STRENGTHENING RESEARCH – INDUSTRY COLLABORATIONS IN AFRICA

Maurice Bolo

The Scinnovent Centre
2nd Floor, Wing C
Karen Plains Arcade, off Karen Road
P.O. Box 52486, 00100
Nairobi, Kenya

August 2020

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This material has been funded by UK aid from the UK government; however the views expressed do not necessarily reflect the UK government's official policies

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EXECUTIVE SUMMARY

Technology transfer, knowledge exchange and commercialization of research findings remains a key concern for governments, development partners, the private sector and other innovation practitioners. While new knowledge is generated mainly by the public research organizations and demanded by the private sector, mechanisms for connecting and facilitating knowledge flows and technology exchange between the research organizations and the private sector has remained a challenge. The Science Granting Councils (SGCs) play an important role in brokering, facilitating, funding and coordinating interactions amongst science systems actors. In so doing, they confront key challenges including inadequate investments in knowledge production, unequal channels, mechanisms and platforms for information exchange and inadequate capacities for knowledge and technology uptake.

Through a situational and landscaping analysis involving documentary reviews, interviews, thematic analysis, stakeholder surveys and case studies, this paper highlights key issues affecting technology transfer and research commercialization in Africa including: platforms for interactive dialogue with the private sector; funding for research and innovation; innovation and commercialization infrastructure; skills and capacities in intellectual property management, technology transfer and commercialization; communication strategies and monitoring frameworks and the need for policy, regulatory and institutional reforms.

The paper presents the context and sets out key ideological, philosophical and organizational factors undermining research – industry collaborations and the strategic responses by the SGCs in addressing the challenges. Issues and concerns from a diverse group of stakeholders are distilled into themes around which evidence of opportunities, successes and challenges are presented as case studies. Bolstered by lessons from a major continental initiative – the Science Granting Council Initiative (SGCI) Annual Forums, the paper concludes by analyzing the status of technology transfer and commercialization in Africa.

Recommendations are drawn for the Councils, development partners, private sector and other innovation system actors including the need to: (i) create platforms for interactive dialogue with the private sector (ii) promote new and innovative funding mechanisms (iii) improve innovation and commercialization infrastructure (iv) promote equipment and infrastructure sharing (v) enhance skills and capacities in intellectual property management, technology transfer and commercialization (vi) promote inter-country joint programmes and collective action (vii) provide opportunities and incentives through public policies and spending (viii) support local innovators through incubation, mentorship and coaching.

BACKGROUND

The key objective of this study is to increase the understanding of partnerships between research players such as universities, research organizations, science councils on the one hand and industry players such as state-owned enterprises, businesses and the wider community on the other hand, in promoting research commercialization and knowledge transfer in Africa. Specifically, identifying the models that have been implemented in Africa, the key issues, gaps and lessons learnt. Key considerations include but are not limited to policies and regulations, actors, roles and institutions.

The overall goal is to enhance the capacities of the science granting councils (SGCs) to foster greater knowledge exchange between public sector research organizations[1] with the private sector[2]. This section highlights some of the underlying reasons for poor knowledge exchange between the academia and private sector and the potential role of SGCs in stimulating academia – industry interactions. It equally recognizes the evolving science, technology and innovation (STI) context in Africa and how this evolution is shaping the options available to governments and their implementing agencies – the science granting councils.

Section 1 of the paper sets out the context by presenting some of the ideological, philosophical and cultural challenges undermining research industry collaborations and how the science granting councils are responding to these challenges. Section 2 outlines the methodology and approaches used in this study while section 3 presents the key issues and concerns as derived from a stakeholder survey of international experts and practitioners. These are analyzed into key themes and guide the rest of the paper. Section 4 presents evidence of opportunities, successes and challenges of technology transfer and commercialization using contemporary case studies derived from different countries. This is followed by section 5 which distils lessons from a continental initiative – the Science Granting Councils Initiative' Annual Forums. Section 6 focuses on the state – of – the art regarding the key thematic areas of this paper. A short concluding section is dedicated to the recommendations for the science granting councils, development partners, private sector practitioners and other innovation system actors.

[1] Mainly universities and public research institutes, but may include civil society actors and publicly-funded international research centers

[2] Private companies – both for profit and not-for-profit – NGOs, social enterprise, individual entrepreneurs, farmer organizations, industry associations etc).

Challenges of academia – industry knowledge exchange

The poor knowledge exchange between public sector research organizations and the private sector stems from a number of challenges – some institutional, organizational, cultural and even philosophical. These include:

Inadequate investments in knowledge production

Research and innovation are both expensive and inherently risky. As such, knowledge production, especially the type of knowledge that doesn't lead to direct commercial exploitation is often under-funded and not prioritized by private investors. The unclear and sometimes lack of returns on investments in research and innovation undermines the private sector's interest in investing in research and development. From a social welfare perspective, government intervention is justified in cases where profit-driven, private actors under-perform in the generation of STI knowledge that would be of benefit to society[3]. This helps to correct market failures associated with the "public goods[4]" nature of knowledge.

Unequal information access and exchange

Due to the need to recoup investments into R&D projects, and coupled with the fact that innovation is risky and success is not assured, the private sector generally shy away from committing resources to research and innovation. Moreover, the attendant need to protect intellectual property rights as a way to privatize and benefit from research outputs, innovators are often reluctant to share information about their projects with potential outside investors and collaborators. The end result is information is not freely available and knowledge is viewed as a strategic asset that confers competitive advantage. In some cases, however, actors just don't have access to knowledge and information and this undermines their capacities to collaborate and compete. This asymmetric information problem hampers the financing, rate, composition and direction of innovation.

Weak capacities for knowledge and technology uptake

New knowledge builds on prior existing knowledge and as a result, new knowledge might not be employable without substantial investments by the users in complementary human capital and learning[5]. The academia is expected to implement actions that favour the effective exploitation, by the private sector, of the scientific knowledge. However, in most part the knowledge exchange and technology transfer process between these academia and industry is undermined by the lack of skills and expertise for knowledge management, strategic communications and business

[3] For details, see Steinmueller, 2010

[4] Because knowledge is considered non-excludable and non-rival, the private benefits associated with its creation are not fully appropriable by the creators, leading to a wedge between private and social return to investments.

[5] See Cohen and Levinthal (1990) and Steinmueller, 2010

development. These eventually hamper the direct contribution that universities can offer toward the commercialization of viable technologies[6]

Organizational culture and procedures

The choice of potential partners and collaborators is undermined in part by the fact that it is difficult for firms to stay up-to-date on the state-of the- art projects carried out at the university. Secondly, the uncertainty associated with the fact that future output deriving from the application of general and theoretical knowledge is largely unknown. This creates challenges in negotiation and coordination of the parties. Additionally, the cultural disposition of the academia and industry are in most part, opposed to each other. While academia mainly aims to contribute to the generation of public knowledge through dissemination; the private sector seeks to appropriate the advantages deriving from the rapid commercialization of products and services that embody the new knowledge.

[6] Yusuf, 2008

Role of SGCs in facilitating knowledge exchange and technology transfer

The roles and mandate of the SGCs are broad and are set forth in the statutes that set them up. These vary across countries but range from coordination, regulation, quality assurance, facilitation, funding, priority setting etc. This section considers the role of the SGCs in addressing some of challenges undermining knowledge exchange and technology transfer.

Financing Research and Innovation

In many jurisdictions, funding for science, technology and innovation (STI) is channeled through the SGCs as the implementing agency of government. Most SGCs operate two kinds of funds namely: (i) the STI Research grants[7] and the Innovation grants[8]. The STI research grants finance mainly scientific research projects and target mostly the academia though in many cases private sector is encouraged to apply in partnerships with public sector organizations. On the other hand, the innovation grants mainly finance technology development and business innovation projects and are more attuned to private firms and fostering linkages between firms and research institutions. In some countries such as Kenya, a new funding window called (iii) "infrastructure grants[9]" has now been created to support the development of the research and innovation infrastructure in the universities and research institutes.

Coordination

The problems of unequal access to information and the tacit nature of knowledge require better linkages, interactions and collaborations amongst the actors within the innovation system. To ameliorate the high transaction costs associated with establishing and maintaining such partnerships between academia and private sector, the role of the SGCs is to create favourable conditions for such interactions and collaborations to thrive. The SGCs therefore act more as brokers, facilitators and arbitrators in these partnerships. Through this coordination function, the SGCs promote actor linkages, knowledge exchange and facilitate technology transfer.

Institutional capacity strengthening

Institutions govern human interactions and condition actor behavior. Weak capacities amongst the innovation system actors undermines the uptake and use of new knowledge. SGCs contribute to the strengthening of these capacities through ensuring proper innovation system governance (defining rules, roles and guidelines); regulation and quality assurance and facilitating the establishment of complementary and bridging institutions such as knowledge transfer offices (KTOs).

[7] in some cases, called the "science funds"
[8] in some cases, called the "technology development funds"
[9] For details see the NRF – Kenya case study under recommendations section

METHODOLOGY

The study followed a case study approach[10] and used contemporary examples derived from SGCI participating countries. It employed a largely qualitative design involving a systematic collection, organization and interpretation of material derived from document reviews, key interviews, and case studies. This study design triangulates a number of methods involving (i) document reviews in which a number of key policy and strategy documents were consulted. (ii) Issues emanating from initial documentary review were put to selected practitioners and policymakers through short, exploratory key informant interviews: The key informants were chosen for their knowledge and distinctive viewpoints about the issues under investigation.

The key informant interviews were a precursor to more in-depth focused interviews with representatives and coordinators of the science granting councils. The results of this key informant interviews; together with the documentary review of the policies provided a sound basis for designing in-depth interviews.

Two Stakeholder surveys were carried out. The first, conducted through Mentimeter, was carried out during an international workshop in Dakar, Senegal[11] and the second conducted via survey monkey to all the participating science councils

Finally, contemporary case studies drawn from projects funded under phase 1 of the SGCI were selected and analyzed.

[10] Yin, 1994; Thomas, 1998

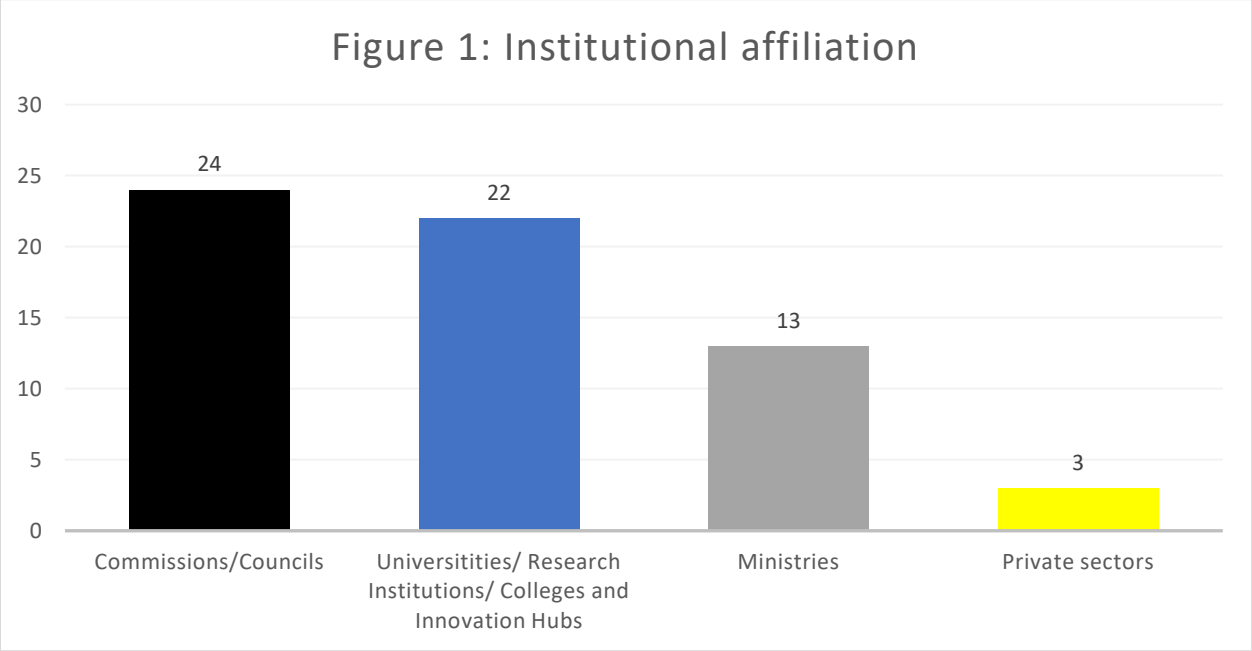
[11] SGCI Theme 3 close-out workshop held in February 2020

RESULTS, DISCUSSION AND ANALYSIS

Stakeholder Surveys

Unpacking the key issues in knowledge exchange and technology transfer

This section presents the results from a stakeholder survey conducted during the international close-out workshop held in by the Consortium implementing theme 3 of the SGCI in February 2020 in Dakar Senegal. This workshop brought together 65 participants from all the 15 participating SGC countries including Heads of Research Councils, SGCI coordinators, researchers from universities and research institutes, private sector representatives, funding agencies and donor representatives, non-governmental and civil society actors. Figures 1 – 3 below show the distribution by institution, gender and country of origin.



