African industrial R&D: investing for the next decade

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> **Science and technology are managed by those who win the struggle for meaning.**
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> **Adesanmi, 2012, Project Nigeria: The Struggle for Meaning, in: *You're Not a Country, Africa*, p. 204**

Summary

In 2023, when the most powerful politician in Africa, President Ramaphosa, addressed the most powerful politicians in Europe, concerning the need to do 'something very practical', why did he propose a giant dam when he could have proposed an African 'Advanced Research Projects Agency'?

The goal of this project has been to identify investment options that would underpin industrial R&D in the African Union (AU) over the next decade (I post as much data as possible on this webpage).

Through a process of reading, desk-based analysis, and communications with African scientists, the following five options emerged that seemed to me among the most interesting:

- An African Advanced Research Projects Agency
- A multipurpose network of research institutes
- A framework to influence overseas scientific institutions established in AU member states; full restitution of remaining colonial-era assets
- An African 'Nobel Prize' to promote achievements in the basic sciences
- Strengthened science diplomacy capacity in strategic areas

These are not new proposals – some, indeed, have been around in various forms for decades; others are 'in the air' concerning what is already being discussed.

Overall cost of all five implemented simultaneously would be multiple billion US dollars. Less ambitious interventions could be delivered in the range of millions of dollars.

The first major cross-cutting obstacle is likely to be the international IP regime that favors the Global North. As currently positioned, it is a logical prediction that increased scientific activity in Africa, leading to increased scale and legibility of African IP, would not accrue commensurate benefits to African inventors.

That would be an untenable situation (as is widely-known). I have no solution for it other than to raise the paramount importance of finding one that is watertight before committing to many of the ideas proposed here.

The second axis obviously lies with under-funding. The concluding section beneath describes some possible sources – national research funds as well as the potential of commerce at the level of individual research institutes.

A good analysis of funding issues can be found in the well-known UNECA policy brief of 2018 (UNECA, 2018, *Towards Achieving the African Union's recommendation of expenditure of 1% of GDP on Research and Development*). The overall point is that relatively modest but, crucially, sustained investment maintained through thick and thin is what would matter most.

Between IP protections and funding, strategizing needs to be stepped up among like-minded people in the science policy community, given the economic and political effects of climate and other crises mean the situation for science and research could yet worsen.

Detail on investment options

An African Advanced Research Projects Agency

Shorthand is the 'ARPA' model, after the US government concept of an Advanced Research Projects Agency. Globally, many policy experts and even some politicians want to create more such agencies, and African countries need to be included.

My meaning is, essentially, a semi-autonomous public fund that takes seriously the ideas of active selection and management of research, development and pilot-scale deployment projects. The goal in this case would be to build a portfolio which includes projects that advance basic science in high-profile ways, while also contributing to wider economic, societal, and political goals.

Fund managers would need to acquire the legal and other expertise to deliver a range of contracts and put together consortia; they would need sufficient contact book and influence to attract investors to the fund. However, besides these practical necessities, I believe they would also have to keep the following ideas in mind.

The first idea of note is that IP would have to be seriously addressed in enforceable (and enforced) contracts. Policy design must be completely watertight. You cannot advocate for a system that exploits African know-how without it including full recompense to Africans, otherwise it is colonialism.

Secondly, you would want an African-designed and built fund, advised by African consultants, staffed by African experts and featuring African contractors. While some investments might be made outside the continent, these would be with a view to acquiring crucial input factors for projects of strategic importance led and managed within the continent.

The overall ethos would be about building an engine through which African counties assert scientific and technical supremacy in areas viewed as strategically important for their citizens, with that as the bottom line for investment.

The third idea would be leveraging the growing number of African scientific publications as a data-driven investment tool, feeding into an expert process that could assess the scientific viability of propositions.

One general feature of African publications, due to the lack of funds, is that projects are sometimes incompletely realized, instead hinting at possibilities that might accrue were more funding made available (while also, of course, requiring imagination and expertise to evaluate the complex and varied mix of scientific visions being described).

