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Assessing the needs of the research system in Nigeria

Report for the SRIA programme

October 2019

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"Assessing the needs of the research system in Nigeria. Report for the SRIA programme."

Report commissioned by: The UK Department for International Development

http://www.dfid.gov.uk

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Report dated: November 2019

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1. Executive Summary

This report provides a high-level assessment of Nigeria's research and innovation system and key research organisations. It seeks to identify the main challenges to research capacity strengthening and some priority areas for intervention in order to support decision-making at DFID and among Nigerian partners. Findings in this report are based on quantitative and qualitative data collected through desk-based research and informant interviews. Over 100 indicators are used to assess the country's research environment and political economy context, research production and research diffusion performance. Some of the qualitative findings are based on the views of a small but balanced number of stakeholders and should be verified through further research. The study does not seek to explore issues such as the historical causes of the current situation or the role of the media and other political actors which, albeit important, fall outside the scope of this investigation.

A. Needs Assessment for Nigeria

Political economy context. The World Bank describes Nigeria as a democracy experiencing political and economic instability, which is exacerbated by religious divisions and economic inequality. The country enjoys relatively good freedom of expression and academic freedom (Freedom House), but according to the World Bank its complex institutional system is beset by low regulatory quality and a weak rule of law. The national policy for research and innovation is set out in several documents and draws direct links between scientific research, innovation and industrial policy; but the consultation revealed that research is still not fully recognised by the Nigerian government for its contribution to social and economic development, a view supported by data showing relatively low government expenditure in research and development (NSTIR 2030). Although science, technology and innovation (STI) policy documents have ambitious targets, implementation is undermined by complexities within public administration (with research funding and competences shared across federal, state and local levels), fragmentation at ministerial level and lack of funding.

Research production. Nigeria has a large network of universities to address the growing demand for higher education, but a low number of researchers relative to its population. Only about a third of all researchers have a PhD qualification or equivalent, and while the country procures a large amount of research overall, productivity per researcher is low. Much of Nigeria's research appears to be of low quality, as inferred by the low number of citations recorded by Nigerian research publications compared to other Sub-Saharan African countries. Moreover, the review found no evidence of mechanisms for research quality evaluation. Scarce research funding and the exclusion of public and private research institutes and private universities from receiving public funding place significant constraints on research production, and international actors have a less significant impact on research production than in other African countries (according to the most recently available UNESCO data, these accounted for around 1% of the total expenditure on research and development in 2007).

Research diffusion. Government procurement has limited influence over the *development* of innovation (World Economic Forum), and research organisations remain largely disconnected from both the public and the private sector. As a result, Nigeria seems to perform better on the adoption of innovation, especially in an industrial context, than on the production of research and innovation domestically. A relatively dynamic private sector has proven to be more adept at adopting foreign

technology than collaborating with in-country research organisations to benefit from innovation originating from the lab benches. This appears to be in line with a government policy that considers adaptation, replication, and utilization of technologies as important as their domestic production. University-industry collaborations appear to be episodic and the consultation responses characterised Nigerian universities as generally 'inward-looking' and disconnected from society.

B. Options for research capacity strengthening

Nigeria's research system would benefit from international support, but its challenges are so systemic that it is uncertain how effective this support can be. Three areas appear important:

- **Strengthen national research funding capacity.** Nigeria does not have a national organisation dedicated to research funding. The National Research Fund is managed by TETFund, a government-controlled foundation whose work is largely focused on education. Whilst the study did not gather evidence on TETFund management capacity, interviews revealed that this arrangement creates problems such as: limited funding for research, no clear research funding priority areas, no research evaluation activities, and ineligibility of private universities and public and private research institutes. The government has expressed an interest in creating a science funding organisation but finding adequate resources would likely be a challenge. Alongside other international stakeholders, DFID could help the government strengthen institutional capacity for national research funding via, for instance, the Science Granting Council Initiative. Building management capacity, training government staff, adopting good management practices and clarifying mandates and competences for new or existing funding organisations could be as valuable as ensuring appropriate national funding for science is provided.
- **Strengthen research support in key universities**. Although productivity per researcher is low, Nigeria has a large overall research output and a lower proportion of Nigerian research is conducted through international collaborations compared to other SRIA countries. At the same time, research quality appears to be lower than other Sub-Saharan countries and research management support is virtually non-existent across most universities. There seems to be an opportunity to help universities invest in research support functions that can help researchers manage research projects from inception to publication. Given the size of Nigeria's research production, the impact of such support could be substantial. DFID could work with existing networks of universities, such as the Nigerian Research and Education Network (NgREN), to establish a programme of research management capacity strengthening. This could be done, for instance, through the recently-established initiative ReMPro Africa.
- **Support the development of mechanisms for research quality evaluation**. A third gap identified in the review is the absence of accepted mechanisms to evaluate research quality that can be used by national research funders. Research quality evaluation would help ensure that research funding is spent on higher-quality projects that are aligned with national priorities, helping distribute research funding more effectively and transparently based on performance. Guidance for research evaluation could also be promoted by the National University Commission.

- Effective interventions will have to be based on an understanding of Nigeria's complex multi-layered bureaucracy and a long-term strategy that relies on the continued engagement of local stakeholders.

2. Contents

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3. Glossary

Organisations

ACE	African Centres of Excellence
APC	All Progressives Congress
ARIPO	African Regional Intellectual Property Organization
MoST	Ministry of Science and Technology
NBS	National Bureau of Statistics
NCSTI	National Council on Science, Technology and Innovation
NgREN	Nigerian Research and Education Network
NIMR	Nigerian Institute of Medical Research
NOTAP	National Office for Technology Acquisition and Promotion
NRIC	National Research and Innovation Council
NUC	National Universities Commission
SSTIC	State Science, Technology and Innovation Council
UNESCO	United Nations Educational, Scientific and Cultural Organization
WEF	World Economic Forum
WHO	World Health Organisation
WIPO	World Intellectual Property Office

Other acronyms

FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GERD	Gross domestic Expenditure in Research and Development

ICT	Information and Communications Technology
IP	Intellectual property
NRIF	National Research and Innovation Fund
NSI	National System of Innovation
NSTF	National Science and Technology Fund
PCT	Patent Cooperation Treaty
R&D	Research and Development
S&T	Science and Technology
STEM	Science, Technology, Engineering and Mathematics
STI	Science, Technology and Innovation
TETFund	Tertiary Education Trust Fund
TTO	Technology Transfer Office
TVET	Technical and Vocational Education and Training

4. Introduction

This report presents the results of an assessment of Nigeria's research needs and is part of a broader needs assessment of the seven countries in the 'Strengthening Research Institutions in Africa' (SRIA) programme: Ethiopia, Ghana, Kenya, Nigeria, Rwanda, Tanzania and Uganda.

4.1. Structure of the report

The document is divided into two parts. The first part presents a political economy analysis of the country, building on DFID's guidance. Section 2 discusses the country's 'structures', or long-term contextual factors that have a direct or indirect effect on the research system. Section 3 looks at the legal and policy framework for research, while section 4 analyses relevant political economy dynamics within the country, specifically looking at relations between public sector bodies, research organisations and individual researchers. The second part of the document assesses research performance in the country. Section 5 explores research production by assessing research inputs, research culture and support, and research outputs. Section 6 assesses research diffusion by looking at actors and networks working on knowledge exchange (KE), and existing KE practices. The last part of the document focuses on the main bottlenecks or constraints affecting the research system and discusses opportunities to strengthen research capacity. It builds on the performance indicators explored in the previous section and considers the overall impact of each indicator on the research system. A full list of indicators and their relative score is contained in Appendix A.

4.2. Methodology

The evidence presented here has been obtained through desk research and informant interviews. Desk research gathered quantitative data from 16 sources (see Appendix E), while qualitative data was obtained from interviews with 11 informants, working for research organisations (6), intermediaries (2) and international organisations (3) based in Nigeria (see Appendix C). Interviews were conducted, recorded, transcribed and analysed using a consistent methodology. Qualitative findings reflect the perceptions of more than one stakeholder, and they have been compared, wherever possible, with available data from published sources. They informed the authors' views on the country performance on each of the indicators listed in Appendix A.

This report has been peer reviewed by the individuals listed in Appendix D and circulated with interviewees for comments and clarifications. Previous versions have been significantly improved in response to the constructive feedback provided by Dr Tom Drake and Dr Alba Smeriglio (DFID), as well as input from DFID staff located in relevant country offices.

4.3. Limitations

The study provides a high-level assessment of the strengths and weaknesses of the Nigerian research system and research organisations. It paints a broad picture of the current situation to inform understanding and action by DFID and others; it does not seek to explore issues such as the historical causes of the current situation or the role of the media and other political actors which, albeit important, fall outside the scope of this investigation. Some of the qualitative findings are based on the views of a small but balanced number of stakeholders and should be verified through further research.

5. Structures

This section provides an overview of the country's demography and of key political-economic parameters.

