns not only for recipient countries but also for investing countries. Technology diffusion

and human capital accumulation increase productivity, expand markets, and strengthen trade linkages, creating positive spillovers for advanced economies (Borensztein et al., 1994; Xu, 2000; Heidland et al., 2025). Moreover, countries with higher levels of education and technological capability are better able to absorb, adapt, and scale foreign innovations, which enhances the effectiveness of international investment and cooperation (Cohen & Levinthal, 1990; Alfaro et al., 2004). From this perspective, technology and knowledge investments function less as transfers and more as growth-enhancing global public goods, improving the stability and performance of the international economic system in which developed countries are deeply embedded.

Similar logic applies to private organizations and philanthropic actors, such as large foundations, that invest in education, technology, and institutional capacity. The literature suggests that returns to investment, whether measured in productivity, welfare improvements, or policy effectiveness, are significantly higher in contexts with stronger human capital and technological readiness (Javorcik, 2004; Keller, 2004). For philanthropic organizations, this implies that early investments in skills and technology increase the marginal effectiveness of subsequent interventions. By strengthening local capacity to implement, monitor, and adapt programs, such investments reduce implementation risk, lower transaction costs, and improve accountability. As a result, private funders are more likely to achieve sustained impact rather than short-lived or fragmented outcomes.

Importantly, higher levels of education and technological capability also make investments more secure and efficient, allowing both public and private actors to reallocate resources toward other pressing challenges. When countries possess the skills and systems needed to maintain and scale technological inputs, donors and investors face lower risks of misallocation, underutilization, or project failure. This efficiency gain implies that fewer resources must be continuously devoted to basic capacity-building, freeing funds for complementary priorities such as health, climate adaptation, governance, or social protection. In this sense, investments in education and technology act as enabling investments: they increase the productivity of all future spending and create conditions under which development cooperation, whether by states or private organizations, can be sustained politically and financially over the long run.

## 8 Recommendations

Building self-sustaining R&D systems in Africa requires a coordinated transformation among donors, governments, and universities. Innovation does not emerge in isolation; it depends on the deliberate alignment of international cooperation, domestic policy, and institutional reform. This section outlines how these three actors, development partners, national governments, and universities, can together reshape the continent's innovation future.

For **donors and development partners**, the first imperative is to **redirect aid toward innovation-driven development**. Traditional aid models have focused overwhelmingly on social service delivery, often at the expense of long-term investments in technical capacity, research infrastructure, and STEM education. Development cooperation must now treat innovation as a core pillar of growth, just as aid to East Asia in the 1970s and 1980s supported industrialization and technology transfer.

Donors should also **support basic and foundational sciences**, establishing a Global Fund for Basic Science and Innovation in Africa dedicated to financing departments of physics, chemistry, biology, and mathematics, the intellectual bedrock of technological progress. The neglect of these disciplines has slowed Africa's capacity to generate frontier knowledge and sustain innovation.

Equally important is the need to **institutionalize innovation conditionality** within aid frameworks. Rather than providing uniform grants, donors should create incentives for governments and firms that invest in R&D. Concessional loans, matching grants, and preferential financing could be tied to a recipient's domestic spending on innovation or private-sector investment in research. Such incentives would reward governments and industries that commit to scientific advancement.

Foreign partners should also **finance inter-university and industry collaboration**, promoting joint research between African and international universities. Initiatives like the **Princeton– African School of Economics Research (PASER) Hub** exemplify the kind of decentralized partnerships that expand research capacity through shared laboratories, collaborative PhD programs, and mobility schemes connecting African scholars with global peers. These collaborations not only enhance scientific output but also nurture human capital and institutional competence.

To broaden participation and reduce concentration, donors should **foster decentralized and networked partnerships** rather than channeling support through a few flagship universities. Regional innovation clusters, linking institutions across **West Africa (Benin, Nigeria, Ghana)**, **North Africa (Morocco, Egypt)**, and **Southern Africa (South Africa, Botswana)**, can encourage competition, knowledge diffusion, and specialization.

Development cooperation should also be linked to private-sector engagement. Donors can **encourage innovation-linked foreign direct investment (FDI)** by conditioning investment licenses and trade benefits on local R&D commitments. Multinational corporations operating in Africa should establish innovation centers, internship programs, and technology-transfer facilities in partnership with local universities.

Long-term stability is equally critical. Donors should **establish innovation endowments** modeled on the World Bank's Centers of Excellence program, ensuring predictable financing insulated from political or market fluctuations. In parallel, they can **build platforms for global scientific networking**, funding conferences, digital repositories, mentorship initiatives, and exchange programs that connect Africa-based researchers with the global scientific community. Expanding platforms such as the

**PASER Hub** into continental nodes would allow continuous collaboration and visibility for African research.

For **African governments and universities**, innovation must be elevated to the highest tier of national priorities. Governments should **make innovation a central development pillar**, embedding R&D and STI objectives in national industrialization and economic growth plans, with clear, legally mandated budget allocations. Science policy should be treated as an economic strategy, not an auxiliary social investment.