Reading across the scientific literature from Africa reveals an emergent and highly-prescient program of industrial research that is already occurring and warrants scale-up, such as:

- Improvements to production processes.
- Valorization of underappreciated materials and feed-stocks.
- Scalable methods to detect and control industrial pollution.
- Reliability of the energy system and public infrastructure.

A multipurpose network of research institutes

Most if not all the AU countries harbor at least one national industrial research institution (a selection are listed here). Only CSIR in South Africa is adequately funded and therefore has sufficient force to shape the global scientific agenda. Raising the profile of a wider range of institutions so that they begin, in a way, to resemble a multipurpose industrial R&D network, would therefore be a major achievement.

Multipurpose refers to an ability to solve a range of scientific problems across multiple industry sectors and deploying varied R&D methodology, at will, according to the problem.

It is easy to think of models for such a network, like Fraunhofer-Gesellschaft, the other German research networks, or perhaps the Swiss ETH Domain (some of these networks incorporating both government labs and a subset of prominent universities considered strategic assets). Equally, we might think about CGIAR, with its vaunted multidisciplinary capacity, including social sciences (Lynam, *et al.*, 2024).

These models serve as interesting case studies, with strengths and weaknesses, while also raising particular scientific and bureaucratic questions. But an African industrial R&D network of the kind envisaged here would also have to take account of the past history of such policies on the African continent.

The idea of a multilateral industrial research entity in Africa is not new; it dates back to at least the Lagos Plan in 1980. In that case, the solution chosen was not to integrate existing efforts but to create new entities, with efforts focused on building institutes in Kenya, Nigeria and Sénégal.

As far as I am aware, however, only one of these institutes appears to cling on, namely, the Centre Régional Africain de Technologie (CRAT). The failure to sustain industrial R&D capacity at a pan-African scale during the 1980s is not surprising – it was the disastrous era of 'structural adjustment' cut-backs. The prescient but mostly unrealized ambitions of the Lagos Plan faded from memory.

The research labs and universities that survive today are mostly national institutions bound by national legislation and with national constituencies. While the AU harbors multilateral scientific bodies, none would qualify as an industrial research institute; policy in this field remains a stubbornly national phenomenon.

The national factor in my view sets a very narrow landing zone for what can be achieved in a multilateral way or, in other words, developing and sustaining a multilateral scientific network will prove difficult.

It seems the priority would be to ensure adequate funding for day-to-day activities of the industrial R&D institutes that already exist. This would give the time for managers to step back and think strategically. At present, even the most essential facilities might be lacking such as reliable payroll and basic equipment.

Once that situation had been stabilized, there would be opportunities for joint R&D projects through a research fund.

It seems to me, therefore, that a network of institutes would have to be gradually built over the next decade by the most imaginative senior officials, as an emergent property that would slowly come to be seen as politically necessary.

It might then provide an anchor for integrated actions that created splashes in global science and were therefore self-reinforcing in terms of encouraging more funding.

A framework to influence overseas scientific institutions established in AU member states; full restitution of remaining colonial-era assets

There are many overseas scientific institutions based in AU member states, probably of the order of tens but perhaps, I guess, less than 100, which overall comprise a significant scientific enterprise. The extent to which these institutions merge into a more numerous category of donor grant programs remains a grey area but I suggest there are likely to be legal distinctions we could put our finger on if we knew more about the phenomenon in general.