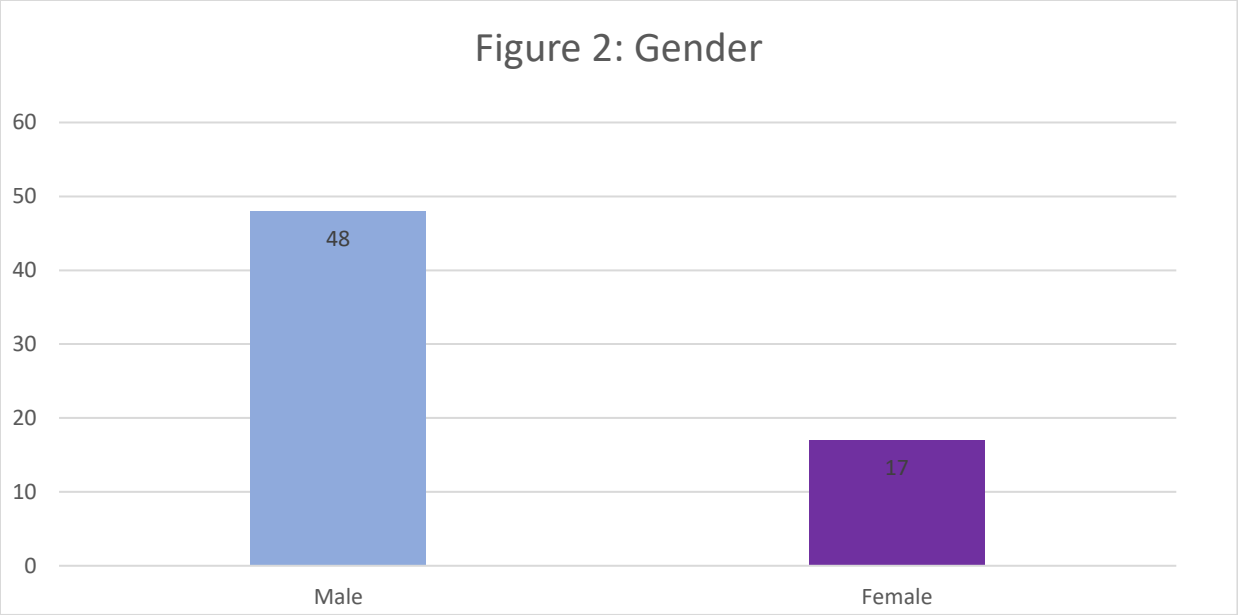


Figure 2: Gender
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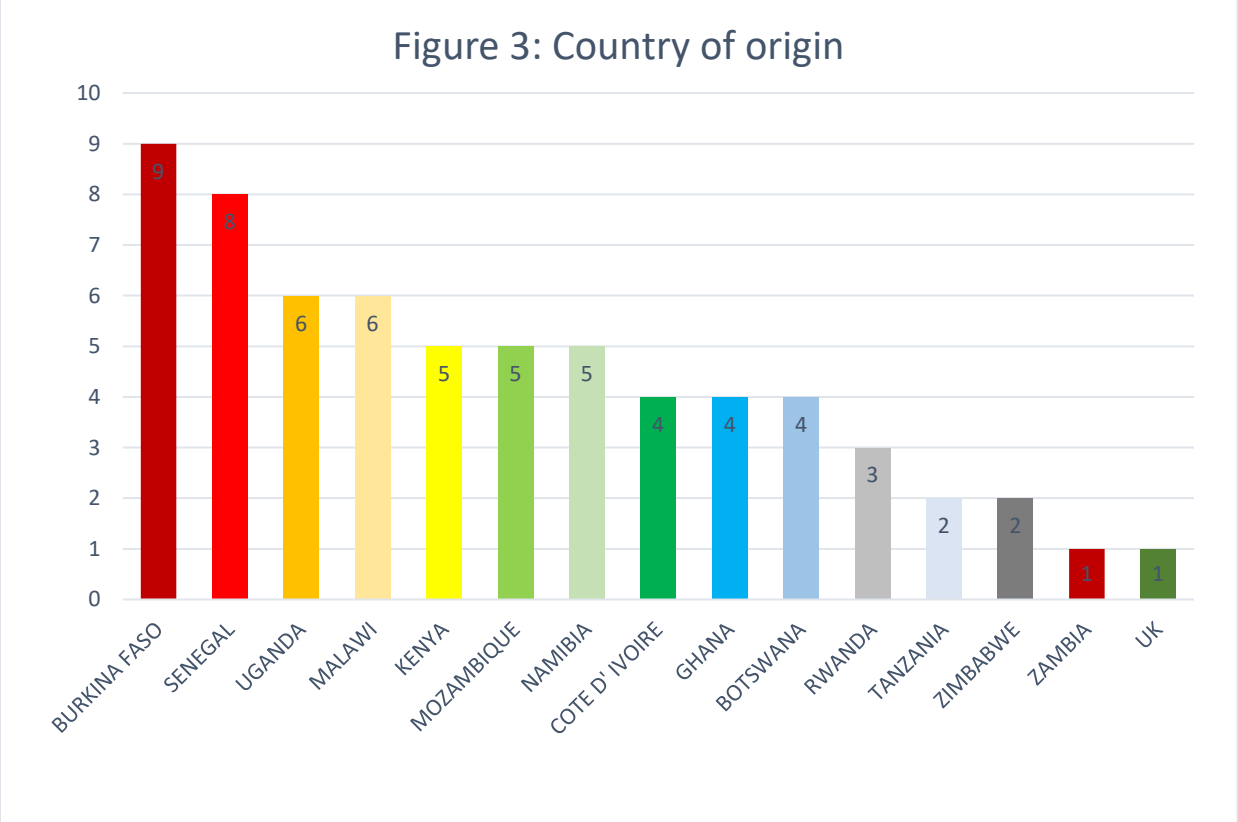
Figure 3: Country of origin
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1
1
BURKINA FASO
SENEGAL
UGANDA
MALAWI
KENYA
MOZAMBIQUE
NAMIBIA
COTE D' IVOIRE
GHANA
BOTSWANA
RWANDA
TANZANIA
ZIMBABWE
ZAMBIA
UK

In plenary, the participants were asked to respond to the following 5 questions and results collated in real time:

- What are the key issues affecting technology transfer and commercialization?
- What approaches to technology transfer have worked in your country?
- What are the key challenges to commercialization of research outputs?
- What are the existing research commercialization pathways?
- What should SGCs do to enhance technology transfer and commercialization of research outputs?

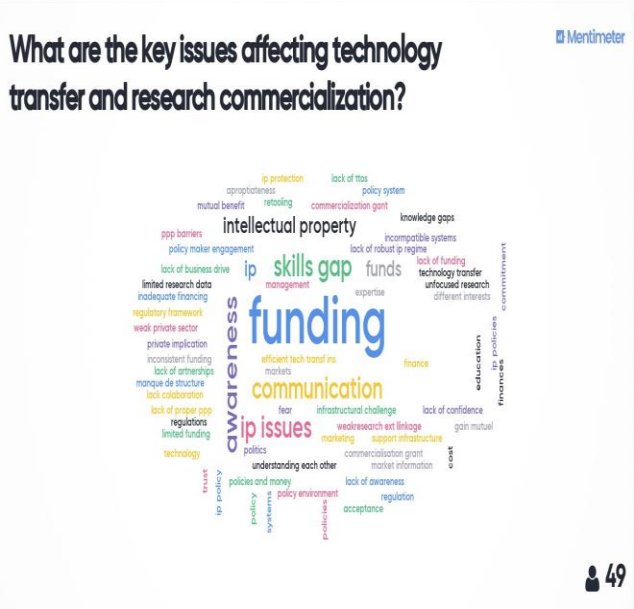
The results of this survey, generated as word cloud were further analyzed to determine the relative importance of each of the issues and suggestions presented. The key words (descriptors) were used to categorize the responses into sub-themes and the frequency (number of times the descriptors were mentioned in each question) were used to calculate the percentages (see annexes for details).

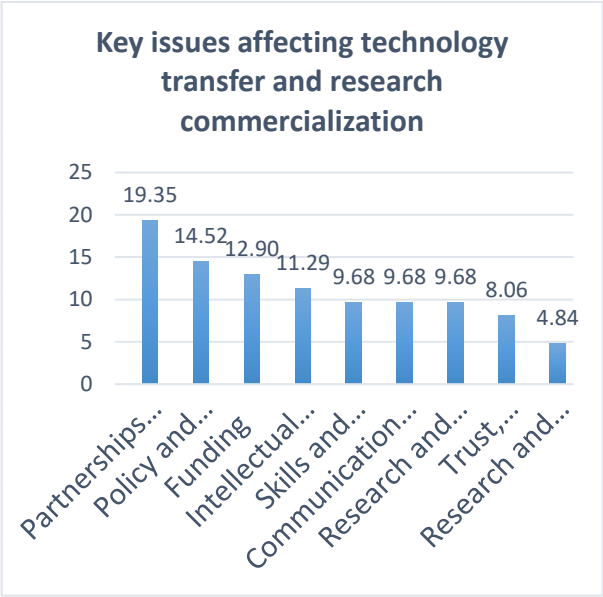
Mentimeter[12] survey results

Key issues affecting technology transfer and commercialization

There were 49 respondents to this question and 62 words (descriptors) were used to describe the key issues. In the analysis, these descriptors were distilled into 9 themes/topics (see annex 1). Partnerships and linkages with the private sector were rated highest (19.35%) followed by policy and regulatory systems (14.52%), funding (12.90%), intellectual property rights regimes (11.29%), Skills and capacities (9.68%) same as communication and coordination (9.68%). Other strategic issues include: research and innovation infrastructure (9.68%); trust, confidence and interests (8.06%) as well as research and data quality (4.84%)

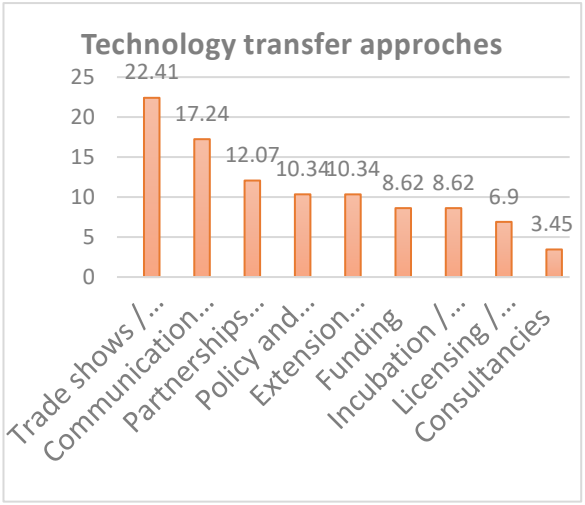
[12] Mentimeter is a cloud-based solution that allows you to engage ad interact with your audience in real time. It is a polling tool that can be used to set questions and the audience give their input using mobile phones or any other gadget connected to the internet. For details on the use of this tool, see www.menti.com.





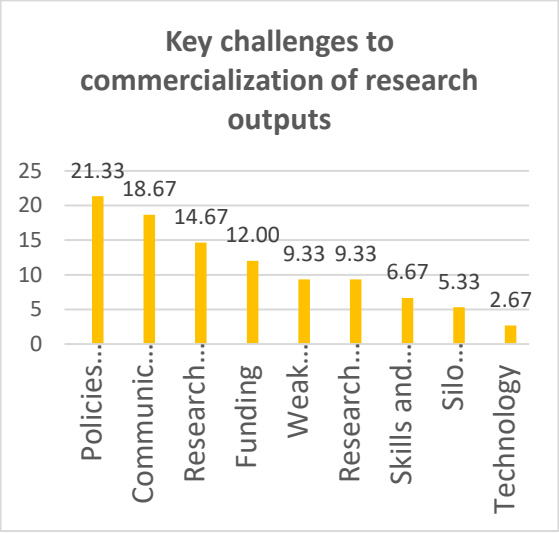
Approaches to technology transfer and commercialization

A total of 41 respondents used 58 descriptors across 9 themes/topics (annex 2) to highlight the important role of trade shows, exhibitions and advertisements (22.41%); communication and mentorships (17.24%); partnerships and linkages (12.07%); policy and regulatory systems (10.34%); extension services (10.34%). Other approaches include: incubation and innovation hubs (8.62%); licensing/technology transfer offices (6.9%) and consultancies (3.45%)



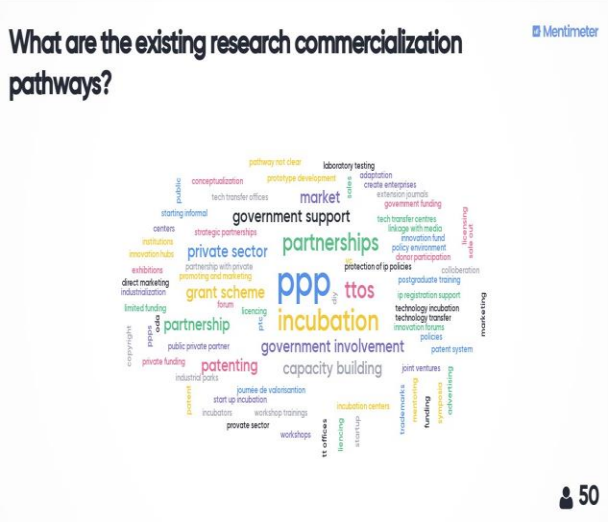
Challenges to commercialization of research outputs

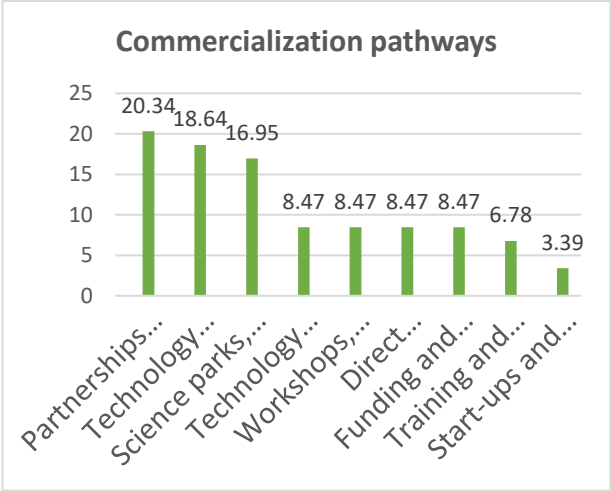
There were 49 respondents and 75 descriptors which were grouped into 9 themes/topics (details in annex 3). Policies and regulations topped this category (21.3%), followed by communication and coordination (18.67%); research quality and relevance (14.67%); funding (12.0%). Other issues included a weak private sector (9.33%), research and innovation infrastructure (9.33%), skills and capacities (6.67%), silo mentality and trust (5.33%) and limited technology (2.67%)



Research commercialization pathways

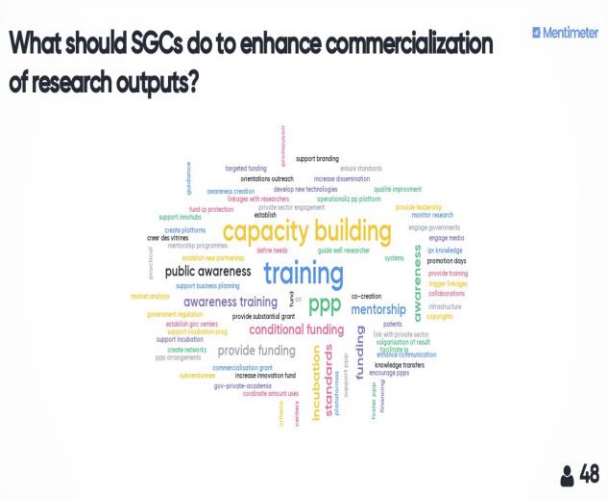
This question attracted 50 respondents and 59 descriptors which have been grouped into 9 themes (3.39%) (annex 4). Existing impact pathways include partnerships and linkages with the private sector (20.34%); technology licensing and sale of IP (18.64%); science parks, innovation hubs and incubation centers (16.95%); technology transfer offices/centres (8.47%). Other approaches are workshops, symposia and advertisements (8.47%); direct marketing and own production (8.47%); startups and spin-offs (3.39%).

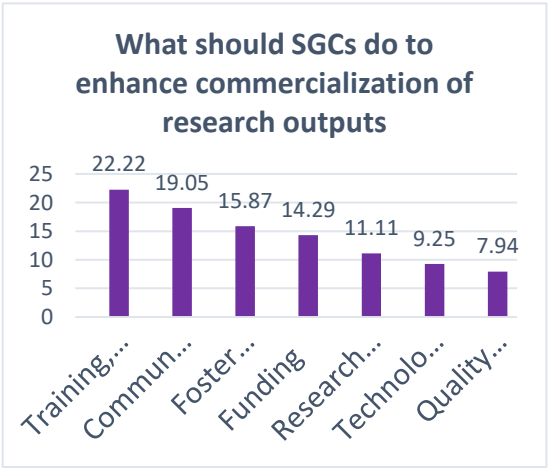




Role of SGCs in enhancing technology transfer and commercialization

There were 48 respondents and 63 descriptors across 7 themes/topics (annex 5). Training, capacity building and mentorship (22.22%); communication and coordination (19.05%); foster platforms and forums for collaborative engagement (15.87%); funding (14.29%); Research and innovation infrastructure (11.11%); intellectual property rights support (9.25%) and quality and standards (7.94%)





CASE STUDIES: INSTITUTIONS, PRACTICE AND PARTNERSHIPS

The eight case studies were spread across four themes and eight countries. These include:

- New institutional architecture: National Innovation Agencies in Ghana, Kenya and South Africa
- Technology transfer and commercialization in practice in Ghana and Botswana
- Supporting local innovators through incubation, mentorship and coaching
- Partnerships and collaborative research in Uganda and Malawi

New institutional architecture

Case Study 1: The Ghana Innovation, Research and Commercialization Centre (GIRC)

The GIRC Centre is one of the larger components of Ghana's STI Framework for national development. The national STI framework has 7 Pillars namely: (i) the Presidential Advisory Council on STI (PACSTI) (ii) the Inter-sectoral coordination and collaboration (iii) Innovation and research Commercialization (iv) National STI Fund (v) Science, Technology, Engineering and Mathematics (STEM) (vi) STI bill (viii) Strategic Technology Areas. Out of the 7 pillars, the GIRC Centre supports directly 2nd, 3rd, 4th and 7th pillars:

Under pillar 2 on *Inter-Sectoral Coordination and Collaboration*, there's recognition of the need for collaboration among all the relevant ministries through a Council which will be chaired by the Minister in charge of the Ministry of Environment, Science, Technology and innovation (MESTI), working with all other ministries to ensure that the efforts of the Centre are cross-cutting and to avoid duplication. In this respect, the GIRC Centre has the following functions: (i) foster inter-ministerial collaboration (ii) facilitate international research collaboration (iii) ensure government to government STI Collaboration and (iv) enhance research institutions and private sector collaboration

In pillar 3 on *Innovation and Research Commercialisation*: The Centre is expected to solicit, evaluate and support projects that are aligned to the national development agenda and have high commercialization potential. The Centre will support prototyping for commercialisation and institute solid monitoring and evaluation and economic impact assessments.

