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Strengthening Research Institutions in Africa: A Synthesis Report

Report for the UK Department for International Development

December 2019

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"Strengthening Research Institutions in Africa: A Synthesis Report"

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Executive Summary

Background and scope. This report summarises the key findings arising from the needs assessment of seven African countries that were considered for inclusion in DFID's 'Strengthening Research Institutions in Africa' (SRIA) programme: Ethiopia, Ghana, Kenya, Nigeria, Rwanda, Tanzania and Uganda. It is based on qualitative and quantitative data collected from published sources and in-country interviews conducted between March and October 2019. The document explores the ability of a country's research system (and its various stakeholders) to produce high-quality research and disseminate it effectively so as to support knowledge-driven sustainable development. Finally, the report highlights areas where research capacity strengthening interventions could be considered.

Similarities among the in-scope countries. The review has shown that the research systems of all the countries included in this review present critical gaps and needs. Common problems include underinvestment in research infrastructure (both physical and digital), a low number of researchers, the vocational nature of universities, and an incomplete and under-resourced national institutional framework. On a more positive note, encouraging trends have emerged: over the past decade, all countries have increased the share of Gross Domestic Product (GDP) invested in research and development (R&D), have developed their policy and institutional framework and have drawn a link between research and socio-economic development (albeit often a theoretical one). This creates the opportunity, across all the in-scope countries, to invest in interventions that support research and innovation in national priority areas.

National research framework. Six out of seven countries have a national strategy or policy for science, technology and innovation (STI), while only two have a dedicated research policy. National research and STI policy is generally of good quality, often drafted with support from international actors and published or updated within the last 10 years or less, but tends to lack implementation details. Dedicated government departments or high-level ministerial forums are tasked with crafting and implementing research policies and with bringing research into the broader STI agenda. These institutions often lack the capacity to properly implement, evaluate or enforce research policy. This makes it difficult for governments to translate their policy ambitions into reality and to understand what can be done better.

Research production. The report also highlights clear differences among countries with regards to the production of research. Gross national expenditure in research and development (GERD) fluctuates considerably, from below 0.2% of GDP in Uganda to 0.8% of GDP in Kenya [1]. Similarly, while most countries have less than 50 researchers per million people, Rwanda and Tanzania are at the bottom of the scale with just 12 and 18 researchers per million people respectively, while Kenya has over 220 researchers per million inhabitants (for reference, South Africa has almost 500 researchers per million inhabitants and the UK has over 4,000) [1]. Researchers from the analysed countries appear productive, publishing a median of 0.8 scientific articles per year compared to 0.9 publications per researcher in South Africa and 0.7 in the UK [2]. Interestingly, productivity per researcher is inversely correlated with the number of researchers in a country.

Research diffusion. The research produced in the in-scope countries has good international visibility, but its influence on domestic economic, social or environmental issues is limited. International collaborations are a good vehicle for increasing the visibility of African research within the scientific community. The number of citations per article ranges between 0.75 and 0.49 in 2018, with only Kenya and Rwanda performing above the African average of 0.67 citations per paper in 2018 [2]. Research dissemination through knowledge exchange activities is seen as a national priority in most national policy documents, as it links to the government ambition of exploiting STI as an economic development driver. Most of the in-scope countries have made significant progress in this area over the past decade but performance remains mixed. According to data from the World Economic Forum, most countries are in the upper half of a global ranking of countries' ability to promote university-business collaborations, and low-income Ethiopia, Uganda and Rwanda outperform more affluent countries [3]. However, the number of innovations coming out of the research system appears very limited. According to WIPO analysis, Africa contributed only 0.5% of the total number of patent applications in 2016, down from 0.7% in 2006, and Kenya is the only country among those analysed where a significant number of patent applications were filed over the last decade [4].

Priority needs. Having identified the needs of each country, the document sums up the priority areas for intervention identified in the study. These are organised into three groups:

Type of intervention	Scale	Examples
Interventions aimed at government entities	National	Improving national research policy, strengthening coordination among national institutions or changing the way research funding is managed
Interventions aimed at research organisations or research intermediaries	Subnational	Establishing centres of research excellence, strengthening research support services, and developing the research communication infrastructure
Recommendations aimed at both national and subnational actors	Networks	Creating networks of research producers and research users, further developing knowledge exchange systems and practices, and pooling resources to create research training opportunities

Intervention strategies. Finally, the report highlights three factors that donors should consider when planning their interventions:

(i) the role of research capacity within a country's existing socio-economic strategy, as framed by the government and other key national stakeholders, determines *what research capacity strengthening interventions are acceptable*;
(ii) the maturity of the research system and the constraints (financial, administrative and cultural) to its development determine *what objectives are achievable*;
(iii) existing stakeholder relations and the identification of credible local partners and allies determine *what strategies are effective*.

The recommendations are based on a strong body of evidence collected over the course of the project and presented more extensively in the Rapid Evidence Assessment and country needs assessments.

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Contents

Glossary

ARIPO	African Regional Intellectual Property Organization
COSTECH	Commission for Science and Technology (Tanzania)
DFID	Department for International Development
EPHI	Ethiopian Public Health Institute (Ethiopia)
GDP	Gross Domestic Product
GERD	Gross domestic Expenditure in Research and Development
ICT	Information and Communication Technology
IP	Intellectual Property
KE	Knowledge Exchange
LMICs	Low-Middle Income Countries
MoE	Ministry of Education (Rwanda)
NACOSTI	National Commission for Science, Technology and Innovation (Kenya)
NCST	National Council for Science and Technology (Rwanda)
NCSTI	National Commission for Science, Technology and Innovation (Nigeria)
NRF	National Research Fund (Kenya)
NSI	Framework for the Nigeria National System of Innovation (Nigeria)
NSTIC	National Science, Technology and Innovation Council (Ethiopia)
NSTIR	National Science, Technology Innovation Roadmap (Nigeria)
PCT	Patent Cooperation Treaty
PPP	Purchasing Power Parity
R&D	Research and Development
R&I	Research and Innovation
RCS	Research Capacity Strengthening
SRIA	Strengthening Research Institutions in Africa
STI	Science, Technology and Innovation
U/B	University-Business
UNCST	Uganda National Council for Science and Technology
UNESCO	United Nations Educational, Scientific and Cultural Organization
USD	United States Dollar
WEF	World Economic Forum
WIPO	World Intellectual Property Organization

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1. Introduction

1.1. Background to the report

This report brings together some of the key findings and high-level messages from a set of country needs assessment reports prepared for the programme 'Strengthening Research Institutions in Africa' (SRIA), on behalf of the UK Department for International Development (DFID). It provides a summary of the evidence on the research needs of seven Sub-Saharan African countries (Ethiopia, Ghana, Kenya, Nigeria, Rwanda, Tanzania and Uganda) and it draws some cross-country comparison of the findings. The SRIA programme seeks to strengthen research systems in the in-scope countries, which are seen as integral to their long-term economic and social development.

The research on which the reports are based was conducted between March and October 2019 and drew together qualitative and quantitative data from dozens of published articles and databases, as well as information collected through 63 informant interviews within the in-scope countries. Appendix A includes a list of the in-country stakeholders consulted during the study, Appendix B lists the study's peer reviewers, Appendix C contains the Needs Assessment Protocol and Appendix D presents a list of references. The assessments also build on a review of over 220 studies on research capacity strengthening interventions, which were reviewed as part of a Rapid Evidence Assessment (REA) [5] conducted between January and May 2019. In particular, the REA findings influenced the needs assessment in three ways: by guiding the selection of the issues and challenges that have been explored; by informing the questions asked in the qualitative interviews; and by providing the conceptual frameworks and good practices that inspired the recommendations contained in the assessment reports. To this effect, section 2 presents a proposed overarching theory of change that links the good practice emerging from the REA and the evidence collected in the needs assessment.

1.2. Methodology

This report builds on the evidence gathered across seven needs assessment reports. This evidence was analysed comparatively to highlight common trends and differences between the countries. The country-level data displayed in sections 5 to 11 provides a brief overview of the main findings of each report across four areas: national context, national research framework, research inputs and research outputs, as defined in the country reports. The needs assessments followed a protocol developed between February and March 2019 (a short version is available in Appendix C). The protocol maps out five main components of the research system which have then been explored in the needs assessments:

1. the national economic and socio-political context;
2. the national institutions for research and innovation, including both the public-sector bodies and the laws, policies and plans related to research and innovation;
3. the number and role of, and relationships between, stakeholders in the research system;

4. the factors affecting research production in a country, including inputs (human capital, funding and research organisations), outputs (research publications and research quality) and the culture and support services underpinning the delivery of research; and
5. the factors affecting research diffusion, including the actors and networks involved in knowledge dissemination and use of research outputs nationally, intellectual property protection and knowledge exchange support systems and structures.

The protocol also lays out the data collection methods, the databases consulted to gather quantitative data on research system performance and the approach used to measure the health of a research system. It identifies over 110 indicators – both quantitative and qualitative – covering the five research system components listed above and introduces a scoring system that provides a common framework for assessment of each indicator. Section 3 provides a summary of the scoring of each research systems component for the seven countries considered in this analysis.

1.3. Limitations

This report is the result of a large study conducted over a relatively short period of time. Overall, it presents a reliable overview of the research system in the selected countries. However, the scope and constraints of the study also presents some limitations that can be addressed in follow-up studies:

- **High-level overview**. The needs assessment analysis represents a high-level evaluation of the research system of seven Sub-Saharan African countries. Like all high-level studies, some details are inevitably missing and will require additional investigations to be filled in.
- **Lack of historical and sociological analysis**. The assessment paints a broad picture of the current situation to inform understanding and action by DFID and others. The underlying analysis did 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.
- **Porous boundaries between research and innovation systems**. Defining the boundaries of the research system was challenging. For the purpose of this study, the research system includes those policies, institutions, organisations, mechanisms and practices that concern the production and diffusion of research. It was clear, across all the in-scope countries, that the boundaries between research systems and innovation systems are especially porous. Research policies, strategies and funding are generally part of a broader innovation agenda that directly links public investments in science to national development and have – in effect – a dual role of promoting scientific investigation as well as supporting science- and technology-enabled innovation. The reports consider these initiatives from a research perspective and do not examine the support systems for business innovation.
- **No consideration of research uptake**. The study does not seek to assess the extent to which research uptake has occurred in a country, i.e. the extent to which it has influenced the social and economic systems in practice. Instead, it has looked at whether the right mechanisms are in place for the research to reach stakeholders in the government, business and civil society – and the extent to which these actors actively seek to benefit from it.

- **Limited data availability**. There does not appear to be up-to-date data on national-level research capacity indicators for all the countries considered, meaning some figures are several years old and may not accurately reflect the current situation in the country.
- **Limited stakeholder engagement**. The study has tried to obtain and document the views of a broad spread of stakeholders, but stakeholder engagement was limited by the time and budget available. Given the broad scope of the investigation, it was not feasible to obtain detailed data on all the actors that play a role in a country's research system. Moreover, in some countries, stakeholder engagement might have been limited by self-censorship and a reluctance to offer independent views on controversial issues. As a result, some of the qualitative findings are based on the views of a few stakeholders and should be further verified in subsequent iterations of this study.

2. Theory of change

Interventions to strengthen research capacity at organisation and system level are based on the observation that long-term, large-scale improvements to a country's ability to produce and diffuse high-quality research require interventions at multiple levels. The literature on research capacity strengthening analysed in the REA showed that over the past 30 years most international interventions sought to support capacity strengthening at researcher level, neglecting the important role played by research organisations, national institutions and other national stakeholders [5]. Building on this evidence and on the evidence collected through informant interviews, the theory of change underpinning the SRIA programme makes a number of assumptions. These can be organised as relating to an intervention's inputs, outputs, outcomes and impacts. Below is a list of assumptions and their references in the literature (note that the references are included in Appendix D).

The assumptions related to an intervention's **inputs** are based on the evidence gathered in the REA and further validated through stakeholder interviews:

- Interventions have limited funding available, and spending needs to be prioritised to achieve the intended results [6] [7] [8] [9] [10]
- No single intervention is sufficient to address the needs of a research system and system-level change should be sought as a result of interventions that are part of a long-term strategy [11] [12] [13] [14] [7] [15]
- Some coordination or synergy among different donor interventions increases overall [16] [17] [18] [7] [19]
- Joint planning and execution of interventions with local and national stakeholders increases buy-in and effectiveness of the actions [20] [21] [22] [23] [24]

The assumptions related to an intervention's **outputs** are:

- Investments in research support and management services and appropriate career incentives for researchers lead to increased research outputs [25] [26] [27]

- Investments in digital and physical research infrastructure lead to higher quality research [28] [29] [30] [31] [32] [33]
- Institutional capacity strengthening and cross-ministerial coordination will improve research policy implementation, monitoring and evaluation [34] [7] [35] [36] [19].
- Policy implementation plans and strategies are a necessary but insufficient condition for research policy effectiveness[37] [38] [7] [29].
- There is no simple and direct way of transferring research knowledge into practice: instead, incentives and opportunities for interaction between researchers and other stakeholders are needed to create an enabling environment for knowledge exchange [39] [40] [41] [42] [43] [15].

Thirdly, the assumptions related to an intervention's **outcomes** are:

- Government buy-in and continued political commitment is essential to the long-term success of a research capacity strengthening intervention [44] [45] [17] [7] [46] [47] [19].
- Working with local partners helps to better identify and implement appropriate interventions [39] [40] [41] [42] [43] [15].
- Working in partnership with LMIC governments helps generate national buy-in and supports the long-term sustainability of the intervention [48] [49] [43] [13] [50].
- South-South collaborations help support commitment by, self-reliance of and mutual learning among LMIC stakeholders [51] [18] [52] [53] [12] [54] [34] [55] [56] [57] [58] [43].

Finally, the assumptions related to an intervention's **impacts** are:

- Where they align with LMIC government policy, interventions that consider research and innovation jointly can be more effective in those circumstances [44] [45] [17] [7] [59] [47] [19].
- A thriving national research system needs strong research policies, national institutions and research organisations [13] [60] [61] [12] [54] [62].
- A thriving national innovation system needs strong research capacity, knowledge exchange mechanisms and the ability of government and the business sector to adopt innovation outputs [9] [63] [64] [65] [24] [66] [67].
- Applying research in society or in the market requires support mechanisms, skills and expertise that most researchers and LMIC research organisations do not possess [7] [68] [69] [60] [61] [12] [9] [70] [71] [72].

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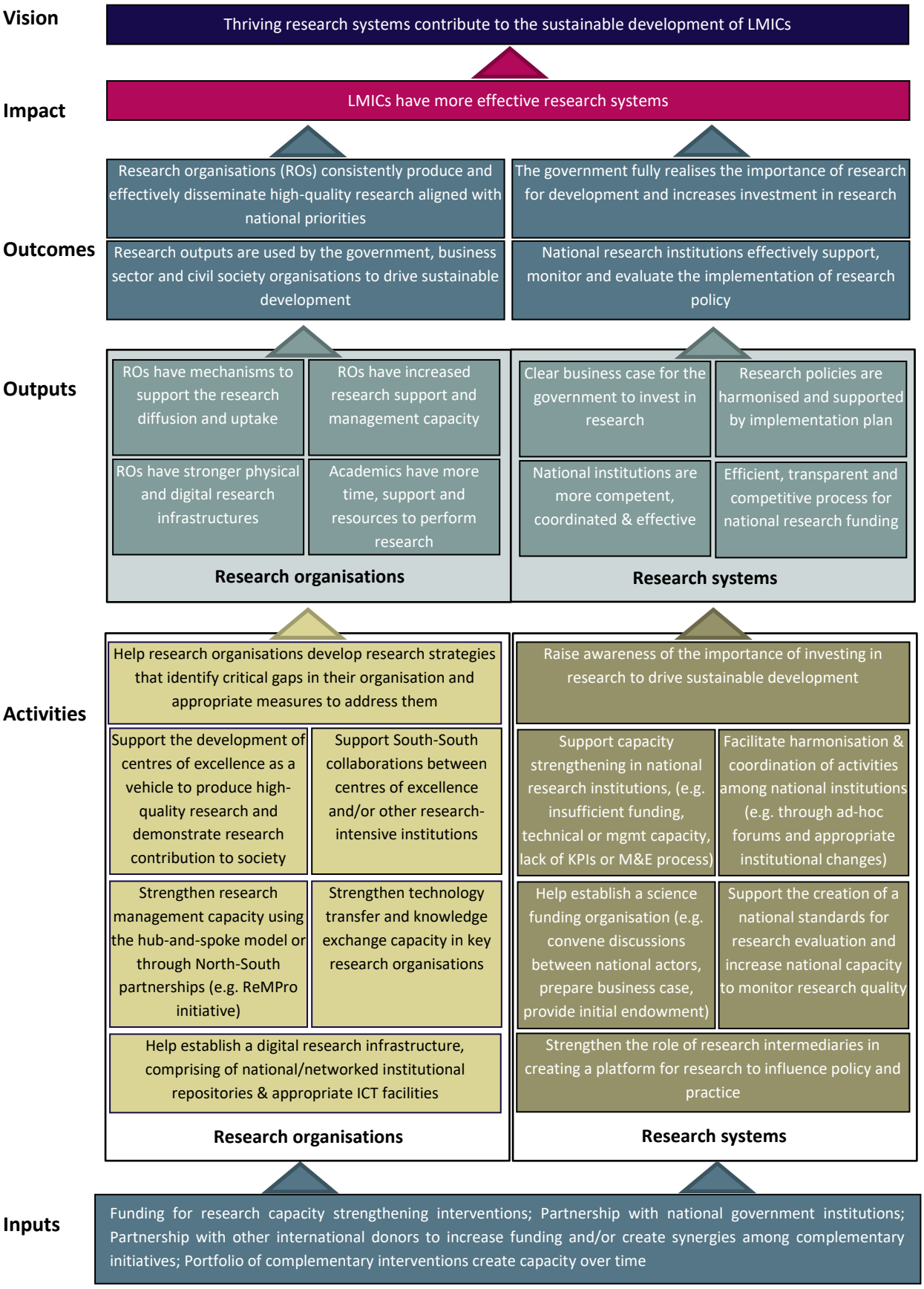
Figure 1. Draft Theory of change for the SRIA Programme



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3. Country assessments

This section summarises the overall score of each research system component (RSC) for each of the seven countries. RSCs are calculated as an average of all indicator scores within a given component, for which full details are available in the country needs assessment reports. They are scored on a 7-point scale, where 7 indicates highest performance, 4 average and 1 lowest.

