Commercializing African health research: building life science convergence platforms


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The application of science and technology is fundamental, and indeed indispensable, to the social and economic transformation of our countries... We in Africa must either begin to build up our scientific and technological training capabilities or remain an impoverished appendage to the global economy... There is no reason to believe that Africa cannot achieve what others have achieved in these fields.
HE Paul Kagame, President of Rwanda

A to Z Textile Mills, a company in Arusha, Tanzania, in a joint venture with the Japanese company Sumitomo, is the largest manufacturer of long-lasting insecticide impregnated bednets in Africa. Pellets containing insecticide are shipped from Japan to Arusha, where they are melted, turned into long strings, which are rolled onto spools, and then formed into nets, cut, packaged and shipped using company owned trucks to points of distribution in many African countries particularly in East and Central Africa. A to Z currently manufactures about 12 million bednets a year, which are WHO-certified and reasonably priced. Moreover, A to Z has created more than 5000 jobs for Tanzanians, supporting at least 20 000 people. As an example of manufacturing a science-based health product for one of Africa's most burdensome diseases, A to Z is a huge success.

Now imagine a company like A to Z that relied not on imported technology but on domestic African health research. Over the same time period that A to Z was manufacturing malaria bednets, distinguished East African researchers like Wen Kilama of the National Institute for Medical Research in Tanzania and Onesmo Ole Moi Yoi of ICIPE in Kenya were studying and publishing on the malaria parasite and mosquito vector. Imagine if this domestic East African research was the source of the technology for innovations in long lasting insecticide-treated bednets! Unfortunately, the linkages between African researchers and research institutions, and companies – even those that are domestically based – historically has been weak.

In this article, we propose that African innovation – and in particular African life sciences innovation – could and should become a prime driver for health and economic development on the continent. We consider a model to catalyse life sciences innovation and commercialization in Africa through "convergence innovation", which overcomes the problem of missing links between science, business and capital, and provides a specific focus on product development. Our main focus is life sciences innovation for health but with an understanding that applications in agriculture and energy could also benefit from convergence innovation. In a previous essay *Accelerating health product innovation in sub-Saharan Africa* we set out our initial ideas[1]. Here we review the concept of convergence innovation, elaborate on our real-world experiences in three African countries, and set out opportunities and proposals for the future. While our initial focus has been on Ghana, Rwanda and Tanzania, our vision is a continent where many countries are capturing the health and economic benefits of their own domestic health research.

Vital role of science, technology and innovation in African development

The Global Forum for Health Research has long advocated the importance of domestic health research, sufficient resources and capacity strengthening in the developing world, highlighting in its most recent report the continuing under-resourcing of research applied to the needs of developing countries[2]. Similarly, a UN task force has emphasized the importance of science, technology and innovation for reaching the UN Millennium Development Goals (MDGs)[3].

In 2007 African Union Heads of State strongly urged member states to promote research, development and innovation by allocating at least 1% of Gross Domestic Product (GDP) of national economies to this area by 2010[4], with the aim of improving local technological and human capacity to address local problems. The involvement of the private sector as critical enabler of innovation, economic development and social welfare has also become better understood and emphasized[5].

Life sciences – with applications as diverse as health,

Box 1: Stagnant technologies

Schistosomiasis dipstick test

Professor Kwabena Bosompem of the Noguchi Memorial Institute for Medical Research, Ghana, has developed a dipstick assay for schistosomiasis disease, an endemic problem in Ghana caused by parasites which are present in infected water. Although it has a low mortality rate, schistosomiasis often is a chronic illness that can damage internal organs and, in children, impair growth and cognitive development. Schistosomiasis is the second-most socioeconomically devastating disease after malaria (Danso-Appiah et al, 2008). Despite having developed a prototype test for the disease several years ago, the commercial potential of the test has not been exploited due to a lack of technology transfer capacity or support for product development, field trials or market assessment.

