



Building higher level skills to drive development in Africa: The case of the RUFORUM Doctoral Regional Training Programmes

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ABSTRACT

Africa still lacks the required human capacity to respond to critical development challenges. Skills are inadequate in many areas from primary to tertiary level, and vocational training. There is need to develop high-level skills, institutional capacities, critical technical skills, and resources in key investment areas. The current situation is a major constraint to the implementation of development programmes and continental frameworks hence the foreseen delayed emergence of African countries as knowledge economies. Progress has so far been made by several regional stakeholders to identify the key critical soft and hard skills that are necessary to drive the Africa Agenda 2063. With this, educational institutions being the main actors in the skills, competencies and technological development value chains, are expected to transform and realign their interventions to develop the high-level skills needed to deliver Africa Agenda 2063. The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) responded by commissioning an institutional and competence analysis of its then 10 member universities to document strengths and weaknesses, status of facilities, human resources/expertise and experiences to map out the niche areas as well as institutional comparative strengths and weaknesses. Other studies also identified skills and competence gaps in students graduating from African universities. A key outcome of this process was the adoption of strong course-based doctoral training that involved engagement with other leading experts in and outside Africa in the training. In 2008, RUFORUM launched the coursework-based doctoral regional training programmes, and has since supported the establishment of seven such programmes, namely Agricultural Rural Innovations, Food Science and Nutrition, Soil and Water Management, Aquaculture and Fisheries, Agricultural Resource Economics, Plant Breeding and Biotechnology, and Dryland Resource Management. As part of building institutional capacity and recognizing excellence, some of programmes have become part of the African Higher Education Centres of Excellence. These include: African Centre of Excellence in Agro-ecology and Livelihood Systems (ACALISE) at Uganda Martyrs University in Uganda; Africa Center of Excellence for Climate Smart Agriculture and Biodiversity Conservation at Haramaya University in Ethiopia; African Centre of Excellence in Sustainable Agriculture and Agribusiness Management at Egerton University in Kenya; Africa Centre of Excellence in Aquaculture and Fisheries Science at Lilongwe University of Agriculture and Natural Resources (LUANAR) in Malawi; and Makerere Regional Center for Crop Improvement at Makerere University in Uganda. These programmes have supported training of over 420 doctoral students in Africa who are now contributing to the development of the African continent in different capacities in the agricultural sector and leadership positions. These programmes remain relevant today and are inspiring the development of other regional training programmes to fill the required skills and knowledge gaps in the continent.

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RÉSUMÉ

L'Afrique manque toujours des capacités humaines nécessaires pour relever les défis du développement. Les compétences actuelles restent insuffisantes dans beaucoup de domaines, du primaire au tertiaire et dans la formation professionnelle. Il est donc indispensable de développer des compétences de haut niveau, des capacités institutionnelles, des compétences techniques essentielles et des ressources dans les domaines d'investissement clés. La situation actuelle entrave la mise en œuvre des programmes de développement et des cadres de travail continentaux, d'où une émergence retardée des pays africains pour devenir des économies du savoir. Des progrès ont été accomplis par plusieurs parties prenantes régionales pour identifier les compétences essentielles nécessaires pour conduire l'Agenda 2063 de l'Afrique. Ainsi, les établissements d'enseignement étant les principaux acteurs des chaînes de valeur d'éducation, de compétences et du développement technologique, devraient se transformer et réaligner leurs interventions pour développer ces compétences. Le Forum régional des universités pour le renforcement des capacités en agriculture (RUFORUM) a commissionné une analyse institutionnelle des compétences dans 10 universités membres pour documenter l'état des infrastructures, les ressources humaines/expertises et les expériences afin de mettre en évidence les forces et faiblesses comparatives institutionnelles. D'autres études ont également identifié des lacunes de compétences chez les étudiants diplômés des universités africaines. Un résultat clé de ce processus a été l'adoption d'une formation doctorale qui impliquait l'engagement des experts d'Afrique et d'ailleurs. En 2008, RUFORUM a lancé des programmes régionaux de formation doctorale et a soutenu la création et la mise en exécution de sept programmes de ce type dans les domaines des innovations agricoles rurales, des sciences alimentaires et de nutrition, de la gestion des sols et de l'eau, de l'aquaculture et la pêche, de l'économie des ressources agricoles, de la sélection végétale et de la biotechnologie et de la gestion des ressources des terres arides. Dans le cadre du renforcement des capacités institutionnelles et de la reconnaissance de l'excellence, certains de ces programmes font partie intégrée des centres d'excellence africains de l'enseignement supérieur. Il s'agit notamment: du Centre africain d'excellence en agro-écologie et systèmes de moyens d'existence (ACALISE) à l'Université Des Martyrs de l'Ouganda; du Centre africain d'excellence pour l'agriculture climato-intelligente et la conservation de la biodiversité à l'Université Haramaya en Éthiopie; le Centre africain d'excellence en agriculture durable et gestion de l'agro-industrie à l'Université d'Egerton au Kenya; le Centre d'excellence africain en aquaculture et sciences halieutiques à l'Université de Lilongwe (LUANAR) au Malawi; et le Centre régional pour l'amélioration génétique à l'Université de Makerere en Ouganda. Ces programmes ont soutenu la formation de plus de 420 docteurs en Afrique, qui depuis, contribuent au développement du continent africain à différents niveaux dans le secteur agricole et à des postes de direction. Ces programmes restent pertinents aujourd'hui et inspirent le développement d'autres programmes régionaux de formation pour combler les lacunes en matière de compétences et de connaissances requises sur le continent.