Overseas scientific establishments in Africa (examples)

Country	Institution(s)
China	Sino-Africa Joint Research Center (SAJOREC), Kenya; China National Nuclear Corporation (CNNC) Namibian engineering technology R&D center[1]
France	Institut Pasteur (medical research) in Casablanca, Algiers, Tunis, Antananarivo, Dakar, Conakry, Abidjan, Niamey, Yaoundé and Banguy; La Station d'Ecologie de LAMTO[2]; UMIFRE (humanities) in Cairo, Khartoum, Addis Ababa, Rabat, Tunis, Johannesburg, Nairobi, Ibadan and Khartoum; IRD in Benin, Burkina Faso, Cameroun, Côte d'Ivoire, Kenya, Madagascar, Mali, Maroc, Niger, Réunion[3], Sénégal[4], South Africa and Tunisia.
Germany	Leibniz-Gemeinschaft 'research stations' in Ghana (tropical medicine), Madagascar and Senegal (primate research); Maria Sibylla Merian Centres (humanities) in Ghana and Tunisia.
India	IIT (Tanzania); INCEIT (housing CDAC PARAM supercomputer) in Namibia
Italy	ASI Centro Spaziale Luigi Broglio, Malindi (Kenya)
South Korea	Kenya-AIST
Switzerland	CSRS[5] (Côte d'Ivoire); Nestle R&D centre and experimental farm (Côte d'Ivoire)
UK	MRC (medical research) in The Gambia[6] and Uganda; CABI (agricultural research) in Accra, Lusaka and Nairobi; BIEA (archeology) in Nairobi; Wellcome Trust/KEMRI Research Programme (medical research), Kenya.
USA	Google[7], IBM, Microsoft, CMU-Africa (Rwanda), CGIAR[8]

(1) Associated with the large Rössing uranium mine, formerly operated by Rio Tinto since it opened in the 1970s, but by China National Nuclear Corporation since 2019. The year cited refers to a press release reporting the unveiling or launching of a research center. There is obviously a longer history of scientific expertise connected with the uranium deposit that

dates back to the 1960s. (2) Lachenal, 2005, L'invention africaine de l'écologie française: Histoire de la station de Lamto (Côte d'Ivoire), 1942-1976, *Regards sur des laboratoires en sciences humaines et sociales*. (3) An overseas department (territory under French administration). (4) The most important base overseas for IRD in terms of programs, staffing and budget. (5) Founded 1951. (6) Probably one of the largest European scientific bases in Africa; Ann H. Kelly, 2015, The territory of medical research: experimentation in Africa's smallest state, in: *Para-States and Medical Science: Making African Global Health*. (7) An informative analysis is offered by Bright Simons, 2023, Google came to Ghana, what happened? (8) CGIAR is a multilateral institution but has American roots due to its historical connection to the Rockefeller Foundation.

Sites are arrayed over the territory in an non-strategic manner due to historical contingency and presumably take different legal and organizational forms (such as the extent to which budgetary control is delegated, and so on).

They include research bases of a small number of multinational companies, many establishments of past (and present) development aid and, of course, European institutions founded in colonial times.

French centers associated with the Institut de Recherche pour le Développement (IRD), formerly the colonial-era agency, ORSTOM, probably comprise the largest group. Britain, Germany, Italy and Switzerland also have a notable presence, such as the British and German medical laboratories and an Italian space center.

Unlike the French government, with their IRD, as far as I can determine (data is sparse), the British withdrew major institutionalized scientific assets, such as 'Development Divisions', decades ago, leaving a much smaller footprint, although still a notable one considering the size of their Gambian laboratories.

Establishments associated with non-European countries, citing, America, China, India and South Korea, are also detectable. American IT firms, namely, Google, Microsoft and IBM, have African bases that self-identify with research.

On top of these research centers, we must also talk about the most-heavily capitalized sites of production, such as mines, dams, data centers, transport and other infrastructure projects, factories, 'agro-industrial' (cash crop) complexes, etc.

While some are easy to spot – and obviously entail various kinds of science and technology to build and operate – it is often difficult to work out how they could be mobilized into national industrial R&D programs. The possibilities are probably very limited but perhaps worth considering.*

A study of South Africa's Mintek might offer some clues of how such mobilization has been institutionalized in the post-Apartheid state and what the results have been.

Questions of the decolonization of sites of production are going to dominate in the majority of cases and, in the material terms notably accessible to science and technology, this will mean decontamination of land, water and effluents.