5.1. Social and political context

The Nigerian Government exercised its first democratic transfer of power between political parties in 2015. The country is led by Nigerian president, Muhammadu Buhari, who represents the All Progressives Congress (APC). According to the charity Freedom House, Nigeria is 'partly free' with an aggregate score of 50/100 (where 0 is least free and 100 is most free). Despite improved election processes and the peaceful transition of power, Nigeria experiences political instability and a high level of perceived corruption. Nigeria has an aggregate score of 9/16 for freedom of expression and belief (where 0 is least free and 16 most free). Included within this aggregate score is academic freedom (scored 3/4 where 0 is least free and 4 is most free). Generally, academic freedom is respected by the Nigerian Government, however, according to Freedom House, it is limited by factors such as mandatory religious education and violent interference by extremist groups.

The World Bank ranks Nigeria towards the bottom of a global ranking of government stability (percentile ranking 5/100). This is a measurement of the perception of the likelihood of political instability and politically motivated violence, including terrorism. Political instability undermines government effectiveness, as frequent changes of government (or staff within the government) undermine policy coherence and implementation. The World Bank ranks Nigeria negatively in terms of government effectiveness (27/100), regulatory quality (16/100) and the rule of law (19/100). Nigeria has a high level of perceived corruption at both national and local levels, ranking 144th out of 180 countries in Transparency International's Corruption Perceptions Index. Perceptions of corruption are particularly severe in the oil and security sectors, and the government has made efforts to address the problem through the introduction of a whistle-blower policy in 2016 and the Petroleum Industry Governance Bill passed by the National Assembly in 2017.

5.2. Economic context

With a population of almost 196 million people, Nigeria is the most populous country in Sub-Saharan Africa. According to World Bank data[a], Nigeria has a GDP per capita of USD2,028 and is classed as a lower-middle income country, above the Sub-Saharan average of $1,574. It's national GDP grew from USD69 billion in 2000 to USD568 billion in 2014, before contracting to USD397 billion in 2018 largely due to low oil prices (oil being its main export commodity) and a weak currency. Despite moderate growth of 1.9% in 2018, the country is beset by economic instability and the government's 2017 Economic Recovery and Growth Plan has advanced much needed macroeconomic and structural reforms. Nigeria has a composite Human Development Index score of 0.532 which positions it as 157th out of 189 countries. In 2009, 53.5% of the population lived below the poverty line of USD1.90 a day, an estimated 94 million people.

The Nigerian economy relies on agriculture for 21.2% of its GDP according to data collected by the World Bank. Manufacturing contributes almost 8% of Nigeria's GDP, a figure which has been declining over the past five years. This is relatively similar to the 10% contribution of manufacturing in Sub-Saharan Africa, but less than half of the average for lower-middle income countries (almost 20%). At present, the service sector (including ICT, retail and personal services) dominates the economy and contributes over 50% of GDP. The adoption of digital technologies has increased rapidly since 2004: almost 26% of the Nigerian population are active internet users, around 50% own a mobile phone according to GSMA, and almost 21% have mobile internet subscriptions according to the World Economic Forum. Adult literacy rates are recorded at 51% according to World Bank data, which is the second lowest literacy rate of the seven countries considered in this study behind Ethiopia (39%). In terms of competitiveness, Nigeria ranks poorly according to the World Economic Forum (125 out of 137 countries). This is the lowest of all seven countries considered in this study. Nigeria's capacity for innovation is scored 3.9/7 by the World Economic Forum, indicating a moderate capacity to innovate, but lower than most other countries considered in the study (Nigeria is ranked 114th out of 129 countries).

6. Institutions

This section looks at the strength of the national policy framework. Specifically, it considers whether the country has a national research policy or strategy and whether it was updated in the last 10 years.

[a] Low income countries = $995 or less; Lower-middle income countries = $995 - $3,895; Upper-middle income countries = $3,896 - $12,055; high-income countries = $12,056 or more. In addition, the World Bank identifies further groupings based on their average GDP per capita, which are useful reference points for this analysis: Low income = average $787; Least developed countries = average $1,072; Lower middle countries = average $2,209; Middle income = average $5,282; Upper middle = average $8,610; OECD countries = average GDP £38,283; High income = average $47,892.

It also looks at the existence of an innovation strategy and of national mechanisms for research quality evaluation.

6.1. National policy for research

The Nigerian government has given some recognition to the link between scientific research and economic development. Nigeria's Vision 20:2020 highlighted the importance of research for agriculture, manufacturing and trade, and recommended a reform of Technical and Vocational Education & Training (TVET) in order to provide skilled manpower in applied science, engineering, technology and commerce. More recently, the 2017 Economic Recovery and Growth Plan highlights the importance of research funding and building research capacity in agriculture and encourages research and development (R&D) in manufacturing and trade. Research and development is mentioned as one of the goals of tertiary education in the 2013 National Education Policy, and the policy also mandates that universities reserve 'a sizeable proportion of expenditure' to Science and Technology research and at least '80% of places' to technology and agriculture.

Nigeria's first National Science and Technology Policy was published in 1986 and focused on improving the lives of Nigerian citizens. The policy was first revised in 1997 to improve coordination and management of the science and technology (S&T) system, and in 2003 to develop an institutional framework for S&T. In 2011 the government released a National Science, Technology and Innovation Policy which sets out ambitious strategies for STI promotion, capacity building, sectoral R&D (for agriculture, water, biotechnology, health, energy, environment, ICT, raw materials and mineral resources, ICT, industry, defense, transport, tourism, housing and forests), intellectual property, technology transfer, information management systems and female participation in research. The policy also recommended establishing a National Research and Innovation Fund (NRIF) with a minimum of 1% of GDP strategically sourced from public, private, international sources. The policy states that, "the lack of long-term commitment to STI has been a major impediment to economic development" and purported to accord STI a central role in national economic planning through the "establishment of an effective institutional and legal framework" comprising the National Research and Innovation Council (NRIC), the State Science, Technology and Innovation Council (SSTIC) and the National Council on Science, Technology and Innovation (NCSTI). In 2013, the government produced a draft Framework for the Nigeria National System of Innovation (NSI) that articulated the relationship between the Federal, Sectoral, Regional, State and Local Innovation Councils. Finally, in 2017 the Federal Government published the National Science, Technology Innovation Roadmap (NSTIR) 2030, a high-level document that lays out the long-term framework for science and technology. The document sets specific goals for a number of knowledge sectors and focuses on linking research in all areas to national development and supporting industrial innovation. It aims to facilitate the creation and acquisition of knowledge for production, adaptation, replication, and utilization of technologies, support the establishment and strengthening of STI organizations, institutions, structures and processes, coordinate and manage STI activities and promote the creation of innovative enterprises. NSTIR ties in with Nigeria's Industrial Revolution Plan of 2014, which aims to make Nigeria a manufacturing hub and regional supplier of low-medium-technology consumer and industrial goods.

To achieve that, the plan covers the creation of eight general-purpose specialized industrial cities in strategic locations along transport corridors, creation of six Technology Innovation Clusters and improvement of services at Nigeria's 27 Free Trade Zones.

In addition, critical sectors of the government have policies in place which directly affect research. For instance, health research is partly informed by the National Health Act of 2014, the National Health Policy of 2016 and the National Strategic Development Plan II. Research activities are coordinated by the relevant Ministry and, while cross-references to national development priorities exist, the proliferation of competing sectoral policies and strategies combined with poor mechanisms to ensure their implementation, negatively affect the research system by creating overlapping policies, fragmented activities and failure to achieve synergies with national objectives (see section 4). Stakeholders however indicated that there are ongoing efforts to strengthen the national research system including a situation analysis and eventual development of a National Health Research Strategy and investment plan. Despite this, the country's current STI Policy is unable to harmonise research initiatives, including those supported by international donors.

Aside from establishing the current institutional framework for research, both the STI policy and the NSI framework appear to have limited impact on the national research system. Interviewees stated that policies and strategies are often not maintained by new administrations, and new policies are created that cannot be delivered within the life of the government. This creates duplication of policies and undermines their effectiveness. Consistent with evidence from academic literature, the consultation found that the implementation of STI policy initiatives has been challenging and the overall impact of the STI sector on the Nigerian economy limited. Interviewees expressed concern that, despite the rhetoric, research is not a genuine national priority. Lack of funding is widening the gap between policy and practice and has increased Nigerian researchers' reliance on international research funding and increasing researchers' responsiveness to international agendas rather than national priorities. Moreover, no sectoral research policies or strategies appear to be in place that translate the general objectives of the STI policy into more specific sectoral policies. Interviews conducted at the Nigerian Institute of Medical Research (NIMR) highlighted that health research organisations conduct their research in response to immediate needs (e.g. the outbreaks of disease) or to international policy priorities rather than to any long-term strategy for improving public health.

6.2. National institutions for research

The Science, Technology and Innovation Policy 2011 establishes a governance structure for STI which includes the following organisations:

- **National Research and Innovation Council (NRIC):** comprising the President and Federal Ministers from sectoral ministries with connections to STI, NRIC is mandated to set national priorities on research and development and set and coordinate STI activities in line with national priorities. The NRIC is also responsible for the establishment of new research institutes and the strengthening of existing ones. NRIC facilitates fund raising activities to support innovation activity in alignment with national priorities.