Artemisia annua

Artemisia annua grows in the highlands in Arusha, Tanzania, with 2–10 times higher yield than anywhere else in the world (transcripts from participant interviews, Tanzania). At the National Institute for Medical Research, scientists developed an innovative process to enhance the production of Artemisia, which is not being locally applied. Once grown, however, all Tanzanian Artemisia is farmed, dried and exported to Kenya, where extraction occurs, before being shipped to Switzerland where it is further processed for use in the antimalarial Coartem ® produced by Novartis. Little commercial value is captured locally, and though there are efforts to commercialize Artemisia locally using innovative processes these remain uncoordinated across the private sector, government and universities.

Agricultural research

This included a fertilizer formulated at the Institute of Research into Science and Technology in Rwanda by a scientist who refused to disclose its formula. Due to lack of awareness of the innovation process and support structures to protect inventions, the potential value of this discovery was untapped. In another example, seed varieties developed at Rwanda's Institute of Agriculture and Scientific Research are being marketed in Malawi – no royalties are flowing back to the Institute, hence no local value has been captured.

agriculture and environment – have found special attention from national governments and policy-making bodies such as the African Union[6] and United Nations. Countries are being encouraged by pan-African and multilateral bodies to see life sciences as a route through which innovative, entrepreneurial activity can be channelled to produce local solutions to local problems, in time helping to diversify economies, capitalize on local talent and reduce dependency on outside sources for needed technologies.

Realizing this goal will require not only increased investment in R&D, but also in the tools, skills and infrastructure to commercialize R&D, turning it into products and services for local benefit and, ultimately, regional and global export. Included under this umbrella are a vibrant private sector, flexible financing mechanisms for small businesses, support structures for small business development and expertise in management, technology transfer, intellectual property and regulation[7]. Most importantly, as we shall argue below, the disparate elements of science, business and capital need to be brought together and collectively energized.

Other developing countries, now known as "emerging economies" – with India and China as leading examples – are beginning to commercialize innovative health products[8,9,10]. Will African countries also begin to turn their domestic health research into products and services that address their local health problems?

MRC research in Ghana, Tanzania and Rwanda

The McLaughlin-Rotman Centre for Global Health (MRC), based at the University Health Network and University of Toronto, Canada, has built expertise in the use of life sciences in the developing world, with an emphasis on health technologies. In 2002, we published our study on the Top Ten Biotechnologies for improving health in developing countries within the next 5 to 10 years[11] conducted in partnership with scientists from around the world. In 2004, we published a series of seven case studies which explored the national health biotechnology innovation systems in the developing world, primarily in emerging economies, and set out policy recommendations[12]. Current activities include a project on biotechnology firms in a number of emerging economies, including India, China, Brazil and South Africa, which seeks to raise the profile of indigenous innovation and understand the challenges and opportunities facing these firms.[8,9,13] MRC is also involved in technology-specific projects, such as the role of human genomic variation projects and regenerative medicine technologies in improving public health in developing countries[14,15].

Since early 2007, we have been working with three African governments to explore ways to strengthen their life sciences innovation, and accelerate the commercialization of science-based health products based on domestic African health research. So far more than 100 stakeholders from academia, private sector, government and civil society have been interviewed face-to-face in Ghana, Tanzania and Rwanda, with the aim of gaining understanding of the obstacles to innovation and product development and commercialization and exploring potential solutions. Several hundred stakeholders have been engaged through workshops where we reported back results and discussed health product commercialization in these countries. In each country, we have sought to identify the areas of local strength which offer the greatest promise of commercialization and ways in which this process could be catalysed through "convergence innovation".

The first country we began working in was Ghana, where we were hosted by the Ministry of Health and Honourable

