

Understanding knowledge systems and what works to promote science technology and innovation in Kenya, Tanzania and Rwanda

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Abstract (200 words max.)

It has long been recognized that investment is needed to build capacity in Science Technology and Innovation (STI) particularly in low and medium income (LMI) countries. Yet there is little understanding as to how to do this. The combination of a) the use of research and innovation policy frameworks more aligned with High-Income Countries rather than LMI country social and economic environments and b) new commitments in many SSA countries to using research and innovation to meet the Sustainable Development Goals (SDGs) mean that we need to develop new practical conceptual policy frameworks to guide future research and innovation investments that are more deeply embedded, sustainable and locally owned than was perhaps the case in the past. In relation to that need, a pilot research project is developing a new framework rooted in knowledge systems (KS) perspectives. Conceptually, a practical knowledge system approach offers potential to provide a more comprehensive understanding of science technology and innovation (STI) investment contexts, generate new evidence on the impact effectiveness of different investment options and help define tangible policy instruments/interventions. Against this backdrop the current project is developing a practical KS concept and applying this in three-country cases, Kenya, Tanzania and Rwanda.

Keywords:

Knowledge systems; knowledge systems innovation; science technology and innovation

JEL classification: O11; O19; O32; O55

1. Introduction

The sustainable development agenda is a response to a new class of challenges that call into question current patterns of human activity in relation to production and consumption, in relation to access and distribution of resources and in relation to the way these processes and patterns of human activity are governed and directed. Broadly these challenges relate to environmental sustainability of the resource base and the planet as a whole and the crisis of unbalanced patterns of growth that are failing to eradicate poverty, inequity and food, water and energy resource insecurities. These are global scale issues, but have particular poignancy and manifestations in low and middle income countries (LMICs) where poverty is wide spread and where climate change is a major threat to already fragile and degraded environments.

Science, Technology and Innovation (STI) could form a critical plank in addressing these challenges. But that will require of a form of innovation that is much more deeply embedded in society than it has been in the past. This will entail a much closer alignment of STI policy with development priorities in a particular country and will require patterns of governance and participation that gives a wider set of stakeholders ownership of both the priorities and the outcomes of the innovation process. Building this new form of innovation capacity will need to look beyond traditional science and technology providers – although it is essential to strengthen these too - and will need to embrace the full gamut of knowledge production and use actors and process that society has to offer.

While few would argue against the need to give this STI question urgent attention, there is much less clarity on how to proceed. What sort of capabilities need to be built? What would new forms and patterns of investment look like? How can the performance of existing and new investments in this domain be evaluated? And perhaps most fundamental of all what would an overarching framework look like that could guide policy and practice in prosecuting the new form of innovation action that the sustainable development agenda demands? This paper introduces a project funded by UK aid through the East Africa Research hub that has been tasked with answering some of these questions. We believe that only by providing some fresh direction can the ambition of creating sustainable and locally owned STI capacities and processes be achieved.

2. The Knowledge Systems Innovation project: Rationale and intent

The Knowledge Systems Innovation (KSI) project aims to develop a practical approach to guide capacity development and investment in knowledge systems in Kenya, Rwanda and Tanzania. Part of its rationale is founded on a major paradox in international development practice, policy and investment. On the one hand there is widespread recognition of the need to invest in STI capability in LMICs (Cirera and Maloney, 2017), but on the other hand there is limited evidence of how this can best be achieved. The idea of a national research or innovation system or ecosystem has been articulated through a number of different conceptual traditions, approaches and policy framings. However these have often emerged in the context of high-income (HI) countries, with evidence of what works relating to these contexts. The importance of understanding the context specific nature of knowledge production and use and associated practices and capabilities, also sometimes known as national styles of innovation has in many cases been lost (Arocena et al, 2018). There has often been a tendency to try and use lessons and insights to develop standard models of research and innovation systems to guide policy and investment across a range of contexts (Chataway, 2019; Srinivas and Sutz, 2008). The importance of context in knowledge generation and dissemination goes beyond Cirera and Maloney's (2017) ideas about the importance of management and other complementary factors. It focuses also on the misalignment of knowledge production with social and economic goals in particular contexts. The aim of this work is to develop a practical and contextually relevant knowledge system concept for LMI countries and back this with an evidence base of how particular types of investments in some specific LMI country contexts drive (or could drive) knowledge-based development.