- **Ministry of Science and Technology (MoST):** centrally coordinates research and development (R&D) activities in Nigeria. It is responsible for the formulation, monitoring and review of the STI policy, diffusion of agricultural research and technology, R&D funding the energy sector and the promotion of indigenous research capacity to facilitate technology transfer.
- **National Council on Science, Technology and Innovation (NCSTI):** NCSTI sets broad directions to coordinate STI activities in line with national priorities, monitors the activity of public STI agencies and is responsible for the dissemination of outputs from scientific research.
- **State Science, Technology and Innovation Council (SSTIC):** provides leadership and direction for STI activity at a state level, promote science education and disseminate STI information, align policies and programmes with those of the NRIC, promote and implement decisions and programmes of NCSTI.
- **Tertiary Education Trust Fund (TETFund):** established for the purpose of promoting higher education, TETFund also manages a NGN5 billion National Research Fund (USD13.8 million)[b] providing grants in three areas: humanities and social sciences, STI and cross-cutting research.

Nigeria has a complex institutional framework for research that operates across various government levels. There appear to be overlaps between the roles and responsibilities of organisations within the Nigerian STI system that create inefficiencies and complexities for researchers. For example, while the STI Policy lists both NCSTI and SSTIC as key actors within the STI system, it appears that their roles are largely similar with both councils responsible for STI coordination. Some of this confusion is created by frequent changes in the administration. Moreover, interviews with in-country informants revealed low awareness of national research priorities and limited communication between national research institutions and research organisations. It is also unclear the extent to which the institutional set-up established in the policy is working in practice. The study did not provide conclusive evidence on whether NCSTI is functioning in practice, or whether NRIC has an active role in driving research policy. The discrepancy between policy ambition and institutional reality is not uncommon across the SRIA countries, but appears especially acute in Nigeria.

7. Agents

7.1. Stakeholder mapping

Nigeria has a large number of active research stakeholders (see Appendix B). At Federal level, policy is formulated and implemented by MoST, sectoral Ministries, NRIC and NCSTI. Funding is also provided

[b] The calculation uses the exchange rate as of Thursday 10 October: 1 Nigerian Niara equals 0.0028 US Dollars

by several actors, including the TETFund, several Ministry departments and international sources, with little or no coordination.

Nigeria hosts 95 public universities, the majority of which are funded through the National Universities Commission (NUC) and the National Board for Technical Education. The NUC oversees the Centres of Academic Excellence in Nigeria, grants approval for education programmes, and ensures quality assurance of Nigerian Universities. Funding for public universities however is generally irregular and inadequate (see section 5.1). Generally, within the context of research, the Government's main funding instrument is the National Research Fund (NRF). Within this mechanism, universities must compete for funding. However, there are insufficient funds at this level and the country's 79 private universities are excluded from accessing funds through the NRF (see section 4.2).

There are a large number of public and private research institutes. MoST directly supervises the activity of 17 public research institutes (see section 4.1),[c] and other specialised public research institutes are influenced and/or controlled by sectoral Ministries.

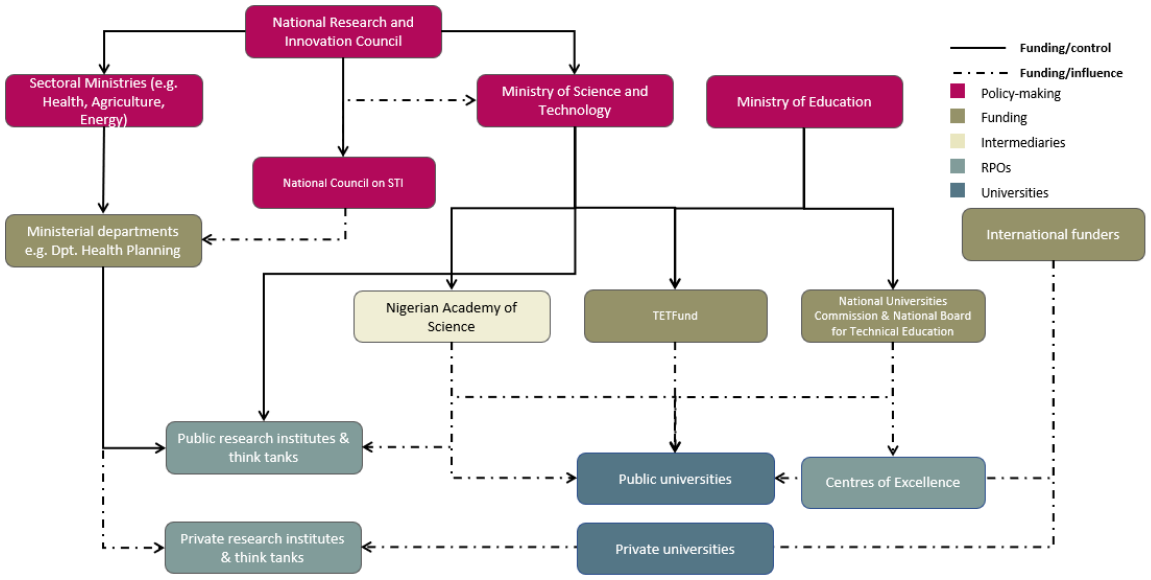
7.2. Relations and interdependencies

Despite the development of the National Science, Technology and Innovation Roadmap (NSTIR) in 2017, interviewees stressed a need for a coherent implementation roadmap and defined roles and responsibilities of actors within the Nigerian research system. In addition, no interviewees made any reference to this NSTIR throughout the consultation, including those who work for the National Universities Commission. The interview process suggested that, at present, there are barriers to research dissemination and diffusion. Knowledge transfer for example was reported to have been hampered by weak coordination and collaboration between industry, the government coordination and research institutions. Complexities in the coordination of activities between federal, regional, state and local levels and fractioned R&D budgets across different levels of governments appear to contribute to creating a somewhat disjointed and ineffective research system. Our consultation suggested that there is a need within the Nigerian national research system for the coordination of stakeholder groups, specifically to address the apparent disconnect between the national research

[c] National Board For Technology Incubation (NBTI), Energy Commission of Nigeria (ECN), The Nigerian Institute of Science Laboratory Technology (NISLT), Nigerian Institute For Trypanosomiasis And Onchocerciasis (NITR), National Biotechnology Development Agency (NABDA), National Centre For Technology Management (NACETEM), National Office For Technology Acquisition And Promotion (NOTAP), Nigerian Natural Medicine Development Agency (NNMDA), National Space Research & Development Agency (NARSDA), Raw Materials Research and Development Council (RMRDC), Nigerian Building and Road Research Institute (NBBRI), National Institute of Leather Science and Technology (NILEST), Zaria, National Research Institute for Chemical Technology (NARICT), Sheda Science and Technology Complex (SHESTCO), Project Development Institute (PRODA), Federal Institute of Industrial Research, Oshodi (FIIRO), National Agency for Science and Engineering Infrastructure (NASENI)

policy and its implementation among research organisations. Research in Nigerian universities is often misaligned with national priorities as these are not clearly defined or communicated (for example, the National Research Fund's funding calls are rarely linked to national research priorities). Moreover, private universities and research institutes are excluded from accessing NRF research grants, which are limited to public universities, and therefore seek financial support from international sources. This creates a natural separation between the activities and priorities of public and private research organisations. Interviewees also indicated that, while public research institutes are commissioned to undertake research by the government, the government does not make frequent or consistent use of research findings and institutes struggle to drive evidence-based policymaking.

Figure 1. Stakeholder relationships in Nigeria's research system



8. Research production

This section discusses the factors necessary for research production within a national system. It considers three components of a research system:

- Research inputs, or the tangible assets that are directly connected with research production: human resources, financial resources and infrastructure.
- Research culture and support, or the enabling environment for research.
- Research outputs, including the products of research and the incentives for producing research.

8.1. Research inputs

A. Human capital

Nigeria has a low number of researchers relative to its population. According to UNESCO data, there are 38.8 researchers in Nigeria per million of the population, substantially less than the average figure for other low-income countries (63.2 researchers per million) and far below the African average (95 per million). UNESCO data from 2007 indicated that the majority of Nigerian researchers were employed in higher education (80.4%) with the remaining 19.6% employed by the Nigerian Government. No researchers however were employed in the business or non-profit sectors, which may raise questions regarding the quality of data reported by UNESCO. While the distribution of researchers by sector might have changed since then, the predominance of academic and government researchers is unlikely to have changed. UNESCO statistics again show that Nigeria ranks below the African average for number of female researchers: only 23% of researchers in Nigeria are female, compared to the African average of 31.6%.

Just over a third (34.1%) of researchers in Nigeria are educated to the level of PhD or equivalent according to UNESCO. While this is generally in line with the other countries considered in this study, the consultation indicated that the capacity of Nigerian institutions to facilitate training at this level is insufficient.

B. Research funding

Research funding, according the National STI Policy, is the responsibility of the Nigerian government. The National Research Fund is the main national funding instrument for research, and it awards competitive research grants for researchers working at public universities. The NRF is managed by the Tertiary Education Fund (TETFund), which was established to provide "supplementary support to public tertiary institutions", including: essential physical infrastructure for teaching and learning, institutional material and equipment, research and publications, academic staff training and development and any other need which is critical and essential for the improvement and maintenance of standards in the higher educational institutions. The TETF lists thematic areas of interest for research, but these themes are broad and cover 25 topics without any indication of which areas are a priority. It is not immediately clear how the selected topics align with the research and development sectors outlined in the National STI Policy or the national development priorities.