Table 1. Summary of research system component scores

RSC	Ethiopia	Ghana	Kenya	Nigeria	Rwanda	Tanzania	Uganda
Social and political context	2.2	4.3	3.2	2.6	2.9	3.3	3.2
Economic context	1.8	3	3.3	2	2.7	2.4	1.9
National context (avg.)	2	3.7	3.3	2.3	2.8	2.9	2.6
National policy for research	4.3	3.0	4.2	3.3	3.7	4.5	5.9
National institutions for research	3.5	2.2	3.3	2.2	4.2	2.7	3.5
Stakeholder composition & relationships	3.8	2.2	3.7	2.3	3.2	3.2	4.2
Policy & institutional framework (avg.)	3.9	2.5	3.7	2.6	3.7	3.4	4.5
Human capital	2.1	2.5	3.8	2	1.8	2.2	1.8
Research funding	2.3	3.8	3.7	1	1	1.3	2.8
Research organisations	2	4	5.5	2.7	2.5	3	3.3
Research inputs (avg.)	2.1	3.5	4.3	1.9	1.8	2.2	2.6
Research culture	4	2.5	3	3.5	2	3.5	4
Capacity building	2.7	2.7	4	2.5	2.5	2.7	2
Research support	2.7	3	2.7	2	2	-	3
Infrastructure and data	2.5	2.5	3.5	2.5	2	2	4
Research culture & support (avg.)	3	2.7	3.3	2.6	2.1	2.8	3.3
Research publications	3	2.5	4.8	3.3	2.8	2.6	4.5
Research evaluation	3	1.5	4	2	3	2	3.5
Research outputs and evaluation (avg.)	3	2	4.4	2.6	2.9	2.3	4.0
National users of research	3.3	3.5	4.3	3.3	5	3.5	3.8
International exposure	4	4	6	3.5	5	6	5.5
KE actors & networks (avg.)	3.6	3.8	5.1	3.4	5	4.8	4.6
Intellectual property	3	4.7	5	4	4.3	1.5	3.5
KE support & administration	5.4	2.8	3.4	2.6	5	3	3.8
KE practices (avg.)	4.2	3.7	4.2	3.3	4.7	2.3	3.9

Legend: 1-1.9. Very poor/very low; 2-2.9. Poor/low; 3-3.9. Somewhat poor/Somewhat low; 4-4.9. Neither poor/low nor good/ high; 5-5.9. Somewhat good/somewhat high; 6-6.9. Good/high; 7. Very good/very high

The scores should not be interpreted as an absolute assessment of a country performance, but rather as an estimate of the intensity of country needs within different domains. Although the scores allow some comparison across countries, these should not be taken at face value given that they are sometimes based on limited evidence. Moreover, the quantitative scoring of complex indicators fails to reflect the specific challenges and broader circumstances that determine the status quo. As such, scores should be seen as a convenient yet crude summary of the overarching assessment of a country's need in a particular area, and they should be at least complemented by the reading of the relevant section in the country needs assessment report for a more balanced understanding of what the score means. The aim of this scoring exercise is to highlight countries' relative strengths and areas that could be improved and to allow for cross-country comparison. However, two caveats apply: first, 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; second, cross-country comparisons should consider the different national circumstances, the different starting points, the recent country history and the different country priorities and development strategies.

The next section provides a comparative summary of key indicators under each RSC. The comparison is useful to contextualise the findings, by highlighting the very diverse national context in which research actors operate. They also help to identify common trends across these countries, which may provide an indication of systemic challenges that can be tackled through multi-country international interventions.

4. Research system comparators

Section 4 of the report compares some key indicators covering the national context, research environment, research production and research diffusion issues across the seven in-scope countries. Most of the data is taken from the published sources listed in Appendix D.

4.1. National context

[i]An overview of the in-scope countries' social, political and economic context shows that although these countries face many similar socio-economic challenges, the differences between their socio-economic contexts are stark. For instance, countries vary in size from just over 12 million inhabitants in Rwanda to almost 200 million in Nigeria [73] (see Figure 2). There is also a clear economic difference between a group of low income countries whose gross domestic product (GDP) per capita hovers around or below US$1,000 (Uganda, Ethiopia, Rwanda and Tanzania) and a group of lower-middle income countries (Kenya, Nigeria and Ghana) with a GDP per capita of between US$1,700 and US$2,200 [74] (Figure 3).[a] By contrast, poverty levels do not appear decisively correlated to GDP. The proportion of people living in poverty (i.e. with less than US$1.9 a day) ranges between 13% in Ghana to 53% in Nigeria (two countries with similar GDP levels), while Ethiopia has the second lowest share of population living in poverty despite having the second lowest GDP per capita in the group. Figures 3 and 4 and below, show the difference in GDP and poverty levels between the in-scope countries [74].

Figure 2. Total population (in millions), 2018 [73]

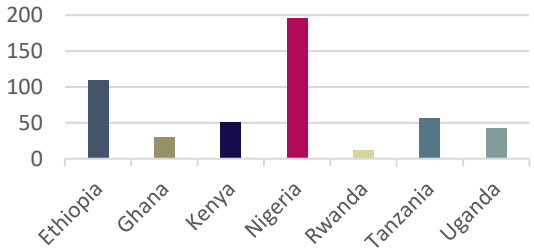


Figure 3. GDP per capita (US$), 2018 [74]

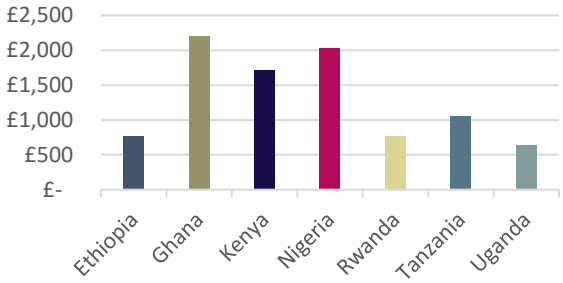
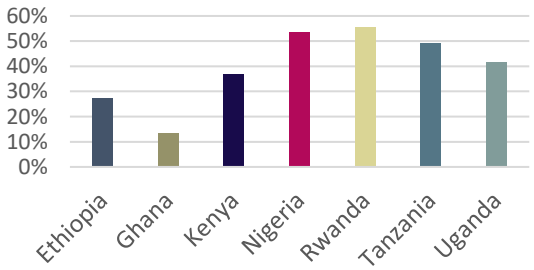


Figure 4. Share of the population living in poverty, 2018 [73]



[a] Using the World Bank classification, low income countries have a gross national income (GNI) per capita of $1,025 or less, while lower-middle income countries' GNI per capita is between $1,026 and $3,895. Using the World Bank Atlas method, GNI calculations are used to correct GDP by inflation. See: https://datahelpdesk.worldbank.org/knowledgebase/articles/378832-what-is-the-world-bank-atlas-method

4.2. National research environment

Some consistent trends have emerged across the seven countries in the way national policies and institutions for research are set up. Six out of seven countries have a national strategy or policy for science, technology and innovation (STI), while only two have a dedicated research policy. The review has provided evidence that there is no separation between the science and innovation agendas in these countries, as is common in high-income countries. Instead, the governments see research and innovation as two sides of the same coin, part of a broader 'knowledge sector' that can help modernise the economy, increase productivity and produce practical solutions to the material challenges faced by the population. Although the value of research activity is more explicitly recognised in Kenya, Uganda and Tanzania, national policy documents across all seven countries seek to establish a direct connection between research and the national development priorities.

Generally speaking, national policy for research and STI appears to be of good quality. Often drafted with support from international actors and published or updated within the last 10 years or less, policy documents are comprehensive and ambitious in scope but tend to lack implementation details. Consistent with publicly available data showing low government effectiveness and regulatory quality, the consultation indicated that government departments and relevant national institutions lack the capacity to properly implement research and STI policies. Moreover, there appear to be no systems and processes to monitor, evaluate and enforce policy implementation in any of the in-scope countries (with the partial exception of Uganda), making it difficult to for governments to translate their policy ambitions into reality and to understand what can be done better. The key message from the review is that the development of sound research and STI policy is not sufficient to deliver improvements across the research system. Although there appears to be a stronger correlation between the presence of national institutions (such as a dedicated research ministry and research funder) and the country's overall research performance, this correlation is also imperfect. Some countries with no dedicated research institutions but well-resourced STI institutions (e.g. Ghana) have a better performing system than countries with dedicated national research institutions or funders (e.g. Tanzania and Uganda). What appears to be universally important for future interventions is to give relevant stakeholders the resources and motivation to implement existing policies more effectively, regardless of the specific institutional shape this support takes.

Table 2. National research policies and institutions

Institutional component	Kenya	Ethiopia	Tanzania	Ghana	Nigeria	Uganda	Rwanda
National research policy	No	No	Yes	No	No	Yes	No
National STI strategy	No	Yes	Yes	Yes	Yes	Yes	Yes
Ministry or department for research	Yes	No	Yes	No	No	No	No
National research funder	Yes	No	No	No	No	Yes	Yes
National mechanisms for research quality evaluation	Yes	No	No	No	No	No	Yes

The set-ups of national research institutions have some similarities. First, countries tend to have institutions dedicated to science, technology and innovation, whose mandate includes but is not

limited to research (CSIR in Ghana, NACOSTI in Kenya, NSTIC in Ethiopia, COSTECH in Tanzania, NCST in Rwanda, NCSTI in Nigeria and UNCST in Uganda). These bodies, which can operate as government departments or as a high-level ministerial forum, are generally tasked with coordinating very diverse activities related to research production, diffusion and adoption. They tend to shape and implement regulations and, more often than not (Ethiopia, Rwanda, Tanzania and Uganda), they also manage funding for research and innovation activities. Another common trait of countries considered in this study is that research responsibilities are generally split between the ministries for education (which distributes funding to universities) and the ministry for STI – and very few mechanisms (formal or informal) exist to coordinate activities between the two ministries. Furthermore, research also happens with the support of sectoral ministries (health, industry and agriculture are the most common examples), often without involvement from the STI body that is supposed to coordinate scientific activities.

The ambition to use research and STI as a vehicle for development is undermined by the lack of adequate funding. Only Kenya and Uganda have a dedicated science granting council, while in other countries science funding is managed by the relevant Ministry or by funders with broad mandates that cover education or innovation. Deliberate reliance on international research funding appears to undermine the government ambition to use research to address national priorities, as stakeholders indicated almost unanimously that international research grants follow a separate and independent agenda. There is some evidence that international development funders are increasingly trying to coordinate their activities with national actors and harmonise their agenda with nationally identified priorities. However, it is unclear to what extent research funders are also taking a similar developmental approach when deciding to fund North-South academic collaborations.

Finally, only one country (Uganda) has established mechanisms to assess research quality and performs some monitoring of the research project and outcomes. However, in Uganda monitoring activities are part of the research permit system which focuses on ascertaining that the research outcomes are aligned with the national agenda. Emphasis is therefore placed on the scope of the enquiry and its practical impact on society rather than on the scientific quality of the project. The review has not found any mechanisms to assess research quality in the other in-scope countries. Overall, the countries considered in this study have developed policies and an evolving (albeit often incomplete) institutional framework, but in practice policies are not adequately implemented and still fall short of the governments' ambitions. This can create a discrepancy between stakeholder expectations of the contribution research and innovation can make to the broader economy (especially among those in government) and the demonstrable impact of research activities.

4.3. Research production

Back in 2014, 55 African countries - all members of the African Union Commission - had agreed to invest 1% of their GDP in research and development activities [75]. Based on the available data, it does not appear that any country has yet met that target. Gross national expenditure in research and development (GERD) fluctuates considerably, from below 0.2% of GDP in Uganda to 0.8% of GDP in Kenya. Nigeria and Uganda appear to be investing considerably less than the other countries, while

no GERD data is available for Rwanda (Figure 6). However, the country analysis indicates that research funding in Rwanda comes primarily from international sources and it is unclear whether the government provides any dedicated funding for research. However, the dates of the latest data available on UNESCO vary, meaning that not all recent changes in spending are reflected.

Although a similar caveat applies to the available data on number of full-time researchers per million inhabitants, the current number of researchers per country is less likely to have changed significantly due to the time it takes to train and recruit researchers in such numbers. Most countries have less than 50 researchers per million people, placing them towards at the bottom of a global ranking (for reference, South Africa has almost 500 per million inhabitants and the UK has over 4,000) (Figure 7).

Figure 5. GERD as a share of GDP (%) [1]

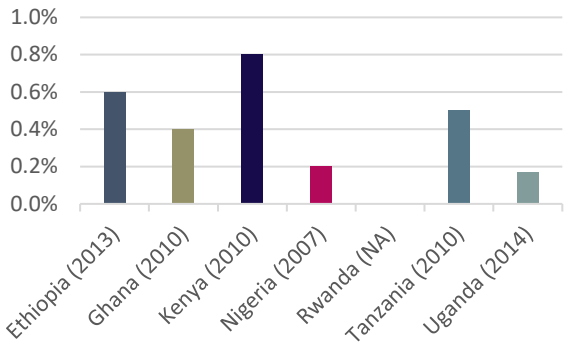
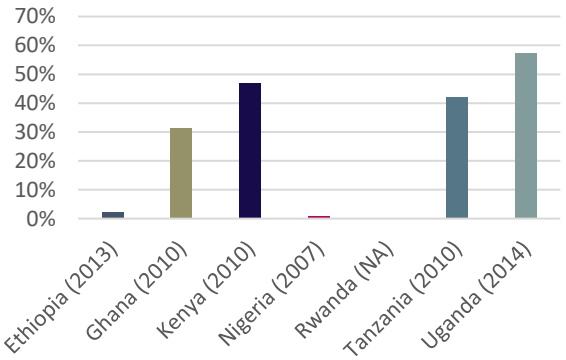


Figure 6. GERD financed by abroad (% total) [1]



Rwanda and Tanzania are at the bottom of the scale, with just 12 and 18 researchers per million people respectively. At the opposite end of the spectrum, Kenya has over 220 researchers per million inhabitants, reflecting in part a high GERD as a proportion of a relatively high GDP and the fact that several international research organisations are headquartered in the country. The lack of researchers has been highlighted across all countries as a major barrier to the development of an effective research system. The problem appears to have at least three root causes: first, higher education institutions are ill-equipped to train students for research as they generally lack capacity, funding and incentive to invest in research training; second, research is not an attractive career choice for many young and bright people since research jobs are uncommon and underpaid, and most higher education institutions focus on teaching over research; finally, international research collaborations give local researchers opportunities to continue their career abroad, where they can find higher salaries, better working conditions and a better research infrastructure (often in Europe or North America). This brain drain contributes to depressing the number of researchers that decide to continue their career in the reviewed countries.

Researchers are moderately productive, publishing a median of 0.8 scientific articles per year compared to 0.9 publications per researcher in South Africa and 0.7 in the UK [2]. Interestingly, productivity per researcher is inversely correlated with the number of researchers in a country: Figure 9 below shows that Kenyan researchers only manage to publish one article every five years on average,

while Ugandan researchers publish 1.4 articles per year [2]. The data only provides a partial picture in so far as it considers the total number of publications per researcher and not their quality.

The share of international research collaborations in the country appears to have a significant impact on research productivity, as local researchers publish as part of international research teams. Rwanda is the country with the highest proportion of papers published as a result of international research collaborations (91%) while Nigeria has the lowest proportion (46%) (see Figure 10) [2].