Under pillar 4, the *National STI Fund*, the government of Ghana has pledged to set up the Fund with an initial capitation of not less than 1% of the GDP and with a target of 3% of GDP over time. The GIRC Centre will support the allocation of government funds, application of donor grants, sector funding contributions, local government contributions as well as private sector contributions;

In pillar 7, *Strategic Technology Areas*, the GIRC will ensure optimal allocation of resources and technologies for national development. For each strategic technology area, they will set up a Strategic Technology Centre (STC) as integrated state-of-the-art facilities, which will be centres for job creation. The GIRC Centre will be housed at the CSIR-INSTI in Accra, while the STCs will be distributed across the country. As at the time of this case study, the implementation and establishment of the GIRC centre was on-going.

Case study 2: Kenya National Innovation Agency (KENIA)

In 1977, Kenya set up the National Council for Science and Technology (NCST) through the Science and Technology Act (Cap 250) laws of Kenya. NCST was mandated, amongst other functions, to advise government on matters of science and technology and support S&T policymaking. It also had an oversight role over the statutory research bodies created under the same law and in a more general sense, the country's science system. As debate on the inadequacy of the S&T policy focus raged and the need to consider application of knowledge to economic development increased, the need to include innovation in the country's policy framework increased.

To further harness its STI potential, in 2013, Kenya repealed its S&T Act (cap 250) and set up the Science, Technology and Innovation Act (2013), disbanding the NCST and creating three autonomous institutions and changing the country's STI institutional architecture. These include:

(i) The National Commission of Science, Technology and Innovation (NACOSTI) mandated to set research priorities and quality assurance;
(ii) The National Research Fund (NRF) charged with the responsibility of resource mobilization and allocation and
(iii) The Kenya National innovation Agency (KENIA) to spearhead innovation and commercialization.

The three institutions are created under the same law (STI Act, 2013) but have very distinct mandates and are independent in terms of governing structures but their functions are interrelated. They have the CEOs of each of these institutions sitting as members of the boards of the other institutions. This helps in maintaining the interrelationships and complementarity.

The core mandate of the KENIA is to develop, coordinate, promote and regulate the National Innovation Ecosystem. Its key functions include:

i) institutionalize linkages between universities, research institutions, the private sector, the government, and other actors;
ii) scout for and nurture innovative ideas from individuals, training institutions, the private sector and similar institutions;
iii) establish and regularly update a database on innovation in collaboration with other relevant institutions;
iv) increase awareness of intellectual property rights among innovators;
v) create synergies among different technological innovations, incubations initiatives for diffusion of technology in Kenya;

vi) facilitate the application for grant or revocation of patents and institution of legal action for infringement of any intellectual property rights; and
vii) recommend the provision of financial and any other assistance to any person for the purpose of encouraging the person to develop any technological innovation.

Case study 3: Technology Innovation Agency (TIA), South Africa

The Department of Science and Technology (DST) was created in 2004, to assess the status of R&D and support commercialization of research products. In 2009, the Ministry of Technology created the Technology Innovation Agency (TIA) to spearhead the exploitation of the commercialization opportunities in the country. At this time, South Africa had 23 universities and 10 research councils, generating a lot of research output but the products did not make it to market. This low transition to market rate was attributed to amongst other things:

- Lack of coordination: there existed numerous STI funding instruments developed by different ministries which acted in isolation.
- Risk absorption: they had strong financing systems but were risk averse. No institution was ready to absorb the high failure risk associated with research and innovation projects.
- Innovation culture: there existed a general poor culture of innovation.
- Skills and capabilities: there was inadequate skills for innovation management and commercialisation.

The DST developed a strategy to fund early stage research output coming out of research communities including universities and research councils. A TIA Act was passed in 2008 and the TIA was set up in 2009. The TIA Act defined the objective of the agency: *support the State in stimulating and intensifying technological innovation in order to improve economic growth and the quality of life of all South Africans by supporting the development and exploitation of technological innovations*.

To achieve its objectives, TIA crafted its value proposition to include:

(i) establish new industries (ii) diversify the economy away from primary systems of production to knowledge based products (iii) localisation and beneficiation of minerals, (iv) transform the industry and create sustainable jobs by providing an enabling environment.

TIA defined its roles in terms of 4 functions:

(i) a connector (operating at Technology Readiness Level (TRL) 3
(ii) a funder (TRL 4-7, for example actively administering the Technology Development Fund (TDF) and Pre-Commercialisation Support Fund (PCSF)
(iii) a facilitator (TRL 8, PCSF)
(iv) a service provider (in charge of technology stations and platforms).

Summary: Lessons, experiences and impacts

While the Ghanaian GIRC Centre is still in its early phases of development and therefore no assessments on its successes or challenges are possible at this time, the Kenyan innovation agency is also in its infancy and had just begun its operations in about 2017. With barely two years since being set up, any evaluative assessments at this stage would be premature. In South Africa, TIA operates mainly in applied technologies at TRL 4-7, and commercialisation demonstration at TRL 8. At these levels, they have issued and administered the technology development fund and a commercialisation

support fund. These funds are used to support specific and well-defined activities including: initial proof of concept, prototype development, sourcing of IP opinions, production of market samples, refining and implementing designs, conducting field studies, support of certification activities, piloting and scale-up, techno-economic evaluation, detailed primary market research, and business plan development.

Within TIA, the Innovation Enabling Division focuses on the ecosystem and supports programmatic interventions that strengthen the ecosystem. These include:

a. Infrastructure support: Achieved through technology stations and technology platforms, this function focuses on connecting the engineering and industrial expertise to high end infrastructure and make it easily accessible to private sector and researchers.
b. Funding Support: They have created various targeted funding instruments for the different categories of stakeholders including the technology development fund, the pre-commercialization support fund amongst others.
c. Skills and capacities development: geared towards developing the requisite human capital to provide skills and enterprise development.

As at 2018, TIA reportedly had eighteen (18) technology stations based in universities of technology across South Africa. These stations provide varied services such as testing and analytical services, prototyping and manufacturing, consultation, technology audit, research and development, process and product improvement, applied development engineering and design, as well as technology demonstration and training. Similarly, TIA has 10 Platforms across the country that deal with drug discovery, proteomics, bioprocessing platforms, bioprospecting platforms, and metabolomics.

Technology transfer and commercialization in practice

Case study 4: The case of Ghana's Council for Scientific and Industrial Research (CSIR)

CSIR is an umbrella body with 13 research institutes – headed by a Director General (DG) but each institute is autonomous – running their own accounts, including foreign accounts. The DGs management committee meets every quarter. This committee comprises all the Directors of the Institutes together with the Deputy Director General (DDG) and four (4) Corporate Directors, commercial director and finance directors. The Commercial Director is the Coordinator of Commercialization. There exists a commercialization division in all the institutes with a mandate to develop businesses for the Institutes

The CSIR has undertaken steps geared towards unlocking the entrepreneurial potential of the institute and its employees. At the HQs, there is the CSIR+ set up in the early 2000s as a commercial wing of the entire CSIR. CSIR+ is a limited liability company to promote participation in businesses in the interest of CSIR without any encumbrances. For bids in which CSIR cannot participate or is disqualified because of its public nature, then CSIR+ steps in.

One of their key products that has been commercialized is the *Sircool water* from its Water Research Institute (WRI). The investment into the water purification and commercialization was spearheaded by the Institute's supper-annuation (investment) committee. When WRI floated their intention to commercialize the sircool water, it emerged that the WRI couldn't operate commercially and they

therefore requested CSIR to re-look at the law establishing WRI. The CSIR management then gave permission to establish a company outside the CSIR to manage the commercialization and technology transfer activities. This company was established in the early 2000s as a private entity under CSIR and is located about 1.5hrs drive outside Accra. The Sircool water started selling in sachets and targeted ordinary people as their clients. Soon the water hit the supermarkets and as at the time of this interview, production could meet the demand.

Another key research product is the *Pozolana Cement* from the Building and Road Research Institute (BRRI). Commercialization was a problem till an American investor helped build a factory for production and upscaling. It was anticipated that government procurement would support the business and hoped to persuade the government funded public institutions such as schools, hospitals district assemblies etc to purchase exclusively from the factory. Unfortunately, this government promise didn't come through and the new factory couldn't compete with Ghasem Cement which still monopolizes the cement business in Ghana. The American investors eventually opted out but the BRRI bought back the rights and keeps running the business[13].

Interviews revealed that SUMATRA – a company from Indonesia – entered into agreements with the Oil Palm Research Institute for a joint venture to produce and market a germplasm with beneficial traits. There were indications that they had started with germinated seeds/seedlings to continue what was already going on at the Institute. Later on, the company (SUMATRA) withdrew from the partnership but the OPRI is continuing into the plantation of oil palms[14].

The Food Research Institute has come up with numerous products including fufu flour and other maize based cereals. However, these have not been commercialized or up-scaled due to the large capital outlay required to take them to market. They are currently being produced on a pilot basis at the Institute's premises.

Summary: issues, lessons and impacts

(i) Institutional mandates as a limiting factor

The CSIR, like many other public research institutes across the continent were established when the linear transfer of technology model (ToT) still dictated how research was organized, conducted and applied. As such, for most researchers, "your work ends when you have developed the technology and someone else needs to take over"

In the case of CSIR, this limitation was even ingrained into the law. Established in 1968, CSIR mandate didn't include commercialization and it was until 1996 at the height of international debate on commercialization that the law establishing the CSIR was reviewed and its mandate expanded to include commercialization function.

(ii) Formulating and operationalizing institutional IP policies

[13] As at the time of this interview, it was not possible to determine the relative success of this project. It would require a larger study to assess its performance

[14] For additional reporting see the case example under recommendations on public policies and spending

Even though Ghana has a Patent Act (1994) and other IP-related laws such as copyrights and trademarks, not all the institutions have developed institutional IP policies to guide their technology transfer and commercialization approaches. It was alleged for example during the interviews that a businessman had poached the technician involved in the formulation of the *fufu flour* from the Food Research institute and had succeeded in establishing the Institutes technology as a competing product in the domestic market yet the Institute had no legal recourse.

A related issue is that even though the different Institutes under the CSIR have developed these novel products, all the technologies were already in the public domain and so couldn't be appropriated through patenting. Though closely tied to the issue of mandates – being publicly funded, CSIR is expected to generate public goods – there's a deeper issue of IP awareness and the implications of obtaining IP rights vis-à-vis the researchers needs to publish and progress in their careers.

(iii) The need to exploit diverse commercialization pathways and infrastructure

As demonstrated by the cases at the different Institutes of the same umbrella body (CSIR), there are many pathways to commercialization. For example, the Water Research Institute (WRI) built their own production and distribution facility for its *sircool water*, the BRRI's *Pozolana cement* got a foreign investor, the Oil Palm germplasm tried the joint venture with the Indonesian company, while the Food Research Institute is pilot testing its products such as *fufu flour* using internal structures.

Supporting local innovators through incubation, mentorship and coaching

Case study 5: Ghana: an exemplar of thriving incubation and innovation hubs[15]

Educational Quality Work Improvement Programme (EQWIP[16]) Hubs

EQWIP is an initiative of Youth Challenge International[17] and Canada World Youth (CWY) through the funding support of Global Affairs of Canada. The hub builds capacity in the area of entrepreneurship and business management and recruits, provide training, funding support, mentoring and coaching free of charge. The hub has two branches in Kumasi - housed at the Kumasi Technical University (KTU) and Tamale - hosted in the Regional National Service Office.

Since the inception of the project in Tamale, the hub has trained over 600 youth and 45 of them supported with the Youth Innovation Fund. The Youth Innovation Fund is opened to all who have been trained to present their businesses and portray creativity and innovation. Upon selection, the

[15] Additional material for this section was distilled from a report/study funded under the SGCI on behalf of the Ghana's Ministry of Environment, Science, Technology and Innovation (MESTI) and conducted by the Science and Technology Policy Research Institute (STEPRI). The author duly acknowledges this.

[16] https://www.eqwiphubs.org

[17] https://www.yci.org

start-ups are taken through 5 days of comprehensive accelerator workshop to equip them with the practical experience needed by private sector practitioners

Accelerator workshops enhance capacity building and target specific topics which takes about 12 weeks to complete. After the accelerator workshop, an amount ranging from $500.00 to $2,000.00 is given to the start-ups depending on the business idea.

University of Cape Coast Business Incubator (UCC-BI[18])

The business incubator was established with funding from the School of Business in 2013 and provides support in ICT, agribusiness and fashion. Other areas of professional services include accounting and auditing. They support start-ups with mentoring, training, and provision of co-working space. The incubator has 8 spaces available for start-ups which are provided for a maximum of 2 years. The centre has incubated about 30 businesses and formed partnership with the Ministry for Business Development (MoBD) and National Entrepreneurial and Innovation Programme (NEIP) to train about 300 entrepreneurs.

Limited funding has been highlighted as a key challenge to this university-based incubator. The UCC-BI does not provide funding to its incubates and after incubation, the start-ups find it difficult to survive due harsh conditions outside such as rental of space and payment of utilities and staff. During incubation, however, the start-ups pay eighty (80 cedis) per month for all the services including the working space.

Additionally, the UCC-BI has to operate within the Institutional constraints of the hosting university. The business incubator is a unit within the Centre for Entrepreneurial and Small Enterprise Development (CESED) which is embedded in a larger university framework. The university procedures and hierarchy limits to what can be done. On the positive side, though, the location at the university provides access to all the expertise in the school of business and others within the university for its training requirements.

Ho Node Innovation Hub[19]

The Ho Node was established in 2017 to inculcate the culture of innovation among the youth. The hub trains on digital skills such as design, artificial intelligence (AI), coding and other emerging technologies. The achievements of the hub include the shaping of the youth to develop the culture of innovation which led in the creation of innovation communities for like-minded people such as (i) community for software developers or those interested in technologies (ii) community for women entrepreneurs to create a safe space for women to meet and deliberate on issues and help each other (iii) community for creativity such as tourism and graphic designing and (iv) general community for

[18] https://web.facebook.com/pages/category/Business-Consultant/University-of-Cape-Coast-Business-Incubator-UCCBI-2144181989196559/?_rdc=1&_rdr
[19] https://honode.org/about/

entrepreneurs. The communities regularly have virtual meetings and also meet together physically to engage and encourage peer learning and sharing of ideas to foster innovation.

To ensure gender and inclusion, the hub has conducted digital skills training focusing on women. This has enabled the training of women in coding and artificial intelligence, photography, mobile app, graphic design among others. The hub has trained close to 500 people in use of digital skills.

The key challenges facing this hub include (i) difficulty of attracting and keeping talents or expertise as a result of its location in a rural setting (ii) limited access to funds since the hub is a non-profit, self-funded by the founders who in invested in the business through provision of infrastructure and logistics. The hub depends on grants and project funding from donors and (iii) the challenge of infrastructure is mainly on internet which is costly, unstable and not fast enough. In terms of equipment and machinery, the hub lacks skilled laboratory such as a Maker Space.

Case study 6: Botswana Innovation Hub (BIH[20]) opening domestic and export market opportunities for local innovators

The collaboration between the Botswana Innovation Hub (BIH) and Kalahari Secrets, producers of donkey milk products, is a move aimed at ensuring the Hub assisting in the development of local products.

Kalahari Secrets products range from soaps to lotions made from donkey milk and some other natural products. Speaking during the launch of the products, BIH chief executive officer Allan Boshwaen said they would be instrumental in ensuring that Kalahari Secrets products penetrate other markets beyond the country. *"We are impressed with the talent that we see locally hence the reason the Hub has stepped in and assisted with the product laboratory testing, certification and would also continue to assist market them just like we have done before with other innovators,"* he said. Boshwaen said the BIH is concerned with preserving indigenous products hence their collaboration adding that they have managed to secure a stall for the Kalahari Secrets at Sir Seretse Khama International Airport (SSKIA)[21].

Following are excerpts from an interview with an official at the Ministry of Tertiary Education, Botswana

[20] https://www.bih.co.bw

[21] http://www.mmegi.bw/index.php?aid=76264&dir=2018/june/18

http://www.mmegi.bw/index.php?aid=65818&dir=2017/january/16
http://www.mmegi.bw/index.php?aid=70295&dir=2017/july/14

http://www.mmegi.bw/index.php?aid=71954&dir=2017/september/25

The donkey milk has gained a lot popularity. Traditionally, donkey milk has been known for its medicinal properties. Given to small babies at about 3-6 months old, they will not need to be vaccinated and even in modern times with new vaccines, people still offer donkey milk to babies as to protect them from flu and other common diseases".