NSTIR 2030 estimates the total funding need for research and innovation in the country at NGN180 billion (USD 497 million) over three years, or an average of NGN60 billion a year.[d] The Government did

[d] The sum is broken down as follows: N25 billion for facilitating researchers' contribution to economic growth; N30 billion for STI infrastructure improvement; N40 billion for R&D intensification ; N6 billion for training and talent development; N36 billion for technology development and commercialization; N10.5 billion for science literacy and stakeholder engagement (including the establishment of a science museum); N2.5 billion for system monitoring, evaluation and improvement.

spend NGN65 billion (USD 180 million) when NSTIR was published in 2017, but funding has been reduced in 2019 to N35 billion (USD96 million). This sum is equivalent to the government's research expenditure in 2014 and represents 0.73% of the total government budget. TETFund manages a NGN5 billion National Research Fund (USD13.8 million) providing grants in three areas: humanities and social sciences, STI and cross-cutting research. The remaining research budget is spent directly by Ministries and State authorities, therefore making coordination and harmonization of research funding challenging.

When looking at the combination of STI funding from public and private sources, the picture is not much better. In 2007, UNESCO data shows that Nigeria had a Gross domestic Expenditure in Research and Development (GERD) of 0.2%.In 2011, the government established the National Research and Innovation Fund (NRIF) with the aim of providing a minimum funding level 1% of GDP from government allocations, public-private Partnership, international sources and private investments - in line with the 1% target set by the African Union. The review has not found any official data on current GERD, but estimates are between 0.1 and 0.5% of GDP – at the lower end of the countries considered in this study. The government's own target (as set in NSTIR 2030) is to achieve the following funding mix: 15% of funding through a National Development Fund; 50% through government allocations, 15% via public-private partnerships, 10% from international sources and 10% from venture capital funds. However, when considering Gross domestic Expenditure for Research and Development (GERD) there are no recorded contributions from the private or business sectors. The largest expenditure comes from the higher education sector (64.8%) and the rest (35%) comes directly from the Nigerian Government.

The Nigerian Government spends USD242 per researcher in GERD, this is considerably higher than the average for Sub-Saharan Africa (USD168). Despite this, funding for research is reportedly insufficient, according to the consultation process. Interviews found that a number of researchers source funds internationally due to insufficient support for research in Nigeria. Yet UNESCO data shows that international research expenditure in 2007 was the lowest of all countries considered in this study, with GERD financed from abroad totalling USD14 million in current prices or just 1% of total GERD in the country – whereas in most other SRIA countries international GERD ranges between 30% and 60% of the total. No data could be found on GERD financed from abroad over the last decade, but the proportion of international research funding is likely to have increased given the rising number of international research collaborations in the last decade (see section 6.1).

C. Research organisations

Nigeria has an extensive network of research organisations, comprising publicly and privately funded organisations. Nigeria has 95 public universities and 79 private universities. Public universities include both Federal and State universities. All State and private universities have been established since 1999 pursuant to the revised guidelines for the establishment of higher institutions of learning in Nigeria (Amendment Decree No. 9 of 1993), and the vast majority were established between 2005 and 2015. Universities are severely underfunded due to limited government spending and alleged financial mismanagement. All universities are funded by the NUC with regards to their educational and training functions and by the National Research Fund for their research function, albeit only public universities

have access to NRF funding. Despite the rapid growth of their number, universities struggle to keep up with population growth and the increasing demand for higher education. Stakeholders indicated that the number of think tanks in the country is limited and the quality of information and recommendations which they produce is questionable. This, combined with a limited capacity within policy-making bodies, limits the possibility for policy implementation based on research-informed evidence.

The World Economic Forum ranks the average quality of research institutions in the country 122nd out of 137 countries globally, and 24th out of 32 Sub-Saharan African countries – the lowest of the seven SRIA countries considered in this study. According to Scimago's Institutional Ranking, none of the top three Nigerian universities – the University of Ibadan, the Federal University of Technology Akure, and the University of Nigeria –rank among the top 700 universities worldwide. Moreover, Nigerian universities under-perform on research, producing only 44% of the "scholarly output" of South Africa and 32% of Egypt despite Nigeria having nearly four times more universities than Egypt and over six times more than South Africa. The consultation has revealed that incentives to produce research are inadequate for universities, and that the lack of clearly communicated, nationally-defined research priorities and related funding criteria, has driven many universities away from developing research strategies consistent with national development objectives. For instance, the consultation revealed that the University of Lagos and Obafemi Awolowo University have conducted research with little or no coordination with national priorities.

8.2. Research culture and support services

A. Research culture

Overall, the financial incentives to conduct research are limited for both research organisations and individual researchers. While interviewees stated that the NUC recognises excellence in research and provides annual monetary awards, there does not appear to be a systematic assessment of research quality or productivity and connected financial incentives for universities. Research production appears to be one factor influencing career progression for academics, but this does not appear to be a formally recognized promotion criterion. Interviews did not clarify whether or not the influence of research productivity on promotion is *significant*, but revealed that most academics are not being promoted, which leads to frustration and fuels the brain drain.

The World Bank is funding a network of African Centres of Excellence (ACE), that aims to create an enabling environment for research through improved R&D infrastructure, research capacity and international collaborations. There are eight Centres of Excellence in Nigeria, with three of these in the field of Science, Technology, Engineering and Mathematics (STEM), that encourage collaboration across Nigerian institutions. The visibility and prestige given by collaborative research activities with international universities appear to be an effective incentive to produce research. The University of Jos, for example, runs research partnerships with Harvard University that help raise the institution's international profile. However, interviewees noted that the impact of such collaborations on research capacity strengthening is often limited by the fact that Nigerian institutions and researchers generally

play a junior role in projects managed by Northern partners, and that international research funding can inadvertently contribute to promoting inequitable research partnerships.

B. Capacity building

Consultation with key stakeholders suggested that support for early career researchers is limited in Nigeria and the retention of PhD researchers is a challenge. The consultation found that studying for a PhD overseas is attractive for many early career researchers due to limited funds and resources available locally. At present, Nigerian institutions cannot compete with international universities in this respect (see Section 5.1. A). In response to this issue, according to interviewees at the NIMR, the organisation has recently refocused its efforts to support early career researchers by beginning to invest in internal seed grants of NGN1.5m (USD4.150) per project. These grants are designed to develop researchers' management skills and help them secure further research funding. This has led to a small increase in retention levels but, generally, interviewees at the NIMR reported that many students who have travelled overseas to study do not return to Nigeria. In cases where students do return from overseas, interviewees suggested that the adjustment period is challenging due to poor quality equipment, a lack of sustainable research funding and a fragmented political system which drives them to leave again.

Interviews found little evidence of capacity building initiatives led by the Nigerian Government at the national level. The Nigerian Research and Education Network (NgREN) is an example of such an initiative, which was developed through a collaboration between the National University Commission and the World Bank. NgREN organises regular stakeholder sensitization meetings, operational readiness workshops and technical training on various aspects of research communication, while also channeling development assistance from other national and regional research networks into technical capacity strengthening among its university members. Some research organisations are also working to improve researcher skills through collaborative research partnerships, while interviews found no evidence of capacity building initiatives led by the Nigerian Government at the national level. The University of Jos for example is partnering with Northwestern University in the United States to train local researchers on contemporary research methods and build research capacity in the long-term. A comprehensive review of research capacity strengthening activities was outside the scope of this study.

C. Research support and administration

The consultation found that, while university-level processes and systems are in place, research support and administration are limited and insufficiently resourced. Interviewees highlighted that many university research offices (ROs) are understaffed and undertrained. For instance, the University of Jos' Research Office has only four staff members. Similarly, the Innovation Unit at the University of Abuja has a staff of two comprising the Unit's Director and a part-time administrator. Interviewees also highlighted that professional skills such as the ability to write business proposals or grant applications are often lacking, but there are very few training opportunities. These problems appear to cause significant disruption and inefficiencies within ROs.

The NIMR has only recently started to provide grant-writing training for health researchers across the country, but the impact of this initiative outside of the organisation appears limited. Generally, poor quality equipment, lack of funding for research and political corruption remain significant barriers, pushing many researchers to continue their careers abroad. Staff at the University of Abuja have ambitions to create a regional hub-and-spoke shared services model whereby the University provides research support services for all the universities in the region with the aim of reducing financial liabilities, spreading costs, minimising risks and maximising resource efficiencies. The initiative is however still at project inception.

D. Digital infrastructure and data

Digital infrastructure in Nigeria is still underdeveloped. The country is ranked 105th out of 137 for access to the internet with just under 26% of the population using the internet according to the World Economic Forum. Fixed broadband subscriptions however are the lowest of all countries considered in this study at 0.05 internet subscriptions per 100 people. To address these problems, the NUC and the World Bank established the Nigerian Research and Education Network (NgREN), a foundation that supports digital communication, collaboration, access and sharing of resources across 40 Nigerian universities for the purpose of research and learning. NgREN has recently invested EUR200,000 in the Africa Connect 2 project, which supports the development of high-capacity internet networks for research and education across Africa.

