STRENGTHENING RESEARCH - INDUSTRY COLLABORATIONS IN AFRICA

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STRENGTHENING RESEARCH – INDUSTRY LINKAGES IN AFRICA

Summary Report and Key Recommendations

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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.

The key objective 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[2] with the private sector[3].

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.

KEY 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[4]) 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[5].

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).

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

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

[4]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.

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

The overall management of the partnership rests with MINEDUC through the [6]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[7]. 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.

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[8] and the Southern Africa Innovation Support Programme[9] (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.

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6 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.

7 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.

8 https://en.wikipedia.org/wiki/National_Technology_Business_Centre

9 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 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[10],[11] 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.

Whereas implementation challenges and associated risks (including targeting criterion, political

[10] 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

[11] 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.

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[12] 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[13] 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

[12] see annex 7

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

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[14] including lab space, conference facilities, personnel, consumables, transport, workshops, softwares, training opportunities, furniture etc

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[15], Hawassa[16] ,Jima[17], Adama[18] ,Kombolcha industrial parks[19] 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[20] to build their science park. Similarly, the government is establishing a minimum of twenty-two Industrial and Business Parks (IBP's)[21] including Namanve, Luzira, Bweyogerere, Jinja, Kasese, Soroti, Mbale, Karamoja[22], Kashari and Mbarara Industrial and Business Park.

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

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

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

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

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

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

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

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

[22] http://uacciap.org/uganda-government-to-construct-cement-factory-in-karamoja/

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[23].

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.

A notable example is the Communities of Research Excellence (CoRES) programme under the Consortium for National Health Research (CNHR[24]) 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[25])

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

https://www.konza.go.ke/project/kenya-advanced-institute-of-science-technology/, https://www.weforum.org/agenda/2015/01/how-can-kenya-boost-growth/

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

24 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.

25 www.cernvec.icipe.org

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."*

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[26]) 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.

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

26 Source: https://www.nrf.ac.za/division/rcce/instruments/research-chairs

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[27]

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[28] (NIPMO) and (ii) the TTO personnel training and joint learning meetings offered by the Southern Africa Research and Innovation Management Association (SARIMA[29]).

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.

[27] Annex 6 shows the existence of IP support in different countries

[28] https://nipmo.dst.gov.za/

[29] https://www.sarima.co.za/

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 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[30])

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[31]). 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[32], 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).

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

31 http://mofa.gov.gh/site/programmes/pfj

32 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[33] 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[34] 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[35] 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[36] 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.

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

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

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

36 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[37] (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[38] (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 economic impacts and performance evaluation was outside its scope.

Many of the initiatives identified in this study are recent and it would be impossible to assess their mid to long term impact. 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 at a later date.

[37] https://www.cbu.ac.zm/research/
[38] https://www.unza.zm/units/tdau