"Recently, we have had an innovator working on developing donkey milk products and he has developed a facial lotion and baby milk solution which comes in the form of tablets and another one in the liquid form. Now an IP controversy came in when the innovator was linked up with the university professor to get into a product level stage of market acceptance and getting his products patented. At some stage, the two had a disagreement and they parted ways. The professor went ahead and patented the product by himself and the innovator was just left in the dark. Through assistance from some other groups, the innovator formed a company and then on his own, got IP rights over the same products. Eventually, the two managed to get the IP for this product independently."

"The innovator has been getting a lot of support from the Botswana Innovation Hub; he has been able to get contracts outside of Botswana to export. However, the main challenge has been lack of standards and certification. There are no standards and the government through the Botswana Bureau of Standards (BoBS) in the process of developing milk product certification for this particular product. Another challenge is that the innovator has been producing from home yet for him to access export markets, the products need to be certified and the production facilities need to be lab-based"

Summary: issues, lessons and impacts

(i) The need to build coaching and mentorship as integral parts of incubation programmes

The EQWIP Hubs shows the need to incorporate mentorship and coaching are an integral part of the incubation service. Besides the accelerator workshops, peer to peer mentorship is organized between the Canadian volunteers and their Ghanaian Start-ups. Coaching is once monthly and involves helping the start-ups identifying challenges and finding solutions in their businesses, field trips and regular visits to the start-ups. The project also instituted 6 months sustainability service, where the start-ups are matched to mentors in similar industry to meet and discuss their businesses, provide support and guide them through the start-up phase. The Ho Node hub, provides one-on-one business support for entrepreneurs. This support includes training on general business management, financials/records keeping among others.

(ii) The need to cater for stakeholders with special needs

To ensure gender and social inclusion, the EQWIP hub introduced a "girls-only-spaces" and "child care services" for incubatees who were mostly women. The girls-only-spaces was introduced to create a safe place for women to meet and share ideas. The success of this model has enabled its adoption by the department of gender and civil society organisations (CSOs) in Ghana's northern region.

(iii) Standards and certification are key to penetrating domestic and export markets

The case of BIH is instructive. As the interviewee noted, *"The innovator has been getting a lot of support from the Botswana Innovation Hub; he has been able to get contracts outside of Botswana to export. However, the main challenge has been lack of standards and certification. There are no standards and the government through the Botswana Bureau of Standards (BoBS) in the process of developing milk product certification for this particular product. Another challenge is that the innovator has been producing from home yet for him to access export markets, the products need to be certified and the production facilities need to be lab-based"*

Partnerships and Collaborations

Case Study 7: Creating New Products Through Public – Private Partnerships (PPPs) In Uganda

This case study looks at three projects funded under the public-private partnerships grant scheme implemented by SGCI and implemented between 2018 – December 2019. The first project, *"High fibre bakery and confectionery products from maize germ and bran[22]"* focused on the utilization of maize bran and germ generated by the different millers in product development for bakery and confectionery enterprises. The project aimed to incorporate bran and germ into various baked and confectionery products such as muffins, bread and cookies. The project is led by Makerere University's department of Food Technology and Nutrition in partnership with private partners include: (i) Maganjo Grain Millers - producing a range milled cereal flours, extruded breakfast and snack food; (ii) Agro ways (U) Limited – producing maize grit and (iii) JOVAY School of Cookery – producing a variety of bakery and confectionery products.

The second project, *"Commercial Exploitation of Propolis and Bee Venom in Uganda[23]"* aims at developing propolis and bee venom-based products including: propolis powder supplement, bee venom powder supplement, a syrup drink and a ready – to – drink beverage. The School of Veterinary Medicine & Animal Resource-Research Center for Tropical Diseases and Vector Control (SVAR-RTC) at the College of Veterinary Medicine, Animal Resources & Biosecurity (COVAB)-Makerere University, have partnered with private sector players such as The Uganda National Apiculture Development Organization (TUNADO) which has a network of 9,000 beekeepers and Aryodi bee farm with a network of 500 producers, an already running business with between 10,000 kg to 15,000 kg of honey per season.

The third project *"Cocoa waste to wealth using yeast strains from Ugandan box fermentation[24]"*, aimed to develop a single cocoa fermentation box to help small scale farmers who cannot generate large quantities of cocoa beans required in storey box fermentation. This project was led by the National Coffee Research Institute (NACORI) in collaboration with the private actors in the cocoa industry namely ICAM Chocolate and Lwanga enterprises.

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[22] For details on this project, see policy brief, "*Maize germ and bran for value addition: high fiber bakery and confectionery products"* available here: https://scinnovent.org/wp-content/uploads/2020/02/Policy-Brief-08-for-print.pdf

[23] For details on this project, see policy brief, *"Strategies for increased utilisation of new propolis products in Uganda"* available here: https://scinnovent.org/wp-content/uploads/2020/02/Policy-Brief-11-for-print.pdf

[24] For details on this project, see Policy brief, *"Building the capacity of small scale cocoa farmers to conduct on-farm fermentation* available here: https://scinnovent.org/wp-content/uploads/2020/02/Policy-Brief-04-for-print.pdf

Summary: Issues, lessons and impacts

(i) Obtaining, ensuring and maintaining quality and standards

The maize germ and bran project highlights the challenges of standards and quality, especially as regards locally-sourced raw materials and products. The partnership between Makerere and Maganjo led to new product lines (at Maganjo) and access to research infrastructure by the University. However, as the principal investigator in this project noted:

"The challenge is to continuously obtain the quality of the germ and bran from Maganjo. The quality of bran and germ is variable and greatly affected by many factors such as the quality of the grains and their duration during storage. To overcome this, arrangement was made with Maganjo Grain Millers to store the bran and germ obtained from early harvest mains in Triple bags to reduce on deterioration of quality…it requires a good budget for product development as involves numerous sensory evaluations and chemical and nutritional evaluations."

The factory manager at Maganjo confirmed, *"initially we were using maize bran for dog food. It wasn't used for human food. Now, at least it can be used to make flakes which people consume as breakfast cereal"*

(ii) Building partnerships with beneficiaries is key in promoting uptake and commercialization

The bee propolis project shows the benefits that accrue from research partnerships and linkages. As one of the team members noted:

"First as a team we have appreciated the importance of joint research initiative between academicians and private sector as it develops impactful research that addresses local needs. Lesson from this project is that the outcomes are readily accepted by communities and all parties involved learn."

"Through the project, we have built a strong partnership and network between the university, communities (beekeepers) and private processors (Aryodi), MAAIF (department of entomology) and TUNADO. These partnerships can be used as a leverage for sustaining the commercial exploitation of propolis and other bee hives products in Uganda."

"The challenge for this project now remains in training of persons in processing of the products, establishment of a product development mini-factory to continue incubating and upscale research innovations while offering opportunities for employments and income generation"

(iii) Technology fairs, field demonstrations and other extension and advisory services are still required.

In the Cocoa waste project, the technologies are being disseminated via the participating project partners especially the private sector (ICAM chocolate and Lwanga enterprises) and farmer groups from the cocoa growing regions. Technology demonstrations on fermentation have been carried out at farm level and prototypes issued to two farmer groups in Bundibugyo and Kasawo. Through this project, more funding has been attracted from EU-funded Market Access Upgrade Programme (MARKUP[25]) and UNCST and the project targets to extend the fermentation technologies to farmers through trainings for improved quality of cocoa.

Case Study 8: New Business Models in The Renewable Energy Sector in Malawi

In this case study, two renewable energy projects implemented under SGCI phase 1 are presented. The projects were implemented over an 18 months period between May 2018 and December 2019. In the first project, *"Piloting biogas as a social enterprise at Tsangano vegetable market, in Ntcheu District"* is premised on the fact that production of biogas from the abundant vegetable waste at the market would help to provide alternative source of energy for cooking to restaurants, chips making businesses and households. This, it is anticipated would help to reduce deforestation, and promote sanitation at the market and the surrounding communities. The project seeks to pilot "fee-for-service social enterprise business Model" in biogas. The entrepreneurship component of the project will help to generate funds for operation and maintenance of the biogas plants. Malawi University of Science and Technology (MUST) implemented this project in partnership with a local energy company, Green Impact Technologies (GIT).

In the second project, *"Solar Powered Technologies for Smallholder Dairy Industry*[26], the overall objective was to contribute towards improved milk production among smallholder dairy farmers in Malawi through the introduction of two innovative solar powered dairy production technologies; (i) solar powered milking machines which are neither available at the local market nor utilized in smallholder dairy production systems, and (ii) solar powered water supply systems which are currently not used in the smallholder dairy production systems. The project was jointly implemented by Lilongwe University of Agriculture and Natural Resources (LUANAR) and a Malawian registered private company – Orifice Irrigation and Water Supply (OIWS) Limited – which specializes in supply and installation of solar energy technologies and water supply systems.

[25] https://www.eacmarkup.org

[26] For details on this project, see policy brief, *"solar powered technologies for the smallholder dairy industry in Malawi"* available here: https://scinnovent.org/wp-content/uploads/2020/02/Policy-Brief-06-for-print.pdf

Summary: issues, lessons and impacts

(i) The importance of user participation in project implementation, knowledge exchange and technology transfer.

In the case of the biogas, the private company was involved from the inception meetings, community mobilization, awareness, sensitization and actual construction of the plant. The company was engaged in the project design to ensure that after commissioning it would take over, expand, sustain and replicate the technology to other areas where there are similar challenges of wastes problems addressing deforestation and providing alternative energy for cooking.

(ii) The role of communication and coordination in enhancing knowledge exchange and technology uptake.

The biogas project team made presentations at a Cleaner Cooking Camp through National Cook Stove Steering Committee which is chaired by the Department of Energy affairs to sensitize stakeholders on the project. It has further produced a policy brief and shared with relevant policymaking agencies including the Parliamentary Committee on Environment, Department of Forestry, Department of Energy, Department of environment and the overall Ministry of Energy, Natural Resources and Mining. The policy brief has also been shared with the Malawi Energy Regulatory Authority (MERA) to inform the development of regulatory framework for Biogas systems in Malawi[27].

(iii) The importance of institutions and frameworks in collaborative research and innovation projects.

In the solar powered milking machines project the two parties signed a Memorandum of Understanding (MoU) for the working partnership of the project. Under the partnership, responsibilities of each party and other logistical and management issues between the two parties were agreed upon. The governance and conflict resolution mechanisms spelt out in the MoU ensured stability and success of the partnership.

Further, the machines installed at Bunda College Animal Science Students' farm are being used for teaching animal science students in use of solar powered milking machines. This helps to build future skill sets and ensure sustainability of the technology. The project team linked up farmers with suppliers, service providers and agents providing technical back-up services. The project team also provided training to the farmers both during and after implementation of the solar powered equipment project to ensure sustainability of the innovation. The involvement of OIWS is also very key in ensuring that the technologies are sustainable. OIWS is expected to continue

[27] As at the time of this interview, it was reported that the government of Malawi through the Department of Energy Affairs had adopted the biogas model and was considering replicating it to other municipal councils.

to market the technologies as a business entity thereby also providing additional backup services to farmers with the technology.

LESSONS FROM THE SCIENCE GRANTING COUNCILS INITIATIVE (SGCI)

The Science Granting Councils Initiative in sub-Saharan Africa (SGCI[28]) aims to strengthen the capacities of Science Granting Councils (SGCs) in sub-Saharan Africa in order to support research and evidence-based policies that will contribute to economic and social development. Launched in April 2015, the Initiative is strengthening the ability of Councils in 15 countries[29] in order to i) manage research, ii) use robust STI indicators to design and monitor research programs, iii) to strengthen knowledge transfer to the private sector, and collaboration among themselves, and iv) to promote networking among themselves and with other science system actors. The capacities strengthening activities are expected to lead to more effective research investments and strengthened research leadership for development in sub-Saharan Africa.

The SGCI convenes Annual Forums (AFs) that bring together the Initiative's participating Science Granting Councils (SGCs) and other key stakeholders around the world to deliberate and develop interventions in strategic areas of interest to the Councils and the wider science, technology and innovation (STI) community thus contributing to key Science Technology and Innovation (STI) policy debates at regional and continental levels. To facilitate sharing of lessons and good practices, the SGCI commissions a state-of-the-art paper on topics and themes of interest for Africa's development.

In the past, the SGCI Annual Forums have addressed issues relevant to the theme on strengthening collaborations and technology transfer in Africa. In this section, we distil key issues and lessons from three of these Annual Forums.

2017 Annual Forum: Effective Public – Private Partnerships for Research and Innovation

In 2017, the Annual Forum focused on the theme "Effective public – private partnerships for research and innovation[30]". This Forum addressed some key issues and themes relevant to collaborations and technology transfer including:

1. Research prioritization and agenda setting

[28] The Initiative is jointly funded by the United Kingdom's Department for International Development (DFID), Canada's International Development Research Centre (IDRC), South Africa's National Research Foundation (NRF) and the Swedish International Development Cooperation Agency (Sida).

[29] Botswana, Burkina Faso, Côte d'Ivoire, Ethiopia, Ghana, Kenya, Malawi, Namibia, Mozambique, Rwanda, Senegal, Tanzania, Uganda, Zambia, and Zimbabwe

[30] Held in Livingstone, Zambia, The Forum was guided by the Commissioned paper on the topic, *"Effective public – private partnerships for Research and Innovation: Perspectives for African Science Granting Councils."*

The 2017 Forum observed that a key issue undermining collaborations and technology transfer is the different focus and priorities of research interest from both the public and private sectors. In some cases, there is complete lack of priorities and each sector pulls in their own direction. Findings from the commissioned paper as well as experiences shared by the discussants and plenary showed that this problem is widespread and affects both developed and developing countries alike. However, key differences were highlighted on how countries are dealing with the challenge for example:

- In the Netherlands, the government through a "Top Priority Sectors Approach" identified the country's top 9 sectors and created incentives and support structures to facilitate the competitiveness and position them as global players in their respective value chains.
- In Costa Rica, the Ministry of Science and Technology and ICT champions agenda setting and leads other sectoral ministries in scouting for private sector research needs before making international calls to address them**.**
- In the UK, the Research Councils work closely with businesses to understand business needs and priorities and offer the required support. The Councils work in tandem with *Innovate UK* to implement a sectoral approach towards supporting businesses.
- In Africa, Botswana has developed a national research agenda and a private sector engagement strategy with support from the SGCI while countries such as Kenya already have national research priorities outlined.

2. Institutional architecture/infrastructure and governance patterns

The importance of institutions governance patterns – roles of different actors in decision-making and project execution – was equally highlighted with examples showing that this is an area that is often neglected but easily contested when projects take off.

- Examples from the PASRES programme in Ivory Coast showed how the private sector is involved in decision-making including choosing new leaders. The professional agricultural organizations representing the private sector are part of the management committees and the manager is appointed competitively from the private sector.

- In Costa Rica, in order to cater for the interests of the SMEs in the Papaya value chain, a special window was created for targeted support and to lessen the administrative burden. This led to a differentiated governance approach that served the interests of both the big players and the SMEs.

3. Funding models/ Mobilizing domestic resources for research and innovation

Generally, it was observed that most SSA countries are under-investing in R&D compared to their counterparts in other regions of the world. Most are yet to reach the continental targets of 1% of GDP, even though there are ambitious declarations from countries such as Kenya to invest up

to 2% of GDP. Failure to meet the targets notwithstanding, it is notable that there is an upward trend in resource allocation to research and innovation.

2018 Annual Forum: New Approaches for Funding Research and Innovation in Africa

In 2018, the Annual Forum focused on the theme, "New approaches for funding research and innovation in Africa.[31]"

The Forum dwelt mainly on funding and the key message highlighted the need for the funding models to be relevant to local contexts; highlight the role of partners and demonstrate value and impact; emphasize international competitiveness; strengthen the science-policy linkage; ensure enhancement of human and societal benefits. The following were highlighted as the desired characteristics of the funding approaches:

- Consistency of the funding

Predictability and surety of consistent funding sends signals to the researchers and innovators that long-term planning is possible. This is important for establishing collaborations and partnerships as partners become more confident that activities would not stop mid-stream. It is however notable that fluctuations in funding allocations and in some cases, even re-allocation of funding to STI is a common feature of government funding systems. In certain cases, projects have been delayed for years because funds allocated to the projects have been shifted to more urgent spending priorities.