While there is no national repository for research data or publications, university repositories have been established across the 40 NgREN member organisations and these are connected to a central repository using a hub-and-spoke model. As more research organisations join NgREN, the central repository could become the equivalent of a national research repository; however, at the moment there are concerns around the universities' ability to use their institutional repositories correctly and input data in a way that is compatible with the central repositories. The National Health Research Ethics Committee has plans to establish a central repository for health research, but progress is reportedly hampered by lack of funding.

8.3. Research output and evaluation

A. Research publications

According to Scimago, Nigeria produced 9,299 scientific papers in 2018, accounting for over 12% of the total research output for Africa. However, due to the country's high population, this only equates to around 48 publications per million people, placing the country behind Ghana (104 publications per million and Kenya (61 per million). In 2018, 36% of Nigeria's research outputs were open access, in line with other SRIA countries.

Moreover, publications from Nigerian researchers are not widely cited. The average paper from a Nigerian researcher yields 0.49 citations (compared, e.g. to 0.75 for Kenya), and Nigeria is ranked 43 out of 54 African countries, and at the bottom of the seven countries considered in this study. Due to its seize, Nigeria's h-index, which measures the number of scientific publications and their citation

impact combined, ranks the country 68 out of 239 countries, ranking only behind Kenya (54 out of 239) among the seven SRIA countries. International collaborations accounted for 46% of Nigeria's research outputs in 2018, a figure which has been rising for the past decade (see section 6.1).

B. Research evaluation & ethics

Nigeria has established a National Health Research Ethics Committee under the Federal Ministry of Health which sets standards for conducting research on humans and animals (including clinical trials), registers and audits health research ethics committees and adjudicates complaints about their functioning and takes disciplinary action in cases of violations of ethical or professional rules. No similar body for research ethics exists in other disciplines. Generally, matters concerning research ethics are assessed at an organisational level. The University of Jos for example has established a committee responsible for research ethics at an institutional level. Similarly, at the University of Abuja, a mandatory course on research ethics and integrity is currently being introduced for all PhD students.

The review did not find any entity in charge of, or policy concerned with, the evaluation of research quality. Interviewees indicated that the NUC considers research quality in its annual allocation of university funding, but, the review did not find any formal mechanisms to assess research quality at an institutional level, and no formal connection with academic career progression.

9. Research diffusion

This section focuses on the stakeholders and practices underpinning the diffusion of scientific research in the country, which involves efforts to disseminate research findings and innovation across non-academic actors.

9.1. Actors and networks

A. National users of research

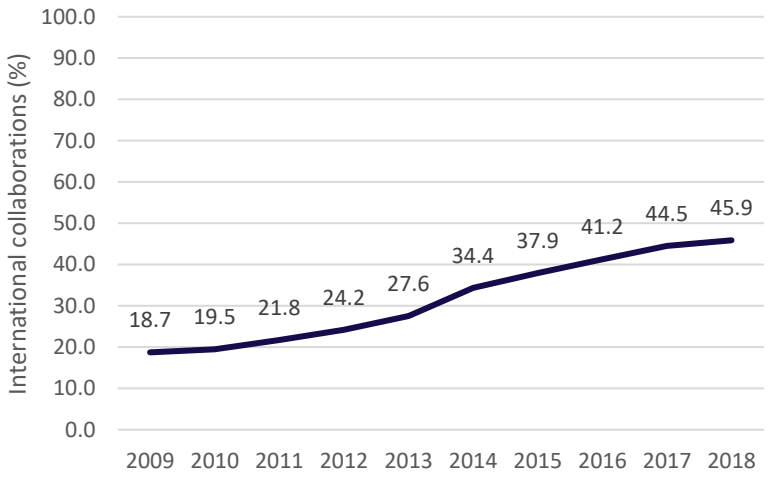
With regards to domestic demand for research and innovation outputs, the picture for Nigeria is mixed. On the one hand, the World Economic Forum (WEF) ranks Nigeria in 100th place out of 137 countries for the effect its government purchasing decisions have on fostering innovation within the country (score 2.9/7), with a negative trend of declining influence over the past 5 years. On the other hand, the government has established a National Office for Technology Acquisition and Promotion (NOTAP) under the Ministry of Science and Technology, which is tasked with promoting university-industry collaboration and research commercialization. The existence of a government body dedicated to knowledge exchange and commercialization is positive and can be related to firms' above average capacity to adopt the latest technology (scored 4.3/7 by the). However, technology adoption seems to largely be the result of foreign direct investment in the country (score 4.2/7) and not by connecting firms with local innovation. The WEF finds that collaborations between universities and businesses on research and development (R&D) is very limited (score 2.5/7), although performance will likely vary between universities. The data is consistent with a government focus on adoption of

existing technology as a way of bridging productivity gaps with wealthier economies and supporting economic growth that is reflected in both the Economic Recovery and Growth Plan and the STI policy.

B. International exposure

The proportion of publications in Nigeria that are based on international collaborations is the lowest of all seven countries considered in this study. For the past decade, the proportion of literature from international collaborations has increased, but has remained below 50% of Nigeria's total research output. Nigeria's international exposure is measured by looking at the diffusion of its best scholarly production (measured as the percentage of papers in the 10% most-cited papers in a field of research) and by looking at the number of international collaborations. This shows that Nigeria produces a high quantity of research, but much of it appears to be of dubious quality or academic impact. Despite a high research output, in fact, only 4% of Nigeria's research is ranked among the 10% most-cited papers in specific fields of research. This is a far lower figure than the other countries involved in this study and far behind the G20 average of 10.2%. According to Scimago, in 2018, 45.87% of Nigeria's research outputs were a result of international collaboration. This proportion has risen steadily over the last ten years which is consistent with the findings of the consultation process which have indicated an increased reliance on international research funders. Nigeria's international research collaborations are primarily with research institutions based in the USA, South Africa, the UK, Germany and China.

Fig 2. International collaborations in scientific publications (% of total)



9.2. Knowledge exchange practices

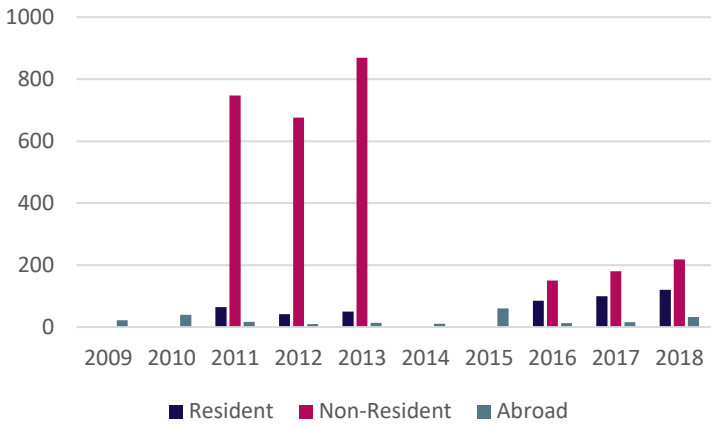
A. Intellectual property

Nigeria has a fairly strong regime for intellectual property (IP) protection relative to other SRIA countries, but relatively little IP to protect. IP rights are governed by the Trademarks Act, the Patents and Designs Act, the Merchandise Marks Act, the Federal High Court (Civil Procedure) Rules, and the Copyright Act, in addition to the principles of common law. NOTAP is the body in charge of IP in the country. As a state-owned entity under the Ministry of Science and Technology, NOTAP reports to have established 43 Technology Transfer Offices (TTOs) in research organisations across the country and to be actively promoting university-industry collaboration. For instance, the TTO of the University of Jos was established by NOTAP and has some internal IP protection expertise. Despite this however,

the World Economic Forum scores university-industry collaboration poorly (see Section 6.2 B). The Ministry of Industry, Trade and Investment is responsible for maintaining the Trademarks, Patents and Design Registry, which protect patents and designs arising from academic research but that, in practice, is mainly used to protect manufacturing and industry.

According to the World Economic Forum, Nigeria ranks 111th out of 119 countries and 16th out of 21 Sub-Saharan African countries for its number of patents filed under the Patent Cooperation Treaty (PCT) per million population. Data from the World Intellectual Property Office (WIPO) shows that non-residents have filed far more patent applications than residents, arguably due to the attractiveness of securing a patent in the large Nigerian market. Overall, very few patents are filed by resident researchers and innovators, but numbers are rising. By contrast, resident industrial design applications and registrations are far more common, reaching 1,138 registrations out of 1,146 applications in 2018. This confirms that much of Nigeria R&D activity is focused on manufacturing efficiency and industrial development over new technology development.

Figure 3. Number of patents filed in Nigeria.



B. Knowledge exchange support and administration

Interviews conducted at Nigerian research organisations confirmed engagement between the research sector and industry is very limited. These collaborations occasionally happen at the level of research project or, more rarely, between university and a particular business and are often mediated by international actors. For instance, Nigerian universities are participating in the Africa Non-Communicable Diseases Open Lab project, which is funded by GlaxoSmithKline and managed by R&D facilities in UK universities. Similarly, in 2005, the World Health Organization (WHO) established a knowledge translation platform called EVIPNet to promote the systematic use of health research evidence in policy-making.