Science and research is, in many cases, being configured as a progressive agent in that task. However, the scale of pollution control and remediation increase as, for example, mining, cash-cropping, etc., rise due to the influx of international capital.

Whether these firms could be persuaded to part with budget in favor of science and research is moot but my gut feeling is they would not give ground.

In light of such a large problem, it might indeed be a good idea to start on a relatively small scale as test of political viability. The most obvious intervention in this regard would be a baseline monitoring framework covering the sample of research institutes cited in the table above. This would assess factors like scientific quality of research activities, governance, IP ownership, training provisions, benefits to the local community, and collaboration with nearby innovation ecosystems.

A second point to make is that the colonial era research institutions must now all be transferred to African ownership on a new basis – an opportunity for intellectual restitution.

The relatively recent case of the UK medical laboratory in The Gambia, which was deliberately not transferred to African institutions in a process that was also quite opaque, illustrates the acute need for closer scrutiny of colonial-era establishments.

African ‘Nobel Prize’ to promote achievements in the basic sciences

In a recent book, Van and Ado (2020) proposed an African Intellectual (‘Nobel’) Prize that would be awarded to individuals with citizenship of African nations in a range of academic fields.

The authors envisaged the prizes would be awarded by a foundation based in their home country, Côte d’Ivoire, supported initially with cash from donors in the public and private sectors but ultimately aiming for a self-supporting entity deriving investment income from endowments.

Each prize would be valued at around 300k, with juries drawn from the faculties of prestigious academic institutions across the continent, such as Makerere University and the University of Cape Town.

A lower-key alternative would be a communications package intended to raise the international profile of existing African science prizes such as the NSTF Awards in South Africa.

Strengthened science diplomacy capacity in strategic areas

Quoting recent expert commentary by Simelane and Inyang (2023), ‘diplomatic engagement on science, technology, and innovation among African countries is negligible’. As in most fields of science and technology, the authors argued that only South Africa had the wherewithal to articulate science diplomacy at scale.

There is evidently a repeated need for assertion of African scientific priorities on the global scene.

These priorities would include governance of scientific programs and their associated IP including, obviously, reform of the international IP regime; demands for effective representation in funding processes; contributions to international regulations, technical standards and norms; accessibility of visas for free exchange of scientific personnel; and general intelligence-gathering and political foresight in regard to science and technology.

It would be a critical mistake to think in general that Western donors will become constructive agents, or could ever be, as such, reformed. Even the most sincere among them have not grasped the full meaning of decolonization of science (and there is a well-known risk of retaliation against those who raise such issues, which leads to circumspection).

However, interactions with science and R&D in donor countries and in multinational firms could not be avoided completely and would still occupy effort. This is because of the collective financial weight of these groups in international science and research (a weight that lies far beyond the narrow category of ODA).

The political positions of science ministries in donor states, for example, is an input for any influencing strategy in terms of understanding openings to gain purchase, as well as identifying and building links with politically well-connected scientists in those countries.

As with most diplomacy, the benefits would accrue slowly and sporadically, requiring, at base, consistent investment in human expertise as well as data analysis capacity.

A history of African science diplomacy would help refine some potential landing zones (on this latter point, the history of the UN Environment Programme [see chapters 2 and 5] proves instructive as, perhaps, one of its greatest achievements).

Detail on sources of finance

All of the above would require billions of dollars and considerable effort to bring to life. What chance of such an eventuality?

The options reported here were chosen because they are conceptually interesting, not for their political practicality as implementable solutions. I am obviously not in a position to comment on political viability of any ideas in the countries concerned, let alone all of them together.

We might never experience a strategic program of the kind outlined above. Science and research policy is often furthest from politicians' minds. But we could see gradual, piecemeal steps taken which, collectively, produce substantial effects.

The positive story – African science and technology is an untapped new source of innovation that will shape the world over the next decades; investment in it will pay significant dividends.

