Unpacking Knowledge Systems for sustainable development in East Africa: Practical perspectives from Kenya, Rwanda and Tanzania.

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Many Low-Middle Income Countries (LMIC) are embracing Science, Technology and Innovation (STI) as a means of catalysing their development agenda and achieving the post-2015 Sustainable Development Goals (SDG). A number of LMICs, especially those in sub-Saharan Africa (SSA), are now attempting to strengthen STI systems with new policies, institutional arrangements and investments. These countries are further motivated by the desire to speed up Africa's transition to an innovation-led, knowledge-based economy. Indeed, the African Union's STI *Strategy for Africa 2024* (STISA-2024) and its *Agenda 2063* ('The Africa We Want') are strongly pushing innovation agendas – including green innovation and business innovation – as catalysts for the continent's prosperity.

Most African countries have historically lagged behind in STI investment. For the last decade, Africa has contributed only 0.6% of the world's gross expenditure on research and development (GERD), as compared to the figures for Asia and Europe 30.5% and 27.2% respectively. So, this new focus on STI, and the emerging policy support for it, marks a major milestone.

Yet even with such vibrant policy ambitions, innovation experts and policy makers still grapple with the question of what effective STI systems look like in practice, and what can really work for SSA. There is growing awareness of the need to better understand the barriers and enablers for harnessing knowledge to meet social, economic and sustainable development ambitions in SSA contexts. There are also concerns about the mismatch of STI theories and policy and investment framings developed elsewhere, to addressing African concerns. These are poorly suited to support innovation towards the balanced growth ambitions of SSA, where inclusive and sustainable development targets are also critical.

In order to help address these challenges, the United Kingdom Government's Department for International Development (DFID) through the East Africa Research Hub (EARH) has commissioned a study on 'Understanding knowledge systems and what works to promote science, technology and innovation (STI) in Kenya, Rwanda and Tanzania' – shortened to *Knowledge Systems Innovation (KSI)*. The project is implemented through a robust North-South partnership bringing together the Natural Resources Institute of University of Greenwich, African Centre for Technology Studies, Science Policy Research Unit at the University of Sussex, the Commonwealth Scientific and Industrial Research Organisation in Australia and the Science, Technology Engineering and Public Policy (STEaPP), University College London. The project involves a number of in-country partners[1] in Kenya, Rwanda and Tanzania.

The initiative aims to help guide patterns of investment in STI capability and capacity such that they address the SDGs. The work is underpinned by a knowledge system[2] perspective.

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[1] University of Nairobi-Kenya, University of Rwanda-Rwanda, and the University of Dar es Salaam-Tanzania.

[2] Knowledge system is defined as the "agents, practices and institutions that organize the production, transfer and use of knowledge'' (Cornell et al., 2013)

Using a knowledge systems approach is useful in understanding the practical aspects of STI. The approach reveals the interconnections between diverse actors, sectors, capabilities, processes and institutional arrangements that shape the way knowledge drives different societal outcomes. The approach recognizes formal STI systems -- research agencies, universities and science and innovation coordinating agencies, clusters of policies and firms in the formal economy – but also highlights the importance of a large array of knowledge related activity in the informal sector.

A knowledge systems approach also challenges the idea that the linear transfer, use and dissemination of research and other knowledge are the key mechanisms driving innovation and development impact. In contrast to other STI frameworks, it provides a lens to understand the *political economy* of STI arrangements, and the way this shapes the direction and pattern of investment in knowledge and innovation.

We work on the simple premise that a knowledge system that can deliver effectively for the SDGs will engage a wide diversity of actors and ways of using knowledge for innovation. It will also involve policy and governance arrangements that can harness these to enable or reinforce more inclusive innovation trajectories which address SDGs.

Through processes of research and consultation, the KSI project will challenge and develop these ideas, and establish a practical knowledge system concept. This involves building an evidence base, and evaluation frameworks which will support decision making on knowledge system investments to enhance development impact.

We began the KSI project with an initial mapping of knowledge systems, examining the actors involved and the processes through which knowledge is currently organized, produced, disseminated, used and governed, in Kenya, Tanzania and Rwanda. This was also used to identify further information needed to give an adequate picture of the nature and functioning of the knowledge system in the terms that we have conceptualised it.

This blog post describes some of the early findings from initial stakeholder engagements (see [Tanzania](#), [Rwanda](#) and [Kenya](#)) and a review of literature. To date, there are several ongoing interventions that are operating beyond the formal STI arena of the knowledge systems, but most of these are yet to be documented.