Figure 7. Researchers per million inhabitants (FTE) [1]

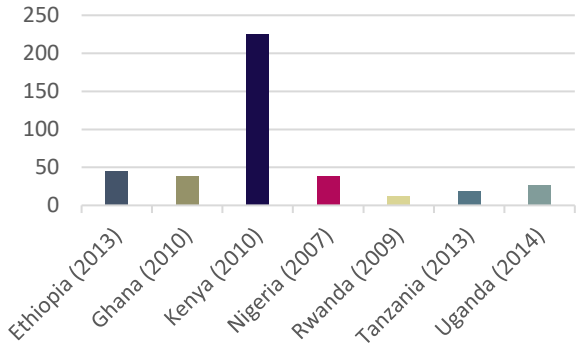


Figure 9. Publications per million people, 2018 [2]

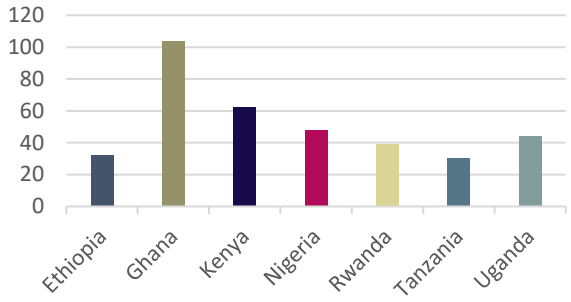


Figure 8. Number of yearly publications per researcher [2]

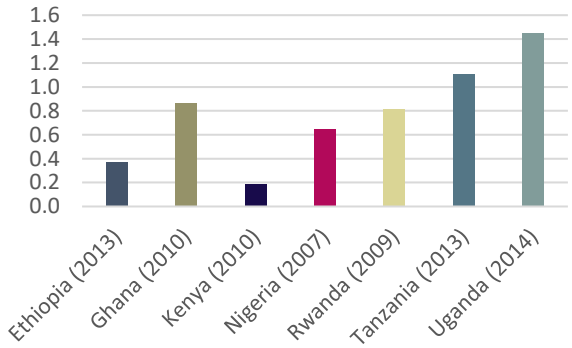
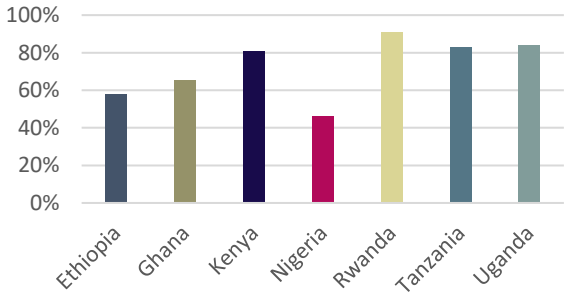


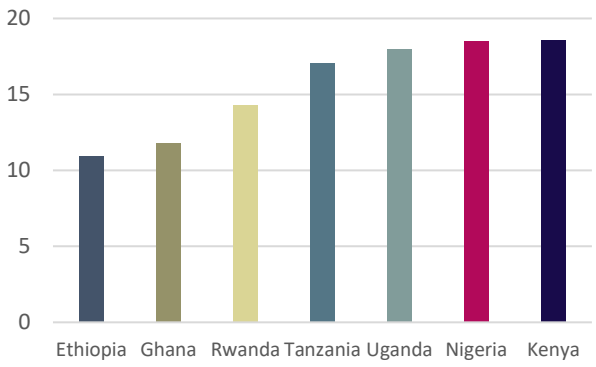
Figure 10. Publications from international collaboration (% of total), 2018 [2]



4.4. Research diffusion

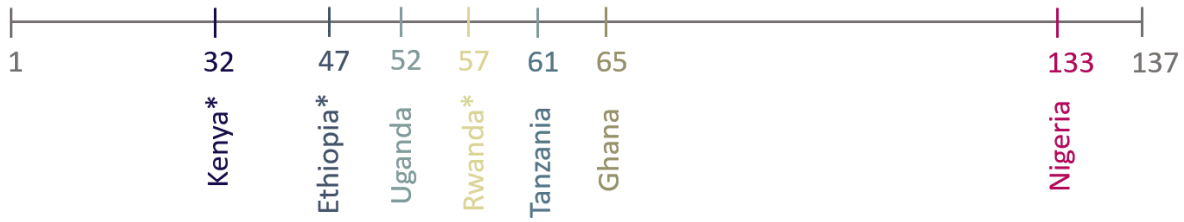
International collaborations are also a good vehicle for increasing the visibility of African research within the scientific community. Articles written by African authors working with international partners tend to have a relatively high number of citations. The number of citations per article ranges between 10.96 and 18.59 over 1996-2018 in the selected countries, with only Ethiopia and Ghana performing below the African average of 13.59 citations per paper according to Scimago (Figure 11).

Figure 11. Number of citations per article, 1996-2018 [2]



Research dissemination through knowledge exchange activities is seen as a national priority in most national policy documents, as it links to the government ambition of exploiting STI as an economic development driver. Most of the in-scope countries have made significant progress in this area over the past decade but performance remains mixed. According to data from the World Economic Forum, Kenya ranks 32nd in a global list of 137 countries for its ability to promote collaborations between universities and non-academic actors (also known as university-business collaborations or U/B collaborations), while Nigeria ranks close to the bottom of the list (133rd out of 137). Figure 12 shows most countries are in the upper half of the list, and low-income Ethiopia, Uganda and Rwanda outperform more affluent countries (Tanzania, Ghana and Nigeria). Countries marked with an asterisk also have national organisations for knowledge exchange.

Figure 12. University-industry collaborations (ranking), and existence of national organisation for knowledge exchange (*) [3]



Performance on knowledge exchange activities seems to be linked to whether universities embrace knowledge exchange as part of their mission, which is turn influenced by whether, or not, the government has developed a KE strategy. The consultation has revealed that, while most universities across the seven countries considered in this review tend to see themselves primarily as teaching-oriented organisations, in some countries there is a distinct push for research organisations to be better connected to business and other social actors. In two of the four countries with good university-business collaborations (Ethiopia and Rwanda), the government has developed knowledge exchange policies or strategies, while in the top-performing country the government has established a dedicated institution (the Kenya National Innovation Agency). Finally, most in-scope countries have established a framework for the protection of intellectual property (IP). Six countries have a national body in charge for IP protection, including patents, designs, trademarks and copyright. Tanzania is the only country where a dedicated IP office has not been established. All in-scope countries are members of the World International Property Organization [4] and all but Ethiopia are also members of the African Regional Intellectual Property Organization [76].

Overall, the number of innovations coming out of the research and innovation system appears very limited. According to WIPO analysis (Figure 14), Africa contributed only 0.5% to the total number of patent applications in 2016, down from 0.7% in 2006. Among the in-scope countries, Kenya is the only country where researchers and innovators filed a significant number of patents (1121 domestically and 302 abroad in the 2008-2017 period). This is almost 10 times as many patents as the second country, Nigeria. At the other end of the spectrum, Ethiopia did not file a single resident application and only a few dozens of applications were filed abroad by their nationals. There is also disparity in the number of applications filed domestically (resident applications) and in foreign IP offices (abroad applications). A number of factors are likely to contribute to the decision of whether or not to file a patent in a country, including market size, the level of protection afforded and level of enforceability [77].

Figure 13. National IP framework

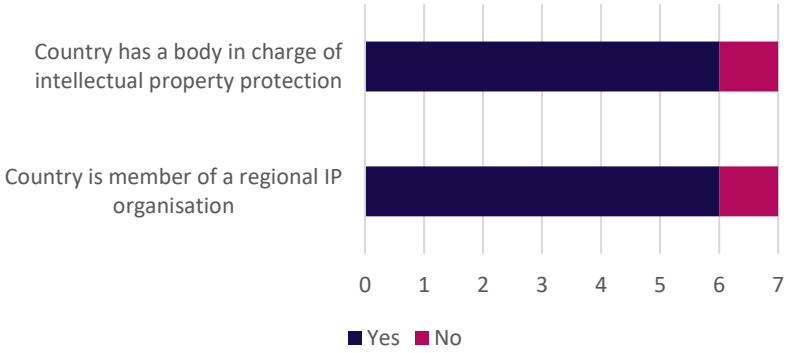
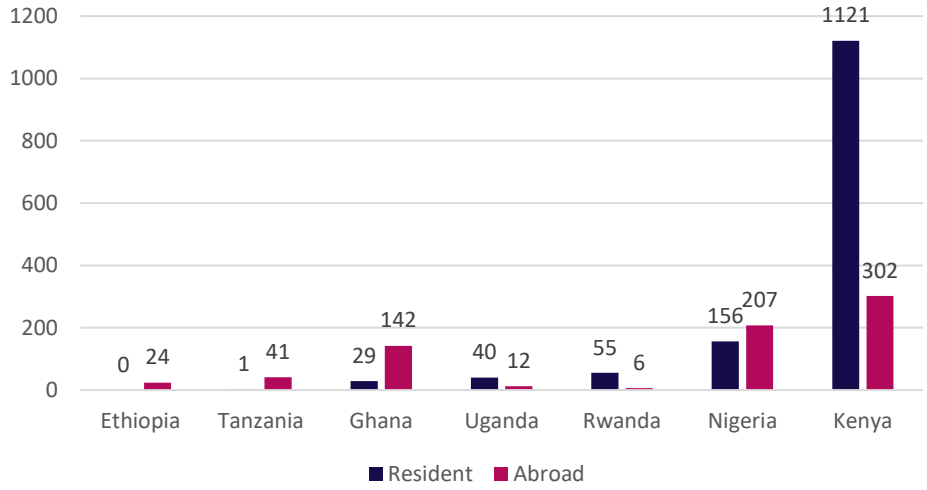


Figure 14. Patent applications (2008-2017) [4]



5. Ethiopia

5.1. Overview

The needs assessment revealed several areas where Ethiopia's research system could be strengthened. Using the scoring presented in section 3, six out of the seven main research system components (RCS) are below average. The areas of most serious concern are the national economic and political context, and the factors driving research creation (funding, researchers and research organisations). Research culture, research support services and research publication performance are also weak, whereas knowledge exchange actors, networks and practices appear stronger. The national policy framework is relatively good, but it is undermined by weak national institutions and an insufficiently large and varied network of research stakeholders in the country.

Figure 15. Research system components (see the country scores in table 1)

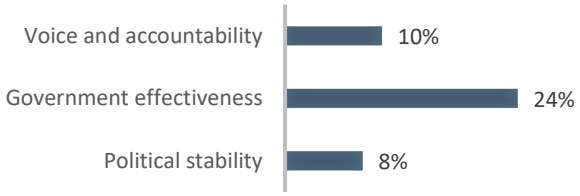
5.2. National context

Ethiopia is a populous country in East Africa. It is a low-income country with an annual GDP of USD772 per capita and 27.3% of people living in poverty. According to World Bank data, the country faces public governance challenges such as high government instability and limited freedom of expression. Over two thirds of the population lives in rural areas and literacy rates are low. Ethiopia has a rural economy with high illiteracy and an underdeveloped digital infrastructure, but competitiveness is improved by the government's emphasis on innovation as a development driver. Political instability, poor regulatory quality and government threats to academic freedom create an unfavourable social and political context. RCS interventions should tailor their ambition, scope and approach to the economic and political complexities underpinning the research system.

Figure 16. Socio-economic indicators [105] [90] [73]

110M inhabitants	**39%** literacy rate
$772 GDP per capita	**27%** live in poverty

Figure 17. Governance indicators (percentile ranking) [100]



5.3. National framework for research

Although Ethiopia's institutional framework for research has developed over the past few years, gaps remain. The country does not have a national policy, funder or government department dedicated to research. Instead, the government has focused on STI to support economic development: it published an STI policy in 2012 and has made efforts to integrate it within its development planning. Responsibilities for research are split between the Ministry of Innovation and Technology, the Ministry of Science and Higher Education and sectoral Ministries but some coordination is provided by the National Science, Technology and Innovation Council. Ethiopia does not have national mechanisms to evaluate research quality in the country. However, it has a national standard for research ethics [78] and national strategy for KE. Facilitating the establishment of a government department for research as well as a national research funder are clear opportunities to strengthen national research capacity.

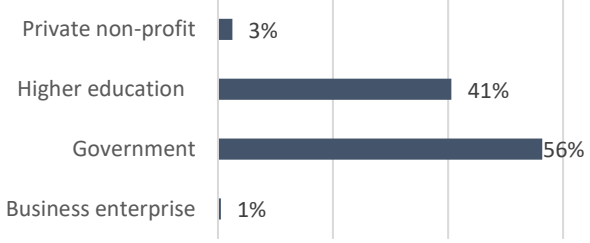
Figure 18. National institutions for research [123] [78]

5.4. Research inputs

The number of universities has grown from just two in 1991 to 40 in 2019 (of which 36 are public and 4 are private), but this still represents only 0.4 universities per million inhabitants. Moreover, universities are teaching-oriented and provide a modest contribution to research production. As a result, most research is undertaken by government-linked, non-academic organisations. Only a few public institutes produce influential research (e.g. EPHI [79]) while independent think tanks are marginalised. Research capacity is hampered by lack of funding and lack of research support. The national GERD has increased from 0.17% in 2007 to 0.6% in 2013, but expenditure is depressed by low R&D investment from business and international actors (only 2% of the total).

Figure 19. Key research capacity indicators [1]

Figure 20. Distribution of researchers [1]



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Overall, research funding remains severely insufficient. There are few researchers in the country (45 per million), and only 16.7% have PhD qualifications or equivalent. Most researchers work for the government or in higher education. The increase in GERD is a positive signal for Ethiopia. Interventions that support continued investment in high-quality research centres around national priority issues could create positive dynamics for continued national investment in science, innovation and evidence-based policy.

5.5. Research outputs

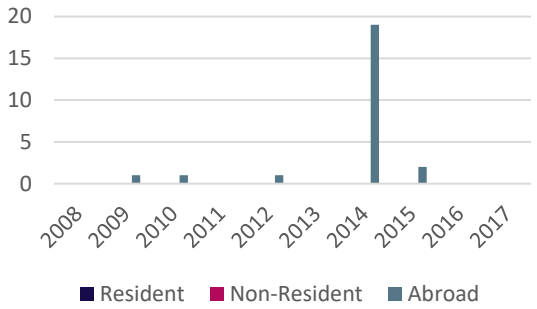
Ethiopia has a moderately high production of scientific literature in absolute terms but low relative to its size (33 publications per million people). Publications from Ethiopian researchers are not widely cited: according to Scimago, Ethiopian publications had 0.53 citations in 2018, placing the country in 69th place worldwide. Ethiopian research can count on fairly good international visibility due to the high number of international research collaborations (58% of the total in 2018). While collaborations can be a vehicle to increase research performance and visibility, these should be equitable to Southern researchers and respectful of national priorities.

Figure 21. Key research outputs indicators [2] [3]

33 Publications / million	**0.53** Citations / publication
58% International research	**47th** for U-B collaborations

However, Ethiopian research does not appear to be linked to innovations and technologies that can contribute to the national economy. WIPO data shows that no patent applications were filed by residents over the past decade, while a small number of patents were filed by Ethiopians abroad. This is potentially a missed opportunity, since according to the World Economic Forum, Ethiopia has a good ability to support university-business collaborations, ranking 47th out of 137 countries. Given government commitment in this area, there appear to be opportunities for interventions to strengthen national demand for knowledge generation and diffusion, further demonstrating the value of research.

Figure 22. Number of patent applications [4]

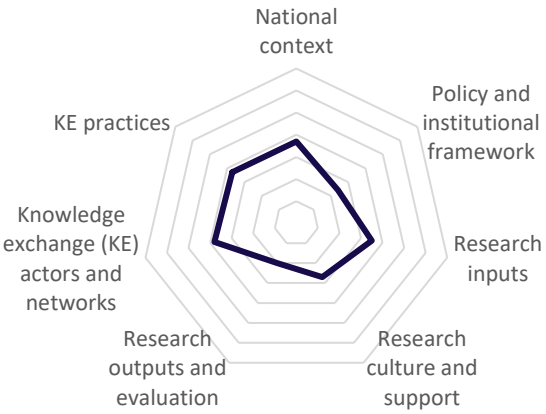


6. Ghana

6.1. Overview

Despite having a stronger performance compared to other in-scope countries, Ghana's research system has clear needs. The areas in which Ghana appears comparatively strong are the socio-political context, research inputs (especially the availability of research funding and the strength of some research organisations) and a relatively strong intellectual property framework. By contrast, the national institutional framework appears weak, undermined by the lack of dedicated research policies and institutions. Ghana's researchers are productive overall, but the quality of the research outputs is mixed. Our analysis suggests that part of the problem is related to the research culture and to the weak system of academic incentives and disincentives connected to research production.

Figure 23. Research system components (see the country scores in table 1)



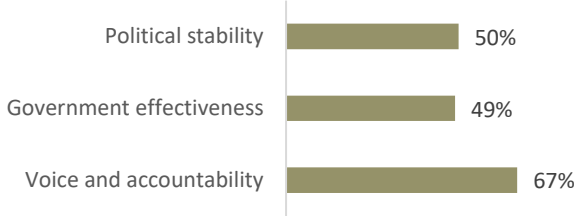
6.2. National context

Ghana is a country in West Africa, with a population of around 30 million and a fast-growing economy driven by the service sector. Ghana is a lower medium income country with an annual GDP of USD2,202 per capita – the highest among the reviewed countries. Only 13% of Ghanaians live below the poverty line, a low proportion for Sub-Saharan Africa. At 72%, the country's literacy is high. According to the World Bank, Ghana has a moderately stable and effective system of government and strong civil liberties place few limits on academic freedom. Overall Ghana's national context compares favourably with other in-scope countries. However, the country still has significant issues affecting competitiveness, economic dynamism and public sector resources.