At the national level, Nigeria does not appear to have an overarching knowledge exchange (KE) strategy, but the commercialisation support provided by a national office (NOTAP) compares positively against other SRIA countries. Research organisations involved in the consultation process are only just starting to think about the potential for collaboration. Interviewees stressed that most universities are only just coming to terms with their research impact function and predict that it is going to take a long time before impactful engagement on a national/sector scale emerges. They characterised academia as still being 'inward-looking' and disconnected from society. Research commercialisation is rare and private sector investment episodic and not part of a national strategy or aligned to development priorities covered in the National STI Policy. Knowledge exchange and

commercialisation are also hampered by the lack of dedicated trained staff within research organisations.

10.Needs assessment

This section summarises the overall score of each component of the research system using a 7-point scale (see Appendix A). Research system component (RSC) scores are calculated as an average of all indicator scores within it (see Table 4). All research system components are assigned a component ID (see Table 1). The aim of this exercise is to show which components are most deficient. However, there is no exact equivalence between a low score for one component and identification of needs since different components have a different impact on the system. Section 8 discusses other considerations that influence the choice of priorities for action, such as the feasibility of interventions.

Nigeria is a large country with good research potential, but also systemic weaknesses. Its vast territory, complex history and very large population make it difficult to govern (RCS1, score 2.6 out of 7). Ethnic and religious divisions undermine government stability and – combined with a complex bureaucracy – limit government effectiveness in Nigeria. Government action is also hampered by limited regulatory quality, while weak rule of law and high levels of perceived corruption appear to undermine implementation of research-related policies. On a more positive note, Nigerian academics benefit from relatively strong freedom of expression, which is however limited by religious education and interference by extremist groups. Nigeria also suffers from an unstable economy (RSC2, score 2/7) that is excessively reliant on commodity exports. While its GDP per capita is higher than the African average and places Nigeria in the lower-middle income country category, over half of the population of Nigeria live below the poverty line – indicating extremely high economic inequality. Despite having a rapidly growing digital network and a large urban population relative to the total, the country has the one of the lowest literacy rates in Africa. As the government is faced with pressure to service a growing population in a context of economic and political instability, priority is accorded to education over research.

In this context, it is unsurprising that the Federal government has had, so far, limited success in developing a strong national research system (RSC4, score 2.2/7). Its ambitious STI policy is not widely implemented, and research organisations have independent strategies that are often influenced by international funding opportunities. Nigeria has long-established national institutions for science and technology, but their effectiveness appears limited by a lack of coordination and funding at a national level. Scoring just 1/7 for example, research funding from the federal government has only been recently introduced and appears too small to have an impact on research production (RSC7). Moreover, funding and policy are set by sectoral ministries and there is little clarity about the role of the NUC in funding and evaluating university research, or in the ability of the NCSTI to coordinate STI activities across the country (RSC5, 2.3/7). Distribution of competencies between Federal and State actors further creates complexities for research organisations, while the inability of research institutes and private universities to apply for public research funding creates a barrier between public universities and all research organisations.

Table 1. Scoring of research system components

Section	Research system component	Score	Component
National context	Social and political context	2.6	RSC1
	Economic context	2.0	RSC2
	Total	2.3	-
Policy and institutional framework	National policy for research	3.3	R SC3
	National institutions for research	2.2	RSC4
	Stakeholder composition & relationships	2.3	RSC5
	Total	2.6	-
Research inputs	Human capital	2.0	RSC6
	Research funding	1.0	RSC7
	Research organisations	2.7	RSC8
	Total	1.9	-
Research culture and support	Research culture	3.5	RSC9
	Capacity building	2.5	RSC10
	Research support	2.0	RSC11
	Infrastructure and data	2.5	RSC12
	Total	2.6	-
Research outputs and evaluation	Research publications	3.3	RSC13
	Research evaluation	2.0	RSC14
	Total	2.6	-
Knowledge exchange (KE) actors and networks	National users of research	3.3	RSC15
	International exposure	3.5	RSC16
	Total	3.4	-
KE practices	Intellectual property	4.0	RSC17
	KE support and administration	2.6	RSC18

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	Total	3.3	-

Despite efforts from the government to enhance the role of science, innovation and technology as an economic driver, demand for research from national actors is low (RSC15, 3.3/7). Government procurement has little influence over technology development, while research organisations remain largely disconnected from the government and struggle to influence decision-making. A fairly dynamic private sector has proven to be more adept at adopting foreign technology than collaborating with research organisations, and university-industry collaborations are episodic. Overall, Nigeria produces a large amount of research papers, but their quality (as inferred from the number of citations) appears very low.

11.Recommendations

11.1. Identification of priorities

This section identifies options for research capacity strengthening in Nigeria by looking at the poorest-performing indicators and considering their overall impact on the research system and their tractability, or the feasibility of external interventions in that area. Three areas appear important:

- **Strengthen national research funding capacity.** Nigeria does not have a national organisation dedicated to research funding. The National Research Fund is managed by TETFund, a government-controlled foundation whose work is largely focused on supporting education. Whilst the study did not gather evidence on TETFund management capacity, interviews revealed that this arrangement creates problems such as: limited funding for research, no clear research funding priority areas, no research evaluation activities, and ineligibility of private universities and public and private research institutes. The government has expressed an interest in creating a science funding organisation but finding adequate resources would likely be a challenge. Alongside other international stakeholders, DFID could help the government strengthen institutional capacity for national research funding via, for instance, the Science Granting Council Initiative. Building management capacity, training government staff, adopting good management practices and clarifying mandates and competences for new or existing funding organisations could be as valuable as ensuring appropriate national funding for science is provided.
- **Strengthen research support in key universities**. Although productivity per researcher is low, Nigeria has a large overall research output and a lower proportion of Nigerian research is conducted through international collaborations compared to other SRIA countries. At the same time, research quality appears to be lower than other Sub-Saharan countries and research management support is virtually non-existent across most universities. There seems to be an opportunity to help universities invest in research support functions that can help researchers manage research projects from inception to publication. Given the size of Nigeria's research production, the impact of such support could be substantial. DFID could

work with existing networks of universities, such as the Nigerian Research and Education Network (NgREN), to establish a programme of research management capacity strengthening. This could be done, for instance, through the recently-established initiative ReMPro Africa.

- **Support the development of mechanisms for research quality evaluation**. A third gap identified in the review is the absence of accepted mechanisms to evaluate research quality that can be used by national research funders. Research quality evaluation would help ensure that research funding is spent on higher-quality projects that are aligned with national priorities, helping distribute research funding more effectively and transparently based on performance. Guidance for research evaluation could also be promoted by the National University Commission.

11.2. Conclusions

Nigeria is already involved in a number of international RCS initiatives, but the country's needs are commensurate to its size. The Needs Assessment has indicated that the country contends with deep-rooted problems of governance, complex institutional systems and severe underfunding for research. The picture is further complicated by the different ways in which private and public universities, federal and state universities, and universities and research institutes are regulated. The consolidation of research funding could provide an opportunity to simplify some of these complexities by creating a more consolidated system of research governance. A national research funder could help distribute research funding that is currently provided on an ad hoc basis by sectoral Ministries, the NUC, and a small National Research Fund managed by an education-focused organisation. Consolidating research funding may affect a precarious balance between national institutions and should be approached with care, but the problem might be mitigated by the small sums dedicated to research funding.

As in many other Sub-Saharan African countries, the debate about the value of research against competing priorities cannot be considered settled. It is important that work with national institutions and research organisation stems from an understanding of local priorities and seeks to make the case for research in such contexts. The experience of World Bank-funded interventions, such as the ACE programme and the NgREN network, suggests that international initiatives are more effective when they are part of a long-term engagement with national actors, managed by local professionals that understand the dynamics and complexities of the country. The key message here is that lasting change in Nigeria is unlikely to happen fast, but that the country has enough dynamism to engage in new initiatives and programmes that can support its growth. Partnering with international donors and national stakeholders might be especially important to secure sufficient financial leverage, expertise and access to achieve lasting change.

Appendix A – Full list of indicators and scores

Table 2. How to read the scales

	1	2	3	4	5	6	7
Qualitative indicators	Very poor	Poor	Somewhat poor	Neither poor not good	Somewhat good	Good	Very good
Quantitative indicators	Very low	Low	Below average	Average	Above average	High	Very high

Table 3. Score conversion table

Data type	Description	Score conversion
Absolute country rank	Country ranks are converted to scores by dividing the total number of countries ranked in seven groups of equal size and then positioning the country in one of the seven groups.	Variable based on number of ranked countries
Country scores (1-7)	A number of indicators have already been scored on a 1-7 scale. Decimal numbers will be rounded up or down to their closer whole number.	Maintained (rounded)
Country score (1-16)	Freedom House (FH) scores freedom of expression and belief from 1 to 16. We convert the score to 7, but consider performance of the sub-rating "academic freedom" when rounding up the overall score for freedom of expression.	FH score 1-2 = Needs Assessment score 1; 3-5 =2; 6-7 =4; 8 =5; 9-10 =6; 11-16 =7
Percentile score / percentile rank (1-100)	This scale uses a 1-100 score, generally with 0 indicating the lowest score and 100 the highest (in a few cases, 0 is the best score and 100 the worst). Scores are divided in 7 groups, and the score is given depending on what group a country falls under. Note that	Original score 1-14 = Needs Assessment score 1; 15-28 = 2; 29-43 = 3; 44 – 58 = 4; 59-72 = 5; 73-86 = 6; 87-100 = 7.