- Sufficiency of the funding

Funding decisions are investment decisions. They require strategic guidance on the levels of input vis-à-vis the returns on investment. They require data and solid evidence to back them up. They require resources to be mobilized from different sources (both public and private; local and international, in cash and in-kind).

A number of key issues arise here:

- How much is enough? How do we determine that?
- Do we have the capacity to absorb it all?
- Given the procurement bottlenecks, is the annual funding cycle the best approach?

A related issue is whether the Councils have the capacity to absorb and utilize the resources allocated to them through the national treasury. Given the short turn around (annual funding cycles) and the bureaucratic government systems (procurement laws) and the nature of STI research projects (sometimes requiring specialized equipment and infrastructure) a key question remains: what are the most appropriate funding instruments that have been deployed by the

[31] The Forum was held in Abidjan, Cote d'Ivoire and was driven by guided by a commissioned paper under the same topic**.**

various SGCs?

- Relevance of the funding

A key consideration for the Councils is the entry points and targets for their limited funding. It is unwise to spread too thinly but they must also balance the needs to be focused and targeted with the long-term national research priorities and stakeholder needs. In the funding continuum, the public sector (represented by the Councils) focuses a lot more on the basic and applied research, supported mainly through STI grants and targeting universities and research institutes as the primary audience. They also support the private sector through technology and innovation grants while there are other instruments set up for collaborative research activities. The technology and commercialization grants are designed mainly for the private sector. However, usually there's a funding gap for prototype development and refinement, new products development and market feasibility studies. Targeting and prioritizing the limited funds is therefore paramount.

2019 Annual Forum: Open Science in Research and Innovation

In 2019, The Forum focused on theme, "Open Science in Research and Innovation for Development[32]"

A number of key issues from this Forum are relevant to research – industry collaborations and technology transfer. African Science Granting Councils are already working collaboratively in bilateral and multi-lateral cooperation, sharing resources, infrastructures, skills and capacities. These collaborations promote openness and, in some cases, have led to peer – to – peer learning, experience and knowledge sharing and replicability. Below are some of the issues highlighted from the Forum

Policies and strategies for managing data: Noting that data is the fuel that drives open science, the delegates called upon African governments to enact and harmonize policies, strategies and incentives for data acquisition, publication, use and disposal.

Capacity and infrastructure for computing: Delegates emphasized the need for enhanced computational ability for the continent to harness the potential for open science. This should be accompanied by skills and capacity enhancement, support for researcher mobility, sustainable funding and creation of accredited data centres.

Community and consensus building: Continuous dialogue is required to set priorities, goals and ambitions. There's need to create platforms and forums for regular engagement of the different players including public and private sectors as well as the funders.

[32] The Annual Forum was held in Daar es Salam, Tanzania and hosted by the Commission for Science and Technology (COSTECH)

Linguistic and cultural diversity: Noting that open science is embedded in cultural and institutional contexts characterized by diverse languages – English, French, Portuguese and Swahili as well as numerous dialects – the delegates emphasized the need to harness the opportunities presented by this diversity to promote valorization of research findings, enhance inclusivity and participation.

Strategic communication and public engagement: Communication of scientific outputs to the community was identified as a weak link that undermines uptake of research findings. Delegates emphasized the need to exploit the opportunities under open science to promote sharing of information and strengthen knowledge use.

Data ownership, access and ethics: Create frameworks to guide data ownership and access in collaborative partnerships

STATE OF THE ART: A SITUATIONAL ANALYSIS

This section analyzes the contemporary situation of seven sub-Saharan Africa countries with respect to main thematic areas that are the focus of this paper namely: (i) Partnerships and linkages with the private sector (ii) Funding for research and innovation (iii) Policies, regulations and incentives (iv) Innovation and commercialization infrastructure (v) Skills and capacities. It derives largely from interviews and surveys with key stakeholders, literature reviews and secondary literature to present the most current status from across the selected countries.

Theme 1: Partnerships and platforms for dialogue with private sector

In order to foster partnerships and collaborations, countries have established platforms and forums for enhanced dialogue with their stakeholders, particularly the private sector. The following examples illustrate this point:

In **South Africa**, the Technology and Human Resources for Industry Programme (THRIP[33]) was designed to fund applied research, design, engineering and technology development. THRIP aims to boost South African industry by supporting research and technology development and enhancing the numbers of appropriately skilled people. It brings together researchers, academics and industry players. Other initiatives include (i) workshops, conferences, dialogue with participation from both sectors (ii) innovation roadshows to raise awareness of the innovation needs, existing solutions and help market the innovations (iii) knowledge/innovation portals showcasing the existing innovations and (iv) business to business (B2B) meetings at events. The University of Witwatersrand, Johannesburg through its WITS Enterprise Innovation Support Unit[34] is an example of what specific universities are doing to support stakeholder dialogues and engagements.

In **Kenya**, collaborations and partnerships have been promoted through the establishment of units and directorates that promote the linkages, where the entry points include technology transfer contracts, contract research and startups arising out of ideas and university students' projects. Similarly, there are regular meetings with various stakeholders including the Kenya Association of Manufacturers (KAM), Kenya Private Sector Association (KEPSA) etc. In **Uganda**, partnerships and linkages are nurtured through dedicated funding of the research process, sharing available research results with the private sector as well as publishing of research results

In **Burkina Faso**, the forum of scientific research and technological innovations under the Centre National de la Recherche Scientifique et Technologique[35]. Similarly, there exists a consultation framework for institutes of higher education and research with the private sector under the

[33] For details see https://www.thedti.gov.za/financial_assistance/THRIP.jsp
[34] https://wits-enterprise.co.za/
[35] http://www.cnrst.bf/index.php/2020/02/19/forum-national-de-la-recherchescientifique-%20et-des-innovations-technologiques-frsit-du-26-au-30-mai-2020/

Ministry[36]. Burkina Faso also created platforms for consultation and dialogue both, higher education and research institutes / private sector through a ministerial decree in 2019.

While in **Mozambique**, partnerships and linkages between research and the private sector takes place mainly through applied research in different lines of financing, for example, innovation and technology transfer projects, in **Zambia** regular consultations are made with research institutions and industry to facilitate demand driven research and ensure uptake of technologies by industry. The National Science and Technology Council (NSTC) funds the identified research.

Theme 2: Funding research and innovation

Funding of R&D is a key function of the SGCs and countries have experimented with different approaches and mechanisms. In **South Africa**, for example, the Technology Innovation Agency[37] (TIA) – is instrumental in funding research, innovation and technology transfer activities. The Technology and Human Resources for Industry Program[38] (THRIP) - and the Industrial Development Corporation[39] (IDC) are some of the initiatives and programmes supporting funding of research.

Kenya recently re-organized its research funding framework through the science, technology and innovation Act (2013) and created three institutions each with a specific mandate along the research, innovation and commercialization continuum. These include: The National Research Fund[40] (NRF), the National Commission for Science, Technology and Innovation[41] (NACOSTI) - and the Kenya National Innovation Agency[42] (KENIA)

In **Uganda**, the Innovation Fund under the Ministry of ICT through the National ICT Initiative (NIISP[43]) program encourages software innovations and supports Ugandan developers to bring to the market solutions which can benefit the nation.

Similarly, there have been established the University Research Grants[44] – for example, the Government of Uganda committed to the Makerere University a special fund worth US$ 8,100,000 (UGX 30 billion) under the government's Research and Innovations Fund. The fund is meant to support high impact Research and Innovations and will be directed towards increasing local generation of translatable research and scalable innovations that address key gaps required to drive Uganda's development agenda. The Research and Innovations Fund is aimed at

[36] https://www.mesrsi.gov.bf/accueil
[37] www.tia.org.za
[38] https://www.thedti.gov.za/financial_assistance/THRIP.jsp
[39] https://www.idc.co.za
[40] https://researchfund.go.ke
[41] https://www.nacosti.go.ke
[42] http://www.innovationagency.go.ke
[43] http://niisp.ict.go.ug
[44] https://www.asareca.org/news/ugandan-government-sets-pace-funding-university-research-innovation.

complementing available research funding to address unfunded priorities critical to accelerating development across different sectors of the economy in Uganda. The Science, Technology and Innovation Budget Framework Paper[45] (2018/19 – 2022/23_ under the Ministry of Finance, Planning and Economic Development has outcomes, indicators objectives and financial allocations to support skills, development, technology generation and transfer, intellectual property and commercialization.

The government of **Malawi** established the Science and Technology Fund[46] for the advancement of science and technology. The Fund is administered by the National Commission for Science and Technology (NCST) and supports (i) any research or study carried on, by or for the benefit of persons or organizations engaged in research matters relating to the development of science and technology;(ii) the training of citizens of Malawi for the benefit of organizations engaged in research in the development of science and technology; (iii) scientific research and technology development and the application of the results in compliance with the national priorities determined by the government.

In **Burkina Faso**, the National Fund for Research and Innovation for Development, FONRID[47].the National Fund for Education and Research, FONER[48] and Agence nationale pour la valorisation des résultats de la recherche et des innovations (ANVAR[49]) are some of the funding initiatives and mechanisms

According to a review by SIDA[50], **Mozambique**, through the FNI provides funding to research and innovation projects, including technology transfer. The calls are announced in national papers, on the home page of FNI and in special announcements at the university departments. One such call in 2006 resulted in 42 proposals submitted to the FNI. Of these 18 were rejected, 17 were funded. Of the 17 successful ones, 12 projects were in research and 5 in innovation and transfer of technology. A second call in 2008 attracted 115 project proposals of which 28 of the proposals were approved for funding at approximately US$ 800 000. Of these, 17 projects were in research and 11 in innovation and technology transfer. The maximum sum approved for funding was US$ 50 000 for the two calls. FNI in participates in bilateral cooperation with the National Research Fund of South Africa (NRF) and have had joint calls for research within the areas of biosciences, space science, mathematics, energy, environment and traditional, local knowledge.

In **Zambia**, the government, through the Ministry of Higher Education created the Strategic Research Fund[51] (SRF) administered through a Fund Management Committee at the Ministry of

[45] https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=5&ved=2ahUKEwjf7OCeuJToAhUPkhQKHYjaAOsQFjAEegQIBxAB&url=https%3A%2F%2Fwww.parliament.go.ug%2Fcmis%2Fviews%2Fb4d0e32b-02d5-48ba-bb2c-e60589dbcd3e%25253B1.0&usg=AOvVaw030RbADIPs5nHRfk_krPF0

[46] https://www.ncst.mw/?page_id=770

[47] http://www.fonrid.bf/

[48] http://www.foner.bf/

[49] https://www.facebook.com/323884727960733/posts/601894553493081/

[50] https://www.sida.se/contentassets/dd24fe10d7df4811bac24b1e60d0649e/the-national-research-fund-fni-as-a-tool-for-research-capacity-building-in-mozambiquean-in-depth-assessment-of-sida-support-_2963.pdf)

[51] https://www.nstc.org.zm/srf/

Higher Education and implemented by the National Science and Technology Council (NSTC). The Fund support basic and applied research prescribed under national priority areas and mainly targets public and private Research and Development (R&D) Centres and Institutions, in order to streamline research and development and to effectively rationalize research resources. The Fund aims to support research and development projects, develop products or processes necessary for further development and commercialization, as well as enhance research capabilities and expertise within Zambia. Other initiatives include the Science and Technology Innovation Youth Fund[52] (STIYF) – which aims at assisting the youth to develop their Scientific and Technological innovations with specific focus on innovations that are relevant to the creation of employment and wealth.

The Fund is administered under the Ministry of Higher Education through a Fund Management Committee and implemented by the National Science and Technology Council (NSTC) through a Technical and Financial Committee. The specific objectives are to (i) support the development and piloting of scientific and technological innovations by the youth; (ii) promote a culture of innovativeness among the youth and; and (iii) To promote the acquisition and use of intellectual property rights (IPR) by youth innovators. The National Technology Business Centre (NTBC) also administers the Technology Business Development Fund (TBDF)

Theme 3: Skills and Capacities

The weak capacities, the inadequate skill sets and the low numbers of expertise have been highlighted as key challenges facing collaborations, technology transfer and commercialization. Countries have taken steps to shore up the numbers, provide requisite skills and enhance the individual and institutional capacities.

In South Africa for example, there are (i) the IPR Act training by the National Intellectual Property Management Office[53] (NIPMO) and (ii) the TTO personnel training and joint learning meetings offered by the Southern Africa Research and Innovation Management Association (SARIMA[54]). Similar initiatives are offered in Kenya through (i) Leadership in Innovation Award implemented by KENIA[55], (ii) Innovation Incubation Programmes[56], (iii) Science Technology and Innovation Congress[57] (iv) Annual TVET Fairs by the Ministry of Education[58] and (v) the Nairobi Innovation Week[59]. In Uganda, the Manufacturing Industrial Skilling Centre[60] - offers industrial skills training

[52] https://www.nstc.org.zm/stiyf/.
[53] https://nipmo.dst.gov.za/
[54] https://www.sarima.co.za/
[55] http://www.innovationagency.go.ke
[56] see here for a list of incubators in Kenya https://weetracker.com/2020/01/14/a-list-of-startup-incubators-in-kenya/
[57] https://www.nacosti.go.ke,
[58] https://www.education.go.ke/index.php?catid=0&id=19
[59] https://innovationweek.co.ke
[60] https://www.ugandainvest.go.ug/construction-of-the-industrial-skills-training-and-production-center-project-in-namanve/

programmes while In Malawi, there are post graduate programmes in innovation, technology transfer and commercialism at universities[61].

In Burkina Faso, the National Economic Development Plan (PNDES[62]) and the National Strategy for the Valorization of Invention and Innovative Technologies (SNVTII) (MRSI, 2012) and the Capacity Development for Agricultural Innovation Systems (CDAIS[63]) project are examples of skills upgrading projects and initiatives while in Zambia, accelerator programmes are implemented by NTBC[64] and the Information and Communication Technology Agency (ZICTA[65])

Theme 4: Innovation and commercialization infrastructure

Countries have created various infrastructure to support research, innovation, technology transfer and commercialization. These include but are not limited to science and technology parks, incubation centres, incubation hubs and technology transfer offices or centres

South Africa has about 33 science centres[66]/parks interconnected, aligned with, and supported by the Department of Science and Technology (DST). The science centres are the basic infrastructure for the delivery of the DST-led science promotion programme that seeks to (a) create a society that is knowledgeable about science, critically engaged, and scientifically literate; and (b) encourage the youth's participation in science, technology, and innovation. Similarly, there are more than 58 business incubators[67] in South Africa for example, the University of The Witwatersrand – owned, Tshimologong[68] is where the incubation of Digital entrepreneurs, commercialization of research and the development of high-level digital skills for students, working professionals and unemployed youth takes place and at least 17 innovation hubs[69]. For example, the Innovation Hub[70], the innovation agency of the Gauteng Province is a wholly owned subsidiary of the Gauteng Growth and Development Agency. It was established by the Gauteng Provincial Government through its Department of Economic Development to promote economic development and competitiveness of Gauteng through fostering innovation and entrepreneurship while nearly each University in South Africa has a technology transfer office[71] (TTO).