Figure 24. Socio-economic indicators [73] [74] [104]

30M inhabitants	**72%** literacy rate
$2,202 GDP per capita	**13%** live in poverty

Figure 25. Governance indicators (percentile ranking) [100]



6.3. National framework for research

Ghana's policy and institutional framework for research is underdeveloped. Whilst the government has recently enacted an STI policy containing objectives and provisions for specific sectors of the economy, Ghana still lacks a dedicated policy for research, a national research funder and a ministry or department dedicated to research. Overall, Ghana's focus on science and technology as an economic driver is in line with other African countries, but on balance efforts appear more focused on the adoption of existing technology than on the development of new knowledge. There appears to be limited consideration of research in non-technical disciplines and there are no established mechanisms to promote knowledge exchange activities. Moreover, the roles and responsibilities of national research actors are not clearly defined, and coordination appears limited.

Figure 26. National institutions for research [124]

6.4. Research inputs

Ghana has 26 public universities and 2 technical universities, but only a handful of large universities perform research and only the University of Ghana appears to have significant research activity. Excluding the private institutions affiliated to the public universities, Ghana has almost one university per million people. There are several public research institutes with direct links to government, but evidence about their influence on policy is mixed. The country has a low number of researchers (38 per million) but the government has supported researcher training at PhD level, which has increased the number of researchers with PhD level qualifications (34%). Almost all researchers work in higher education or for the govenrment. Ghana's overall R&D expenditure is low (0.4% of GDP): the amount of money spent for each researcher is higher than the African average,

Figure 27. Distribution of researchers [1]

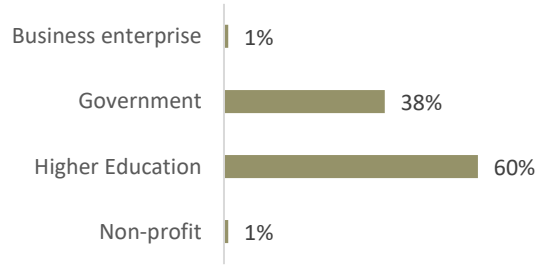


Figure 28. Key research capacity indicators [1] [125]

0.9 Universities / million	**38** Researchers / million
0.4% GERD / GDP	**34%** Researchers with PhD

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but much of this funding is provided through an allowance that is often not spent on research.

6.5. Research outputs

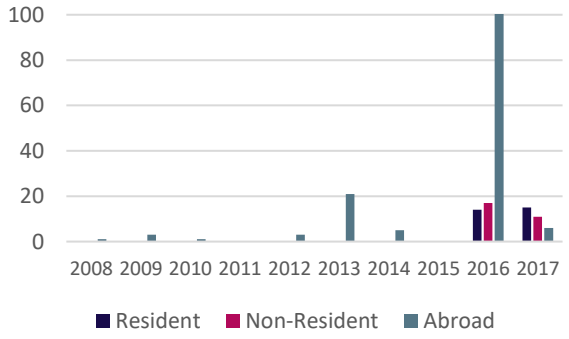
Ghana produces a high quantity of research publications (104 publications per million people), the highest of the in-scope countries and much higher than the average for Sub-Saharan Africa. However, Ghanaian publications are not widely cited: according to Scimago, citations per publication in 2018 were 0.57, placing Ghana in 73rd place worldwide. Approximately two thirds of Ghana's publications are the result of international research partnerships, increasing the country's international visibility.

Figure 29. Key research outputs indicators [2] [3]

104 Publications / million	**0.57** Citations / publication
65% International research	**65th** for U-B collaborations

According to the World Economic Forum, the country performs moderately well in its ability to support university-business collaborations, ranking 65th out of 137 countries. Informant interviews showed examples of good practice on knowledge exchange at the University of Ghana, but also argued that this remains a somewhat isolated example whereas the reality in smaller universities is less encouraging. Moreover, demand for research from the government and businesses is limited. Finally, Ghana has a good framework for intellectual property protection but WIPO data shows that resident patent applications were only filed since 2016 and remain low (17 in 2016 and 15 in 2017). Overall, the country presents examples of good practice in research production, support and diffusion within a context of struggling research production across most universities, scarce funding and insufficient incentives for researchers.

Figure 30. Number of patent applications [4]

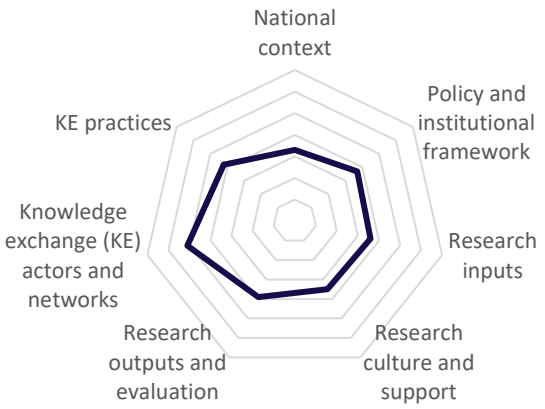


7. Kenya

7.1. Overview

Kenya has a relatively strong research performance among the seven countries included in the review. Despite the lack of a dedicated research policy and a national context characterised by political instability and widespread poverty, Kenya is the overall best-performing country among those considered in this study. A key area of strength is the system for knowledge exchange comprising of several research organisations with good ties with the government and (to a lesser extent) the private sector. Kenya produces a good amount of research overall and it has a much larger number of researchers than other in-scope countries, but many of these researchers have no doctoral qualifications and productivity per researcher (measured by number of publications) is low. Kenya has a well-functioning institutional framework, but key national institutions would need better resources to fully implement the country's research and STI policies.

Figure 31. Research system components (see the country scores in table 1)



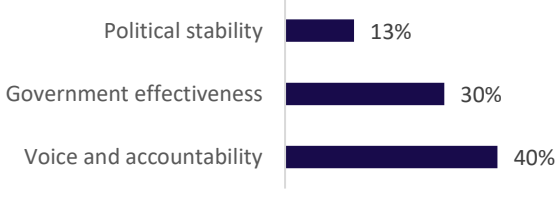
7.2. National context

Kenya is a lower-middle income country in East Africa with an annual GDP of USD 1,710 per capita and 37% of the population living in poverty. Despite the fact that 73% of the population lives in rural areas and low levels of internet penetration, literacy rates in the country are high for Sub-Saharan Africa (79%). According to the World Bank, Kenya has very low government stability, low government effectiveness and high perceived levels of corruption. However, freedom of expression is relatively strong and academic freedom is well established. Overall, Kenya has an overperforming research system when measured against its key socio-economic indicators.

Figure 32. Socio-economic indicators [73] [74] [90]

51M inhabitants	**79%** literacy rate
$1,710 GDP per capita	**38%** live in poverty

Figure 33. Governance indicators (percentile ranking) [100]



7.3. National framework for research

Kenya has a well-developed institutional framework for research, but significant gaps remain. The national research framework builds on the central role of the national department for STI (National Commission for Science Technology and Innovation - NACOSTI) and a draft STI policy that is well-integrated in the country's development strategy. Research is supported by the National Research Fund (NRF). Kenya also has Advisory Research Committees playing an important role in NACOSTI, and effectively making up for the lack of a government department for research. However, no dedicated national research policy exists to date. Kenya also lacks appropriate mechanisms to evaluate research quality at the national level, and national standards for research ethics. Finally, the country does not have a national strategy for promoting knowledge exchange activities, but the Kenya Innovation Agency works to facilitate relationships between research actors and society and promote the diffusion of scientific knowledge.

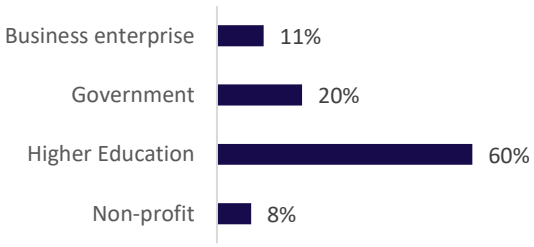
Figure 34. National institutions for research [127]

7.4. Research inputs

Kenya has 31 public universities and 30 private ones, nine of which are in the top 1000 universities globally for their research performance and innovation output. The number of universities has increased from 22 in the space of seven years, thanks to the introduction of the Universities Act 2012. Moreover, Kenya has a large number of think tanks and research institutes that produce influential research of international relevance. This helps explain the large number of researchers in Kenya (225 per million inhabitants) compared to the other in-scope countries. Most researchers work for universities and the government, but the proportion of those working for businesses and non-profits is larger than other in-scope countries. By contrast, the number of researchers with a PhD is much lower than other countries (6.1%). Kenya

Figure 35. Key research capacity indicators [1] [126]

Figure 36. Distribution of researchers [1]



spends 0.8% of GDP on R&D - almost twice the African average. Almost half of Kenya's R&D expenditure comes from international sources.

7.5. Research outputs

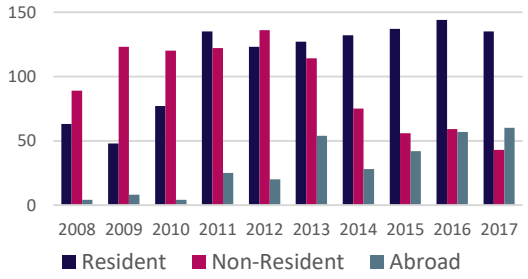
Kenyan research productivity is just above the average for the in-scope countries, at 62 publications per million people. However, given the large number of researchers in the country, publication per researcher remains low. 81% of Kenya's publications come from international research partnerships, confirming the country's international focus and status as a research hub in East Africa. Citations are also higher than other countries within the scope of this review, at 0.75 per publication in 2018 according to Scimago - placing Kenya in 72nd place globally.

Kenya also has a fairly competitive innovation throughput compared to other countries, with resident patent applications consistently above 120 per year since 2011 according to WIPO data. This compares very favourably with other in-scope countries and shows that both residents and foreigners have a high level of trust in Kenya's IP system. Finally, according to the World Economic Forum, the country performs well in its ability to support university-business collaborations, ranking 32nd out of 137 countries – the highest ranking of all seven countries. Despite the lack of an overarching knowledge exchange strategy, the presence of the National Innovation Agency (KENIA) has contributed to the development of a culture whereby knowledge and innovation are transferred from the research sector to society.

Figure 37. Key research outputs indicators [2] [3]

62 Publications / million	**0.75** Citations / publication
81% International research	**32nd** for U-B collaborations

Figure 38. Number of patent applications [4]

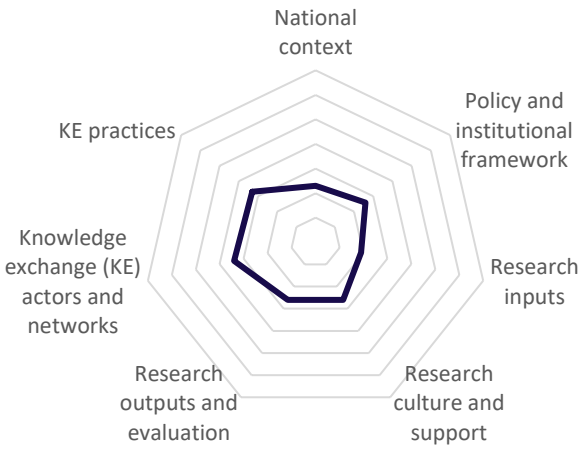


8. Nigeria

8.1. Overview

Nigeria's research system faces considerable challenges. A national context characterised by political and economic instability and a high level of poverty is further complicated by the size and complexity of the bureaucracy and the distribution of powers and responsibilities across government levels. Nigeria's strength is also its weakness: at almost 200 million people, the country has the size to produce high quality research in great quantity, but governance challenges and lack of funding hamper this potential. In line with other countries considered in this study, Nigeria has a relatively good knowledge exchange framework, but the country's research system is hampered by a weak institutional framework and especially by the lack of a national research funder. Nigerian researchers contribute a large number of publications in absolute terms, but their individual contribution is very modest both in terms of quality and quantity.

Figure 39. Research system components (see the country scores in table 1)



8.2. National context

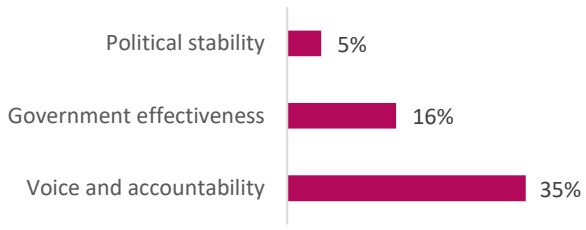
Nigeria is the most populous country in Sub-Saharan Africa with almost 196 million inhabitants. Nigeria has a GDP per capita of USD2,028 and, in 2009, 53.5% of the population lived below the poverty line of USD1.90 a day. Adult literacy rates are recorded at 51% according to World Bank data.

The World Bank ranks Nigeria poorly in terms of government effectiveness, regulatory quality and the rule of law. Nigeria has a high level of perceived corruption at both national and local levels and is reported by the World Bank to experience significant political instability, politically motivated violence and terrorism. While academic freedom is generally respected, it is at times limited by violent interference.

Figure 40. Socio-economic indicators [73] [74]

196M inhabitants	**51%** literacy rate
$2,028 GDP per capita	**53.5%** live in poverty

Figure 41. Governance indicators (percentile ranking) [100]



8.3. National framework for research

While Nigeria's policy framework for STI is fairly developed, the framework for research is not. Since 2011, the government has published the National STI Policy, the Framework for the Nigeria National System of Innovation (NSI) and the National Science, Technology Innovation Roadmap (NSTIR). By contrast, Nigeria does not have a national research policy and the country's national education policy does not deal with research adequately. Moreover, the STI policy documents appear to have had a limited impact on the national research system due to a lack of funding. Nigeria's complex institutional framework for research operates across various government levels, leading to confusion between actors and overlaps in their roles and responsibilities. Nigeria has no national research funder with research funding currently allocated on an ad-hoc basis. There are currently no national mechanisms for research quality evaluation and research ethics standards and monitoring systems exist only in the health research sector.

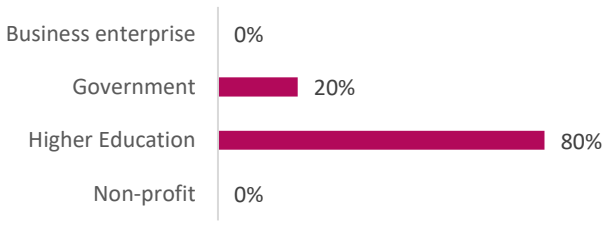
Figure 42. National institutions for research

8.4. Research inputs

Nigeria has a low number of researchers relative to its population at just 38.8 per million people and over a third (34.1%) of researchers have a PhD or equivalent qualification according to UNESCO. The majority of researchers are employed in higher education (HE) (80.4%) which correlates to the high number of univerisites in the country (95 public and 79 private). UNESCO reports no researchers employed in the business sector or not-for-profits. The latest available data shows a very low GERD in Nigeria at just 0.2%. The HE sector is responsible for the greatest share of GERD at almost 65% with the other 35% performed by the Nigerian government, while business and non-profit organisations provide a negligible contribution to research and development.

Figure 43. Key research capacity indicators [1]

Figure 44. Distribution of researchers [1]



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More importantly, international R&D expenditure in the country is extremely low at just under 1% of GERD (compared to 30-60% in the other in-scope countries). This contributes to research funding being severely insufficient in the country, which in turns hampers research production.

8.5. Research outputs

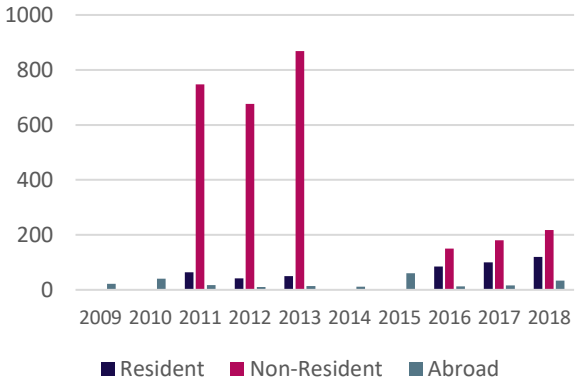
Nigeria has a high production of scientific literature in absolute terms but low productivity overall (48 publications per million people). Nigerian universities under-perform in terms of their research output [80]. Moreover, Nigeria research citations are the lowest of the seven countries considered for this study. Publications from Nigerian researchers are not widely cited: according to Scimago, citations were just 0.49 per publication in 2018, placing the country at 149th place in a worldwide ranking and 43rd out of 54 African countries. Nigerian research has high international visibility with almost 50% of its research resulting from international collaborations in 2018, despite international sources contributing relatively little to national R&D.

Despite being home to a large number of multinationals (especially in the extractive sector), Nigerian research organisations suffer from a lack of industry engagement. The country scores poorly in terms of university-industry collaborations (133rd out of 137 countries) and government procurement of research is also low. Finally, despite the existence of mechanisms to protect IP, there is little national IP to protect. WIPO data shows that non-residents have filed far more patent applications than residents in recent years. This confirms that the size of Nigeria's market makes it an attractive destination for IP protection, but also that national innovation has not expressed its full potential.