African states must also **invest strategically in basic sciences and human capital**, strengthening STEM education from secondary school to postgraduate levels. Funding research chairs in core scientific disciplines, alongside graduate scholarships and exchange programs modeled on Korea's "Brain Korea 21" initiative, would help cultivate the next generation of scientists and engineers.

At the institutional level, universities must **professionalize their research systems** by creating dedicated offices for grants management, ethics compliance, data governance, and intellectual property. Administrators should be trained in international funding procedures and peer-review standards to increase competitiveness in global research calls.

African higher education institutions should further **expand inter-university cooperation** through the creation of **University Innovation Consortia (UICs)** that connect regional and global partners. Decentralized collaboration, where universities jointly develop curricula, share laboratory facilities, and co-supervise doctoral students, can accelerate capacity building while reducing duplication.

Governments and universities alike must **connect research to industry** by establishing liaison offices, innovation incubators, and science parks that translate academic discoveries into commercial applications. Tax incentives, procurement preferences, and innovation grants should reward companies that invest in R&D partnerships with local universities, turning campuses into engines of entrepreneurship.

Financing innovation will require creativity and commitment. Governments should **create national innovation funds** and issue **sovereign R&D bonds** to finance high-impact scientific infrastructure such as biotechnology laboratories, renewable energy testing centers, and supercomputing facilities. These mechanisms can attract private capital while ensuring domestic ownership of research priorities.

At the continental level, it is essential to **strengthen collaboration among African research hubs**. Supporting regional centers of excellence such as **PASER**, the **African Research Universities Alliance (ARUA)**, and the **African Academy of Sciences (AAS)** will foster shared standards, mobility, and critical mass in research capacity. Harmonizing research regulations and easing cross-border mobility for scientists can turn Africa's diversity into an asset.

Governments should also **leverage international cooperation strategically**, pursuing partnerships built on co-creation, reciprocity, and shared intellectual property rather than donor-driven transfers. Joint laboratories, dual-degree programs, and

collaborative technology ventures can embed African institutions in global scientific networks while preserving local agency.

Finally, governments and universities must **promote a culture of innovation and trust in science**. Public outreach campaigns, science festivals, and media partnerships can elevate the visibility of African researchers and inspire young people to pursue scientific careers.

Celebrating African scientific achievements is essential to building a constituency for sustained investment in knowledge creation.

In essence, these recommendations converge on a single vision: a future where foreign aid acts as a catalyst for innovation rather than dependency, where African universities operate as professional research institutions linked to global networks, and where governments view science as the cornerstone of economic sovereignty. By aligning these efforts, through long-term financing, strategic partnerships, and institutional reform, Africa can move from the periphery of the knowledge economy to its very center, driving the next wave of global innovation.

## 9 Conclusion

Africa stands at a critical juncture in its development journey. The continent's abundant human capital and entrepreneurial energy coexist with a persistent innovation deficit, rooted in decades of underinvestment in science, weak institutional coordination, and aid systems that prioritize relief over research. Yet, as this report has shown, this gap is not destiny. Experiences from Ethiopia, Brazil, and China demonstrate that with political vision, long-term investment, and institutional coherence, developing nations can build world-class research ecosystems and achieve sustained, innovation-led growth.

The central insight is clear: Research and development (R&D) must become the engine, not the byproduct, of Africa's development strategy. Economic diversification, state capacity, and social welfare all hinge on the continent's ability to generate and apply knowledge. Innovation is not only about technology, it is about sovereignty, the ability of nations to shape their own futures.

Closing Africa's innovation gap will require both domestic commitment and international reorientation. Governments must place science at the heart of national planning, professionalize research institutions, and invest systematically in basic sciences. Universities must evolve into hubs of experimentation, linked to industry and global research networks. Initiatives such as the Princeton–African School of Economics Research (PASER) Hub demonstrate how decentralized, inter-university cooperation can nurture a new generation of African researchers and global partnerships rooted in equality.

At the same time, foreign aid must be reimagined. Development assistance should move beyond social programming toward innovation-driven growth, financing laboratories, technical education, and industrial R&D rather than short-term humanitarian interventions. Aid must incentivize governments and firms that invest in research through innovation conditionality, and it should support regional collaboration, networking between African and diaspora scientists, and long-term endowments that sustain excellence.

Transforming Africa's innovation landscape is a generational project. It calls for the same patience and purpose that powered the industrial revolutions of earlier nations, but adapted to Africa's realities and aspirations. With deliberate policy, sustained financing, and genuine international partnership, Africa can shift from being a consumer of technology to a creator of knowledge, from a receiver of aid to a generator of ideas, and from the margins of the global economy to its center of innovation.

The task ahead is not easy, but it is essential. Building Africa's future begins in its laboratories, lecture halls, and research networks. The continent's greatest resource is not only its natural wealth or youthful population, it is its potential to innovate, to imagine, and to lead.

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**Value Added Tax Identification Number**  
DE 251899169

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