Tens of billions of US$ are already spent every year on science and research across all the AU member states, noting, the spending is concentrated in the Mediterranean (Egypt) and the handful of major economies south of the Sahara (South Africa).

As highlighted in the *African Innovation Outlook* (p. xviii), public sector expenditure on R&D as % of GDP in Africa sits around the global mode (these data are now slightly out of date). Of course, it is the absolute numbers that matter in terms of the amount of science that can be bought, not the % of GDP, which counts only symbolically.

The negative story – not enough potential investors had the imagination to see the opportunities available.

Investment is not currently flowing into the developing world; the opposite, indeed, occurred (citing, for example, the recent comment by Summers and Singh). We also know that cynical foreign powers and capricious politicians consistently sabotaged African science and research in the past – and will do so again.

Crises have arrived with regrettable regularity in African science and research. It is not clear if we currently face a new dynamic, or whether this is a repeat of previous crises such as structural adjustment. It is also unclear how such a dangerous dynamic could be stopped.†

Conflict zones obviously extinguish science and research, as they do other positive aspects of civic life. The economic and political effects of the climate and other crises mean the situation could worsen. Brain drain would become brain flight and science would cease as a going concern in parts of the continent.

Ideas about spending at least 1% of GDP on science have been around for decades, unmet; SDGs, proposed in 2012 by a committee of worthies chaired by Susilo Bambang Yudhoyono, are also quite old – and unmet (we might even invoke the previous MDGs as prequel in the story of unmet goals).‡

It is very difficult to evaluate the rhetorical salience of the 1% target and SDGs; in other words, whether lobbyists should double down on them or whether, instead, they should be abandoned as false prophesies with only political, not real, efficacy.

One approach to sourcing funds for African science is to leverage capital from outside the continent, whether it is ODA, development banks, or private investors (distinctions between categories are blurred, such as when dealing with multinationals that have close political connections with governments).

I think two further but possibly much less discussed ideas are also worth noting (beneath), although I am not able to evaluate their significance. Remember, modest but reliable funding that could be sustained over a decade, is often the crucial factor in the development of R&D programs.

A far more comprehensive analysis than mine can be found in the well-known UNECA policy brief of 2018 (UNECA, 2018, *Towards Achieving the African Union's recommendation of expenditure of 1% of GDP on Research and Development*). However, as noted beneath, I used slightly different terminology than UNECA.

The political economy of national funding mechanisms

The first point for discussion lies with the political economy of Africa's national science and technology funding mechanisms – how they function in detail, and how they obtain political support. Orchestrating such intricate mechanisms needs both political support and administrative capacity that delivers funds to scientists in a regular and timely fashion.

The problem is we don't really have a forensic picture of this area, in terms of the politics of funding mechanisms across the continent and where the levers might rest.

I will take one example we all heard about – funds that draw revenue by taxing particular sectors, but aim to dispense funding in a more autonomous way independent of those sectors. In other words, they are not industry research associations, as such, but general purpose funds for strategic investment in science and research.

The idea was (somewhat) as promoted long ago in the Lagos Plan, requiring firms with foreign equity to expend budget on R&D, as well as contribute tax to national R&D pots (link, p. 53). Arguably similar approaches did indeed develop (UNECA, *ibid.*, gives examples).

Nigeria's TETfund and the proposed NRIC/NRIF research and innovation fund (link, pp. 11-12) are two of the most notable examples. The former pays out to universities; it derives revenue via a 2% tax on profits of firms, mainly deriving from the oil and gas industry. The latter has yet to be established and is currently subject to political operations, but could, in theory, invest more widely such as in research institutes.

There are identifiable problems with a fund based on oil and gas like TETFund, as income varies with market price while also, of course, noting the climate risks of such a revenue stream.

These imply an unmet need for widening the tax-base and other reforms of the fund itself (link, p. 118). There have also been calls to increase the tax to 5% of company profit (e.g., Abdallah, *et al*., 2023).