Figure 45. Key research outputs indicators [2] [3]

48 Publications / million	**0.49** Citations / publication
45.9% International research	**133rd** for U-B collaborations

Figure 46. Number of patent applications [4]

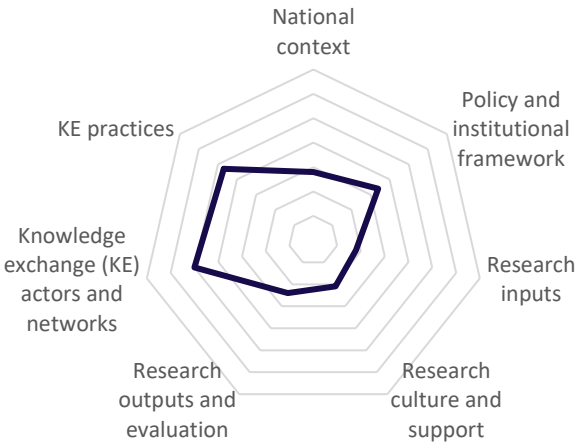


9. Rwanda

9.1. Overview

Rwanda's research system has some distinctive features. On the one hand, it is challenged by the country's financial problems, limited size and complex socio-political circumstances. On the other hand, Rwanda's rapidly growing economy, clear business focus and stable government appears to be driving innovation at rapid speed. More so than in other countries, Rwanda is focusing on science, technology and innovation as a growth driver. Investments in physical and institutional infrastructure appears to be paying dividends, but the business focus of government action appears to have side-lined research so far. The sector remains severely underfunded, most universities do not perform any research and the country has very few researchers overall. Yet the recent establishment of a national fund for research, the continued economic growth and the established collaboration between international actors and the government give rise to optimism.

Figure 47. Research system components (see the country scores in table 1)



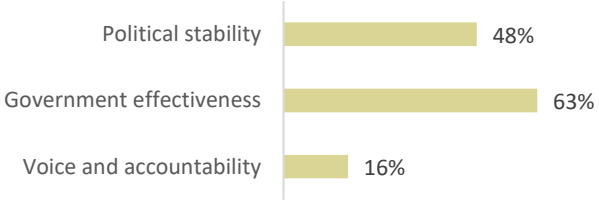
9.2. National context

Rwanda has a low population of 12.3 million people and a GDP per capita of USD772, the second lowest of all seven in-scope countries. Around 55% of the population live in poverty and over 70% of the population live in rural areas. However, Rwanda has a high literacy rate of almost 71%. Rwanda's digital infrastructure and internet access are poor.

Figure 48. Socio-economic indicators [74] [86]

12.3M inhabitants	**70.8%** literacy rate
$772 GDP per capita	**55.5%** live in poverty

Figure 49. Governance indicators (percentile ranking) [100]



Freedom House reports that the Rwandan government limits individual freedoms which directly impacts research production and diffusion. The charity defines Rwanda as 'not free' [81]. The World Bank ranks Rwanda poorly in terms of voice and accountability, but moderately highly with regards to government effectiveness and political stability. It is unclear to what extent limits to

academic freedom affect the attractiveness of research careers in Rwanda, with interviews suggesting that low salaries are a more decisive factor.

9.3. National framework for research

There is room to improve Rwanda's national framework for research. The country does not have a national research policy, or a government department dedicated to research. Instead, the country has an STI Policy encompassing sector-specific policies in relation to research. The STI Policy outlines responsibilities for research and highlights the Ministry of Education (MoE) and the National Council for Science and Technology (NCST) as key policy-makers. Overall, the adoption of technology and innovation appears to be prioritised over research production and knowledge exchange is central to Rwanda's research and innovation approach. Rwanda has a National Ethics Committee which focuses on the protection of human subjects in research. Mechanisms for research quality evaluation are in place in some fields of research but not all. Until very recently, the country did not have a national research funder but a recent loan from the African Bank has given the country a sizeable amount (USD 30 million) for investment in R&D.

Figure 50. National institutions for research [128]

9.4. Research inputs

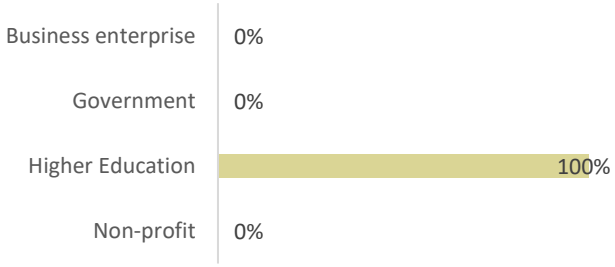
Universities are key actors in the Rwandan research system. There are very few other research organisations in the country due to a lack of government funding. Generally, the quality of scientific research institutions is low. Again, a lack of funding and coordination reduces research capacity. Research funding is driven primarily by external donors and there has been a reduction in government spending in recent years. A 2015 study estimated that national funding for research and

Figure 51. Key research capacity indicators [1]

innovation represented approximately 0.4% of Rwandan GDP [82].

Another significant barrier to research in Rwanda is human capital. In 2009, the number of researchers with a PhD or equivalent qualification was reported at 38% according to UNESCO, equating to around 12 researchers per million of the population. UNESCO data suggests 100% of researchers in Rwanda are employed in higher education, which raises questions around data quality. Interventions will need to consider the need to train more researchers at a higher level and to create attractive career paths within the country to prevent them from leaving.

Figure 47. Distribution of researchers [1]



9.5. Research outputs

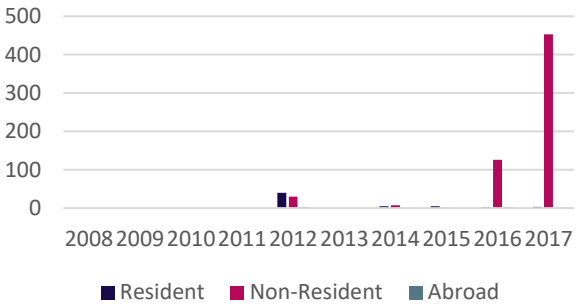
Rwandan researchers produce 39 publications per million people. When accounting for population size Rwanda's research productivity is in line with the other countries considered in this study. Rwandan research received an average of 0.68 citations per publication in 2018. Both productivity and citation score, however, are likely to be linked to its high number of international collaborations which are much higher than the other in-scope countries and accounted for over 90% of research outputs in 2018.

According to the World Economic Forum, the country performs relatively well for its ability to support university-business collaborations, ranking 57th out of 137 countries. This relies on a dynamic business sector and above-average demand for research and knowledge coming from both the private and the public sectors. Finally, filing for patents in Rwanda is a relatively recent phenomenon, with WIPO data showing no patents filed nationally before 2012. The number of non-resident applications, however, has risen dramatically in the last two years which indicates confidence in the country's IP protection system.

Figure 48. Key research outputs indicators [2] [3]

39 Publications / million	**0.68** Citations / publication
90% International research	**57th** for U-B collaborations

Figure 49. Number of patent applications [4]

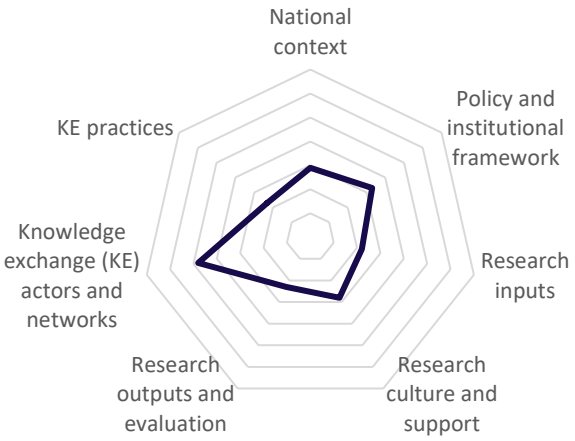


10.Tanzania

10.1. Overview

Tanzania's research system faces considerable challenges. The country's national context is characterised by political instability, a weak economy and large number of people living in poverty. Whilst the country has a well-developed policy and institutional framework, its effectiveness is undermined by lack of funding and capacity by national actors to implement and support the existing policies. Given underinvestment in research and the low number of researchers, it is unsurprising that Tanzania has low absolute and relative numbers of publications. However, the review has revealed that the government is aware of the importance of research and innovation and that the large share of international collaborations gives Tanzania research good visibility. The extent to which this research overlaps with areas of national priority and yield benefits to the national economy, however, is unclear.

Figure 50. Research system components (see the country scores in table 1)



10.2. National context

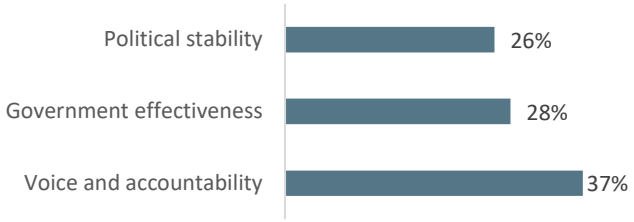
Tanzania is a country of 56 million people and a GDP per capita of USD1,050 which is well below the Sub-Saharan average. Almost 50% of the population live in poverty with less than USD1.90 per day, and two thirds live in rural areas. Despite this, literacy rates remain relatively high at 78% and the country's economy is growing rapidly, with a positive outlook. This may open up the opportunity for the government to further incorporate research and innovation in their development strategy, and for donors to align their interventions to the national priorities.

Figure 51. Socio-economic indicators [73] [74] [104]

56M inhabitants	**78%** literacy rate
$1,050 GDP per capita	**49.1%** live in poverty

According to the World Bank and Freedom House Tanzania's people have limited individual freedom. There is a high level of political instability due to government crackdowns on the opposition, limited voice and accountability and low government effectiveness. This has a negative effect on academic freedom, which is particularly limited according to Freedom House [83]. Despite these constraints, the country has considerable potential to develop its research sector.

Figure 52. Governance indicators (percentile ranking) [100]



10.3. National framework for research

Tanzania's institutional framework is relatively clear. The country has a national research policy and an STI Policy (1996). The country's only national research funder, the Commission for Science and Technology (COSTECH), is not sufficiently resourced. COSTECH also acts as Tanzania's department for research and struggles to fulfil both roles due to limited resourcing. Various government ministries have a role in the Tanzanian research system such as the Ministry of Communication, Science and Technology and the Ministry of Education, Science and Technology. However, a lack of coordination negatively impacts policy implementation.

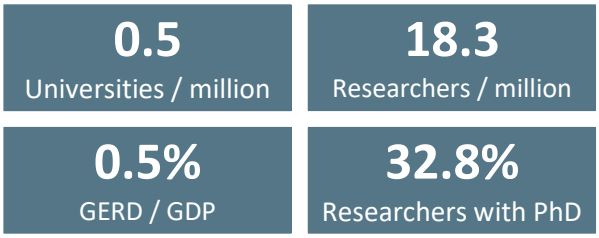
Tanzania has not yet developed national mechanisms for research quality evaluation or institutional policies for knowledge exchange. There is also no national research ethics policy or body in the country other than in health research.

Figure 53. National institutions for research [129]

10.4. Research inputs

Tanzania's research happens predominantly in publicly funded research institutes and non-profit organisations and in alignment with government priorities. Universities struggle to contribute to research due to a lack of research funding and infrastructure and a lack of clear career paths for researchers. Tanzania's GERD is low at 0.5% of GDP.

Figure 54. Key research capacity indicators [1]



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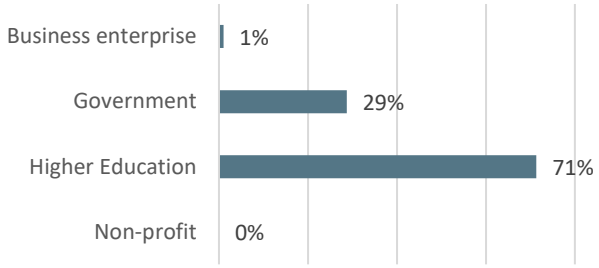
Tanzania has 18.3 researchers per million people which is far below the African average of 95.1 researchers per million. The majority of researchers (71.3%) are employed in higher education and the remaining 28.7% are employed by the government according to UNESCO. 32.8% of researchers have a PhD or equivalent qualification. However, there is a low number of researchers engaged in research and Tanzania struggles to retain researchers after the completion of their studies which exacerbates the issue.

Figure 55. Distribution of researchers [1]



10.5. Research outputs

Tanzania has a relatively low number of publications compared to other Sub-Saharan countries (30.3 publications per million people). The country's research publications received an average of 0.64 citations per paper in 2018, likely due to the high number of international collaborations (82.9%) and the high level of empirical research conducted. This places Tanzania 87th worldwide for citations per paper in 2018.

Figure 56. Key research outputs indicators [2] [3]

30.3 Publications / million	**0.64** Citations / publication
82.9% International research	**113th** for U-B collaborations

According to the World Economic Forum, the country does not perform well for its ability to support university-business collaborations, ranking 113th out of 137 countries. Demand for research by the government and the business sector is limited, and the role of research in informing policy appears limited. Finally, according to WIPO, no patent has been granted to Tanzanian nationals between 2007 and 2017, and only one application has been filed by residents over the same period, while several dozens were filed abroad by Tanzanians. The focus within the country appears to be on adopting and adapting foreign innovation to the national context rather than producing research and innovation. A relatively strong higher education sector gives an opportunity to strengthen the research base, but these cultural issues would need to be addressed for the potential to be translated into practice.

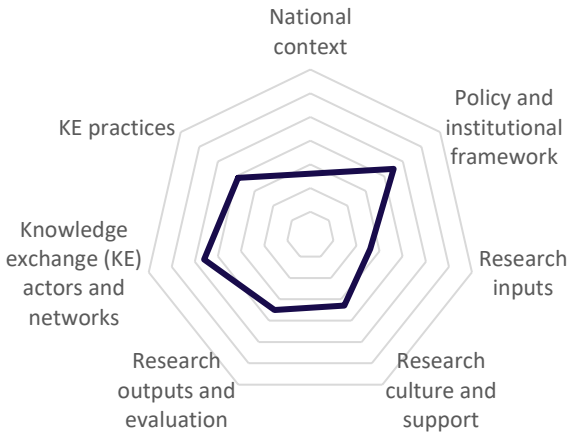
Figure 57. Number of patent applications [4]

11.Uganda

11.1. Overview

Uganda is the poorest of the countries considered in this study and its researchers are constrained by a context of limited civil freedom. However, in many ways, Uganda's research system outperforms its challenging national context. The national policy and institutional framework for research is among the most well-developed among the countries considered, with sound policies, strong regulations and relatively effective institutions. The country is also home to an the internationally renowned University of Makerere, and it has seen a rapid growth in the number of universities. Research productivity and citations are low, but the proportion of international collaborations is high. Research production is limited by the lack of funding and a complex research permit system, while knowledge exchange activities are fairly well-established among a restricted number of research organisations.

Figure 58. Research system components (see the country scores in table 1)



11.2. National context

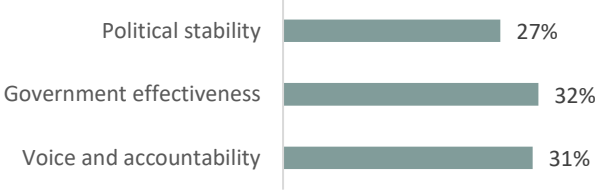
Uganda has a population of 42.7 million people and has one of the highest population growth rates worldwide [84]. Uganda's GDP is low at just USD643 and the World Bank reports that almost 42% of the population live in poverty. The country has a high rural population (76%). Adult literacy rates are high at 70% as reported by the World Bank [ii]. Digital infrastructure remains underdeveloped with just over 20% of people having internet access (World Economic Forum).

The World Bank gives a low score to political stability, government effectiveness and voice and accountability and according to Freedom House, the country has recently experienced an erosion of academic freedom and contends with high levels of

Figure 59. Socio-economic indicators [73] [74] [90]

42.7M inhabitants	**70%** literacy rate
$643 GDP per capita	**41.7%** live in poverty

Figure 60. Governance indicators Percentile ranking) [100]



perceived corruption, political instability and low government effectiveness.

11.3. National framework for research

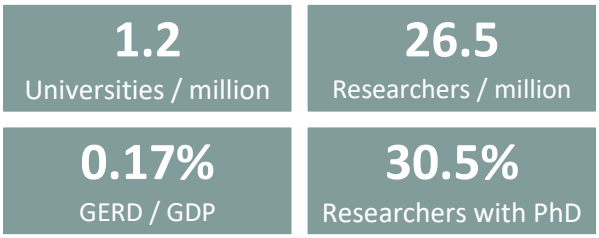
Uganda has a very robust and comprehensive policy framework for STI and research which clearly links research activities with national priorities and establishes mechanisms of control of coordination of research activities. Uganda has a national research policy, sector-specific research policies and a strategy for STI. Uganda has established its own mechanisms to assess research quality and performs some monitoring of the research project and outcomes. Responsibilities for research are split between government ministries, these include the Ministry of Science and Technology and the Ministry of Education and Sport. The Uganda National Council for Science and Technology (UNCST) is the country's primary research funder. However, it is not sufficiently resourced to fulfil its responsibilities. The UNCST is also responsible for implementing research policy in the country. The country began to establish a national research ethics body, but all research ethics committees operating in Uganda must be accredited by the UNCST. There is no national strategy for KE.