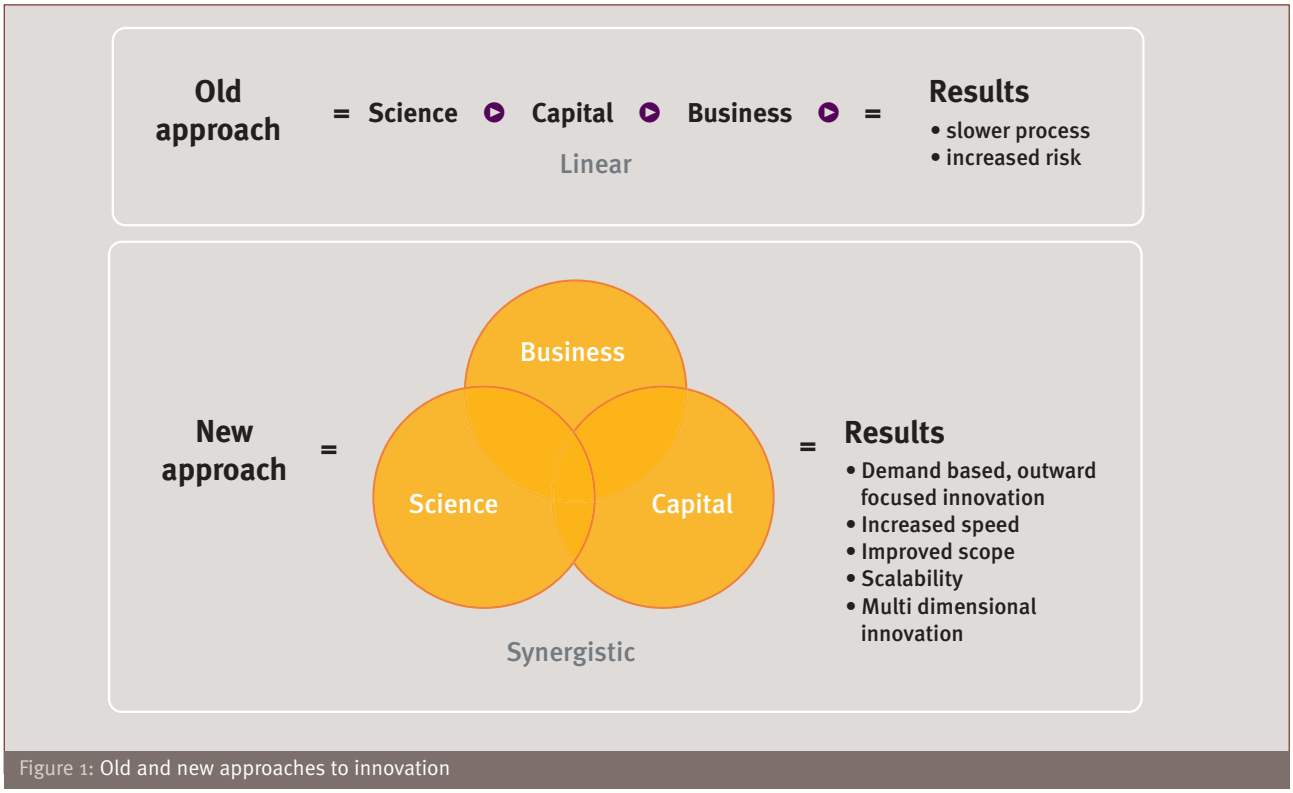

Figure 1: Old and new approaches to innovation

Minister Courage Quashigah. Through our interviews, we found many of the key elements of innovation to be in place – a strong regulatory body for food and drug products; pockets of innovative research; a relatively strong pharmaceutical sector accounting for the production of 30% of Ghana's health products (including La Gray Pharmaceuticals, a facility focusing on the production of Active Pharmaceutical Ingredients); the existence of financing mechanisms for science-based businesses (for example the Government's Venture Capital Trust Fund); and an entrepreneurial mindset among Ghanaians, reflected in the number of business schools and the growing success of the IT industry. Particular knowledge areas that were considered to be of most promise were traditional medicine and tools for diagnosis of local diseases. Some elements of innovation policy and practice, such as technology transfer and intellectual property protection, were found to require attention, however the key limitation in the product development pathway was the lack of inter-sectoral linkages. Connections between researchers and the private sector, between government and end users, and between all other entities in the innovation system, need to be built.