How do knowledge systems work in Tanzania, Rwanda and Kenya?

Knowledge production

Knowledge production in the three countries is driven by both state and non-state actors as well as the formal and informal sectors, but the organizational and institutional framing across the three countries differs considerably. For example, while Kenya has liberalized its knowledge production, drawing from both public and non-public systems, in Rwanda the knowledge production system is dominated by state-led public policies. In the case of Tanzania, knowledge production is evolving between consolidated and liberal systems, aligned to sectors and with emphasis on agricultural co-production through extension services.

Universities and public research organizations are far from the only knowledge producing actors in each country, but they are important, with significant differences in their organisation and roles within the wider knowledge system. Kenya has embraced a relatively open university system, comprising a number of public universities that generate research knowledge, teaching and training. By contrast, Rwanda has consolidated its public universities

into a single body, 'The University of Rwanda', viewed as the country's 'knowledge hub' with a number of constituent colleges. Rwanda has developed a vibrant Technical and Vocational Education and Training (TVET) system that absorbs a growing number of students in an attempt to address social and economic challenges, as well as inclusion. The characteristics of Tanzania's University system is still not clear to us at this stage, although sectoral alignment appears important.

The outcomes of open or consolidated knowledge production systems vary from one context to another. Open- liberal systems could promote inclusivity of a diversity of actors, both formal and informal, in knowledge production – a critical factor for sustaining and expanding the knowledge base, as witnessed in Kenya even though coordinating the vast set of actors is a key challenge for the country. This may explain why Kenya's share of the total publications from the region stands at 65%, compared to Tanzania's 32% and Rwanda's 5%. It should, however, be noted that the country share of publication is also influenced by many other economic and demographic factors including population size among other.

Indeed, some of Kenya's most outstanding innovations have been led by non-state actors, including the private sector and development partners. The M-Pesa innovation is a key example here. The initiative uses mobile phone technology to catalyse money transfer, credit facilities and information flows (market information, social and environmental information among others) between producers and users of various social groups. M-Pesa's success has largely been steered through a private company, Vodafone (Safaricom), with the support of DFID (a development partner). Early development stages drew heavily on feedback from low-income user groups and feedback was incorporated into the design. Yet despite M-Pesa's high profile, its impact on broader Kenyan policy-making remains unclear.

The Rwandan government, on the other hand, seems to have established clear institutional mandates that set the agenda and enhance clear flows between knowledge production and use. This more state-led system is younger and less established, and its outputs and outcomes are less clear. For Tanzania, our early insights suggest that there is an emerging intermediary/sectorally aligned system which could be strengthened further to ensure more clarity between institutional establishments and mandates. Clarifying the directionalities of such systems and potential optimal investment options is central to this study.

How knowledge flows into use

Our mapping has also begun to examine flows of knowledge production into use in the three countries and relationships with knowledge governance – including institutional set-ups and coordination, knowledge financing and structural knowledge linkages as key enablers.

In Rwanda, a relatively consolidated and state-led system of knowledge governance has provided clarity of roles and an institutional setup that connect knowledge production and its use in selected priority areas. Rwanda has set up national structures and institutions such as the National Industrial Research and Development Agency (NIRDA), charged with coordinating and implementing knowledge use through establishment of incubation centers, training of entrepreneurs, promoting public private partnerships (PPP), and capacity building of Small and Medium Enterprises (SMEs).The result is therefore a knowledge production system that is driven predominantly from industry and industrial opportunities inform knowledge creation.

While such institutional establishments exist in Kenya and Tanzania (i.e. the Kenya Industrial Research and Development Institute (KIRDI) and Tanzania Industrial Research and Development Organization (TIRDO)), their engagement with produced knowledge remains unclear – mainly due to lack of proper structural pathways to enable these agencies to

effectively coordinate knowledge flows. Instead, many other actors and institutions (both state and non-state) have emerged, apparently playing the same role, and thus creating overlaps, redundancies, poor coordination and overall lack of clarity.

Funding knowledge

Knowledge financing in the three countries is viewed as a way of enhancing knowledge production and use, but this plays out in different ways for the three countries. Rwanda targets both local and international Research and Development (R&D) funding streams through its Ministry of Education (MINEDUC's) Directorate of Science, Technology, and Research (DSTR), which has some very specific structural linkages to knowledge use: it sets budgets for funding facilities such as industrial incubation centers, product laboratories and so on.