The intent of this ongoing research is to develop an agnostic knowledge system concept that draws on a range of different theoretical explanations of the way knowledge is produced and used, as well as drawing on evidence of the effectiveness of approaches to strengthening knowledge systems performance. By agnostic we mean that this work draws on a range of theory, concepts and methods to build an approach with the aim of rooting policy advice in context aware analysis. Recognising that there are many

evidence gaps in the context of LMI countries, evidence of effective interventions in other country contexts is being “ground truthed” by an extensive knowledge systems mapping exercise in the three countries. The emphasis in these mapping exercises is to understand the nature and functioning of knowledge systems in the target countries and to explore the types of interventions that have proved effective in these contexts. Ultimately research of this type should improve the ability of the target countries to respond to their individual sustainable development related challenges.

In a similar way the starting point of the research is to be agnostic as to whether knowledge systems should be analysed at sectoral or national scales. The choice of scale is viewed as a question for this research to answer in its development of a practical knowledge system concept and the testing of this through mapping exercises and economic appraisal techniques. The research does however recognise that irrespective of the scale of analysis, links between different sectoral knowledge systems and links between national and regional and global knowledge systems will need to be better understood.

The core of the research approach is thus to iterate between evidence collection, concept development, concept testing and refinement underpinned by a comprehensive stakeholder and engagement process that is discussed in detail in later sections of the paper. This iteration is characterised by the development and use of quantitative methods to assess the economic returns to interventions and investment and by qualitative approaches to understanding the performance and dynamics of knowledge systems in different country settings. By looking at how knowledge is produced, shared and used through the lens of different conceptual perspectives and methodologies we hope to build up a multidimensional picture in each context. The following section presents the rationale and approach of the research and the way this supports the intended outputs of this research. We then go on to provide an overview of component parts of the project and a very preliminary insight into the findings.

3. Why is a new knowledge system concept needed?

There is growing concern that the application of many commonly used STI perspectives (i) fail to provide a comprehensive account of the nature and functioning of knowledge system; (ii) struggle to define tangible policy instruments and intervention; or (iii) are based on unrealistic assumptions of the LMI context of application. The following highlights some issues that inform the rationale of the research project being presented here.

Narrow perspectives and flawed assumptions. Research systems perspectives have been, and remain particularly important in framing the development of core science and technology capabilities. However the perspective only focuses on the supply side of the knowledge system, rather than the process that shape and enable the demand for and use of knowledge (World Bank 2006). The perspective also assumes that resource allocation to the research system is rational and evidence based. Recent work by Chataway *et al* (2019) on the Science Granting Councils (SGCs) in Africa has revealed deeper problems in the political economy of funding arrangements that often cause priorities to be skewed and determined by specific agendas, groups and players leading to misalignments between resource allocations and social and economic development aspirations.

Unrealistic assumptions about the role of the private sector. Knowledge systems perspective that focus on innovation capacity rather than research systems capacity have led to an emphasis on strengthening public-private partnerships and more generally giving the private sector a more central role in the innovation landscape. However a recent World Bank Study, *The Innovation Paradox* (Cirera and Maloney, 2017), has provided comprehensive evidence that suggests that weakly developed innovation capabilities (capabilities to assimilate and manage technological change) of companies accounts for the failure of many countries to take advantage of globally available knowledge and technology. On going DFID-funded research by University of Tilberg (Voeten 2017) draws similar conclusions, but goes on to suggest that where companies are innovating they rarely rely on public R&D but instead access ideas and information from social networks or the internet. Efforts to build public-private sector partnerships to overcome this have often failed because of the weak innovation capacity of much of the private sector (Chataway *et al* 2019).

Innovation systems perspectives misaligned to LMI country contexts. While there has been much advocacy for the innovation systems perspective in LMI countries there have been a number of application challenges: the misunderstanding of it as a policy and practice blueprint rather than a way of understanding and strengthening context specific national styles of innovation; the difficulties of coping with country setting where a large proportion of innovation activity is centred in and around the informal sector; mistaken assumptions about the strength and functionality of formal research systems; the qualitatively more complex nature of institutional, policy and cultural setting compared to its developed country origins; a lack of attention to the political economy of the innovation process; and relatedly the concern that the framework's emphasis on all types of private sector led innovation was inappropriate in countries where inclusive and sustainable growth are as important as overall economic performance (Cirera and Maloney, 2017; Schot and Steinmueller, 2016; Chataway *et al* 2019, Hall and Dijkman, 2019).