In 2016, Kenya allocated funds for a 10 – year Master Plan for development of Science and Technology Parks and Incubators[72]. The Science and Technology Parks and Incubators Master

[61] https://www.must.ac.mw/schools/research-and-pg-studies/

[62] http://cns.bf/IMG/pdf/pndes_2016-2020-4.pdf), https://www.pndes2020.com/presentation/,
[63] https://cdais.net/home/accueil/apropos/
[64] https://ntbc.co.zm
[65] https://www.zicta.zm
[66] https://www.saasta.ac.za/saastec/.
[67] https://www.entrepreneur.com/article/327566.
[68] https://tshimologong.joburg/
[69] https://www.dr-hempelnetwork.com/digital_health_contact_lists/17-keyinnovation-hubs-in-south-africa/
[70] http://www.theinnovationhub.com/
[71] https://nipmo.dst.gov.za/uploads/files/140127_LNIP01_OTT-Framework_REV05.pdf
[72] https://www.education.go.ke/index.php/tenders/file/211-consultancy-for-the-procurement-of-a-consultant-to-

Plan was envisaged to adopt a one-village-one-product concept, business plans as well as encourage cooperation and synergy between universities, research institutions, and the private sector and create a favorable environment for innovation, renovation and training. The State Department for University Education in the 2016/2017 Financial Year committed part of its budget to develop the master plan, develop a framework on public investment in the STP development and support existing science and technology parks and incubators

Kenya has at least 10 business incubators[73] while according to the World Intellectual Property Organization in its latest Global Innovation Index (GII) 2019 report, Kenya has been ranked the second[74] leading innovation hub in sub-Saharan Africa coming after South Africa. There were at least some 27 innovation hubs in Kenya as at 2016[75]. and most universities have established technology transfer officers or intellectual property management offices (IPMOs) as part of their institutional IP policy infrastructures

In Uganda, there plans by the government to set up two industrial parks[76] are still in their infant stages, but the Uganda Industrial Research Institute (UIRI[77]) already has an incubation centre whose purpose of technology incubation is to effectively link talent, technology, capital and know how to leverage entrepreneur talent in order to accelerate the development of new firms and thus speedup the uptake of technology within economy and growth of private industry.

The Malawi Innovation Hub[78] and the Polytechnic Innovation Hub[79] are examples of recently launched technology accelerator centers in Malawi. In Mozambique, the construction of the Maluana Science and Technology Park[80] (Parque de Ciência e Tecnologia de Maluana): the country's first science park has been launched and is estimated to cover an area of nearly 950 hectares. The park aims to promote entrepreneurship and incubate small and medium sized companies, besides serving to spread knowledge and product development among anchor companies, incubators and national education and research institutions.

The Incubation Center of Superior Institute of Tete[81] and the Innovation and Technological Development Center (Centro de Inovação e Desenvolvimento Tecnológico) at the Maluana Science and Technology Park are good examples. In Zambia, the Kabwe Institute of Technology[82],

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carry-out-10-year-national-masterplan-for-science-and-technology-parks-in-kenya-and-designs-for-konza-and-nyeri-science-parks?start=60

[73] https://weetracker.com/2020/01/14/a-list-of-startup-incubators-in-kenya/

[74] https://www.businessdailyafrica.com/corporate/tech/Kenya-ranked-top-tech-hub-in-sub-Saharan-Africa/4258474-5235558-5nocvhz/index.html.

[75] https://qz.com/africa/1059305/kenyas-newest-tech-hubs-are-sprouting-outside-its-silicon-savannah-in-nairobi/

[76] https://www.busiweek.com/uganda-to-set-up-two-technology-industrial-parks/

[77] http://www.uiri.go.ug/services/business-incubation

[78] http://www.mhubmw.com

[79] http://www.poly.ac.mw/news/polytechnic-innovation-hubthe-leading-incubator-of-innovation-in-malawi-20-09-2018

[80] https://macauhub.com.mo/2010/05/06/9038/

[81] http://www.cedol.org/partner/polytechnic-institute-tete/

[82] https://www.kit.edu.zm

Technology Incubation Centre is a Government Institution under the Ministry of Higher Education operating under the umbrella of TEVET ACT No. 13 of 1998, continues to provide various pre-service and in-service programs to support the commercial and industrial sectors by providing market responsive technological training in order to produce qualified graduates who will fulfil industry demands and develop their own ideas to become successful entrepreneurs.

There are 3 private innovation hubs in Zambia namely **(i)** BongoHive[83] **ii)** We-Create[84]: The Women's Entrepreneurial Center of Resources, Education, Access, and Training for Economic Empowerment (WECREATE) Project is specifically designed to advance gender equality in entrepreneurship through a portfolio of programs, tools, and events created to address barriers faced by women seeking to start and grow their businesses. The Center's collaborative approach convenes key players to develop an entrepreneurial ecosystem in a culturally sensitive and safe environment for women **and (iii) the** Jacaranda Hub[85] which aims at developing young people in ICT and entrepreneurship through innovation hubs. It supports young people to have the right facilities, knowledge and mentorship.

Theme 5: Policies, Regulations and Incentives

South Africa offers tax breaks and the Broad-Based Black Economic Empowerment (BBBEE) points initiatives designed to foster collaborations and capacity enhancements. Other relevant policies include the National Development Plan, S&T white paper and policy, Technology Innovation Agency Policies, National Intellectual Property Management Office (NIPMO) and IPR Act. The STI Act of 2013 in Kenya led to the establishment of three autonomous institutions for the promotion of science, technology and innovation namely: The National Commission for Science, Technology and Innovation (NACOSTI); Kenya National Innovation Agency (KENIA) and National Research Fund (NRF).

Malawi has the Science and Technology Act, the Science and Technology Policy and the Intellectual property policy. In Burkina Faso, since 2011, the government has made science and technology a development priority. The establishment of a Directorate General for Scientific and Technological Research and Innovation within the Ministry to coordinate research activities demonstrates this. In 2012, Burkina Faso adopted a national scientific and technical research policy, the strategic objectives of which are the development of research and development as well as the application and commercialization of research results.

In 2013, Burkina Faso adopted the orientation law for scientific and scientific research[86], which provides for the establishment of three mechanisms intended to finance research and innovation, which shows a high-level commitment. Technology transfer and popularization of research results are the responsibility of the National Agency for the Development of Research Results and the National Center for Scientific and Technological Research; the creation of a center

[83] https://bongohive.co.zm
[84] http://zambia.wecreatecenter.com
[85] https://web.facebook.com/jhubzambia/?_rdc=1&_rdr
[86] https://archives.assembleenationale.bf/20122014/IMG/pdf/loi_no038_portant_loi_d_orientaiton_de_la_recherche_scientifique_et_de_l_innovation-2.pdf.

of excellence at the International Institute of Water and Environmental Engineering in Ouagadougou as part of a World Bank project ensuring essential funding for capacity building in these priority areas. The government developed a National Strategy for the Valorisation of Technologies, Inventions and Innovations in (2012) as well as a National Innovation Strategy (2014).

Mozambique has policies, regulations and incentives to promote collaborations, technology transfer and commercialization are guided by the National Research Fund's creation decree and the FNI's organic statute while in Zambia, the National IP Policy; tax exemptions for R&D and Industry.

RECOMMENDATIONS

Create platforms for dialogues between research and industry

Collaborations, knowledge exchange and technology transfer are undermined by the lack of opportunities for continuous, interactive dialogue between research and industry. In many cases, this arises from different organizational cultures, language, priorities and approaches. In some countries, such platforms have been piloted and positive results reported.

Case example: The knowledge transfer partnerships (KTPs) in Rwanda

The launch of Knowledge Transfer Partnership (KTP) in January 2013 under the umbrella of African Knowledge Transfer Partnerships (AKTPs[87]) was to help companies improve their productivity and competitiveness by using the scientific knowledge, technology and skills available in higher education institutions through collaborative projects[88].

The partnership was governed through a Memorandum of Understanding (MoU) between the KTP Partners including: The Ministry of Education (MINEDUC), the Knowledge Partner (Higher Learning Institution / Research and Development Institute) and the Industrial Partner (Company).

The overall management of the partnership rests with MINEDUC through the [89]Directorate General of Science, Technology and Research. The governance and actual management of the KTP projects is undertaken through the Local Management Committee meeting (LMC) which comprises the representative of MINEDUC, the Managing Director of the company and the representative of the knowledge partner.

The overall responsibility of MINEDUC is to ensure the successful project implementation and funding required is made available to the project implementing bodies. The Knowledge partner (Higher Learning Institution or R&D Institution) is responsible for identification and nomination of the appropriate academic staff to serve as an academic supervisor[90]. The Industrial Partners (private sector company) is the custodian of the partnership project and is responsible for developing the proposed partnership projects in line with the company's business strategy.

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[87]African Knowledge Transfer Partnerships (AKTPs) are UK-sponsored partnerships between higher education institutions and private sector organizations in the UK and Sub-Saharan Africa. The partnerships were piloted in six African countries - Kenya, Uganda, Ghana, Nigeria, South Africa and Rwanda.

[88] http://www.universityworldnews.com/article.php?story=20100409205111528

[89] The Directorate of Science, Technology and Research (DSTR) in the Ministry of Education (MINEDUC) was the equivalent of the SGC in Rwanda until 2015 when the National Commission for Science and Technology was established and de-linked from the Ministry to start operating as an autonomous institution.

[90] The academic supervisor should have an advanced and wider knowledge on the proposed partnership project to ensure the relevant contribution to the project for the benefit of the company.

The company recruits the KTP associate who is a young graduate responsible for daily management of the partnership project within the company. The company also appoints the company supervisor who is an experienced employee of the company and responsible for guidance and mentorship of the associate in line with the implementation of the partnership project.

For the implementation of the KTP Programme, each partnership project was provided with a budget of 10 million Rwandan Francs per year per project for two years (a total of Twenty Million Rwanda Francs (20,000,000rwf) to cover the costs for travel and subsistence, academic development, graduate training and minor equipment. The private sector company contribution covered the salary of the graduate trainee.

Other Examples include the Innovation dialogue programmes implemented by the National Technology Business Centre[91] and the Southern Africa Innovation Support Programme[92] (SAIS). Whereas the National Technology Business Centre (NTBC) is a Zambia government agency that supports the commercialization and transfer of technology; The Southern Africa Innovation Support Programme (SAIS) is a regional initiative that supports the growth of new businesses through strengthening innovation ecosystems and promotion of cross-border collaboration between innovation role-players in Southern Africa. SAIS is supported by the Ministry for Foreign Affairs (MFA) of Finland, in partnership with the Ministries responsible for Science, Technology and Innovation of Botswana, Namibia, South Africa, Tanzania and Zambia, and the Southern African Development Community (SADC) Secretariat.

[91] https://en.wikipedia.org/wiki/National_Technology_Business_Centre
[92] https://www.saisprogramme.org

Promote new and innovative funding mechanisms

The availability, consistency and relevance of funding mechanisms is key in supporting research and innovation. Work under the SGCI has shown that co-investment between development partners and national governments is a viable way to mobilize domestic resources. Similarly, the case studies under collaborative public private partnerships (PPPs) have demonstrated that the private sector can co-invest in research, even though not always in financial terms. Non-financial, in-kind and infrastructural support as well as expertise are credible contributions. Further, in some cases, crowd sourcing, use of innovation vouchers and domestic philanthropists have been tested.

Case example: Use of vouchers – the Case of Farm Input Subsidy Programme (FISP) in Malawi

In Malawi, the implementation of the FISP programme in 2005/06 employed the use of vouchers (or coupons) to improve smallholder farmers' access to agricultural inputs, boost crop maize productivity and promote food self- sufficiency. The input vouchers allowed eligible farmers to access to agricultural inputs at subsidized prices from the Agricultural Development and Marketing Corporation (ADMARC) outlets or from Farmers Fertilizer Revolving Fund of Malawi (SFFRFM).

Recent reviews[93],[94] show that as at 2009, there were four types of input vouchers entitling eligible farmers to: (i) a 50-kg bag of basal maize fertilizer (NPK-23:21:0+4s or Chitowe), (ii) a 50-kg bag of urea fertilizer, both for a base price of MK500, (iii) either a 5-kg bag of hybrid maize seed or a 10-kg bag of open pollinated varieties (OPV) maize seed for a price up to MK150, and (iv) a flexy voucher which can be exchanged for a free 1 kg bag of legumes or groundnut seeds.

The programme targeted marginalized smallholder farmers with input vouchers being allocated in a three-stage process. In the first step, the Ministry of Agriculture and Food Security (MoAFS) distributes vouchers to the districts, followed in the second stage in which the district authorities allocate the vouchers across villages. In the final step, the village traditional authority (TAs) identifies beneficiary households according to a targeting criterion.

As at 2008/09, it is reported that more than 1.5 million fertilizer coupon beneficiaries were selected from over 2.5 million farm households, 5.9 million coupons were printed and distributed, and over 3.4 million bags of fertilizer purchased with subsidized commodities worth around US$220 million.

[93] Andrew Dorward & Ephraim Chirwa (2011) The Malawi agricultural input subsidy programme: 2005/06 to 2008/09, International Journal of Agricultural Sustainability, 9:1, 232-247, DOI: 10.3763/ijas.2010.0567

[94] Asfaw, S., Cattaneo, A., Pallante, G. & Palma, A. 2017. *Impacts of modifying Malawi's farm input subsidy programme targeting.* FAO Agricultural Development Economics Working Paper 17-05. Rome, FAO.

Whereas implementation challenges and associated risks (including targeting criterion, political interference, fraud and access) have been reported in the impact evaluation studies of this programme, it nonetheless showcases the possibility (with changes in design, targeting and implementation) of adapting lessons and approaches to funding of innovation and technology uptake.

Improve innovation and commercialization infrastructure

Countries[95] have set up science parks, innovation hubs, technology centres and in some cases, high-end laboratories. However, these remain inadequate and continuous investments are required. Some of the SGCs are responding to this need through a new funding window – the infrastructure support funds.

Case example: Infrastructure Grants in Kenya

The National Research Fund (NRF – Kenya) introduced the "infrastructure grants" category as a new funding window for research, innovation and commercialization infrastructure. NRF made an open call for applications targeting all public universities, research institutes and tertiary and vocational institutions (TIVETs). Out of 140 applications received, NRF funded 20 organizations including 15 universities, 3 public research institutes and 2 TIVETS.

The total funding for the 2018/2019 funding cycle was US$ 99.6[96] million over an implementation period of 2 years. The funding targeted research infrastructure and equipment and not building and the applicants had to demonstrate that the requisite physical infrastructure already exist, including laboratories, workshops and other housing requirements. Applicants were also required to submit a justified budget detailing the costs of the equipment, machinery or infrastructure requested and provide supporting documentation including recent quotations from at least three suppliers. These would help the review team in verifying the costs of the equipment/infrastructure during evaluation.

To promote wider usage and sharing of the infrastructure by other researchers and users, the applicants were required to list their potential collaborators and users of the facility. To actualize this, the infrastructure was billed as "national assets" and "every Kenyan citizen" has the right to access and use the facility for their research and innovation work. This requirement to share and conditions accompanying it were built into the grant contracts and recipients understood the need for granting access to other users.

A key criterion for the infrastructure grants facility is the need for institutional commitment and co-investment by the recipient organization. The top leadership at the recipient institutions were required to commit in writing their full support not only for the co-investment but the general grant conditions, particularly the understanding that the organization would be holding the infrastructure "in trust" and that ultimately the equipment is a national asset and accessible to all Kenyans.

The recipient organizations pledged their co-investments both in cash and in-kind[97] including lab space, conference facilities, personnel, consumables, transport, workshops, softwares, training opportunities, furniture etc

[95] see annex 7

[96] See the actual distribution of recipients, amounts and types of infrastructure in table V in the annexes.

[97] For a full list see table X in the annex.

The selection followed a four-stage process involving (i) the initial screening for eligibility by the NRF administration staff to ensure adherence to the application guidelines, eligibility criteria and completeness of the application including the supporting documentation (ii) the peer review for shortlisting the applicants according to a set criteria (iii) Physical verification visits by the NRF technical team to each of the shortlisted applicants to ascertain the existence of the physical facilities such as workshops, laboratories and other buildings quoted in the applications (iv) oral presentations to the NRF Board of Trustees. This is the final stage and checks on issues of institutional commitment, sustainability and maintenance issues. The Board makes the final decision on the funding levels.