Figure 61. National institutions for research [130]

11.4. Research inputs

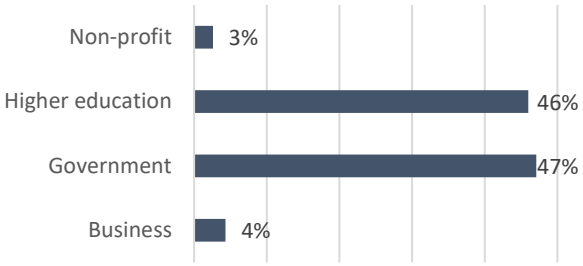
Uganda's network of research organisations is complex. There are 52 universities in Uganda, but most of them produce little research and of a generally low quality. Uganda's research is dominated by publicly funded organisations and a number of international stakeholders. Private think-tanks and research organisations have a limited role in the national landscape and have less influence on government policy compared to other countries considered in this study. The number of researchers in Uganda is low at just 26.5 per million inhabitants, lower than most other in-scope countries, and Uganda appears to suffer from brain

Figure 62. Key research capacity indicators [1]



drain more than other countries. The majority of researchers are employed in government (47%) and higher education (46%). According to UNESCO, 30.5% of researchers were educated to PhD level or equivalent in 2014, which is in line with the average of the other in-scope countries. While there is some uncertainty concerning the level of research funding in Uganda, UNESCO data from 2014 shows GERD to be very low at just 0.17% of GDP. This is the lowest level of funding across the countries included in the review, and it should be considered against the backdrop of one the lowest GDPs per capita in Africa.

Figure 63. Distribution of researchers [1]



11.5. Research outputs

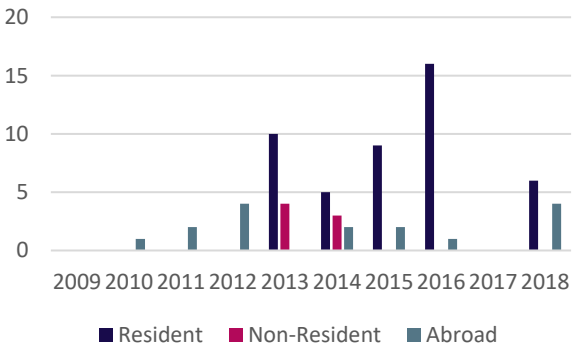
Uganda's production of academic literature is relatively low. Scimago reports just 44 publications per million people. However, Uganda performs relatively well in relation to its research quality. Uganda had 0.65 citations per paper in 2018, which is second highest among the included countries, after Kenya. This may be explained by the fact that the country hosts a few centres of research excellence, and that international exposure is high, with approximately 84% of research outputs being produced a result of international collaborations.

With regards to knowledge diffusion, the picture is also mixed. According to the World Economic Forum, the country performs poorly in terms of its ability to support university-business collaborations, ranking 114th out of 137 countries. Knowledge exchange and commercialisation activities are rarely performed, and the links with between universities and society are weak. The legal framework for IP protection appears to be well-established, but few patents are being filed. According to WIPO data, Ugandan residents made no patent applications domestically in 2017 and only six applications in 2018, down from a peak of 16 applications in 2016.

Figure 64. Key research outputs indicators [2]

44 Publications / million	**0.65** Citations / publication
84% International research	**114th** for U-B collaborations

Figure 65. Number of patent applications [4]



12.Conclusions

12.1. Key highlights

The needs assessment has highlighted some common trends and key differences among the seven in-scope countries. Common trends include underinvestment in research infrastructure (physical and digital), a low number of researchers, a rapidly growing number of universities (but focused on education over research) and a national institutional framework that supports a broad STI agenda (as opposed to a research-focused one). Financially, a rising (albeit slowly) share of GDP dedicated to research and development and the limited contribution of the business sector to national R&D expenditures are also common among the reviewed countries. Moreover, all such countries have developed many dimensions of their research system over their past decade and show an appreciation of the value of research for development, but a limited practical understanding of how this could happen. Initiatives that support the research pipeline from project inception to innovation outcome are more likely to generate interest among national authorities, especially if projects have material impacts in areas of national priority.

Perhaps unsurprisingly, however, the analysis also highlighted many key differences among these countries. These include macro-economic indicators such as population size, GDP per capita, poverty and literacy levels. The economies of these countries are increasingly complex, and the contribution of various productive sectors is very uneven; the primary sector plays an increasingly smaller role but still significant. The quality of the physical and digital infrastructure is also highly diverse between countries (with countries like Rwanda undergoing a rapid process of modernisation) and within countries (Nigeria being the example of significant regional differences). The level of R&D investment relative to GDP and the contribution of foreign entities to R&D expenditures are extremely variable. The mechanisms used to disburse funding and the objectives of the financing activities also differ, including business-focused approaches (e.g. Rwanda), research-focused ones (Kenya) and less coordinated ones (Nigeria). In sum, the differences between national contexts are deep and significant, and the variables influencing the effectiveness of interventions are best unpacked through iterative and adaptive interventions with flexible theories of change. As a corollary, research capacity strengthening interventions should be carefully planned in each country, include collaboration with country stakeholders at various levels of the research system.

12.2. Common and differentiated needs

The country reports list the needs for each of the seven countries considered in the study, and then assessed their intensity (i.e. how much room for improvement currently exists) and importance (i.e. what impact would addressing the need have on the research system). As a final step, the reports suggest three priority needs where an intervention would be especially impactful. The recommendations can be divided in three main groups: those aimed squarely at government entities (national) and related to changes or improvements to national policy, national institutions or national infrastructure; those aimed at research organisations or research intermediaries (subnational) and related to the establishment of centres of excellence, partnerships or better support service; and

finally recommendations aimed at both national and subnational actors (networks) and related to the creation of better knowledge exchange systems and practices, research quality evaluation systems and practices, and research training opportunities. Table 3 below contains a summary of the priority needs across the in-scope countries.

Table 3. Summary of priority needs for the in-scope countries

Country	Priority need: national policies & institutions	Priority need: research organisations	Priority need: other
Ethiopia	Strengthening policy implementation capacity in key national institutions	Establishing or strengthening thematic centres of excellence in priority research areas	Investing in knowledge exchange across key organisations, starting from centres of excellence
Ghana	Supporting the review of the Research & Book Allowance	Establishing a research communication infrastructure	Strengthening research management capacity using the hub-and-spoke model
Kenya	Supporting implementation capacity across national institutions	Strengthening the role of national intermediaries such as think tanks	Establishing mechanisms for research quality evaluation
Nigeria	Strengthening national capacity to leverage and manage research funding	Strengthening research support services in research-intensive universities	Developing mechanisms for research quality evaluation
Rwanda	Creating career paths in research and innovation	Establishing a national research data infrastructure	Supporting South-South collaborations
Tanzania	Supporting capacity and coordination among national institutions	Supporting the development of research infrastructure in key organisations	Creating research training opportunities for women
Uganda	Reviewing the research permit system	Supporting the development of research growth centres	Strengthening knowledge exchange capacity

The summary of priority needs highlights that all the in-scope countries share common challenges, and that improving research systems will require multiple strategies and interventions working in parallel. All countries need increased capacity to implement policy at national level; they either need to develop centres of research excellence to demonstrate the value of research to national stakeholders, or they have the opportunity to build on existing centres of research excellence to spread good practice and further support research capacity strengthening; and they need to improve their ability to connect research with society and demonstrate the practical value of research investment in line with national priorities. Moreover, the review has identified some instances of well-meaning policies that have a negative effect on research (e.g. Ghana and Uganda) and has suggested a process to address that problem. However, even though improvements in some area appear to be universally needed, that does not mean that all countries have a similar starting point: sometimes the

specific need is highlighted because the circumstances appear conducive to progress, while other times it is highlighted because it ignoring the problem would make it a major stumbling block to progress.

12.3. Implications for research capacity strengthening interventions

Building on the findings of the Rapid Evidence Assessment and the needs assessment, it is possible to highlight some practical recommendations to guide research capacity strengthening interventions. Three main factors ought to be considered when planning an intervention in LMICs:

1) **The national context determines what interventions are acceptable.** The national socio-economic context and the government's development vision are likely to influence discourses and approaches in each research area. For instance, if the government is investing in STI and keen to support the adoption of foreign technology in the country (as is the case in virtually all the countries considered), donors should frame research capacity strengthening activities in that light in order to generate interest and buy-in from all levels of government. Wherever the government has established clear and actionable national development priorities, interventions should be inserted within such contextual framework and measured for their contribution to nationally defined objectives. The political context is equally important. Countries with a history of limited freedom of expression or civil and political rights are unlikely to engage in activities that may be seen as supporting critical voices from civil society, while tensions around power and resources (such as the allocation of the Research and Book allowance in Ghana or the eligibility for research funding from Nigeria's TETfund) are difficult to address.

2) **The maturity of the research system determines what goals are achievable.** The level of maturity of the research system is highly variable. While partnerships with national institutions are ultimately beneficial, the effectiveness of such work depends on the political will and the capacity of those institutions in the first place. A research system that lacks basic national institutions, funding mechanisms and infrastructure is intrinsically less able to absorb funding and support research capacity interventions than one where a moderate level of capacity already exists. Recognising the different starting points of each country is an important step since each systemic gap would require expensive, long-term strategies that might yield limited results within the lifetime of a single intervention. In the least advanced research systems, donors might struggle to invest resources in support of long-term, paradigm-shifting activities. Instead, they could work at sub-national level, helping individual research organisations or networks of organisations establish good research practice within the country. The African Centres of Excellence (ACE) initiative operates across several countries with challenging research environments, and demonstrates the value of working at the subnational level. This strategy does not directly address the systemic gaps but can be used to demonstrate the value of research to the government and trigger more significant changes at a later stage. Simultaneous work with national institutions ought to be undertaken but, in countries with a more challenging starting point, expectations of results should be moderate.

3) **The stakeholder composition and power-relations determine what approaches are effective.** The study found that research is undertaken by different types of organisations (public and private

universities, public and private research institutes, think thanks, quasi-governmental organisations, government departments, international institutes and so forth). For instance, in some countries public research institutes are the most influential actors while in others international think tanks have considerable leverage. Universities tend to play a smaller role within the research system compared to high-income countries, so expecting young and under-resourced universities to invest substantially in research is unfair and unrealistic. An analysis of the current capability, credibility and agenda of research stakeholders is needed to identify national partners and shape intervention strategies that maximise effectiveness. For instance, donors could be tempted to focus on 'islands of research excellence' at the expense of the broader system (which has been the case in many countries within the scope of this study, see for instance the disproportionate role played by the University of Makerere, the University of Ghana or the University of Rwanda). Building on the stakeholder analysis provided in this study, donors could either help 'tier 2 organisations' to step up their research activities or work with elite organisations to disseminate good research practice using the 'hub-and-spoke' model. Only the adequate consideration of the influence, agendas and relations between key actors can help develop effective intervention strategies.

Appendix A – List of interviewees

Table 4. List of interviewees and their affiliation (by country)

Name	Organisation
Ethiopia	
Professor Zerihun Woldu	Addis Ababa University
Dr Ebba Abate	Ethiopian Institute of Public Health
Jemal Beker Abedula	Ministry of Innovation & Technology
Dr Berhe Mekonnen Beyene	World Bank
Ghana	
Prof Ernest Aryeetey	African Research Universities Alliance
Santiago Sanchez Guiu	Innovations for Poverty Action
Dr Henry Telli	International Growth Centre
Afua Yeboah	Office of Research, Innovation & Development, University of Ghana
Grace Annan	Office of Research, Innovation & Development, University of Ghana
Selasie Enyonam Agamah	Office of Research, Innovation & Development, University of Ghana
Dr Obed Asamoah Kissi	Research & Grant Institute of Ghana
Dr Samuel Adjorlolo	Research & Grant Institute of Ghana
Eunice Yaa Brimfah Ackwerth	World Bank
Kenya	
Allen Muyaama Mukhwana	African Academy of Sciences
Dr Tom Kariuki	African Academy of Sciences
Marjorie Moraa Okora	African Capacity Building Foundation
Olga Otieno	African Capacity Building Foundation
Dr Grace Amurle	African Economic Research Consortium
Dr Innocent Matshe	African Economic Research Consortium
Sandra Coyle	African Economic Research Consortium
Dr Witness Simbanegavi	African Economic Research Consortium
Dr Anne Khisa	African Population Health Research Centre
Dr Evelyn Gitau	African Population Health Research Centre

Name	Organisation
Christine Kariuki	KENIA, NRF, NACOSTI & MoE
Margaret Muthee	KENIA, NRF, NACOSTI & MoE
Dr Roselida Owuor	KENIA, NRF, NACOSTI & MoE
Dr Salome Guchu	KENIA, NRF, NACOSTI & MoE
Dr Rose Ngugi	Kenya Institute for Public Policy Research & Analysis
Sarah Odera	Strathmore Energy Research Centre, Strathmore University
Nigeria	
Dr Olusoji Oduwole	Cocoa Research Institute of Nigeria
Mr Anthony Adejumo	National Universities Commission
Mr Chinedu Otuya	National Universities Commission
Professor Babatunde Salako	Nigerian Institute of Medical Research
Mr Femi Orgundele	Nigerian Research & Education Network
Mr Tobi Fowora	Nigerian Research & Education Network
Professor Augustine Odili	University of Abuja (Research & Innovation Unit)
Professor Patricia Lar	University of Jos (and WARIMA)
Abul Azad	World Bank
Ayo Fashogbon	World Bank
Rwanda	
Tusingwire Yassin	Great Lakes Initiative for Human Rights and Development
Dr Alexandre Simons	Institute of Policy Analysis and Research
Eugenia Kayitesi	Institute of Policy Analysis and Research
Professor Deo Jaganyi	University of Rwanda
Anghassi Mkrtchyan	World Bank
Peace Aimee Niyibizi	World Bank
Tanzania	
Prof Forunata Songora Makene	Economic and Social Research Foundation
Dr Tausi Mbaga Kida	Economic and Social Research Foundation
Vivian Kazi-Mateng'e	Economic and Social Research Foundation
Donald Mmari	Research on Poverty Alleviation
Erik Thomas	Science, Technology and Innovation Policy Research Organisation

Name	Organisation
Dr Gussai Sheikheldin	Science, Technology and Innovation Policy Research Organisation
Dr Musambya Mutambala	Science, Technology and Innovation Policy Research Organisation
Dr Asifa Nanyaro	Tanzania Academy of Sciences
Prof Esther Mwaikambo	Tanzania Academy of Sciences
Uganda	
Hebert Kamusiime	Associates Research Trust
Jakob Rauschendorfer	International Growth Centre
Nicole Ntungire	International Growth Centre
Edith Wakida	Mbarara University of Science & Technology
Dr Jackson Orem	Uganda Cancer Institute
Hellen Opolot	Uganda National Council for Science and Technology
Ismail Barugahara	Uganda National Council for Science and Technology
Dr Peter Ndemere	Uganda National Council for Science and Technology
Ronald Jjagwe	Uganda National Council for Science and Technology

Appendix B – Peer reviewers

The present report includes information and insights from a range of individual country reports. These were peer reviewed by the following individuals whose assistance we gratefully acknowledge.

Table 5. List of peer reviewers

Reviewer	Affiliation	Country reports reviewed
Ajoy Datta	On Think Tanks	Ethiopia, Kenya, Tanzania, Ghana, Nigeria, Rwanda, Uganda
Justin Pulford	Liverpool School of Tropical Medicine	Ghana, Nigeria, Rwanda, Uganda
Robin Drennan	Wits University	Ethiopia, Kenya, Tanzania, Ghana, Nigeria, Rwanda, Uganda
Yaso Kunaratnam	UK Collaborative on Development Research (UKCDR)	Kenya, Nigeria

Appendix C - Needs Assessment Protocol

Prepared for DFID's Strengthening Research Institutions in Africa project

1. Introduction

This document presents the proposed protocol for the Needs Assessment for research system strengthening in seven African countries: Kenya, Ghana, Ethiopia, Uganda, Rwanda, Nigeria and Tanzania.

1.1 Objectives

The Terms of Reference for the Needs Assessments provides guidance on the objectives of the exercise and the expected approach. In brief, the assessment should aim to:

- Summarise the research system context
- Identify key stakeholders and processes
- Identify bottlenecks or constraints
- Recommend opportunities to strengthen i) the research system and ii) research organisations[b]

Consistent with the ToR, this document presents a clear methodological framework that draws on the findings of the Rapid Evidence Assessment (REA) that preceded this study and seeks to ensure quality and standardisation of findings between countries.

1.2 Scope of work and approach

The protocol combines two separate exercises in a single framework. The first exercise is an evaluation of a country's political economy and an assessment of how this is likely to affect research capacity strengthening activities. This part of the study uses a methodology developed using the key concepts and approaches suggested by DFID's own guidance.

The second exercise is an in-depth evaluation of the research system's current state, looking at two functions of research: production and diffusion. The methodology for this part of the assessment

[b] Note: we do not expect to make recommendations to strengthen specific research organisations, but rather to recommend a general approach to working with organisations in a given country, with suggestions on the most appropriate mechanism(s) for prioritising recipient organisations.

draws on some of the indicators proposed in the Doing Research Assessment Framework, which was developed by the Global Development Network (GDN).

Each indicator is assessed using a 7-point Likert scoring system that ensures comparability between quantitative and qualitative indicators and highlights constraints to capacity strengthening. Among these bottlenecks, priorities for intervention are set by looking at a problem's seriousness, tractability and relative impact.