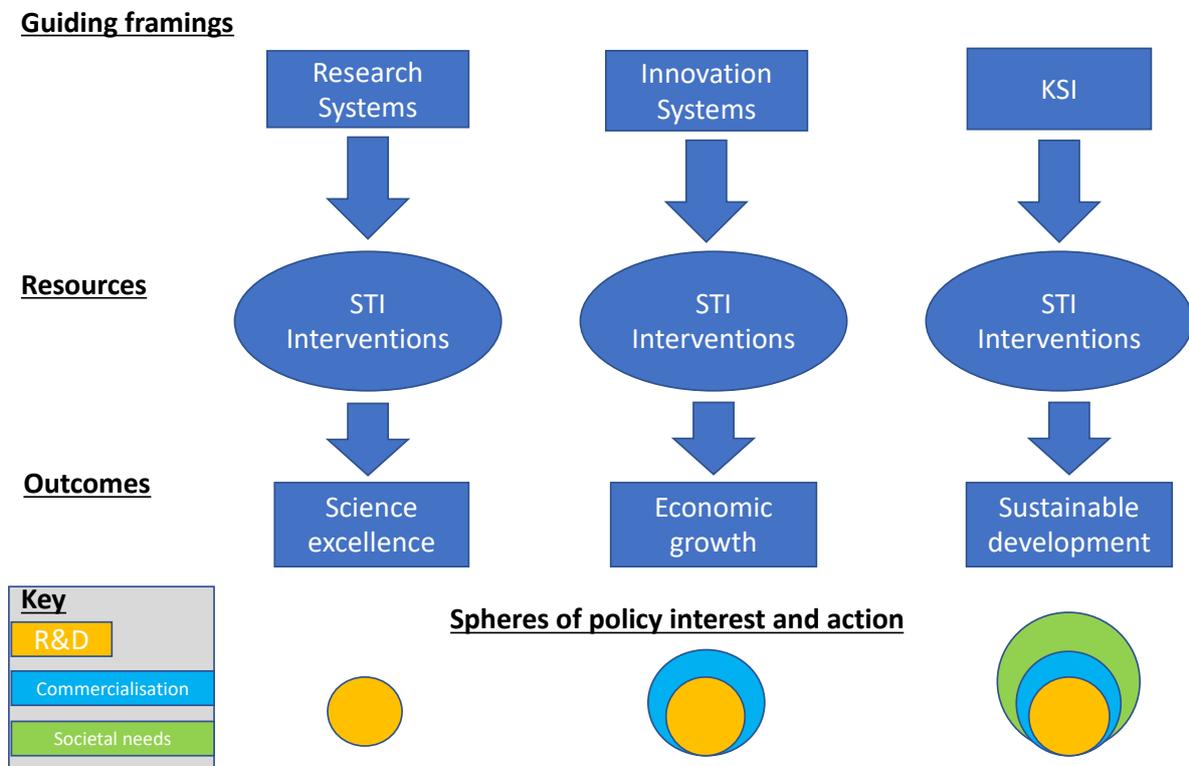
Policy design and measurement challenges in LMI countries. All of these factors compound the difficulties of crafting policy and action that strengthen knowledge and innovation systems capacity in LMI countries (Cirera and Maloney, 2017). Similarly, it creates further challenges for benchmarking and evaluating the performance of knowledge systems in these contexts. Many OECD countries have developed innovation capacity and performance indicators, metrics and survey techniques. These work well in OECD country settings where innovation systems are science centric, largely involve the formal sector and where data sources are available and reliable. These conditions rarely apply in developing countries. As a result there is very thin evidence available about the functioning and performance of knowledge systems in LMI countries.

Directionality and alignment to the SDGs. Responding to many of the issues above, a concern with the directionality of innovation has become more prominent (Schot and Steinmueller, 2016; Chataway *et al* 2019, Hall and Dijkman 2019) and there increasing efforts to engage in the strengthening of knowledge and innovation systems from this perspective. In particular, the design and implementation policy that fosters the use of knowledge to create more inclusive and sustainable innovation. The SDGs are one example of the prominence of these concerns in current policy dialogues and initiatives. Whilst there is now strong evidence for the power of innovation in generating economic growth, little is understood on how knowledge and innovation can foster more equitable societies based on low carbon and less environmentally damaging technologies.

Implicit in many of the shortcomings discussed above is the way there has been a progressive broadening of the scope of the STI domain and the way this has accompanied changing policy framing and interests. For example, Smith *et al.* (2010) argue that the sustainable development agenda represents a progressive broadening of the problem framing to the whole of society and that this has challenged the analytical framing of innovation. This broader problem framing has moved through successive stages from the need for clean, sustainable technology, to the need for innovation systems producing clean, sustainable goods and services, to the need for societal conditions that allow new and more sustainable development pathways to be pursued. Schot and Steinmueller, (2016) in their discussion of transformational innovation similarly discuss three frames of innovation. Figure 1 below illustrates the way the sphere of STI interest has progressively expanded in step with the broadening of policy ambitions from science excellence to economic growth to sustainable development. We argue that it is the need to find ways to embed R&D in both the wider landscape of research commercialisation and societal needs - with all the implications this has for inclusion, transparency ownership of STI policy and practice - that points to the value of the knowledge system concept we are developing.