In Tanzania, we conducted a case study at the invitation of the Minister of Communications, Science and Technology. Here, we found a strong research and tertiary education base both in the private and public sector, with a number of universities running biotechnology programmes. Again, the regulatory system is strong and there is government commitment to building innovative economic sectors and diversifying Tanzania's economy. As in Ghana, traditional medicine and diagnostics were the leading contenders for commercialization, given the right support, but the

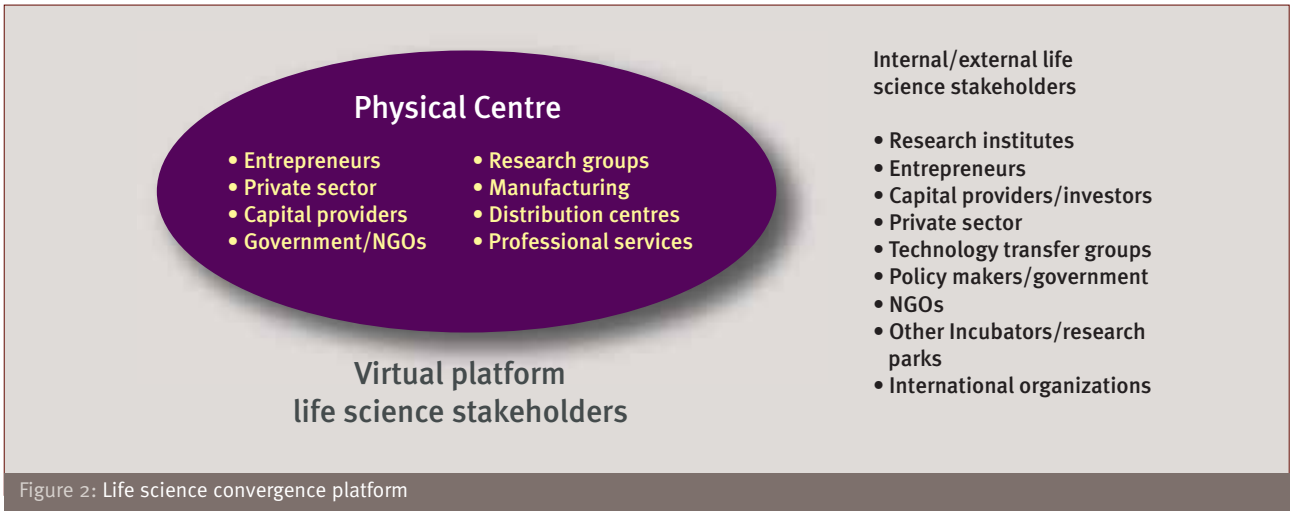

Figure 2: Life science convergence platform

entrepreneurial mindset was not evident among the research community. A number of institutes for traditional medicine are producing products for local consumption; however, these could be significantly improved with the application of business rigour. There were some very interesting efforts to create clusters and SME clubs, but these were relatively small-scale in any particular focus area. Again, there was enormous scope for increasing linkages between researchers and entrepreneurs.

In Rwanda, our host was the Minister in the President's Office in Charge of Science, Technology, Scientific Research, and Information Communication Technologies. The Rwandan case presents a different though exciting model since, compared to the other two countries, the life sciences research base is less well developed and, sadly, there is a smaller base of highly trained science professionals. The government is actively seeking to build capacity with a view to transforming its current agriculture-based economy to a knowledge-based economy by year 2020, and to use science, technology and ICT as a key enabler of this transformation. An important building block, in the shape of the Science and Technology master plan, is already in place[16]. As yet there is no framework to harness health and biotechnology inventions but the government is keen to develop one – for example, the Pharmacy Task Force in the Ministry of Health is working with Tanzania to establish a food and drugs regulatory agency; a patent office is being formed in the Ministry of Commerce and a recent patent law has been passed. There are no major links between scientists in Rwanda and Rwandan scientists abroad and little awareness of scientific investment opportunities by Rwandan entrepreneurs.

One phenomenon that we came across in all three countries was "stagnant technologies": technologies at early stages of development, in need of product development support and expertise, but lacking the means (both resources and experience) to realize their true value (see Box 1).

The main finding from our research in all three countries was a need for improved linkages among different elements in the innovation system – science, business, and capital – to enhance knowledge flow and to stimulate the "innovation culture" necessary to underpin future growth of a knowledge-based economy. Currently, limited contact between sectors and a lack of awareness of the tools to stimulate innovative performance is resulting in the failure to harness the creativity of African scientists, as illustrated by stagnant technologies and an overall lack of examples of locally-driven innovative activity coming from these three countries. In short, Africa is more successful at health research than at commercializing that research into health products aimed at local and regional health problems.