Mots clés: Afrique, Formation doctorale, Enseignement supérieur, RUFORUM

BACKGROUND

The decade of the 1990's saw the implementation of various economic recovery programmes in Africa to catalyze and underpin economic growth. The period into the 2000s saw the fastest and steady economic growth in the continent. During this period of fast economic growth, the proportion of people living in poverty fell to less than 45% and 41 % in 2012 and 2015, respectively, from over 50 % in 1981. Overall, while Africa has slowly regained its economic growth, albeit below 3% annually, after the global economic crises of 2008 (AUC/OECD, 2018), growth in recent years has not translated into rapid structural transformation and job creation. Most African economies largely rely on agriculture to underpin Africa's development as espoused in Agenda 2063 and other medium-term development frameworks, including the Comprehensive Africa Agriculture Development Programme (CAADP) (Okori, 2014; AUC/OECD, 2018; UDNP, 2020).

While indications are that Sub-Saharan Africa (SSA) has steadily increased its trained human capital, it still lags far behind other continents (UNDP, 2020). Training of right-skilled youth is critical to enable the continent sustain a common vision of unlocking prosperity and opportunity for its burgeoning young population for formal and informal work life settings (Motlanthe, 2010). A robust higher education system is critical for the development of any nations' capability to harness its resources for advancement. Indeed, higher education is critical for developing requisite knowledge and skills for agriculture, science, technology and innovation generation in Africa (Boni *et al.*, 2016; Nyerere *et al.*, 2016; Anonymous, 2018). Higher education is widely recognized as being central to development, contributing not only to enhancing individual opportunities in life, but also in creating a vibrant democracy, innovative economy and a range of other societal benefits in areas such as health, nutrition, governance and environmental protection (Nyerere *et*

al., 2016). While Science, Technology and Innovation (ST&I) education are critical for skilling today's and tomorrow's workforce, and are the key drivers for development, the quality of training in many African countries is weak. Governments in Africa are cognizant of this and are implementing various agenda, mostly focusing on strengthening the Technical Vocational Education and Training (TVET), as well as higher level degrees (Nega and Kassaye, 2018). Development of higher education systems is particularly critical in a region like Africa, given the significant youth population, the need for innovation to create new forms of employment, and the potential of research to address the significant social and environmental challenges (Anonymous, 2018). These steps are critical for Africa to step up the pace of its demographic transition needed to underpin any demographic dividend for its young population (Choi, 2016). Specifically, education must unlock opportunity for women delaying early child birth and consequently reducing the fertility rate by getting more women into employment after completing their education.

Like many sectors in African economies, the ST&I and Agricultural Higher Education sectors continue to face challenges characterized by low gross enrolments, limited infrastructure for research and training, mismatch in the skills of the graduates produced to meet industry requirements, as well as low staff capacity to train, especially at doctoral level (Nakayiwa, 2016). The low number of staff with high degree (doctoral) training especially in institutions of higher learning, has reduced capacity to generate required knowledge and appropriate technologies, and to train and produce post-graduates (Okalany *et al.*, 2016; Anonymous, 2018). Overall, competitiveness of SSA economies could be improved by strengthening higher-degree education and innovation, that are key pillars of economic competitiveness (Olssen and Peters, 2005; Okori, 2014; Kruss *et al.*, 2015).

After several decades of economic and agricultural stagnation, and even decline, in Africa especially in the period 1960's to 1990's, agricultural growth and productivity steadily improved, especially over the past two decades (Fufie and Rada, 2013; Block, 2016). Growth however, was mostly due to expansion of hectareage, rather than improvement in total factor productivity (Liu and Benin, 2013). Furthermore, in order to improve land and labor productivity, there is need to enhance production and adoption of new agri-innovation (Liu and Benin, 2013; Kufuor, 2014). For an agriculture underpinned economies, like for most of African countries, a 1% increase in staple crop yield could lift 2 million people out of poverty in Africa (Thirtle *et al.*, 2003). However, while Africa agriculture sector related total factor productivity (TFP) has risen in past decades, it has not recovered to the levels recorded in the early 1960's (Badiane and Collins, 2016). This calls for strong integration of science capacity rebuilding efforts in the continent, that are strategically linked to education and ST&I sectors. That way, Africa will be able to harness science, technology and innovation especially for agricultural growth, as the African countries become competitive in the knowledge economy (Asongu and Odhiambo, 2019). Moreover, a stronger education sector will increase the science foot print from its current levels of just 1% of global knowledge (Nakayiwa *et al.*, 2016).

At the start of the current millennium, African Universities through their umbrella organization, the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), begun to re-engineer their programmes in research and outreach to intensify contributions and impact on development needs and trajectory of the continent. In this paper, RUFORUM's contribution to rebuilding Africa's research capacity through graduate training is shared and discussed.