Data type	Description	Score conversion
	percentile score is expressed differently from the percentage value (%) which indicates quantity.	
University rankings	A score is assigned based on the position in the combined position on the global rankings of the country's top three universities (sum of individual rankings divided by three).	1-100= 7; 101-300= 6; 301-500= 5; 501-1000= 4; 1001-2000= 3; 2001 -3000 =2; 3001+ =1
Percentage values	Indicators such as literacy rates, access to internet etc are measured with percentage values (%). For percentage values, scores are given based on a country's performance relative to other countries.	Relative to other countries' performance
Yes/No	Some indicators are scored using a binary system, e.g. whether a country has a or has not a research strategy. Where additional qualitative evidence is available, this will be reflected in the score. Where no additional evidence is available, Yes is equated with the median point of the high rating (6) and No is scored with the median of the low range (2).	When no additional qualitative evidence is available: Yes = 6; No = 2
GERD per capita	We use the 1% African Union target as best outcome (score 7), and modify the score based on the actual GERD. GERD higher than 1% is scored 7.	GERD 0-0.2% = score 1; 0.3-0.5% =2; 0.6-0.8% =3 0-9-1.1% =4; 1.2-1.4% =5; 1.5-1.7% =6; 1.8-2% =7
GERD funding from abroad	The extent to which external funding in R&D is seen positively or negatively depends on many factors. For instance, foreign investment in business R&D is seen as a positive tech transfer opportunity, whilst excessive dependence on foreign funding in HE R&D is rated negatively. Based on existing studies, we take 35% as an optimal value for GERD from abroad for LMICs. Deviation from optimal value is rated negatively.	Deviation (+ or -): 0-5% =7; 6-10% =6; 11-15% =5; 16-20% =4; 21-25% =3; 26-30% =2; <31% =1
GERD performance by sector	We use the following GERD distribution as optimal (based on a slightly modified distribution from the OECD estimate to take into account LMICs unique circumstances): business enterprise = 50%; HE = 25%; government = 15%; non-profit = 10%. Deviation from this distribution is rated negatively.	Total deviation: up to 20% = 7; 21-35% = 6; 36-50 =5; 51-65% =4 66-80 =3; 81-95 =2; <96% =1
Number of journals listed in Scimago	A high number of local journals is positively correlated with research diffusion.	0-5 journals =1; 6-10 =2; 11-20 =3; 21-30 =4; 31-40 =5; 41-50 =6; <50 =7

Data type	Description	Score conversion
Country income classification	The World Bank identifies further groupings based on their average GDP per capita: Low income = average $787; Least developed countries = average $1,072; Lower middle countries = average $2,209; Middle income = average $5,282; Upper middle = average $8,610; OECD countries = average GDP $45,721; High income = average $47,892.	Low income = 1; Least developed = 2; Lower middle = 3; Middle income = 4; Upper middle = 5; High income = 6; Very high income = 7
Poverty	The score is based on the percentage of population living with less than $1.9/day, using World Bank estimates.	40% or more =1; 25-39% =2 15-25% = 3; 10-15% =4; 9-5% =5; 1-3% =6; less than 1% =7
Urban/rural divide	We assume that there is a positive correlation between the proportion of people living in cities and research. We see a proportion of urban vs. rural dwellers above 60% as optimal, while lower proportions are rated negatively.	1-10%=1; 11-20%=2; 21-30% =3; 31-40% =4 41-50%=5 51-60%=6; >61%=7
Literacy rate	Low literacy is negatively correlated with research. Given the international standards of literacy, we weigh low literacy more heavily than relatively high literacy and only give full score to those countries where almost all the population is literate.	1-20%=1; 21-40%=2; 41-60%=3; 61-75%=4; 76-85%=5; 86-95%=6; 96-100%=7

Table 4. List of country indicators and scores

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
National context					
Social and political indicators (RSC1)					
Social and political factors	Working language	English	-	No direct impact on research performance	[1]
	Total population	195.9million	-	No direct impact on research performance	[2]
	Urban population (% of total)	63%	7		[2]
	Type of government	Democracy		No direct impact on research performance	[3]
	Political stability	5/100	1	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Rule of law	19/100	1	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Regulatory quality	27/100	2	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Government effectiveness	16/100	1	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Voice and accountability	35/100	2	See table 3. Score goes from 0 (worst) to 100 (best)	[4]
	Corruption (ranking)	144/180	2	See table 3. Ranking goes from 1 (best) to 180 (worst)	[5]

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
	Access to information	88/150	3	See table 3. Score goes from 0 (worst) to 150 (best)	[6]
	Freedom of expression	9/16	4	See table 3 and section 2.1	[3]
	Adult literacy rate (% population aged 15+)	51%	3	See table 3	[7]
	Gender Development Index	0.868	-	Women's achievements in health, education and command are much lower than men's, underlying stronger gender inequality than the African average	[8]
Economic indicators (RSC2)					
Economic development	GDP per capita USD	$2,028	2	See table 3	[9]
	Agriculture, value added (% of GDP)	20.24%	-	No direct impact on research performance	[9]
	Manufacturing, value added (% of GDP)	9.75%	-	No direct impact on research performance	[9]
	Population living in poverty ($1.9/day)	53.5%	1	See table 3	[9]
Digital infrastructure	Access to internet (ranking)	105/137	2	See table 3	[10]
	Individual using Internet/100 people	25.7	2	Scored under access to internet.	[10]
	Broadband internet subscription/100 people	0.05	1	Scored under access to internet.	[10]
	International internet bandwidth, kb/s per user	11.3	1	See table 3	[10]
	Mobile internet subscriptions/100 pop	21.8	2		[10]
Competitiveness	Global Competitiveness Index (ranking 2018)	125/137	1	See table 3	[10]
	Overall technology readiness	3/7	3	See table 3	[10]
	Capacity for Innovation	3.9/7	4	See table 3	[10]
	Innovation index (score)	3.3	3	See table 3	[11]
Policy and institutional framework					
National policy for research (RSC3)					
National policies	Existence of a national research policy	No	2	See section 3.1	Desk + Int
	Existence of sector-specific research policies	Partly	4	Broad sector strategies set for the STI policy	Interviews
	Research policy updated in the last 10 years	No	2	STI policy updated in 2011, no research policy	[11]
	Existence of an appropriate Strategy for STI	Yes	6	See section 3.1	Interviews
	Capacity development is part of the Strategy	Yes	6	See section 3.1	Interviews
	Country has appropriate indicators tracking R&D	No	2	See section 5.2	Interviews

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
National institutions for research (RSC4)					
National institutions	The country has a ministry or department for research	No	2	The Ministry for Science and Technology and Ministry of Education have no department for research. See section 3.2	Interviews
	The ministry/department for research is sufficiently resourced	No	2	Unclear what resources are dedicated to research within MoST, but interviewees complain about policy-practice gap	Interviews
	The country has one or more national research funders	No	2	TETFund runs a National Research Fund (NRF), but most of its financing activities are for education	Interviews
	The research funders have sufficient financial resources	No	2	The NRF is capitalized with N5 billion, equivalent to approx. USD13.8 million	Interviews
	Quality of the research funder management capacity	Unclear	NA	Not enough evidence	Interviews
	The country has a national research ethic body	Partly	4	National Health Research Committee and ethics committee within universities only. See section 5.3	Interviews
Stakeholder composition and relationships (RSC5)					
Stakeholder composition	Clarity of relationships between national actors	Below average	3	See section 4.2	Interviews
	Clarity of decision-making and accountability processes	Below average	3	See section 4.2	Interviews
	Level of coordination between government department	Very poor	1	See section 4.2	Interviews
	Cohesion between policy mechanisms	Poor	2	See section 4	Interviews
	Level of participation in decision-making/standard-setting	Average	4	Research organisations operating outside of direct government control struggle to exercise influence on government decisions	Interviews
	Quality of monitoring & enforcement mechanisms (M&E)	Very poor	1	There is no evidence to suggest M&E mechanisms and there are no tools or funding to purchase the tools/systems to monitor/enforce. See section 3.2	Interviews
Research inputs					

COMPONENT	INDICATOR		VALUE	SCORE	DETAILS	SOURCE
Human capital (RSC6)						
Human capital	Total R&D personnel per million people (FTE)		77.4	2	See table 3	[12]
	Researchers per million inhabitants (FTE)		38.8	2	See table 3	[12]
	Researchers (FTE) - Business enterprise %		-	2	See table 3	[12]
	Researchers (FTE) - Government %		19.6%		See table 3	
	Researchers (FTE) - Higher education %		80.4%		See table 3	
	Researchers (FTE) - Private non-profit %		-		See table 3	
	Researchers (FTE) – Female %		23.4%	1	See table 3	[12]
	Researchers (FTE) with ISCED 8 %		34.1%	3	See table 3	[12]
Research funding (RSC7)						
Research funding	Total GERD (in current PPP$)		96 million	-	Official estimate for 2019. See section 5.1	Other
	GERD per capita (%GDP)		0.2%	1	Last available data from 2007. See table 3	[12]
	GERD per researcher FTE (in current PPP$)		9.4	1	Last available data from 2007	[12]
	GERD financed by abroad (% total)		1%	1	Last available data from 2007. See table 3	[12]
	GERD performed by	business (% total)	0%	1	[12]	[12]
		gov (% total)	35.2%			
		HE (% total)	64.8%			
		private non-profit (% total)	0%			
Research organisations	Average quality of research organisations		2.8/7	3	See table 3	[10]
	Global ranking of University of Ibadan		717/3471	4	See table 3	[13]
	Global ranking of Federal University of Technology Akure		742/3471		See table 3	[13]
	Global ranking of University of Nigeria		744/3471		See table 3	[13]
Research culture and support						
Research culture (RSC9)						
Research culture	Perceptions of the utility of research		Average	4	Policymakers perceive the value of research, but use of research in practice is limited. See sections 3.1 and 5.1	Various