Convergence innovation and convergence platforms

Having seen that little African health research is translated into health products, what can be done about this? What approach to innovation can help catalyze new approaches that are more socially and economically productive?

The traditional view of innovation has seen it as a linear process, starting with investment in fundamental science, then seeking capital to further develop applications, leading to the formation of a business or uptake of the technology by the private sector and then to distribution (see Figure 1). This is a slow process, often not directed by market and consumer need, and as such subject to increased risk and uncertainty.

"Convergence innovation" embodies a new approach to innovation, and involves the bringing together of science, business and capital – three key elements of innovation – to create a dynamic environment where scientific knowledge, the demands of the marketplace and the realities of funders exist together. This model aims to increase speed of product development and relevance of products to the population, and reduce risk to investors.

Support structures are needed to create this type of environment including both virtual and physical platforms for stimulating innovation, encouraging cross-sectoral learning and nurturing technologies. Examples of such structures include science parks, technopoles and clusters, each of which differ slightly in approach but for our purposes will be treated as variations on the theme of convergence innovation. Our model is of a "convergence platform" that offers services necessary to grow nascent scientific and entrepreneurial capacity into an organized and fully realized cluster. Acting as the focal point for science, business and capital stakeholders, the platform will provide a forum to effectively integrate diverse expertise and interests and facilitate partnerships. Additionally, a convergence platform will be involved in public advocacy, provide training and offer entrepreneurial support and awareness, providing a balanced approach to bridging business and science. We define a convergence platform as a physical or virtual place that:

- attracts a breadth of talent and resources from science, business, and capital communities across the innovation value-chain to a single point;
- offers entrepreneurial support and services to facilitate business planning, business development and partnership formation;
- provides opportunities for knowledge exchange and shared learning opportunities – entrepreneurial training, special programmes and events, mentorship and peer-to-peer learning;
- provides a focal point for the attraction of risk capital;
- is adaptable to local circumstances and markets – one size does not fit all;
- facilitates connections to related platforms and other institutions locally and internationally.

A concrete example of a convergence platform is the MaRS Centre in Toronto, created with the explicit goal of realizing benefits from the wealth of life sciences research in the Toronto region. By mingling talent across the functional innovation system – from basic scientists to venture capitalists – MaRS provides research and business incubation facilities, co-located with professional services firms and investors, technology transfer offices and venture capital groups. MaRS has connected science, technology and

entrepreneurs with business skills, networks and capital to stimulate innovation and accelerate the creation and growth of successful Canadian enterprises by building a community in which innovators, entrepreneurs, scientists, professionals and investors can meet to establish linkages and exchange knowledge[17].

Key elements of the proposed convergence platforms in Africa

Ghana, Tanzania and Rwanda are three African countries seeking to capture the value of local life sciences research. MRC has been working with these countries, and with SHI Consulting, a strategy consulting firm based in Canada which serves the innovative life sciences sector, to develop business plans for convergence platforms which will enable accelerated health product commercialization and improve innovation capacity. Though each platform has subtly different features, in essence they all consist of three main elements which, together, create a dynamic environment for product commercialization:

Physical centre: this is a physical building which co-locates tenant space for research, companies of all sizes, business advisors, investors, office space and professional services. The aim of the physical centre is both to provide physical infrastructure (Internet access, laboratory services, conferencing facilities, scientific equipment) and to house activities for networking, entrepreneurial services and training which would lead to increased local product development. Activities that would occur in the centre include hands-on advisory services in commercialization and business development, entrepreneurial programming and networking sessions. The location of the physical centre must be well-chosen, ideally within a major city as the "hub" of research, government organizations and private sector activity. It must also be located in a neutral space with accessibility to a critical mass of stakeholders.

Virtual network: the virtual network links together higher education, public and private research institutions, government and other stakeholders, through, for example, events, email listings and site visits. It also manages the pre-incubation and development of promising technologies to support the technology transfer process. Examples of activities include a "technology audit" to identify promising technologies in each country ripe for commercialization, and an annual Venture Forum which will draw out innovative ideas from the research community for further business support and development. The virtual network helps to ensure a national effort – and serves the crucial function of scoping promising technologies, which could later represent "deal flow", as widely as possible. The virtual network also enhances various functions of the physical centre by supporting formation of linkages, deal flow between partners, inter-sector and cross-institutional communication and collaboration, and entrepreneurship/commercialization training.