Unlike Rwanda, whose fund targets specific industrial outputs and outcomes, Kenya has a National Research Fund that mainly supports knowledge production through university research and postgraduate studies, but with unclear structural linkages to knowledge use. Even other financial partnerships such as the Newton Utafiti Fund, established in 2017 in partnership with the British Government (see our commentary on research options for the fund) remain unclear, as regards specified funding for knowledge use.

In Tanzania, policy documents outline very little information in terms of a structured ways of allocating funds to R&D. Much of the funding that supports Tanzania's National Fund for the Advancement of Science and Technology (NFAST) is derived from foreign institutions, some of which largely dictate research agendas that may or may not be in tandem with the country's content; this is a subject of further interrogation.

Linking formal and informal knowledge

Formal-informal knowledge links are also emerging as a key enabler of knowledge use. Evidence from the three countries reveal that informal knowledge sector e.g. the '*Juakali*' sector in Kenya - is closely linked to knowledge use because the sector mainly builds on peoples' capabilities (e.g. entrepreneurship skills, needs and aspirations), making them able to serve and empower people better. As such, strong linkage between informal to formal knowledge systems is likely to spur effective knowledge use. However, this linkage appears to be weak, especially in Kenya and Tanzania where – again – poor coordination and lack of clear structures impedes integration.

In Rwanda, however, we again see some clear efforts in this. The Country launched a manifesto dubbed 'Made in Rwanda Policy', in which Rwanda's indigenous systems inform its policies and industrial revolution. To this end, the State established the Home-grown Department to help promote informal knowledge systems. This department hosts a number of programmes that provide strategic linkages between formal and informal knowledge producers and users, including collaboration with the private sector, and targeted skill development through industrial training.

The three countries are also pursuing Technical and Vocational Education and Training (TVET) as a means of promoting and formalizing their informal sectors, i.e. support for technical skills in Kenya, support to innovation hubs in Tanzania, and support for industrial growth in Rwanda. However, the low level of education in the informal sector appears not to match the formal requirements of these TVETS (for example, the requirement for secondary education).

Strengths and weaknesses

Overall, the three countries' knowledge systems are characterized by knowledge production use and regulations that seek to promote innovation through support for research,

development and capability building. However, the systems have varying characteristics with different implications in terms of effectiveness of the systems, and their potential to support inclusive innovation and address diverse sustainable development goals.

The Kenyan system is characterized by robust set of knowledge producers both with state and non-state actors thus making it more inclusive compared to Rwanda and Tanzania. As such, the Kenyan KS is relatively strong towards knowledge production but weaker in terms of integration with knowledge use. Our early findings suggest that the strengths of Kenya's KS could however be exploited through targeted investments (e.g. research into use hubs) that could coordinate knowledge integration as well as the transition from linear knowledge production to trans disciplinary knowledge use to meet people's needs and the SDGs.

The Rwandan case presents a state-led type of knowledge system that embraces a particular directionality of objectives. It would appear to have huge potential to achieve structural changes in the knowledge system in order accelerate progress towards addressing social and environmental goals. However, the state-centric approach (exclusion of other valuable actors) suggests that it may be less resilient. This calls for KS governance mechanisms in Rwanda to include an array of informal governance actors, and attention to be paid to effective integration.

Although most of Tanzania's institutional set-up are still at infancy compared to other East African Countries (EAC) such as Kenya and Rwanda. The overall governance still appears to be relatively weak but is emerging towards a state-centric knowledge regime that is sectorally aligned. Despite this, Tanzania is uniquely placed to harness its potential by creating an integrated system capable of building inclusive innovations and supporting sustainable development trajectories.

What next

So far, we have sought to characterise the types of structures and processes that are likely to support particular trajectories of change within knowledge systems, and to work towards the idea of a practical knowledge system to support decision making. Our analysis and stakeholder dialogues around this have indicated the enormous potential for transdisciplinary learning within and across LMICs to help direct STI towards desired SDG outcomes. The big question, however, is: what strategic choices and/or interventions can countries pursue or build on to yield optimal SDG outcomes for their particular contexts. In the next phase of this work, we will develop our understanding by engaging with a variety of state and non-state actors in detailed cases study initiatives. We will discuss how patterns of investment in knowledge systems are currently shaped in these contexts and specific opportunities to reinforce or build inclusive innovation trajectories.