Figure 1 Why knowledge systems perspectives are needed

Why KSI?



4. Unpacking the knowledge systems concept

In order to create some boundaries around the research we use a knowledge system definition that makes the scope of this research explicit and thus helps frame its overarching and supporting enquiries and activities. Cornell et al. (2013) defines knowledge systems as networks of “agents, practices and institutions that organize the production, transfer and use of knowledge”. Unpacking this definition by drawing elements from the perspectives discussed above, the approach of this research is informed by an understanding of knowledge systems that encompasses the following elements and propositions.

Knowledge system actors and resources

- All sources of knowledge, formal and informal, public and private and the capabilities to produce and use this knowledge.
- The financial and other resources needed to produce, transmit and use knowledge.

Knowledge system functionality

- The relationships and networks (formal and informal) through which knowledge is transmitted and combined and used for innovation.
- The institutional arrangements, governance arrangements, policy settings and that enable and direct the use of knowledge for innovation.
- The policy-making and entrepreneurial capabilities to design and implement innovation policy and manage technological change across enterprise to system scales.

Knowledge systems performance

- The links between investments in certain components of the knowledge system (e.g. infrastructures; markets and trade; socio-political institutions; technological capabilities) and socio-economic objectives (e.g. SDGs).
- Alignment of scientific research priorities (a small part of the knowledge system for which we have better data) and socio-economic challenges in Kenya, Rwanda and Tanzania (using the relative distance of each of these countries to the best performing country for each SDG).

Knowledge system political economy distortions, lock-ins and contextual factors

- The agency of different groups to act within and influence knowledge systems & the power relations of the incumbent system that constrain and enabled this.
- Capacity of systems to learn and adapt thereby creating new configurations of knowledge, organisations and policies and institutional arrangements.
- The unique historical patterns of institutional and capacity development and cultural and political setting of a particular country.

5. Research questions and Project components

5.1 Research questions

The scope of the research is defined by three interlinked categories of research questions that have been refined by a series of consultations in each of the three countries, Kenya, Rwanda and Tanzania. The categories of questions are as follows:

Category 1: What is the effectiveness and impact of different forms of STI investment in the case study countries?

Methods to be employed

- In country literature review
- In country case studies

Category 2: How can we understand KS in a way to better make informed decisions about investment options?

a) What is a KS, how is it useful?

Methods to be employed

- Literature review on conceptual work
- In country literature review
- In country landscape mapping work

b. How do different bodies of analyses and evidence help us understand KS, how to use different forms of evidence to understand KS? How do you connect them together to come up with decision on what to do?

Methods to be employed

- In country literature review
- In country landscape mapping work
- Economic case for STI investment options
- Case studies
- In country consultations

Category 3.

Diagnosis and investment options

a. What are the current strengths, weakness and dynamic of exiting knowledge system with respect to achieving national development aspiration and supporting sustainable development? What are the key

drivers political economy factors that condition current priorities and approaches and how are different stakeholder groups represented in STI plans and investment decisions? What consultation processes are effective in strengthening inclusive approaches to STI analysis and investment planning?

Methods to be employed

- In country literature review
- In country landscape mapping work, including political economy analysis
- Case studies
- Consultative process of various forms
- In country consultations
- Economic case for STI investment options

b. What is the menu of investment options are relevant to the knowledge systems in the three target countries?

Methods to be employed

- In country literature review
- In country landscape mapping work
- Case studies
- Consultative process of various forms
- In country consultations
- Economic case for STI investment options

5.2 Project components

International conceptual literature review: concerning how understanding of STI processes has evolved, along with assessments of how this is reflected in dominant policies and investment strategies. It produced a characterisation of existing STI investment strategies in relation to different types of development trajectories, and a clearer articulation of the potential value of a knowledge systems approach in helping to identify interventions to support sustainable development outcomes.

In country consultations: In each country a 'community or practice' (CoP) was established to guide the work as it developed, deepen the research questions and feedback on early findings. These CoPs included academics, policymakers, representatives from NGOs and other stakeholders.

Country literature and policy mapping: Codified evidence of knowledge systems and different forms of evidence in the 3 countries. The focus here is on reviewing existing information, identifying gaps and highlighting experiences and approaches that can inform both an understanding of knowledge systems but also an investment strategy. In tackling this question, the project examined both peer reviewed and grey literature.

In-country landscape mapping: Using an initial conceptual literature review, we formulated a tool for mapping STI activities, initiatives and policies in Kenya, Rwanda and Tanzania. We developed maps to illustrate patterns of investment, key actors and institutions involved, and alignment to different types of development trajectories and outcomes for each country. These were based on initial interviews and document review and then refined on the basis of in-country validation exercises.