Product development programme: the product development programme (PDP) acts as a specialized "technology development accelerator programme" to develop pre-commercial technologies identified locally to the point of market readiness. Technologies or ideas selected for the PDP are co-developed with the platform's expert team and given initial seed funding to take them past the proof-of-concept stage and make them attractive to risk capital investors – thus taking technologies across the so-called "valley of death". The PDP will therefore play a key role in facilitating partnerships with local and global risk capital investors and receptors capable of taking the technology to a viable commercial stage. Initially, the PDP will develop pilot projects, focused on areas with potential to realize short-term gains to generate revenue. Anchored by rigorous scientific and business criteria that select only the most promising pre-commercial technologies for further development, the PDP will build a reputation as a consolidator of investor-grade life sciences assets.

Over time, each convergence platform will be networked into its counterparts in other countries, leveraging experience, skills and lessons learned across the continent. Some of these platforms are in the same African region (e.g. Tanzania and Rwanda), in which case the platforms could work together to become hubs for regional innovative activity and attract promising projects from the entire region. Other regional and international incubators and science park networks and associations such as the Africa Incubator Network (AIN), as well as convergence platforms outside Africa, will also be potential partners for collaboration.

Financing convergence platforms and resulting companies

The convergence platforms (consisting of physical, virtual and product development elements) are structured as not-for-profit entities with an independent board of directors. The platforms have the opportunity to become sustainable in the mid-term through fees for services or rent. Reaching sustainability, however, requires an infusion of start-up capital in the millions of dollars, for which several potential funding sources exist. Generally, according to our financial models, the platforms should break even within five years, although they will continue to pay off debt resulting from the initial capital investment for a longer period of time.

Initial funding for the platforms could come from a range of public sources, structured as loans or grants. African governments themselves could be direct funders of convergence platforms, seeing them as promising mechanisms to address a number of economic, health and wider societal goals and to leverage the benefit of R&D investments already being made.

The public sector window of the African Development Bank (AfDB), with its mandate to promote economic and social development through loans, equity investments and technical assistance, is another potential sponsor. Indeed, a recent ADB High Level Panel Report, *Investing in Africa's future – the AfDB in the 21st century* outlines a new role and strategic plan for the AfDB. It highlights the need to foster innovation in Africa and recommends that "the Bank support the development of national and regional centres of excellence in the health sciences and in energy and

environmental technologies. There are significant potential benefits from linkages between life science and the private sector"[18]. Like the traditional infrastructure investment of a bridge joining two sides of a river, a convergence platform is an infrastructure investment for joining science and capital for social and economic benefits to the host country and its people.

The World Bank, with its interest in capacity-building in the crucial areas of science, technology and innovation, is another potential sponsor for the virtual component of these platforms, as are a wide variety of donor agencies for whom science, technology and innovation play a central role in future economic development.

By contrast to the platforms themselves, financing for the technologies which have reached the point of proof of principle or market readiness should come from private investments in the form of equity or debt. In terms of private capital providers for technologies and spin-out companies, there are a number of entities with potential interest in making investments in Africa, including the private sector window of the ADB and the International Finance Corporation (IFC), the private sector arm of the World Bank. In December 2007, the IFC, with support from the Bill & Melinda Gates Foundation, released a report entitled *The Business of Health in Africa*, on opportunities for private-sector approaches to health in sub-Saharan Africa. The report covers health services provision, medical and nursing education, risk pooling arrangements, distribution and retail of health products, and also life sciences manufacturing and innovation[19]. In a promising development, the accompanying announcement states that there are plans to mobilize up to US$ 1 billion in investment and advisory services support over the 2008–2012 time frame, including an equity investment vehicle starting with US$ 100 million (growing to up to US$ 300–350 million over this time frame).

Venture capital firms both within and outside Africa are another potential source of risk funding. Two examples are South-African Bioventures, the only wholly life sciences-focused VC firm in sub-Saharan Africa, which has made a number of successful investments in that country, particularly in the medical device area; and Bridgeworks, a Kenya-based VC, which also has a special focus on health technologies and over the last few years has gained extensive experience in the requisite measures to identify, develop, support and finance small science-based ventures in Africa. These investments would also be appealing for social investors, who will tolerate lower returns in exchange for social benefits.