Promote Equipment and Infrastructure sharing

Modern infrastructure is an important ingredient for enhancing the contribution of R&D in the socio-economic development of countries. These includes the development and sharing infrastructure such as: science laboratories, science parks, industrial parks, innovation and incubation hubs, science observatories, science museums and development of research and institutions of higher Education. Industrial parks, for example, has become a common feature in Ethiopia, Uganda and Kenya

While Ethiopia has made huge investments in the development of industrial parks that are now playing a key role in industrializing the country including Bole Lemi[98], Hawassa[99] ,Jima[100], Adama[101] ,Kombolcha industrial parks[102] that are mainly involved in textile, apparel and leather products; The Ugandan government has set up 5-acre piece of land at in Mukono district[103] to build their science park. Similarly, the government is establishing a minimum of twenty-two Industrial and Business Parks (IBP's)[104] including Namanve, Luzira, Bweyogerere, Jinja, Kasese, Soroti, Mbale, Karamoja[105], Kashari and Mbarara Industrial and Business Park. Kenya is currently developing the Kenya Advanced Institute for Science and Technology, the National Physical sciences Laboratory, 2 national science parks and has planned to put up special economic zones[106].

While these are noble initiatives, a more strategic approach would be to put in place modalities that allow for access to and sharing of equipment, research and innovation infrastructure between countries as well as between research institutions and the private sector. Such an approach would require an audit and inventory of the existing facilities and their locations as well as protocols for accessing and sharing them.

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[98] http://www.ipdc.gov.et/index.php/en/industrial-parks/bole-lemi-i

[99] http://www.investethiopia.gov.et/about-us/how-we-can-help?id=466

[100] http://preciseethiopia.com/huajian-group-to-set-up-footwear-coffee-processing-factories-inside-jimma-industrial-park/

[101] https://constructionreviewonline.com/2019/08/ethiopia-to-construct-a-new-us-300m-industrial-park/

[102] http://www.investethiopia.gov.et/about-us/contact-us?id=469

[103] http://www.xinhuanet.com/english/2018-09/23/c_137486811.htm, https://www.newvision.co.ug/news/1181868/mukono-roots-change-industrial-park

[104] https://www.ugandainvest.go.ug/parks/

[105] http://uacciap.org/uganda-government-to-construct-cement-factory-in-karamoja/ https://www.konza.go.ke/project/kenya-advanced-institute-of-science-technology/, https://www.weforum.org/agenda/2015/01/how-can-kenya-boost-growth/

[106] http://www.industrialization.go.ke/index.php/media-center/blog/310-kenya-to-roll-out-special-economic-zones-in-first-quarter-of-2016

A notable example is the Communities of Research Excellence (CoRES) programme under the Consortium for National Health Research (CNHR[107]) in Kenya which intended to nurture, develop and strengthen multi-institutional collaboration in order to optimize the national research for health environment; enabling institutions to improve their research training and mentoring programmes and better provide research products or outputs that can inform and influence policy.

The CoReS are structured institutional collaborative partnerships involving public or private universities with research institutes that emphasize mutual sharing of available resources (both equipment and infrastructure).

Case example: Community of Excellence for Research in Neglected Vector Borne & Zoonotic Diseases (CERNVec[108])

Equipment and infrastructure sharing is based on the concept of mutual needs and complimentary expertise. It requires that due to the high cost of specialized equipment, not every institution needs to own one but a framework for utilization is required. The equipment needs to be accessible and well managed. This is what CERNVec sought to achieve. It was conceptualized as a "Community of Excellence" rather than a "Center of Excellence". The communities of excellence approach allowed for the establishment of various committees, with a management structure that includes the steering committee, ad hoc committees that dealt with specific issues, hence decision making was representative of the participating institutions.

The partners in this community included the International Centre for Insect Physiology and Ecology (ICIPE) as the lead institution, the Ministry of Health (MoH), Kenya Medical Research Institute (KEMRI), Jomo Kenyatta University of Agriculture and Technology (JKUAT) and Kenyatta University (KU). Each partner was offering different expertise and infrastructure: Kenyatta University has a good geography department; the Ministry has responsibility for surveillance and response in respect to neglected, infectious diseases and then ICIPE had a number of technologies and personnel while KEMRI has a national mandate for health research.

CERNVec supplied equipment to KEMRI's national laboratory; established GIS lab at Kenyatta University for capacity building student training. However, links to industry seems to have been the major weakness of this approach. As the PI of the project noted, *"perhaps we didn't do very much in that respect, not so much because of how we were set up, but more due to lack of pre-existing linkages with industry within our parent institutions."*

[107] The Consortium of National Health Research (CNHR) was established in 2008 under the Heath Research Capacity Strengthening (HRCS) Initiative – a £10m, five-year programme jointly funded by DFID and the Wellcome Trust.

[108] www.cernvec.icipe.org

Another key challenge was that the partners were at different levels of establishment. While some institutions were well established and ready to go, others were not ready and required huge infrastructural investments in facilities. It therefore took time for the partners too come to par and commence project implementation. Labour mobility and key personnel either being transferred or changing jobs posted a sustainability and continuity challenges as progress was often interrupted.

Sustainability of the funding and funding levels for the equipment and infrastructure remains a key sticking point as one of the interviewees noted, *"as long as the funding was there we did okay; when the funding ended we still collaborate but not as strongly as we did then. I think that shared infrastructure should not be based on a specific project it needs to be an institutional collaboration framework so that it is not dependent on the lifetime of a project"*

Promote inter-country joint programmes and collective action

There's need for increased intra-African collaborations in both the generation of knowledge (research) as well as in its application (innovation). Such collaborative action could focus on African grand challenges such as food security, climate change, disease burden etc or build on on-going continental initiatives such as the African free Continental Trade Area (AfCTA). Bilateral and multilateral scientific cooperation agreements between countries that have mutual interests would be a key mechanism for achieving both.

Case example: University Research Chairs Programme – Kenya and South Africa

In 2013, the National Commission for Science, Technology and Innovation (NACOSTI) obtained a CA$ 1 million grant from Canada's International Development Research Centre (IDRC) to implement a Research Chairs Programme in Universities in Kenya. The overarching goal of this initiative was to contribute towards Kenya's social and economic development by strengthening the role of universities in the country's national innovation system.

By establishing these Chairs, NACOSTI sought to enhance research capacity in local universities; create more effective collaborative linkages between the universities and the productive sectors (particularly industry) as well as a wide range of social actors such as non-governmental organizations, community groups, local government and indigenous knowledge producers. Through this programme, NACOSTI also sought to enhance post-graduate training in the selected strategic areas, thereby enhancing the human and technical capacity to engage in high level research and innovation. The programme was piloted in the health systems and manufacturing and was intended to be progressively expanded to cover at least seven priority sectors over ten years.

Similarly, The South African Research Chairs Initiative (SARChI[109]) was established in 2006 by the Department of Science and Technology (DST) and the National Research Foundation (NRF). It is designed to attract and retain excellence in research and innovation at South African public universities with a long-term investment of up to fifteen years.

The Research Chairs programme in both countries are expected to achieve a number of outcomes including: (i) that research capacities at participating universities would be enhanced; research and innovation infrastructures improved; top-notch researchers are attracted and retained in the local universities; (ii) that a critical mass of experts are trained and retained; mentorship programmes enhanced and the inter-generational gap between older and younger scientists/researchers bridged; more young scientists/researchers attracted to select high-priority innovation programmes. (iii) collaborative links with universities are strengthened and industries begin to support research programmes at the universities; increased staff exchange, placements and internships between industry and universities.

[109] Source: https://www.nrf.ac.za/division/rcce/instruments/research-chairs

The Research Chairs Programmes present a new approach that requires universities to interact with other actors who are not their traditional partners (such as business consultants, marketers, IP lawyers etc) as well as promote multi-disciplinary approaches i.e. teams of experts from diverse disciplines (e.g. social scientists, bio-physical scientists, legal experts, value chain analysts, innovation managers etc) working together on identified research problems. This new expectation also behoves the universities to embrace participatory and consultative approaches to knowledge generation and transfer. Recognizing the role of other actors and experts as well as the important role of feedback in realizing success at the marketplace necessitates that universities change their *modus operandi* and embrace systemic approaches that not only value other actors in the process, but more importantly, the importance of other knowledge systems. By establishing Research Chairs therefore, the Councils are presenting platforms and opportunities for interaction and knowledge exchange. Further, the need for involvement of the private sector is a conditional requirement for the award of the chairs and this ensures that products of research and innovation have a ready market/uptake.

Enhance skills and capacities in product development and intellectual property management[110]

Technology transfer and commercialization require specialized skill sets which are neither common within the Councils nor the research institutes. They draw from different expertise and disciplines. In most cases, such expertise does not reside in single individuals. However, customized training courses could be considered as a way of building on the existing capacities. Further to this, issues in intellectual property management are key to technology transfer and commercialization. It is important to provide the Councils with not only the knowledge but also the tools to support their work. Councils should where possible seek to recruit people with relevant skill sets in IP management

In South Africa for example, there are (i) the IPR Act training by the National Intellectual Property Management Office[111] (NIPMO) and (ii) the TTO personnel training and joint learning meetings offered by the Southern Africa Research and Innovation Management Association (SARIMA[112]).

A notable example is the Centre for Innovation and Industrial Research (CIIR) at Malawi University of Science and Technology (MUST) which conducts industrial research, promotes innovation, and produces different technologies for sale to the general public. A technology transfer office has also been established to promote the creation, protection and commercialization of intellectual property developed by staff, students and collaborators. The CIIR, aims to advance science, technology and innovation (STI) through quality research, capacity development, application and commercialization of outputs. CIIR drives STI, enhances knowledge and skills to conduct and disseminate innovative initiatives (capacity building, research, consultancy, outreach, and policy contribution) for transformative industrialization and commercialization in tandem with national, regional and global development goals.

Case example: Centre for Research in Therapeutic Sciences (CREATES), Kenya

CREATES brings together four institutions and is based at Strathmore University which is the lead institution, with the other three being African Centre for Clinical Trials (ACCT), Kenya Medical Research Institute (KEMRI) and the Council for Scientific Research (CSIR) in South Africa.

CREATES provided an avenue for getting resources to setup a platform that brought together several institutions for purposes of research and capacity building in a framework that is not bogged down with bureaucracy and institutional politics.

The Centre has recorded successes but also faced immense challenges. For example, CREATES is training the next generation of scientists and researchers and also actively involved in product development and supporting clinical trials in the region. Since establishment, CREATES has hosted and trained 6 post- doctoral fellows and 3 PhDs on the platform. The Centre has built a

[110] Annex 6 shows the existence of IP support in different countries
[111] https://nipmo.dst.gov.za/
[112] https://www.sarima.co.za/

satellite site for doing in clinical trials in the field and are setting up a demographics surveillance platform in Kisumu, Kenya.

Beyond the infrastructure support, CNHR followed with post-doctoral funding but sustaining this has been a challenge. According to the principal investigator, "*If the funding could have been sustained that could have been a good platform of driving the capacity building agenda and for different tracks of work. However, this was only done once and the CNHR was rolled up so there was no continuity.*"

The other challenge was lack of funding support for personnel costs. As one of the interviewees remarked, *"the lead researchers and mentors were not compensated through the grants and unless one is committed and runs the programme pro bono or they have support from elsewhere to pay the salaries, they will focus on the other things than doing this and I think that was the missed opportunity."*

Lack of co-funding/co-investment by the government to help drive the research agenda to the next level. The one of the partners complained, *"when you get money from other people (international funders/donors), it is more often just seed funding to set up a programme like the CNHR but when they pull out there is no body to fill in the void and the programme discontinues."*

Another partner noted the lack of consistency in funding and remarked, *"It is difficult to keep the track of work because once the programme folds up, as was the case of CNHR, researchers have to look for grants from other sources. However, every grant has its own agenda so the researchers re-shape their work to fit in to the new agenda rather than keeping their own research tracks. There is need for a steady granting framework.*"

There are a number of lessons from this platform including (i) the need for long term investment in product development. CREATES experience shows for platforms engaged in product development, takes 10-15 years. (ii) use of the seed funding to leveraging additional resources. CNHR put seed money for equipment and infrastructure that set up the lab and CREATES leveraged on this initial funding to raise additional money to buy a bigger equipment from the Gates Foundation to complete the development of the lab (iii) sustainability and institutionalization. CREATES experience demonstrates the need to identify and mentor young researchers who will move the research and innovation agenda. Getting the right people, with the right mindset, give them the right framework and they will attract grants.

Secondly, through CREATES, Strathmore University has developed greater interest in biomedical sciences and considering having a medical school with a possibility of CREATES becoming the biotech arm that supports the Strathmore biomedical sciences and medical school.

Provide opportunities and incentives for commercialization and uptake through public sector policies and spending

Countries are experimenting with different policies, strategies and incentives to encourage technology transfer and commercialization. Lessons from Europe have shown that Horizon 2020 as a funding mechanism requires a formal MoU between the applicants and the private sector as a pre-condition for funding. It also focuses on projects that show pre-market products and technologies that are nearly ready for commercialization. Focusing back to Africa's science granting councils, and their roles in research funding, such pre-conditions could be applied to stimulate partnerships and technology transfer. Cases from the NRF of South Africa and Kenya demonstrated that this is already being practiced and could provide good learning opportunities for other SGCs gearing to start funding research and innovation in their contexts. Similarly, there are cases where government programmes have drawn on and provided opportunities for commercialization and technology transfer as the case of Ghana's CSIR below shows.

Case example: The commercialization story of Ghana's Oil Palm Research Institute (CSIR-OPRI[113])

The CSIR-OPRI is tasked to conduct sustainable and demand driven research aimed at providing scientific and technological support for the development of the oil palm and coconut industries. The Institute is currently playing a crucial role in the Government flagship project dubbed Planting for Food and Jobs (PFJ[114]). The Planting for Export and Rural Development (PERD), which is a sub-component of PFJ, captures two mandated crops of the Institute namely: Oil Palm and Coconut. Each of these has been targeted to generate at least US$2 billion to the Ghanaian economy by 2024. The CSIR-OPRI's coconut planting material, which has potential annual yield of 22,000 fruits/ha and highly tolerant to the devastating Cape St Paul Wilt Disease, has been recommended for planting under the coconut sub-component of the PERD.

Similarly, the Institute's high yielding oil palm planting material, with potential annual bunch yield of 20-22 tons/ha and oil extraction rate (OER) of 26-29%, has been recommended for planting under the Oil Palm Sub-Component of the PERD. The Ghana Sumatra Ltd[115], which is wholly owned by the CSIR, takes charge of the Institute's oil palm seed production for supply to the Metropolitan and Municipal District Assemblies (MMDAs).

[113] Source: MESTI (2020). Final Draft Report, *"Business Case for the Establishment of the Ghana Innovation and Research Commercialization Centre (GIRC Centre)". pp. 30.*

[114] http://mofa.gov.gh/site/programmes/pfj

[115] https://www.ghanasumatra.com.gh/index.html

Support local innovators through incubation, mentorship and coaching

Case examples: Innovation hubs and incubation centers in Kenya

The first technology incubators in Kenya have been successful in helping start-ups capture markets in information technology (IT). One pioneer is iHub[116] set up in Nairobi in 2010 to provide an open space for the technology community, including young technology entrepreneurs, programmers, investors and technology companies. iHub has forged relationships with several multinational corporations, including Google, Nokia and Samsung, as well as with the Kenyan government's ICT Board. Another innovation hub is @iLabAfrica[117] established in January 2011 as a research centre within the Faculty of Information Technology at Strathmore University. It stimulates research, innovation and entrepreneurship in ICTs.

A related development in Kenya is the formation of innovation incubation programmes. A prominent example is NaiLab[118] an incubator for start-up ICT businesses which offers a three-to-six-month programme in entrepreneurship training. NaiLab started out as a private company in 2011, in collaboration with the crowd funding platform 1%CLUB[119] and consultancy firm Accenture. In January 2013, the Kenyan government formed a partnership with NaiLab to launch a US$ 1.6 million, three-year technology incubation programme to support the country's burgeoning technology start-up sector. These funds were to enable NaiLab to broaden its geographical scope to other Kenyan cities and towns, helping start-ups to obtain information, capital and business contacts. Nairobi is also home to m:Lab East Africa, which provides a platform for mobile entrepreneurship, business incubation, developer-training and application-testing.

[116] https://ihub.co.ke/, https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/56812/IDL-56812.pdf (Page 15),

[117] http://www.ilabafrica.ac.ke/, http://www.ist-africa.org/home/default.asp?page=doc-by-id&docid=5178

[118] http://icta.go.ke/nailab/, https://www.businessdailyafrica.com/corporate/tech/15-startups-benefit-from-Nailab-innovation-plan/4258474-4541188-ilajj5z/index.html

[119] https://onepercentclub.com/en/

Support the establishment of well-equipped and resourced technology transfer offices

Technology transfer offices (TTOs) or intellectual property management offices (IPMOs) play a crucial role in connecting the academic work at the universities with its external partners, beneficiaries and clients. These have become ingrained into the institutional fabrics of the academic and research institutes. However, often times they are under-staffed and under-resourced.