1.3 Lessons learned from previous assessment exercises

Our approach has been informed by the lessons learnt by similar exercises that were previously conducted. In particular, the Doing Research Assessment Programme mentioned above has highlighted a number of considerations which we have taken into account in developing this protocol. These are summarised in Table 1 below.

Table 1 Lessons learned from the GDN Doing Research Assessment Programme

Area	Findings and lessons learned	Implications for our approach
Research methods	A mixed methods approach that combines qualitative approaches and quantitative data collection is the most effective.	We will adopt a mixed methods approach, combining desk review with informant interviews.
Disciplinary approach and use of quantitative data	It is important to adopt an interdisciplinary approach. Teams comprised primarily of economists and/or which overemphasised the use of quantitative data found it more difficult to develop a holistic understanding of the research environment.	Our team combines expertise from a range of disciplinary backgrounds. The political economy analysis considers political and cultural perspectives alongside economic and quantitative evidence.
Use of surveys	All but one of the GDN pilot studies used quantitative surveys in conjunction with qualitative methods. However, many of the surveys suffered from low response rates, with clustering within certain regions and institutions, and were generally not considered representative.	We do not plan to use surveys as part of our methodology, in light of both time and budget constraints, and the limited value gained from this approach by the GDN research teams. Surveys are also of limited importance given the study's focus on systems and, secondarily, organisations.
Peer review and expert advice	Peer review and the contribution of multiple external advisors was found to be very valuable.	Peer review of our draft outputs is incorporated into our approach, and we will draw on external advisors at multiple stages throughout our work. Peer reviewers will drawn on the list prepared for the REA peer review, complemented by other

Area	Findings and lessons learned	Implications for our approach
		experts and stakeholders (see section 5.2 below).
Scope of work relative to available budget	The broad scope of the objectives makes it difficult to address all research questions, and many teams considered the level of funding received to be insufficient. The budgets for completion of the SRIA assessments are roughly comparable, but SRIA is being completed over a tighter timeframe and is significantly broader in scope (it encompasses the entire research system rather than social science only).	It will be important for the research team and DFID to recognise the broad scope of our objectives from the outset of this work, and to acknowledge that it may be difficult to address these in full for all seven countries. In over to overcome this limitation, the proposed methodological framework relies on existing evidence (secondary data collection) and integrates it with empirical data from informant interviews.
Transferability	The GDN pilot studies were highly contextualised and qualitative, and did not contribute many easily measurable or comparable indicators. Even where studies used a shared research methodology it proved difficult to draw out patterns, commonalities and a common structure.	Our methodology uses an assessment framework that ensures comparability across the in-scope countries for our work. Furthermore, we recognise the importance of context when interpreting the findings and we consider the extensive validation of draft outputs an integral part of the methodology.
Validity and credibility	The external evaluation scored all seven GDN research reports as 'weak' or 'moderate' on the criterion for 'Demonstrating measurement validity'. Validity requires that there is opportunity for feedback from participants or other researchers, and that their opinions are fed back into the research to verify findings.	See above. We propose to share draft outputs with informants and other experts, making provision for their opinions to feed into our final findings and outputs. We will seek validation from national and international stakeholders to mitigate biases, and will consider potential conflicts of interest when interpreting findings.
Research dissemination and policy linkages	The quality of research dissemination and policy linkages was found to be variable, but was strongest where partnerships were formed, or where existing links to policy makers could be leveraged.	We will work with DFID to explore arrangements for research dissemination, ensuring these are maximised in accordance with DFID's open and enhanced access policy. Specifically, sensitive information will be redacted from the publicly available version.

2. Needs Assessment indicators

2.1 Political economy analysis

The first part of the Needs Assessment is a political economy analysis. Following DFID's guidance, country-level political economy analysis comprises of three components: structures, institutions and agents.

2.1.1 Structures

Structures are the long-term contextual factors that are not readily influenced by external action, either because of the time scale needed, or because they are determined outside the country. The contextual factors that are relevant to this study include political, economic and social structures, competitiveness and technological progress.

- **Social and political context**: include demographic and political-economic parameters such as a country's urban population, literacy rates, government stability, rule of law, corruption level, freedom of expression (for press and net) and national literacy rates.
- **Economic context**: include data on the country's economic development. Specifically, it looks at high-level indicators (such as various GDP measures, GNI, population below income poverty line), the quality of its digital infrastructure (e.g. access to and speed of internet connections) and its overall competitiveness (e.g. technology readiness, innovation capacity and global competitiveness ranking).

2.1.2 Institutions

Institutions can be formal institutions or informal. Formal institutions are the codified laws and policies regulating research, and the organisations that promulgate, implement and enforce them. Informal institutions are the political, social and cultural norms that underpin the formal institutions. This section focuses primarily on formal institutions, for practical reasons, but seeks to discuss informal institutions wherever convincing evidence emerges.

- **National policy for research**: includes parameters concerned with the strength of the national policy framework, such as whether the country has an up-to-date national research policy or strategy in place. It also looks at the existence of an innovation strategy and of national standards for research quality and practice.
- **National research institutions**: parameters focus on the existence and perceived effectiveness of policymaking and standard-setting bodies (government) and research funding organisations (public and private). The level of resources and management capacity of national organisation is considered a proxy for effectiveness.

2.1.3 Agents

Agents include internal actors of a governmental and non-governmental nature, and external actors such as foreign donors, international and regional organisations. This section maps the most

influential actors or stakeholders within the national research systems, their roles and influence, and their relationships.

- **Stakeholder mapping**: indicators focus on the clarity of the role of non-institutional actors within a research system, both internal (such as research organisations, research intermediaries and private research funders) and external (such as foreign donors, international and regional organisations).

Table 2. Stakeholder mapping (typologies of stakeholders)

	National		International	
Organisation type	**Public**	**Private**	**Public**	**Private**
Policymaking / rule-setting	Gov department Other	-	Int'l organisation	-
Research funding	Government body Gov-funded	Foundations Charities	Dev. Funders Research funders	
Research intermediary	Advocacy Support Information-sharing			
Research performing	Universities Gov agencies	Universities Think tanks Charities	Universities Think tanks Charities	

- **Relationship and interdependencies**: indicators focus on the hierarchical and horizontal relationships between agents and institutions. Factors considered here include the level of coordination between government departments, the cohesion between policy mechanisms, the level of participation in decision-making/standard-setting, the level of autonomy of research funders and the existence of mechanism for policy monitoring and enforcement (M&E).

In-depth: Stakeholder *relationships*
We will seek to map key stakeholders and their relationships. This aspect of our work will be developed initially through a combination of desk research and our existing knowledge of many of the target countries. Sources and studies that can be drawn on for this work include: • **Previous mapping exercises undertaken by international organisations** – e.g. Mapping Research and Innovation in the Republic of Rwanda (2015), UNESCO • **National science and innovation/technology policies** – e.g. Ethiopia (2012), Kenya (2012), Nigeria (2012). We note that many of these documents are more than 5 years old, however.

- **Regional science, technology and innovation strategies and policies prepared by the regional economic communities (RECs)** – e.g. the Economic Community of West African States (ECWAS), the Strategic Plan of the East African Science and Technology Commission (2017)

The mapping of research actors will be used to categorize the types of institutions present in the system and their relative importance in terms of role and influence in the production, diffusion (knowledge exchange) and uptake of research. Where possible, we will prepare overview maps summarising the major components of national research systems, similar to that presented in *Figure 2*, complete and validate them through informant interviews. In addition, desk-based research will be undertaken to prepare a preliminary analysis of organisational research management capabilities within the selected countries. This will allow us to identify potential opportunities for leveraging policy change and supporting reform which can be validated and further explored in subsequent phases of work.

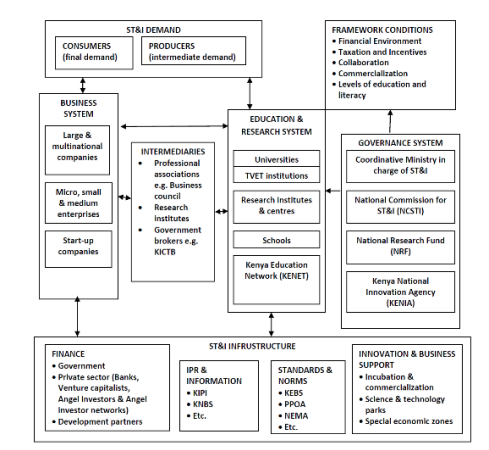


Figure 2 Components of the Kenya National Innovation System (Source: Kenya's 2012 policy framework for STI)

2.2 Research system performance

The second part of the Needs Assessment looks at research system performance within the selected country, and then comparatively across the seven in-scope countries. It does so by looking at two processes:

- **Research production**, or the process through which research is created by researchers and research organizations, including necessary inputs and activities which directly enter the production function.
- **Research diffusion** (knowledge exchange), or the channels through which research knowledge and products are exchanged with different audience groups, including academia, policymakers, civil society and the private sector.[c]

For each function, the assessment considers inputs, activities and outputs. Research culture and support services are considered in a dedicated section due to their relative importance, as evidenced by the REA. Table 3 below summarises the way processes and functions interact in the research system.

[c] Note that 'diffusion' looks at the mechanisms and practices to share research knowledge, outputs and products with non-academic actors. It is not to be confused with uptake, which looks at specific examples of research that has been used by non-academic actors.

Table 3. Matrix of the research processes and functions

Research system functions	Research system processes		Production	Diffusion
	Inputs	Tangible assets needed to produce robust research	RESEARCH INPUTS	ACTORS & NETWORKS
	Activities	Set of rules, ethical principles, activities and interactions producing and promoting research	RESEARCH CULTURE AND SUPPORT SERVICES	KNOWLEDGE EXCHANGE PRACTICES
	Outputs	Tangible products of research including publications, data, patents, materials, communications	RESEARCH OUTPUTS	KNOWLEDGE EXCHANGE PRODUCTS

2.3 Research production

2.3.1 Research inputs

This component considers the tangible assets necessary for research production within a national system. It considers three components of a research system: human capital (researchers), financial capital (research funding) and capital assets (research infrastructure).

- **Human capital**: the indicators considered in this section are the total R&D personnel per million inhabitants and the number of researchers per million inhabitants, including proportion of female researchers. Other factors are the proportion of researchers with ISCED 8 qualification and then the distribution of researchers among different sectors - business, government, academia and non-profit.
- **Research funding**: the key parameter used in this section is gross expenditure for research and development (GERD). The assessment focuses on absolute GERD, GERD per researcher, source of expenditure (foreign funders, national government, business, higher education institutions and non-profit organisations) and distribution of funding across disciplines.
- **Research organisations**: this section looks at the breadth of research organisations, their performance and impact. In particular, indicators assess university research performance and the sector growth over the past decade. They consider the average quality of research organisations, and the quality and global standing of a country's 'centres of excellence'.

2.3.2 Research culture and support services

This component assesses the set of cultural rules and principles, activities and interactions supporting the production of research.

- **Research culture**: the framework assesses the perceived role and value of research among policymakers, university leaders and business leaders, and the time allocated by university academics to research vis-à-vis other functions (such as teaching, supervision and administration).
- **Research training:** indicators seek to assess the ease of getting research training such as PhD, and the ease of finding academic positions and build a research career after training.
- **Capacity building**: indicators for research capacity building include the percentage of academic staff with doctoral qualifications, the availability of specialised research and training services and the level of funding for research capacity strengthening.
- **Research support and administration**: indicators seek to assess the level of research support within individual research organisations and more generally across the system. They include the existence of institutional policies for research support, the perceived quality of administrative support and the level of access to proposal writing support.
- **Digital infrastructure and data**: key indicators are the quality of access to data and quality of research infrastructure, as evidenced through informant interviews.

2.3.3 Research output and evaluation

This component considers the products of scientific research (publications and patents) and the existing incentives for producing research. It is concerned with volume of research and not quality.

- **Research publications**: The document will look at the total publication output from a country's researchers and how this has been trending over time. It will consider both the absolute number of publications and the number per inhabitant. This section does not consider the quality and reach of publications.
- **Research evaluation and ethics**: This section looks at the existence of national standards for research and practice. It then uses evidence gathered through informant interviews to assess the quality of the incentive system to produce research.

2.4 Research diffusion

This part of the framework assesses the actors and practices underpinning the sharing of knowledge with academic and non-academic actors, and the diffusion of tangible products of research including publications, data, patents, materials and communications.

2.4.1 Actors and networks

This component focuses on two categories of actors that are involved in research diffusion: national actors that can commission or directly use research; and international actors arising from research collaborations, and which can be both producers and users of research.

- **National users of research**: indicators focus on the actors exercising a significant 'pull factor' for research: the government and the private sector. Specifically, indicators focus on the level of government procurement of technology products, government commissioning of research, university-industry collaborations, firm-level technology absorption and technology transfer.

- **International exposure**: the focus is on the extent of international collaborations, using that as a proxy for external diffusion of research. Indicators include the total number of international collaborations in a country and list the main foreign countries where research partners established. Indicators also consider the diffusion of scientific publications are the number of national scientific journals, number of citations and average citation rates.

2.4.2 Knowledge exchange practices

This component looks at the activities and structures supporting the exchange of research-based knowledge. Specifically, it considers three domains: the quality and visibility of scientific production, the level of intellectual property generated within the country and the quality of knowledge exchange support and administration.

- **Intellectual property**: the section looks at the total number of residential, non-residential and filed-abroad patents produced in the country and the number of patent grants awarded. The data refers to the overall number of patents, not only those produced by research, and should therefore be interpreted as a crude measure of a country's innovative capacity, as opposed to a measure of the innovative capacity of the research system specifically.
- **Knowledge exchange support**: key indicators are the existence of institutional policies and quality of delivery; the existence and effectiveness of knowledge exchange intermediaries; and the quality of administrative support for IP and commercialization.

Table 4. Complete list of Needs Assessment indicators

COMPONENT	INDICATOR	DATA	METHOD	SOURCE
1. National context (structures)				
1.1 Social and political indicators				
1.1.1 Social and political factors	Working language	Qualitative	Desk review	[85]
	Total population (millions)	Absolute	Desk review	[86]
	Urban population (% of total)	Absolute	Desk review	[86]
	Type of government	Qualitative	Desk review	[87]
	Government stability	Score	Desk review	[88]
	Rule of law	Score	Desk review	[88]
	Regulatory quality	Score	Desk review	[88]
	Government effectiveness	Score	Desk review	[88]
	Voice and accountability	Score	Desk review	[88]
	Corruption (ranking)	Rank	Desk review	[89]
	Access to information	Score	Desk review	-
	Freedom of expression	Score	Desk review	[87]
	Adult literacy rate (% population aged 15+)	%	Desk review	[90]
	Gender Development Index	Score	Desk review	[91]
1.2 Economic indicators				
1.2.1 Economic development	GDP per capita US$	Absolute	Desk review	[74]
	Agriculture, value added (% of GDP)	%	Desk review	[74]
	Manufacturing, value added (% of GDP)	%	Desk review	[74]
	Population living in poverty ($1.9/day)	%	Desk review	[74]
1.2.2 Digital infrastructure	Access to internet (ranking)	%	Desk review	[92]
	Individual using Internet/100 people	%	Desk review	[92]
	Broadband internet subscription/100 people	%	Desk review	[92]
	International internet bandwidth, kb/s per user	Absolute	Desk review	[92]
	Mobile internet subscriptions/100 pop	%	Desk review	[92]

COMPONENT	INDICATOR	DATA	METHOD	SOURCE
1.2.3 Competitiveness	Global Competitiveness Index (ranking 2018)	Rank	Desk review	[92]
	Overall technology readiness	Score	Desk review	[92]
	Capacity for Innovation	Score	Desk review	[92]
	Innovation index	Score	Desk review	-
2. Enabling environment (institutions)				
2.1 Policy and institutional framework				
2.1.1 National policies	Existence of a national research policy	Y/N	Interview	Various
	Existence of sector-specific research policies	Y/N	Interview	Interviews
	Research policy updated in the last 10 years	Y/N		[93]
	Existence of an appropriate Strategy for STI	Y/N	Desk review	Interviews
	Capacity development is part of the Strategy	Y/N	Desk review	Interviews
	Country has appropriate indicators tracking R&D	Y/N	Desk review	Interviews
2.1.2 National institutions	The country has a ministry or department for research	Y/N	Interview	Interviews
	The ministry/department for research is sufficiently resourced	Y/N	Interview	Interviews
	The country has one or more national research funders	Y/N	Interview	Interviews
	The research funders have sufficient financial resources	Y/N (value)	Interview	Interviews
	Quality of the research funder management capacity	Score	Interview	Interviews
	The country has a national research ethic body	Y/N	Interview	Interviews
3. Stakeholder analysis (agents)				
3.1.1 Stakeholder composition	Clarity of relationships between national actors	Score	Interview	Interviews
	Clarity of decision-making and accountability processes	Score	Interview	Interviews
	Level of coordination between government department	Score	Interview	Interviews
	Cohesion between policy mechanisms	Score	Interview	Interviews
	Level of participation in decision-making/standard-setting	Score	Interview	Interviews
	Quality of monitoring & enforcement mechanisms (M&E)	Score	Interview	Interviews
4. Production of research				
4.1 Research inputs People and resources needed to produce robust research.				
4.1.1 Human capital	Total R&D personnel per million people (FTE)	Ratio	Desk review	-
	Researchers per million inhabitants (FTE)	Ratio	Desk review	[94]
	Researchers (FTE) - Business enterprise	%	Desk review	[94]
	Researchers (FTE) - Government	%	Desk review	[94]
	Researchers (FTE) - Higher education	%	Desk review	[94]
	Researchers (FTE) - Private non-profit	%	Desk review	[94]
	Researchers (FTE) – Female	%	Desk review	[94]
	Researchers (FTE) with ISCED 8	%	Desk review	[94]
4.1.2 Funding	GERD per capita (%GDP)	%	Desk review	Desk
	GERD per researcher FTE (in current PPP$)	%	Desk review	-
	GERD financed by abroad (% total)	%	Desk review	-
	GERD performed by %			
	%			
	%			
	%			
4.1.3 Research organisations	Average quality of research organisations	Rank	Desk review	[92]
	Global ranking of Top University	Rank	Desk review	[95]