Lessons learned and next steps

Having begun to operationalize convergence innovation on the ground through working with local governments and other stakeholders, including writing business plans and sourcing potential funders, a number of lessons have been learned which will improve the likelihood of success.

First, flexibility is key. One size does not fit all across Africa and each platform is being developed with sensitivity to local circumstances, goals and capacities. In Ghana, for example, emphasis is being placed on a virtual model that links together stakeholders through events, activities and other virtual means; a central secretariat will coordinate this approach but, at this stage, no physical centre is being proposed. In contrast, the Tanzanian stakeholders are pursuing an integrated physical and virtual model to better leverage local capacities and existing institutions. In Rwanda, again there is likely to be a physical and virtual component, with emphasis on both scientific and entrepreneurial capacity building, and a focus on both health and agriculture.

Second, local champions to spearhead these platforms are vital. Throughout our work in Africa, we have encountered a good deal of local enthusiasm for the convergence innovation concept from those eager to capitalize on the opportunity and catalyze a different approach to health and economic development. Involvement of local partners is the only way to ensure that these platforms are realistic in scope, responsive to local needs and financially sustainable. This is occurring in Ghana, where a Task Force on Life Science Commercialization and Convergence was established by the Honourable Minister of Health and mandated to advise him on next steps. Led by an eminent academic Professor Francis Nkrumah, the task force meets on a monthly basis and is in the process of further developing a business plan for the platform, appointing a secretariat and sourcing funding for the first one or two years of operations. In Tanzania the business plan for its convergence platform has been presented to the Minister and the next step is to appoint a local steering committee to develop and deliver the plan. In Rwanda, the business plan has been presented to the Minister and local champions are being identified.

Third, the role of the local private sector is critical. Ultimately, it is the private sector which has the skills and expertise to commercialize technologies. Prominently included in the local champions mentioned above must be leading entrepreneurs.

The potential benefits, and metrics of success, of a convergence platform include: increased product commercialization in Africa; increased formation of life science enterprises and growth of support industries and therefore increased high value employment; enhanced life science-based entrepreneurial culture; increased formation of sustainable public-private partnerships, linkages and knowledge flow among science, business and capital stakeholders in Africa; increased inward investment and risk capital; increased exports, initially regionally but ultimately globally, of health products; and lastly, and most importantly, improved health, social and economic outcomes for Africa.

Of course, there are also risks. Convergence platforms are complex endeavours highly dependent on the mobilization of sufficient critical mass. Commercialization of innovation is a high-stakes game that fails much of the time. Innovation requires a long-term commitment. To be successful, governments must also simultaneously address gaps across the functional innovation system.

How can this model of convergence innovation, facilitated through convergence platforms, be extended to other countries in Africa and suitably networked so as to gain maximum leverage within and across regions? The first step

is to engage the wider audience of African Health Ministers, both to raise the profile of what has been done so far and to consider how this model of innovation might help them to achieve their public health goals by enabling the growth of indigenous health innovation. Ministers of Science and Technology and of Finance should be interested in these initiatives for what convergence innovation can mean for their countries' social and economic development. A few examples of successfully commercialized products based on African health research will go a long way to building the confidence of African and international investors. If one were a private investor, one would have no idea how to scope promising technologies against health, agricultural, environmental or energy problems in Africa. The convergence platform provides one-stop shopping for investors, greatly decreasing the complexity and cost of identifying promising technologies.

Given the ingenuity, creativity and entrepreneurialism in Africa, it is inevitable that the continent will move towards a more diversified economy through increased knowledge-based activities. What is not at all inevitable is that this process will be as quick and efficient as possible. Failures of both individual technologies and models will pave the path to ultimate success, and mechanisms to leverage learning will be highly desirable. By focusing explicitly on commercialization of domestic African health research, and learning how best to translate this research into commercial products and services, convergence platforms pave a path for African countries towards accelerating social and economic development. As noted by President Kagame, the alternative paths are much less desirable. ❑

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