However, TETFund succeeded in mobilizing funds and provided uplift to facilities in universities since its latest legislative update in 2011. In my judgement, it supported interesting scientific projects. From an analytical perspective, the workings of the fund are relatively well-documented, allowing us to evaluate aspects of its operations in detail.

Conversations about the political and bureaucratic viability of funding based on taxing export commodities, to take an example, are important across all the AU member states. Harnessing the putative *chaebol* qualities of Dangote-type firms, in the name of science and innovation, could yet prove another talking point.

Such detailed conversations call for an understanding of where discussion of science and research policy occurs in each country; this can only be done with assurance in the democratic parts of the continent where freedom of expression still has a place in public life.

In my view, one-size-fits-all campaigns ought to be viewed with a certain circumspection as they cannot engage with the political detail in individual countries, sectors, and policy ecosystems.

For instance, it seems unproductive to talk about ‘the private sector’ when we actually see a complex interplay of state, para-statal, chaebol-type, and multinational entities, that varies with context; in other words, a variable geometry of potential political pressure points. However, in the end, it comes down to political efficacy, and if a certain discourse achieves the goal, it has merit.

Cross-subsidization through commerce

In the case of public research institutes, commerce (sale of goods and services) is an important aspect to mention as a funding source, citing the following illustrative examples.

- The Ghana Atomic Energy Commission (GAEC) sells construction materials, blocks for masonry work, etc. (https://gaec.gov.gh/mechanical-services/ https://gaec.gov.gh/block-factory/).
- The Centre National de Recherche Agronomique in Côte d’Ivoire offers for sale crop seeds, tubers, etc., as well as packaged coffee.
- The Federal Institute of Industrial Research, Oshodi in Nigeria advertises about 100 products such as plantain chips and a drink made from Hibiscus.

As far as I am aware, however, there has been no study of this phenomenon. But, having spent time examining the accounts of some research institutions in Europe and talking to managers in them, I know such commerce is a crucial feature of the business model where, in European cases, it can account for millions of € of vital income.

It may also be a crucial but underappreciated part of the knowledge economy of institutions by linking research and production through daily work, although the evidence for that latter claim is more anecdotal.

My conclusion is that our analyses must encompass the possibilities even if the scale is much smaller on the African continent because the market has less capital. My conception is possibly a bit wider than implied by ‘technology commercialization’ (UNECA, *ibid.*, p. 5) and suggests more than simply policy change.

R&D institutes cannot therefore be accurately characterized as ‘pure play’ research contractors despite the name in the title; they also engage in various kinds of production that earns income, potentially at quite a large scale and of crucial importance to institutional survival.

We obviously need to know more if we are looking into realistic opportunities for cross-subsidization, which would ideally be achieved on a proof-of-principal basis with one institute before expansion to others. I have no idea what has already been tried and what conclusions were drawn.

Ultimately, such an agenda implies finding out what institutes are selling and how they might sell more – as well as what they could, in theory, sell, but are currently unable to do so, due to lack of resources, a restrictive legal framework, etc. These are mainly questions for commercial-minded people, not policy analysts.

* There is an academic literature on mines; although not concerned with science and research in particular, it seems suggestive. Notable recent papers along this line include: Ahmed, *et al.*, 2020, Where are mines located in sub-Saharan Africa and how have they expanded overtime? in: *Land Degradation and Development*; Sethulego Matebesi and Chitja Twala, 2023, Evolution of mining company responses to civil society mobilization in South Africa, in: *Enterprise & Society*; and Muhirwa, *et al.*, 2023, Linking large extractive industries to sustainable development of rural communities at mining sites in Africa: Challenges and pathways, in: *Resources Policy*.

† The issue of brain drain is an enormous topic with a vast literature. Besides exhortations to patriotism or legal threats, which have both been proposed as brakes, increases in funding that improved career prospects would address the problem most effectively. A recent paper by Eyong Emmanuel Ikpi (2023) makes logical proposals, as one example.

‡ Ziai, 2016, *Development Discourse and Global History; From colonialism to the sustainable development goals*, p. 195