Economic assessment of investment case: This work included impact assessment and bibliometric analysis to assess aspects of knowledge system performance. We are aiming to increase our understanding of the links between knowledge system investments and socio-economic objectives, and study how prioritisation in certain components of the knowledge system has been related to future improvements in socio-economic indicators.

Case studies to interrogate existing knowledge system approaches in the three target countries. The focus here was to apply our emerging knowledge system concepts and tools developed in the first and second category of research questions to understand the strengths, weaknesses and dynamics of existing knowledge systems and, in conjunction with stakeholders, define STI investment options that will contribute to sustainable development. A series of six case studies were undertaken, a listing of which are provided in Annex 1.

Integrating methodologies in the context of our conceptual approach. We took seriously the need to integrate methodologies. We did this because a key research objective of the project is, to provide an illustration of the nature of knowledge system diagnosis delivered by a cluster of mixed methods of analysis that helps to better frame and prioritise STI investments options aligned to the SDGs. The following diagram (Figure 2) illustrates our thinking about the need for the different methodological approach.

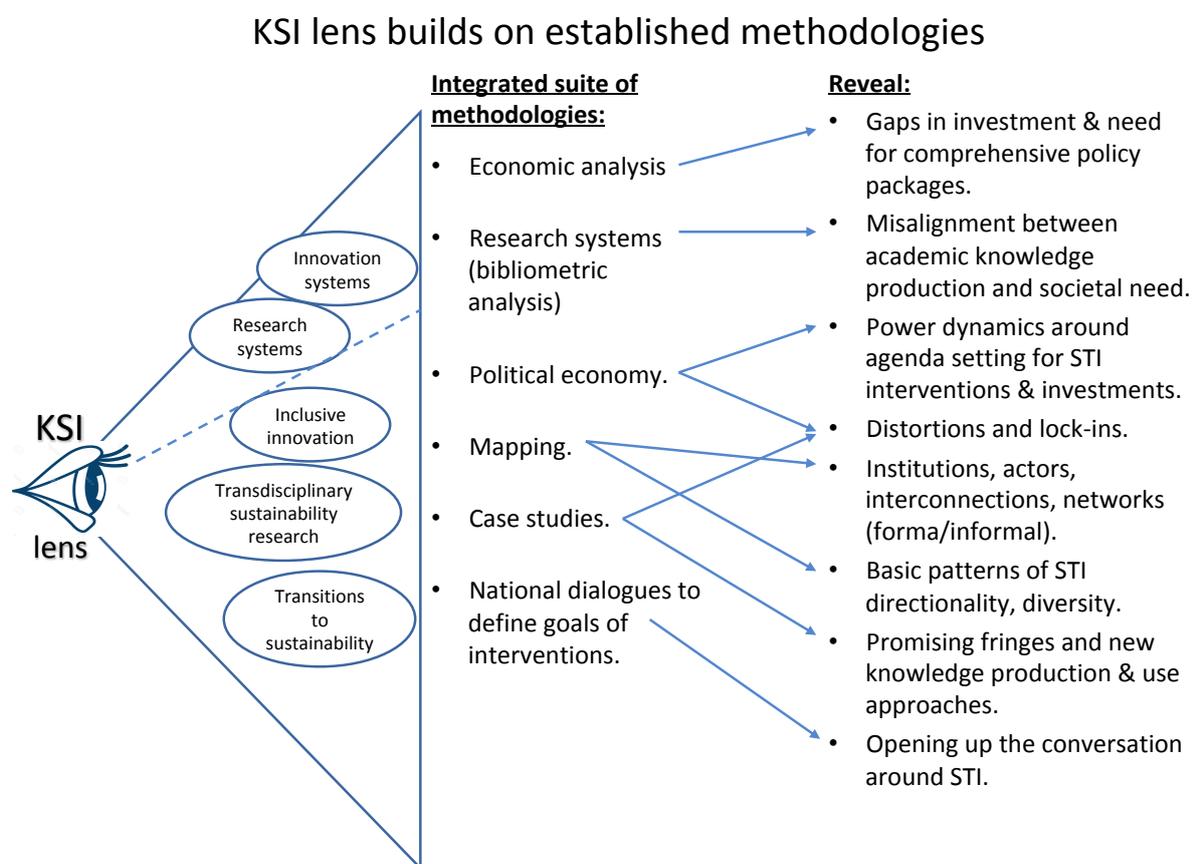


Figure 2 The KSI lens: Marshalling evidence and revealing different dimensions of knowledge systems activity and performance

6. Embedding the research in national debates and process – the in country consultations

While the findings of the research activities above are still being concluded, it is important to explain how this research has attempted to garner ownership and contextual relevance. A guiding principle for the whole of the research – and indeed for the practical concept that is being developed – is the question of knowledge systems for what (and for whom)? Recognising that knowledge systems need to be fit for purpose in specific country contexts and the development priorities in those countries in turn demands significant attention to engagement process in the research design. The in-country consultative process was a vital element of the work presented here.