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
	Time allocated to research	Below average	3	Academic staff are expected to research but class sizes are so big, the focus is on learning and teaching and support huge cohorts of students. See section 5.2	Interviews
Capacity building (RSC10)					
Capacity building	Overall research training capacity				
	Local availability of specialized research and training services	Below average	3	NgREN provides technical training for digital projects to network members. Research training is lacking	-
	Funding for Research Capacity Strengthening	Poor	2	See section 5.2	Interviews
	% HEI with PhD programmes	NA	NA	N/A	-
Research support (RSC11)					
Research support	Level of access to proposal writing support	Poor	2	A few universities have dedicated staff but in most cases research support is virtually non-existent. See section 5.2	Interviews
	Existence of institutional policies	NO	1	Unless they are research-intensive universities, it is unlikely that universities have a KE or tech transfer policy/office.	Interviews
	Quality of administrative support	Below average	2	A few universities have dedicated research staff but research support is virtually non-existent.	Interviews
Infrastructure and data (RSC12)					
	Is there a central repository for research data?	NO	2	There is no central repository for research data and no plans to develop one at a national level.	Interviews
	Quality of research infrastructure	Below average	3	Digital infrastructure is improving, but research infrastructure is severely underfunded. See section 5.2	Interviews

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
Research output and evaluation					
Products of scientific research (publications and patents) and incentives for producing research					
Research publications (RSC13)					
Research publications	Total # of publications (2018)	9,299	-	Not scored, depends on population size	[14]
	Publications per million people	48	2		
	Total # of citable publications	8,346	-	Not scored, dependent on population size	[14]
	Citations per publication (1996-2018)	18.49	-	Scored by citation per publication ranking	[14]
	Citations per publication ranking (1996-2018)	214/239	1	See table 3	[14]
	H index ranking	68/136	4	See table 3	[14]
	# Journals listed in SciMago	18	3	See table 3	[14]
	Scimago country ranking 2018	53/239	5	See table 3	[14]
	Percentage of papers in 10% most-cited papers (2008–2012)	4.1	1	The G20 average is 10.2%	[15]
	% of total publications for Africa	12.1%	-	Not scored.	[14]
Research evaluation (RSC14)					
Research evaluation	Existence of national mechanisms for research quality evaluation	No	2		Interviews
	Quality of incentives for research production	Poor	2	See section 5	Interviews
Knowledge exchange (KE) actors and networks					
National users of research (RSC15)					
National users of research	Firm Level Technology absorption	4.3/7	4	See section 6.1	[10]
	FDI and Technology Transfer	4.2/7	4	See section 6.1	[10]
	Gov't procurement of technology products	2.9/7	2	See section 6.1	[11]
	Government use of research information/products	NA	NA	NA	Interviews
International exposure (RSC16)					
	International collaboration 2018 (% of total)	45.87%	6	See section 6.1	[14]
	Main foreign partners	3/5 Northern	-	No score. USA, South Africa, UK, Germany, China	[14]
Knowledge exchange practices					

COMPONENT	INDICATOR	VALUE	SCORE	DETAILS	SOURCE
Intellectual property (RSC17)					
Intellectual property	Country has a body in charge of intellectual property protection	Yes	6	See section 6.2	[16]
	Country is member of a regional IP organisation	Yes	6	See section 6.2	[16]
	Number of patent applications per million people (global ranking)	111/119	1	See table 3	[10]
	Number of patent applications per million people (African ranking)	16/21	3	Score based on global ranking	[10]
KE support and administration (RSC18)					
Knowledge exchange support and administration	Country has joined a regional initiative for the promotion of STI	YES	6		Interviews
	University-Industry collaboration (score)	2.5/7	2	See section 6.2	[10]
	University-Industry collaboration (ranking)	133/137	1	See table 3.	[10]
	Existence of appropriate institutional policies for KE	No	2	Unless they are research-intensive universities, it is unlikely that universities have a KE or TTO, not least because there is no evidence that NOTAP has the capacity to lead on this at a national level.	Interviews
	Quality of incentives for research diffusion	Poor	2	See section 5.3, 6.1 and 6.2.	Interviews
	Existence of commercial office	No	2	Unless they are research-intensive universities, it is unlikely that universities have a KE or tech transfer policy/office	Interviews

Appendix B - Nigeria stakeholder table

Non-exhaustive list of the MAIN research stakeholders in the country.

	Nigeria		International	
Role	Public	Private	Public	Private
Policymakers	• Ministry of Science and Technology • Ministry of Education			
Intermediaries	• Agricultural Research Council of Nigeria • National Centre for Technology Management • National Office for Technology Acquisition and Promotion • Nigerian Academy of Science • West Africa Agricultural Productivity Programme		• Pan Africa Chemistry Network	
Universities	• 95x public universities	• 79x private universities		

Research funders	• Federal Ministry of Agricultural and Rural Development • National Board for Technical Education • National Commission for Colleges of Education • National Research and Innovation Council • National Science and Technology Fund • National Universities Commission • Tertiary Education Trust Fund		• Bill and Melinda Gates Foundation • British Council • Department for International Development • Fleming Fund • Ford Foundation • Hewlett Foundation • International Development Research Centre • Norwegian Agency for Development Cooperation • Think Tank Initiative • United Nations • United States National Institutes of Health • World Bank	• Flour Mills • MacArthur Foundation • Rockefeller Foundation • Shell

Research performing organisations and think tanks	• Centre for Rural Development and Co-operatives • Centre for Management Development • Cocoa Research Institute of Nigeria • Federal Institute of Industrial Research • Forestry Research Institute of Nigeria • Initiative for Public Policy Analysis • Institute of Agricultural Research and Training • Institute of Archaeology and Museum Studies • International Institute of Tropical Agriculture • International Livestock Research Institute • Lake Chad Research Institute (LCRI) • National Agricultural Extension and Research Liaison Services		• African Heritage Institution (AfriHeritage) • Centre for Population and Environmental Development (CPED) • Centre for the Study of the Economies of Africa (CSEA) • International Think Tank Initiative	

	• National Animal Production Research Institute (NAPRI) • National Centre for Agricultural Mechanization • National Centre for Energy Research and Development • National Centre for Genetic Resources and Biotechnology (NACGRAB) • National Cereals Research Institute (NCRI) • National Horticultural Research Institute (NIHORT) • National Institute for Freshwater Fisheries Research (NIFFR) • National Institute of Pharmaceutical Research and Development (NIPRD) • National Research Institute for Chemical Technology (NARICT) • National Root Crops Research Institute (NRCRI)			

	• National Space Research and Development Agency (NASRDA) • National Veterinary Research Institute (NVRI) • Nigerian Academy of Science • Nigerian Building and Road Research Institute (NBRRI) • Nigerian Educational Research Council • Nigerian Institute for Oceanography and Marine Research (NIOMR) • Nigerian Institute for Oil Palm Research (NIFOR) • Nigerian Institute for Trypanosomiasis Research (NITR) • Nigerian Institute of Medical Research (NIMR) • Nigerian Institute of Social and Economic Research • Nigerian Stored Products Research Institute (NSPRI) • Projects Development Institute (PRODA)			

	• Raw Materials Research and Development Council (RMRDC) • Rubber Research Institute of Nigeria (RRIN) • Social Sciences Academy of Nigeria			

Appendix C – Interviewees

Name	Organisation
Professor Babatunde Salako	Nigerian Institute of Medical Research
Mr Anthony Adejumo	National Universities Commission
Mr Chinedu Otuya	National Universities Commission
Mr Femi Orgundele	Nigerian Research & Education Network
Mr Tobi Fowora	Nigerian Research & Education Network (incl representative of National Universities Commission
Professor Augustine Odili	University of Abuja (Research & Innovation Unit)
Professor Patricia Lar	University of Jos (and WARIMA)
Abul Azad	The World Bank
Ayo Fashogbon	The World Bank
Nkiruka Ukor	World Health Organisation
Dr Olusoji Oduwole	Cocoa Research Institute of Nigeria

Appendix D – Peer reviewers

Name	Organisation
Ajoy Datta	On Think Tanks
Justin Pulford	Liverpool School of Tropical Medicine
Robin Drennan	The University of the Witwatersrand
Yaso Kunaratnam	UK Collaborative on Development Research

UKaid from the British people

Appendix E – Key data sources

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