In Zambia, for example, the Copperbelt University (CBU) has identified research, innovation, consultancy and entrepreneurship as key contributors towards the knowledge based and innovation-driven economy, technology transfer and commercialization of the research products. Consequently, the CBU established the Directorate of Research, Innovation and Consultancy[120] (DRIC) in 2016 to strengthen the commercialization of its research products. The university under DRIC also established a Technology Management Office (TMO) to help it translate its research outputs into inventions and innovations. Similarly, the University of Zambia (UNZA) Technology Development and Advisory Unit[121] (TDAU) operates as a semi-autonomous engineering research and development unit and acts as a nexus between the public and private sectors and capitalizing on cutting edge innovation techniques.

Support further research on impact assessments and performance appraisals of the various approaches and interventions

While this scoping study has identified and profiled the various initiatives in technology transfer and commercialization, an in-depth assessment of their impacts and performance evaluation was outside it scope. However, in order to provide better guidance for policy and action, it is necessary to conduct a follow up, more in-depth analysis of what has worked, under what circumstances and document the key lessons, outcomes and best practices. We highly recommend such a future study.

[120] https://www.cbu.ac.zm/research/
[121] https://www.unza.zm/units/tdau

ANNEXES

Annex 1: Key issues affecting technology transfer and research commercialization

#	Key issues	Descriptors	Frequency (f)	Percent (%)
1	Partnerships and Linkages with Private sector	Strategic partnerships, private sector, partnership with private, PPP, ppps, partnership, public private partner, partnerships, private sector, collaboration, Institutions; Innovation forums	12	19.35
2	Policy and Regulatory Systems / Frameworks	Direct techno procurement, government sponsorship; policy support, enforce IP regulation, policy makers, quadri-helix model	9	14.52
3	Funding	Funding, VC funding, Innovation funding, Tech project fund	8	12.90
4	Intellectual Property Regimes	Intellectual, property, IP, IP issues, IP policies, IP policy, IP regime	7	11.29
5	Skills and Capacities	Skills gap, knowledge gap, education; expertise, management, retooling,	6	9.68
6	Communication and Coordination	Communication, awareness, market information, lack of awareness, understanding each other; markets,	6	9.68
7	Research and Innovation Infrastructure	Manque de structure, systems, efficient tech transfer, infrastructural challenges, support infrastructure, lack of TTOs	6	9.68
8	Trust, Confidence and Interests	Trust, fear, acceptance; lack of confidence, different interest	5	8.06
9	Research and Data Quality	Limited research data, technology, unfocused research,	3	4.84
	TOTAL		**62**	**100**

Annex 2: Technology transfer approaches

No.	Key issues	Descriptors	Frequency (f)	Percent (%)
1	Trade shows / Exhibitions/Advertisements	Exhibitions, workshop, tradeshows, demonstrations, advertisement, promotions, technologies exhibitions; volarisation of results, volarisation of research, forum de valorization, technical support, value recognition	13	22.41
2	Communication and Mentorship	Science communication; training, education and awareness; participative actions, youth empowerment, capacity building, awareness; capacity building, mentoring; starting small	10	17.24
3	Partnerships and Linkages	PPP, public- private partnerships, PPPs, research partnerships, commercial PP, PPP arrangement, mergers	7	12.07
4	Policy and Regulatory Systems	Direct techno procurement, government sponsorship; policy support, enforce IP regulation, policy makers, quadri-helix model	6	10.34
5	Extension Services	Extension services, research ext farmer link, extension*2, training and visits; localization	6	10.34
6	Funding	Funding, VC funding, Innovation funding, Tech Project fund,	5	8.62
7	Incubation / Innovation hubs	Incubations, innovation hubs, innovation centers, Startup incubation, Incubation	5	8.62
8	Licensing / Technology Transfer Offices	TTOs, licensing, TT offices, institutional TTOs	4	6.9
9	Consultancies	Consultancies, consultancy	2	3.45
	TOTAL		**58**	**100**

Annex 3: Key challenges to commercialization of research outputs

No.	Key issues	Descriptors	Frequency (f)	Percent (%)
1	Policies and Regulations	Policies, regulations, policy environment, policy, lack of policy, administration, intellectual policies, transfer de technologie, bureaucracy, IP laws, lack of IP, IP ambiguities; acceptability*2; lack of support*2; intellectual property, lack of support	16	21.33
2	Communication and Coordination	Poor communication, not commutating to society, lack of communication, awareness, lack of dissemination; beneficiaries' awareness on rights, business knowledge; bureaucracy; prioritization; poor prioritizing; coordination; lack of networks; contact	14	18.67
3	Research Quality and Relevance	Quality, unrealistic research, poor quality of commodity, lack of standards, qualite des products, low quality; unrealistic research; topics; non-demand driven research, research	11	14.67
4	Funding	Funding, lack of capital, funding inadequacy, lack incubation, cost is output, resources, lack of funds, capital, cost	9	12.00
5	Weak Private Sector	Narrow industry base; weak Private sector; weak value chain; PPP; low risk-taking behavior, apathy; business,	7	9.33
6	Research and Innovation Infrastructure	Lack of TTOs, commercialization process, no commercialization; not commercialisation; Le cout, l'efficience, Infraestrutura, Infrastructure	7	9.33
7	Skills and Capacities	Marketing skills, lack of knowledge, skills, entrepreneurship skills; administration,	5	6.67
8	Silo Mentality / Mistrust	Mistrust, silo mentality, fear of competition, fear	4	5.33
9	Technology	Limited technology, lack of technology	2	2.67
	TOTAL		**75**	**100**

Annex 4: Commercialization pathways

No.	Key issues	Descriptors	Frequency(f)	Percent (%)
1	Partnerships and Linkages with Private sector	Strategic partnerships, private sector, partnership with private, PPP, ppps, partnership, public private partner, partnerships, private sector, collaboration, institutions; innovation forums	12	20.34
2	Technology licensing and sale of IP	Licensing, patenting, patent, copyright, Licensing, trademarks, patent system, IP registration support, licensing, sale out, Protection of IP policies	11	18.64
3	Science parks, Innovation hubs and Incubation Centers	Start-ups, incubation centers, incubation, incubators, start-up incubation, industrial parks, industrialization, innovation hubs; prototype development, laboratory testing, industrialization	10	16.95
4	Technology Transfer Offices / Technology Transfer Centres	TTOs, TT offices, technology transfer, tech transfer centres, tech transfer offices.	5	8.47
5	Workshops, Symposia and Advertisements	Workshops, symposia, advertising; extension journals; journee de valorization	5	8.47
6	Direct marketing/ own production	Promoting and marketing, direct marketing, market, sales, marketing	5	8.47
7	Funding and government support	Donor participation, linkages with media, limited funding, private funding, government funding	5	8.47
8	Training and capacity building	Conceptualization; capacity building, post graduate training, adaptation	4	6.78
9	Start-ups and Spin-offs	Create enterprises; starting informal	2	3.39
	Total		**59**	**100**

Annex 5: Role of the SGCS in enhancing technology transfer and commercialization of research outputs

No.	Key issues	Descriptors	Frequency (f)	Percent (%)
1	Training, capacity building and mentorship	Training, awareness training, provide training, orientations, outreach, mentorship programmes, guidance, practical, mentorship, capacity building; guide well researchers, define needs, provide leadership, monitor research; guidance	14	22.22
2	Communication and coordination	Public awareness, increase dissemination, orientations outreach, create platforms, create networks, engage media, promotion days, enhance communication, Knowledge transfers, market analysis; awareness creation; vulgarisation of results	12	19.05
3	Foster platforms and forums for collaborative engagement	PPP platforms, support PPP, encourage PPP, link with private sector, private sector engagement, operationalize PP platform; linkages with researchers; Engage government, trigger linkages, collaborations	10	15.87
4	Funding	Provide funding, increase innovation fund, Funding, financing, conditional funding, provide substantial grants, Fund IP protection, Fund, target funding.	9	14.29
5	Research and Innovation Infrastructure	Establish 'GIRC' centers; Support incubation prog, support incubation, support innohubs; infrastructure; centers, incubation	7	11.11
6	Technology and Intellectual Property Rights	Develop new technologies, copy rights, patent, facilitate IP, co-creation, support branding	6	9.25
7	Quality and Standards	Standards, ensure standards; government regulations; criteria; qualite improvement	5	7.94
	TOTAL		**63**	**100**

Annex 6: Intellectual property support

Intellectual Property support	Country						
	South Africa	Kenya	Uganda	Malawi	Burkina Faso	Mozambique	Zambia
Country has a national IP policy	√	√	×	√	×	√	√
Universities and research institutes have institutional IP policies	√	√	×	√	×	×	√
Country has a national IP office for the registration and protection of IP assets	√	√	√	√	√	√	√
SGC has an office with relevant expertise to support our stakeholders on IP, technology transfer and commercialization	√	√	√	√	In progress	×	√
Key: Yes (√); No (×)							

Annex 7: Innovation and commercialization infrastructure

Innovation and commercialization infrastructure	Country						
	South Africa	Kenya	Uganda	Malawi	Burkina Faso	Mozambique	Zambia
Science and technology parks	√	√	-	×	√	√	×
Incubation centres	√	√	√	×	√	√	√
Innovation hubs	√	√	×	√	-	√	√
Technology transfer offices/centres	√	√	-	×	-	×	√
Key: Yes (√); No (×); No response (-)							

Annex 8: Communication and coordination channels

Communication and coordination	Country						
	South Africa	Kenya	Uganda	Malawi	Burkina Faso	Mozambique	Zambia
Institutional websites	√	√	√	√	–	√	√
Emails	–	√	√	–	√	√	–
Seminars, meetings, conferences and workshops	√	√	√	√	√	√	√
Open days/field days	–	–	–	–	–	√	√
Phone calls	–	–	–	–	–	√	–
Social media (twitter, facebook etc.)	√	–	–	–	–	–	√
Radio	√	–	–	–	–	–	√
Word of mouth	√	–	–	–	√	–	–
Policy briefs	–	–	–	√	–	–	–
newsletters	–	√	–	√	–	–	√
Reports	√	–	–	–	√	–	√
Key: Yes (√) Not applicable (-)							

SGCI Close Out Workshop

13th February 2020

Participant list

No	country	Title	First name	surname	Institution
1	**Namibia**	Mr.	Simon	Nghipangwa	National Commission on Research, Science and Technology (NCRST)
2		Dr.	Penny	Hiwilepo Van-Haal	University of Namibia
3		Mr.	Nhlanhla	Lupahla	Ministry of Higher Education Training and Innovation
4		Ms.	Natascha	Cherkhyoussef	Ministry of Higher Education Training and Innovation
5	**Rwanda**	Mr.	Ernest N.	Mapundu	National Council of Science and Technology
6		Dr.	Emile	Bienvenu	University of Rwanda
7	**Tanzania**	Prof.	Mohamed	Sheikh	Tanzania Commission of Science and Technology (COSTECH)
8		Ms.	Neema	Tindamanyire	Tanzania Commission of Science and Technology (COSTECH)
9	**Uganda**	Mr.	Ismail	Barugahara	Uganda National Council of Science and Technology
10		Prof.	Samuel Baker	Kucel	Busitema University
11		Dr.	Patrick	Vudriko	Makerere University
12		prof	Charles	Muyanja	Makerere University
13		Dr.	Mshilla	maghanga	Gulu University
14		Dr.	Geoffery	Ssepuga	Uganda Technical college

15	**Zambia**	Mr.	Filipo	Zulu	National Science and Technology Council
16	**Zimbabwe**	Mrs.	Susan	Muzite	Research Council Zimbabwe
17		Mrs.	Sharia	Nondo	Research Council Zimbabwe
18	**EASTECO**	Dr.	Sylvance	Okoth	EASTECO
19	**Others**	Dr.	Wilber- force	wanyanga	pharmaQ Ltd
20	**Botswana**	Mr.	Abraham	Mathodi	Department of Research Science and Technology
21		Mr.	Ontlametse	Gaothuse	Department of Research Science and Technology
22		Mr.	Molefe	Phirînyane	Botswana Institute for Development Policy Analysis (BIDPA)
23		Dr	Tiroyaone	Ash ukudu	Botswana Innovation Hub(HIB)
24	**Burkina Faso**	Dr.	Hamidou	Tambours	Le fonds National pour la Recherche et de l'innovation pour ie development- FONRID
25		Dr.	Aminata	Kabore	Le fonds National pour la Recherche et de l'innovation pour ie development- FONRID
26		Dr.	Idrissa	Kabore	Scientific Research & Innovation Policier,
27		Mr.	M. Bationo	Saturnin	DG-Statîstîcs and Studies, MESRSI
28		Dr.	Lalla	Berthe/Sanou	Centre MURAZ Bobo Dioulasso
29			Poulouma Louis	Yameogo	Representing project 2 (Agric)
30		Prof.	Athanase	Millogo	Departement de medecine interne
31		Dr.	Germain	Fraoré	Conseil régional des personnes âgëes des
32		Mr.	M. Aïi B	Koné	DRFSNFAH

33	**Cote d'Ivoire**	Dr.	Ouattara Lhaur	Yaigaiba Annette	Programme d' APPUI stratique a ie-Research scientifique- PASRES
34		Dr.	Yaya	Sangare	Programme d' APPUI stratique a ie-Research scientifique- PASRES
35		Dr.	KonanV?A	Brice	Universite Jean Lorougnon Guede UJLoG
36		Prof.	Kopoin	Adouby	Institute national polytechnique felix Houphouel Bougny (INP-HB).
37	**Ghana**	Prof.	Tommy Oliver	Boachie	Ministry of Environment, Science, Technology and Innovation (MESTI)
38		Mr.	Jonathan	AMO-Otoo	Ministry of Environment, Science, Technology and Innovation (MESTI)
39		Dr.	Wilhemina	Quaye	CSIR-Science and Technology Policy Research Institute
40		Prof	George	Essegbey	CSIR-STEPRI
41	**Kenya**	Mr.	David	Ngigi	National Research Fund (NRF)
42		Prof.	Joshua	Ogendo	Egerton University
43		Dr	James	Kimotho	KEMRI
44		Dr.	Salome	Guchu	Kenya National Innovation Agency
45		Mr.	Alick	Manda	National Commission of Science and Technology
46		Mr.	William	Khumbo Ngwira	Department of Science and Technology
47	**Malawi**	Dr.	John	Taulo	Malawi University of Science and Technology
48		Mr.	Mike	Kachedwa	National Commission of Science and Technology

49			Graffin	Chipula	Lilongwe University of Agriculture and Natural Resource
50		Mrs.	Joyce N.	Chivunga	Malawi University of Science and Technology
51	**Mozambique**	Prof.	Langa de	Jesus	Fundo Nacional de Investigacao (FNI)
52		Eng.	Dirce M.	Madeira	Fundo Nacional de Investigacao (FNI)
53		Dr.	Rachida	Mamad	Ministry of S&T
54		Eng.	Benjamin	Langa	Ministry of S&T
55			Damiao	Nguluve	SGCI funded project
56	**Namibia**	Ms.	Enid Anne	Keramen	National Commission on Research, Science and Technology (NCRST)
57	**United Kingdom**	Mr.	Remy	Twirigïyimana	University College London (UCL)
58	**Senegal**	Pr.	Mamadou	sy	Strategic Director, Research Planning, MESRI
59		Ms.	Ndeye Yaba	FALL	Assistante/ DFRSDT
60		M.	Tafsir Babacar	NOOYE	Coordonnateur du FIRST, DFRSDï
61		Pr.	Fariba	Tambours	Representat ve, Univers‹té Alioune Diop de Bambey
62		Pr.	Codou Gueye	MAR	Recteur, Univers té Amadou Mahtar MBOW
63		Dr.	Abden	ndiege	DG/ISRA institute Senegal de recherché agricole
64		Mr.	Gabriel	Sarr	Economic planning
65			Abdepaye	SARR	MESRI

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