This attention to the 'directionality' of knowledge systems capacities points to the "practical knowledge system concept" that the project is tasked to deliver not as a framework per se, but as an integrated and iterative process of research and engagement. The approach certainly does provide a way to understand how different forms of analysis provide insights into knowledge system performance and needs. However its potential power to support transformative change is the way it combines the marshalling of evidence and analysis with stakeholder engagement to provide steer on what direction knowledge system development should follow? What critical dimensions need to be investigated further? And how research findings should be interpreted? And perhaps most importantly of all, the way the approach starts to build a cohort of national champions who can build support for new directions and filling gaps identified through the process.

Elements of the project consultations and engagement strategies are as follows.

The project has established a focal point within a leading university in each country – the Universities of Rwanda, Dar es Salaam and Nairobi respectively and these focal points have played a central role throughout. The working relationship with the focal points have been formalised through Memorandum of Understanding (MoUs) between the respective universities and the African Centre for Technology Studies (ACTS) who have provided a regional overview and stipulated working modalities, highlighting strategies for enhancing uptake and linkages with the various stakeholders and informants for mapping knowledge systems in each country.

The research questions discussed above and the approach for the project discussed below emerge from and were refined through three country inception consultations taking place in June-July 2018. These workshops raised awareness about the project, sought to understand its relevance within the current STI environment in each country, to ascertain feedback on the design and expectations of the project and to explore options for enhancing uptake of the project's outputs. As such these workshops were the start of the knowledge system mapping and stakeholder engagements. About 20-30 stakeholders were invited and mainly drawn from different sectors including government, national commissions for science and technology, think tank organisations working on STI, civil societies, private sector and research institutions. These stakeholders were selected on the basis of their on-going work in the STI/KS arena. The average attendance per country workshop was above 50% of those invited.

The inception workshop consultations highlighted that Tanzania is at an early stage in revising its STI policy, Kenya has a recently revised STI policy, a diverse knowledge landscape with formal research organisation and a large informal sector, and Rwanda is proactively pursuing an STI policy environment aimed at developing a knowledge based economy. The consultations also revealed that there is a range of perspectives as to what constitutes an effective KS and what the potential types of impacts could/should be.

Following the inception workshops, a series of in-country meetings were held with the country team leaders to create their understanding on the project as well as their roles and expectations. The meetings singled out key knowledge players and national bodies involved in areas of STI. These meetings have included calls with the key people - especially Directors of the National STI Agencies – including COSTECH of Tanzania, NACOSTI and NRF in Kenya. These interactions have been undertaken jointly with DFID-East Africa Hub to create awareness among national STI agencies on the aim of the project.

Whilst the current project has a relatively short duration (18 months) the principles of research uptake remain at the core. By its very nature, this project was challenging and demanded active stakeholder engagement throughout. A series of stakeholder engagement mechanisms were established during the Inception phase to ensure the project is well grounded and the project could leverage expertise available in each country e.g.

- **Communities of Practice (CoP)**

To continue with discussions and consultations at country level, participants to the workshops established a country level CoP that are engaging formally and informally through social media platforms as well as on email groups. The CoP are seen as important conduits to ensure research uptake.

- **National Advisory Committees**

Following from the Inception workshops a national advisory committee was been established for each country. These committees are comprised of key players to enhance research uptake and have been strategically chosen, as they will be instrumental in assimilating the outputs of the research in their various institutions and key in influencing use of the findings. The project also intends that the advisory members will take ownership over the activities and help stimulate interest amongst the other stakeholders. National Advisory Committee meetings have been held in all three countries, in Kenya (December 2018), Tanzania (January 2019) and Rwanda (February 2019) to discuss the country literature review and to make preparations for the first face-to-face meeting of the Regional Advisory Group with the country and central project team which took place in Kigali in March 2019.

ACTS has provided regional oversight and synthesized lessons from country level activities. This was implemented with the active engagement of a Regional Advisory Group. This group was strategically selected not only to provide technical rigour and quality of the project but also are strategic in influencing use of the outputs generated.