COMPONENT	INDICATOR	DATA	METHOD	SOURCE
	Global ranking of Top University			
	Global ranking of Top University			
4.2 Research culture and support services Set of cultural rules and principles, activities and interactions supporting the production of research				
4.2.1 Research culture	Perceptions of the utility of research	Score	Interview	Interviews
	Time allocated to research	%	Interview	Interviews
4.2.2 Capacity building	Local availability of specialized research and training services	Score	Desk review	Interviews
	Funding for Research Capacity Strengthening	Score (value)	Interview	Interviews
	% HEI with PhD programmes	%	Interview	-
4.2.3 Research support and administration	Level of access to proposal writing support	Score	Interview	Interviews
	Existence of institutional policies	Y/N	Interview	Interviews
	Quality of administrative support	Score	Interview	
4.2.4 Infrastructure and data	Is there a central repository for research data?	Y/N	Interview	Interviews
	Quality of research infrastructure	Score	Interview	Interviews
4.3 Research output and evaluation Products of scientific research (publications and patents) and incentives for producing research				
4.3.1 Research publications	Total # of publications (2018)	Absolute	Desk review	[96]
	Total # of citable publications	Absolute	Desk review	[96]
	Citations per publication (1996-2018)	Absolute	Desk review	[96]
	Citations per publication ranking (1996-2018)	Absolute	Desk review	[96]
	Publications per million inhabitants	Absolute	Desk review	[96]
	# Journals listed in SciMago	Absolute	Desk review	[96]
	Scimago country ranking 2018	Rank	Desk review	[96]
	% of the total output for Africa	%	Desk review	[96]
4.3.4 Research evaluation	Existence of national mechanisms for research quality evaluation	Y/N	Interview	Interviews
	Quality of incentives for research production	Score	Interview	Interviews
5. Diffusion of research				
5.1 Actors and networks National users of research and international research partners				
5.1.1 National users of research	Firm Level Technology absorption	Score	Desk review	[92]
	FDI and Technology Transfer	Score	Desk review	[92]
	Gov't procurement of technology products	Score	Desk review	[92]
	Government use of research information/products	Score	Interview	Interviews
5.1.2 International exposure	Percentage of papers in 10% most-cited papers (2008–2012)	%	Desk review	[97]
	International collaboration 2018 (% of total)	%	Desk review	[96]
	Main foreign partners	Value	Desk review	[96]
5.2 Knowledge exchange practices Activities and structures supporting the exchange of research-based knowledge				
5.2.1 Intellectual property	Country has a body in charge of intellectual property protection	Y/N	Desk review	[93]
	Country is member of a regional IP organisation	Y/N	Desk review	Various
	Number of patents applications per million people (global ranking)	Absolute	Desk review	[92]
	Number of patents applications per million people (African ranking)	Absolute	Desk review	[92]
5.2.3 Knowledge exchange support and administration	Country has joined a regional initiative for the promotion of STI	Y/N	Desk review	
	University-Industry collaboration (score)	Score	Desk review	[92]
	University-Industry collaboration (ranking)	Rank	Desk review	[92]
	Existence of appropriate institutional policies for	Score	Interview	Interviews

COMPONENT	INDICATOR	DATA	METHOD	SOURCE
	KE			
	Quality of incentives for research diffusion	Score	Interview	Interviews
	Existence of commercial office	Y/N	Interview	Interviews

3. Needs Assessment methodology

In order to ensure comparability between different types of data, each of the above indicators is scored using a 7-point Likert scale.

Table 5. Scoring scale for qualitative and quantitative indicators

Score	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

The scoring of indicators provides the evidence base for identifying constraints affecting the research system. Indicator scores are grouped to provide an average score for each of the research system components discussed above. Averages will be rounded off to the first decimal.

Table 6. Component scoring system

Section	Research system component	Score	Component ID
National context	Social and political context		RSC1
	Economic context		RSC2
	Total		-
Policy and institutional framework	National policy for research		RSC3
	National institutions for research		RSC4
	Stakeholder composition & relationships		RSC5
	Total		-
Research inputs	Human capital		RSC6
	Research funding		RSC7
	Research organisations		RSC8
	Total		-
Research culture and support	Research culture		RSC9
	Capacity building		RSC10
	Research support		RSC11
	Infrastructure and data		RSC12
	Total		-
Research outputs and evaluation	Research publications		RSC13
	Research evaluation		RSC14

	Total		-
Knowledge exchange (KE) actors and networks	National users of research		RSC15
	International exposure		RSC16
	Total		-
KE practices	Intellectual property		RSC17
	KE support and administration		RSC18
	Total		-

We note the importance of defining qualitative and quantitative key performance indicators (KPIs) to assess progress and performance and propose using a mixed method approach comprising of desk review and informant interviews. The above proposed methodology contains qualitative and quantitative indicators to assess both political economy and research system needs.

Quantitative indicators (such as literacy rates, number of publications, GERD etc) are sourced as much possible from existing evidence, some of which was identified in the Rapid Evidence Assessment (REA) that preceded this study. This evidence is then complemented by qualitative indicators (such as the quality of an institution's management capacity, quality of specific decision-making processes etc), which are largely sourced through informant interviews.

4. Recommendations

3.1 Identification of priorities

The scoring of indicators will indicate the main constraints within a research system. To determine the relative importance of these constraints and identify priorities for action, however, a further step is necessary. This will follow three criteria:

- **Severity**: the first is the severity of the constraint, represented by the score of an indicator or set of indicators; the lower the score the more serious the problem, the higher the priority.
- **Significance**: the second criteria is the constraint's significance, determined by its likely or evidenced impact on the functioning of the research system; the higher its overall impact, the higher the priority. Significance will also be scored using the seven-point scale (very low to very high).
- **Tractability**: the final criteria is the tractability of the constraint, by that meaning the ability of an external actor to influence the trajectory of a specific indicator/set of indicators; the more tractable a problem the higher its priority. As above, tractability will be scored using the Likert scale (very low to very high).

The assessment of significance and tractability will be informed by the outcomes of the Rapid Evidence Assessment (REA) and the insights gathered through informant interviews. Interpretation will be validated in the later stages of the project. The combination of the three scores will highlight the indicators and components that should be prioritised by DFID.

The report will present three priority areas for interventions in the country, which result from consideration of the above factors.

3.2 Conclusions

Once the priority issues are identified, the conclusions will briefly consider appropriate approaches to intervention. This section will not focus on specific strategies or action. Instead, it will draw on the REA findings and informant interviews to recommend the appropriate *entry point* for an intervention. The *entry point* indicates the type(s) of organisation(s) that DFID should consider working with to address that problem, drawing on the typology proposed in table 2 above.

5. Implementation of the assessment framework

4.1 In-country visits

Drawing upon the lessons learnt from the pilot country visit, and in consultation with DFID, we have identified a sample of consultee research organisations and stakeholders to reflect differing phases of research activity, discipline, reputation, prevalence, and development. We will thus deliver a focussed appraisal of current research environments, targeting the key stakeholders, and ensuring we gain an understanding of key processes, system bottlenecks, and the opportunities to strengthen research systems and specific organisations.

4.1.1 Stakeholder selection

As opposed to established research sectors such as the UK, USA or Australia, there is a limited number of organisations which commission or conduct research in African countries and therefore our sample size for the in-country needs assessment may *appear* to be limited. Working within these limitations, we sought to engage with a range of organisations that provides a balanced overview of the research system. Specifically, we will engage with the following types of stakeholders:

- National policy-making bodies (e.g. relevant ministries)
- International organisations (e.g. World Bank, UNESCO, UNDP)
- National and international funding agencies
- National and international research organisations
- National and international research intermediaries (e.g. membership associations, advocacy organisations etc).

4.1.2 Schedule of visits

The visits will take place over two periods in order to make results available for a selection of the countries ahead of the final report and to act as a further quality check that the information produced fits what is required. The first set of visits will be undertaken between 22 May – 8 June and it will include the following countries: Kenya, Ethiopia, Rwanda, Tanzania. The second set of visits will be undertaken between the 29th of July and the 14th of August and it will include the remaining three countries: Nigeria, Ghana, Uganda. Table 6 provides a provisional list of organisations that will be consulted in each county. Please note that some interviews have not yet been confirmed, so the final list may change.

4.1.3 Interview process

We anticipate undertaking 6-8 semi-structured interviews in each country. Data will be collected and stored using digital audio recording (e.g. MP3) where interviewees permit. In cases where they do not, all interviews will be undertaken in pairs to enable detailed note-taking. Interview notes will be typed up according to agreed formats and standards, to be developed as part of the pilot visit. The UK researchers will assist with coding and analysis, and integration of the results into the adapted DRA framework.

Table 7. Provisional list of informant interviews (organisations only)

Country	International actors	National and subnational actors
First visit (22 May – 8 June)		
Kenya	• African Academy of Sciences (pilot) • African Capacity Building Foundation • African Population Health Research Center (pilot) • East African Research and Innovation Management Association • World Bank	• Kenya Medical Research Institute • Kenya National Innovation Agency • National Commission on STI • National Research Fund • Strathmore University (pilot)
Ethiopia	• The African Union • UNDP • World Bank	• Adama Science and Technology University • Addis Ababa University • International Growth Centre • Ministry of Innovation and Technology
Rwanda	• World Bank	• Institute for Policy Analysis and Research • National Council for Science & Technology • Rwanda Academy of Sciences • University of Rwanda
Tanzania	• East African Research & Innovation Management Association	• Economic and Social Research Foundation • National Commission for Science & Technology nzania Academy of Sciences • University of Dar es Salaam • University of Rwanda
Second visit (29 July – 14 August)		
Nigeria	• West African Research & Innovation Management Association • World Bank	• Federal Ministry of Science and Technology • National Universities Commission

		• National Office for Technology Acquisition and Protection • Nigerian Academy of Sciences • Nigerian Institute of Medical Research • University of LagosUniversity of Lagos
Ghana	• African Research Universities Alliance • World Bank	• Council for Scientific and Industrial Research • International Growth Centre Ghana • Ministry of Environment, STI • Research and Grant Institute of Ghana • University of Cape Coast • University of Ghana
Uganda	• Associates Research Trust • World Bank	• Development Research and Training • Kampala International University • Makerere University • MRC/Uganda Virus Research Institute • National Council for Science & Technology

4.2 Engagement with delivery partners

In addition to the in-country informant interviews, we will engage with a selected number of international stakeholders. An important part of our work will take the form of consultation with global funding bodies, consortia and projects, to survey successes, failures and their opinion of possible sustainable approaches to system-strengthening in Sub Saharan Africa. This engagement phase will take place between the first and second set of country visits and it will be used to explore and validate our emerging recommendations. After consultation with DFID, a provisional list of delivery partners we propose to contact includes:

- Africa Capacity Building Initiative/ACBI (Royal Society)
- ESSENCE on Health Research (World Health Organisation)
- KSI (University of Greenwich)
- Research Management Programme in Africa/ReMPro (African Academy of Sciences)
- Science Granting Funding Initiative/SCGI (Tritoma)
- Strengthening Evidence for Development
- Strategic Partnerships for Higher Education Innovation and Reform/SPHEIR (British Council)

6. Quality assurance and standardisation between countries

5.1 Potential limitations of the needs assessment

Our previous experience of conducting needs assessment analysis in sub-Saharan Africa suggests that, in addition to the practical challenges and lessons learned outlined in section 2.2, there are several variables that we may not be able to fully control:

False Impressions

- When conducting face-to-face consultations, we have found a tendency for interviewees to give us the information that they *think* we want to hear. This is borne out of an instinctive inclination for interviewees to want to be helpful (which is a common occurrence when conducting any type of interview-based research) but also out of the misconception that we are representatives of a funding body and therefore may be meeting with the intention of investing in research. We will provide absolute clarity about our role and the purpose of our visit but it is worth noting the predisposition to please *may* slightly distort some of our findings.

International influence

- Within the context of a research ecosystem that is supported overwhelmingly by external actors, research organisations are operating against a cluttered backdrop of competing donor priorities and (where they exist at all) fragmented national research priorities. Such influence may also skew our findings if interviewees seek to report to funders' objectives as opposed to nationally-defined ones. This consideration will inform our interviewee selection as well as our approach to informant interviews.

National differences

- Whilst there are some obvious similarities across national research environments, such as funding culture and language barriers, the socio-economic and political environments in each of the seven priority countries bears significant influence on the functioning of the research system and the opportunities to strengthen it. The political economy analysis will follow a framework to expose such differences and interpret the needs assessment in a consistent fashion. Standardisation of approach across the seven countries will be further promoted through the use of a consistent team for the three in-country phases of our work (pilot, first three countries and final four countries).

Score-based evaluation

- We recognise the intrinsic limitation of using a scoring methodology, especially with regards to qualitative indicators. Scoring is a subjective exercise that reduces complex information to a number. The use of a standardised assessment framework facilitates the standardisation of results between countries but may fail to sufficiently reflect the nuances behind each score. Efforts will be made to source as much evidence as possible on each indicator, from a representative selection of in-country informants. Where indicators rely on a small number of interviews and subjective evaluations from informants, extensive validation will be sought (see below). Moreover, indicators will be accompanied by a short narrative that will provide as much context and depth as possible on the issue examined.

5.2 Validation of findings

To address these limitations, we have incorporated extensive validation process into the Needs Assessment methodology, project plan and budget. Specifically, we have planned for four steps:

1. First, when first drafting the country report we will cross-check all information where limited evidence is available with information from the literature, as evidenced by the REA.
2. Second, we will seek to validate the scoring as extensively as possible by circulating a redacted version of the draft country report among informants, so as to ensure that their contribution has been reported fairly and that our assessment is accurate.
3. Thirdly, subject to agreement with DFID, we will share a redacted version of the summary report with international experts (e.g. implementing partners of donor-led RCS activities or relevant members of national and international organisations working in this area) to further validate its analysis and conclusions. Respondents will be asked to focus on those indicators and components where less strong evidence was available.
4. Finally, we will enforce peer review and quality assurance processes within the team itself. Quality appraisal of assessments will be carried out by nominated peer reviewers within our wider team with expertise in systems research.

7. Synthesis and reporting

6.1 Reporting timetable and formats

A large number of deliverables will be produced over the course of the Needs Assessment, as summarised in Table 7. The needs assessment draft protocol, report on piloting and final needs assessment protocol are payment associated milestones and should be no more than 25, 10 and 25 pages respectively. The country needs assessments should be no more than 15 pages each excluding annexes.

Table 8. Summary of project deliverables

Deliverable title	Details and timeframe	Expected delivery date
Needs Assessment protocol (early draft)	12 weeks post-contract	29 March 2019
Pilot country report	Kenya - 16 weeks post-contract	26 April 2019
Steering meeting at DFID	18 weeks post-contract	10 May 2019
Needs Assessment protocol (advanced)	Unplanned	03 May 2019
Needs Assessment protocol (final)	19 weeks post-contract	17 May 2019

Country assessment reports for Kenya, Ethiopia, Rwanda, Tanzania	7 months post-contract.	07 August 2019
Steering meeting at DFID	7 months post-contract	07 August 2019
Country assessment reports for Ghana, Nigeria, Uganda	9 months post-contract	07 October 2019
Dissemination workshop at DFID	9 months post-contract	07 October 2019

The format of the country needs assessment reports will be developed as part of the pilot process and shared with DFID for review and feedback. The agreed format is appended to the final version of the full protocol.

6.2 Synthesis of results and formulation of recommendations

Building on the Needs Assessment methodology, the synthesis report will explore the potential to benchmark research systems across the seven countries, and provide an overall assessment of research system needs, identifying common themes and challenges. A comparative analysis of the indicators will provide the quantitative backdrop to understand the relative performance of different research systems. The document will seek to identify commonalities and differences between sub-groups of countries (e.g. low-income v middle-income, East African v West African, low performance v high performance), while highlighting each country's unique national circumstances.

Where possible, the report will also seek to infer correlations between structural, institutional and agent-related circumstances and the performance of a research system. It will identify common needs with the highest return on investment and provide recommendations on the areas with the greatest scope to intervene, at both system and organisational level.

Finally, the synthesis report will also reflect on the value of the assessment framework, acknowledging any challenges and limitations encountered in its development and implementation, and providing recommendations on how it might be further developed and used in the future.

Appendix D - References

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