6. Initial findings

6.1. The conceptual literature review

This section outlines our findings from the conceptual literature review. Different theoretical explanations of the way knowledge is produced and used have led to a number of distinct perspectives and approaches. In turn these have been used to frame analysis, investment, capacity building and evaluation, each placing emphasis on different dimensions of the knowledge production into use continuum. The following resulted from an initial conceptual literature review and maps the key proposition of these different explanations. The literature review was conducted on the basis of reviewing key texts. It has no pretensions to being systematic. The purpose of presenting them here is to highlight key differences and complementarities and, in doing so (i) help frame an explanation as to why none of these on their own is sufficient in the context of LMI countries; and (ii) to explain the rationale of the scope of analytical perspectives that this research will adopt, the different enquiries that this will support and the insights this will provide, (iii) present our clustering of different approaches into a conceptual framework that we used in subsequent data gathering exercises and analysis and which is outlined later in the paper.

Research systems: Research knowledge as an input into innovation. Based on a rationale of high economic and social returns to investment in R&D, public investments in research, education and associated human resources and infrastructure are justified by a market failure argument (Reid, 2014). That is to say that since the market alone will not invest sufficiently in R&D, publicly supported research systems are needed to perform a public good function to unlock the potential of science and technology to deliver desirable levels of economic and social benefit. This view sees the need for public sector investment as a market failure with linear progression from state supported basic research to private sector funded applied research. Whilst there is plenty of evidence indicating that the returns to investment are high, this perspective has been widely criticised as a partial and flawed account of the way in which research and innovation interact (Nelson, 1959; Pavitt, 1991, Lundvall, 1992 for example).

Building technological capabilities: Entrepreneurial and policy capability to use science and technology knowledge for innovation. Based on the rationale that LMI countries need to shift from simply being recipients of technology from HI countries. To achieve this it is argued that emphasis needs to be given to developing capacities to select, acquire and create 'their own' technologies, know-how and science and to develop the policy apparatus to support this. An important element of this rationale is the emphasis on building capability (particularly in companies, but also other agencies) to assimilate technology in production processes. (Bell and Pavitt, 1993; Bell and Albu, 1999, Nelson, 1959; Pavitt, 1991 for example).

Informal sector innovation: Blending science and technology with informal knowledge and learning. This perspective recognises that informal sector entrepreneurs, artisans and farmers not only represent a substantial segment of the economies in LMI countries, but that they also continuously innovate making use of indigenous technical knowledge, reverse engineering, knowledge acquired through social networks and capabilities learnt through practice, but are rarely connected to formal R&D processes. This in turn has highlighted the need to adjust STI policies to accommodate and support this under the radar dimension of knowledge system activity (Oyelaran-Oyeyinka and McCormick, 2007; Muchie *et al*, 2016; Kraemer-Mbula and Wunsch-Vincent, 2016).

Innovation systems: Systems capacity to generate, distribute and use all knowledge sources for production, institutional and policy innovation. This recognises that innovation is embedded in a dense network of interactions that support knowledge flows, particularly between public and private sectors. It places innovation (rather than innovation inputs such as R&D) at the centre of capacity building and performance measures, highlighting innovation as a learning driven, evolutionary, systemic phenomena involving a range of actors and capabilities including but also beyond research. Emphasis is placed specifically on the way innovation activity is embedded in and shaped by the broader institutional and policy context (Freeman 1987; Lundval 1992). Work on understanding innovation systems in LMI countries highlights the importance of grounded approaches that do not assume the existence of formal sector private and public institutions (Dutrenit *et al*, 2014; Sutz and Srinivas, 2008).

Science and society perspectives: Knowledge systems as a reflection of context and the social shaping of technology use. This recognises that the nature and functioning of knowledge systems is shaped by historical patterns of organisational, policy and institutional development and is overlaid by culture and patterns of power and influence in a particular country setting. A core concept is that technology use is deeply embedded in society, with routines and institutional arrangements co-evolving with technology development to enable its use, but also creating inertia to technological change, reinforced by the power dynamics of incumbent stakeholders (Cornell *et al.*, 2013; van Kerkhoff and Szlezák, 2010; Jasanoff, 2004).

Strategic niche management and multilevel perspectives: Redirecting knowledge production accumulation and use towards sustainability through socio-technical transitions. Building on many of the perspectives above this approach recognises that deep transformations and transition, particularly towards sustainability not only require component innovation, but require changes in the interlocking regime of technology, institutions, values and policies that maintain the status quo that, in turn, form the rules and incentives that frame innovation action and directionality (Geels and Kemp 2006).

6.2 Snapshot of early findings

While it is too early to be definitive about the results of this research and the approach; in working on the proof of concept, a number of things stand out.

In-country evidence reviews tell us that existing bodies of evidence on the impact of STI interventions in the region are thin. There are many analyses of the challenges of the STI environment and a range of policy prescriptions for this, but little clarity on how this could be converted in an operational strategy.

- Policy documents for the region are very broadly framed towards sustainable development. But this is an unclear line of sight between these broad ambitions and the formulation of national STI policy.
- Bibliometric analysis has highlighted the misalignment of patterns of publications and the SDG agenda. It has also revealed the way this pattern of publication is skewed by collaboration (and funding) with organisations in the global North.
- While there is still conceptual work to be done in defining more powerful ways to assess the impact of knowledge system interventions, it is already clear that significant investment will need to be made to collect new types of information to

track knowledge system performance. For example, there is very little information on informal sector activity and the critical interfaces with the formal sector. This also suggests that new forms of innovation surveys will be needed. These will need to capture innovation related activity in both the informal and formal sectors and that takes account of promising new ways of marshalling and using knowledge for sustainable development that are current under the radar of policy scrutiny.

- Review of policy and related documentation in the landscaping exercises reveal that much of the current discourse is framed by innovation systems perspectives. While this has value, our case studies reveal that the reliance on the market and the private sector is an unrealistic assumption. In some countries and sectors the capacity of the private sector to engage in innovation-facing collaboration is limited. While some universities have made good progress towards building partnerships with the private sector, the relevance of this to sustainable development needs further attention and encouragement through incentives and policy support.
- Also from the landscaping and stakeholder engagement processes, the regional conversation on STI remain very research system-centric. Generating a broader conversation, and finding champions beyond research is probably important in arriving at more balanced views on future knowledge system capacity development pathways.
- The case study work has pointed to a number of promising fringe activities that demonstrate the potential of investing in new knowledge related activities. For example, the traditional knowledge case in Rwanda demonstrates the potential for building bridges between science and traditional knowledge. Knowledge hubs in Tanzania have shown the potential for fostering a better research – farmer relationship and demonstrated the way these hubs can create the foundation for a wider array of knowledge related collaboration and information exchange (see Annex 1 for list of case studies undertaken).
- Analysis suggests that it is best to tackle the knowledge system concept at a national rather than sectoral level. The caveat being that case study analysis (which is critical to the approach) needs to focus on bounded sets of activities which also inevitably have a sector focus (although not always).
- While promising schemes have been observed, without exception these are faltering because of second order issues. These tend to be wider “ecosystem challenges” relating to the nature of institutional and policy arrangements. The heart of this challenge is limited capability **and** capacity. There is a dearth of skills to manage and implement new intervention types. And there appears to be limited capability and capacity to revise what the STI and knowledge systems of the future might look like and to design, implement and evaluate the suite of new investments that are required.

Conclusions

Our research is not yet complete but early findings confirm that a practical knowledge system concept that the project has been tasked to deliver, will not offer a one size fits all, silver bullet of how to move forward. It does point to the need for knowledge systems innovation and provides early pointers to how this process of change could be framed and progressed. By knowledge systems innovation we mean the process of recasting the scope and functionality of knowledge systems that includes, but looks beyond conventional STI policy levers such as research and that is inclusive of a diversity development interests and knowledge sources. Our project findings suggest that the process by which this happens needs to be deeply rooted in national conversations with a broad range of stakeholder that generates ownership of chosen directions and pathways. The caveat being that knowledge systems innovation and the re-imagining of knowledge systems capacities will need to be framed and reframed by the questions of “knowledge systems for what”? Even at this early stage, it is apparent that knowledge systems innovation is going to be a long hard slog of capacity building and experimentation and that this process of continuous improvement will always have to run to keep up with the broadening of the development agenda that countries seek to pursue.

What our approach does offer is a structure to facilitate a wider conversation about how to proceed. It both marshals evidence and builds ownership and broader governance of future STI directions and investments. International donors would be prudent to direct resources to building the momentum of this new STI conversation at a time when traditional approaches are running out of steam and where political will to maintain or increase R&D investment remains on fragile foundations and is vulnerable to competing policy agendas and perspectives.

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Annex 1 List of case studies undertaken within the KSI project

In Kenya

- Mechanisms for linking academia with industry in different university settings: Industry-University partnership practice in Strathmore and Jomo Kenyatta University of Agriculture and Technology
- *Utafiti Sera*: a platform for research evidence into policy use and uptake

In Rwanda

- Successful examples of bridging indigenous knowledge with sustainable development and inclusive health systems. The case of medicinal plants research and engaging traditional healers.
- Understanding the impact of investments in development of innovation hubs and centres towards SDGs: the case of K-lab and Fab-Lab incubation centres

In Tanzania

- The impacts of innovations in the context of knowledge systems: The case of the Buni Innovation Hubs versus Tanzania Vocational Education Training Authority (VETA) Programmes
- Village knowledge centres as institutional innovations in agricultural technology outreach: Case of Sokione University of Agriculture