RUFORUM's Contribution to human capital development for Africa

RUFORUM was formed in 2004 by 10 universities in five countries in East and Southern Africa to primarily strengthen and promote the role of universities in agricultural and national development. The new member-based organization was guided by a strategic framework that had seven objectives, three focusing on: (i) Human resource development as a core function of universities; (ii) Production of high quality post-graduates and innovations by African University against a backdrop of limited resources; and, (iii) Effective and efficient contribution to national development through relevant and responsive research and training programmes. Implementation of this strategic vision required ground-truthed facts to guide investments and construction of a shared vision. A needs assessment was conducted among the then 10-member universities in Kenya, Malawi, Mozambique, Uganda and Zimbabwe to establish member universities' capacities, which could be harnessed for training and research for the greater good of the Network and region (Blackie and Woomer, 2005). The needs assessment identified critical operational strategic challenges that African Universities needed to address in order to proactively engage in development processes and practices of their countries (Table 1).

From the needs assessment, RUFORUM was able to anchor its strategic investment planning to national development agenda including the Millennium Development Goals (UNDP, 2003), and the CAADP, key development areas of countries at that time. This process anchored universities within the broader national agricultural innovation systems and development agenda, unlocking opportunity for African universities to engage and contribute to the continent's development agenda and process.

The multi-partners' participatory nature of

Table 1. Strategic challenges to increased operational and strategic engagement and delivery by Africa Universities in national human capital development, research, policy and innovation

Challenge/gap	Characteristics
Limited capacity for graduate training and alignment to Africa's development priorities	In 2004, among member Universities ¹ , there was no coursework based doctoral programme.
Limited number of staff with PhD	There was insufficient number of doctoral level trained faculty to fully supervise the incoming graduate students
Gender and diversity inequality	In several universities staffing reflected a shortage of females. This shortage presented a challenge for the development of gender-sensitive and appropriate on-farm technologies for improving food security and household income by smallholder farmers, and the general lack of female voices in agricultural education and training. In addition, this shortage spoke directly to the need for 'Increased participation and voices of women in training, research, and production and marketing of knowledge' as outlined in RUFORUM's Strategic Objective 5
Overseas staff training	Members of staff on study leave to pursue doctoral training create staff shortages for research and student training in their home institutions
Limited dissemination of research findings	Research outputs were seldom translated into simple extension messages intended for grassroots efforts. This gap was worsened by the lack of consistent faculty policy concerning collaboration with the Agricultural Research and Extension Service in most universities
Rampant 'Brain Drain'	In pursuit of better conditions of service and opportunities, some of the best lecturers were leaving for universities in South Africa or outside Africa were being recruited by international organisations
High cost of tuition and few scholarship opportunities	There was limited numbers of graduate students in existing graduate programmes due to limited funding opportunities and high costs of training
Inadequate and poor research and training facilities	In some universities, library and laboratory facilities were old, not updated and unmaintained
Limited collaboration amongst Africa's universities	Other gaps were commonplace in the higher education sector which hindered universities from executing their roles in the development process. These included, limited participation of universities in National Agricultural Innovation Systems, limited voice from universities in policy agenda, limited capacity by individual universities for graduate training; limited networking and partnership among African universities leading to poor use of resources (human and infrastructure)

Source: Blackie and Woomer, 2005

¹ RUFORUM Founder member universities- Uganda-Makerere University, Kenya - Egerton University, University of Nairobi, Kenyatta University-, Jomo Kenyatta University of Agriculture and Technology, Moi University, Malawi- University of Malawi- Bunda College of Agricultural Sciences- now LUANAR, Zimbabwe-University of Zimbabwe, Africa University, Mozambique- Eduardo Mondlane University-Mozambique

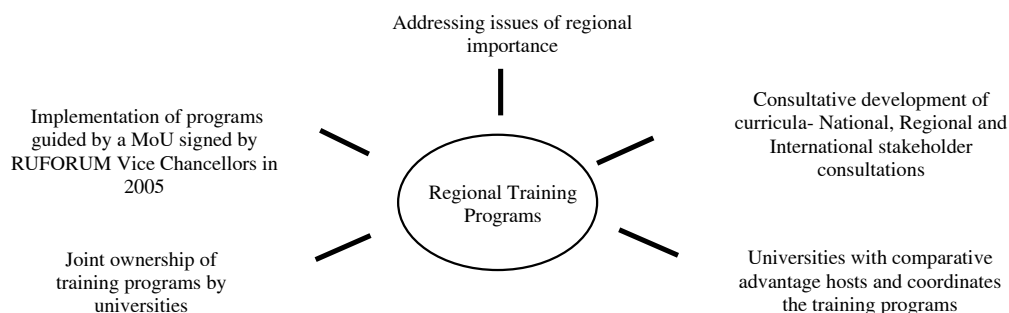


Figure 1. The regional nature and development process of the programmes (Adopted from Ekwamu *et al.*, 2004)

RUFORUM’s strategic planning process in Kenya, Malawi, Mozambique, Uganda and Zimbabwe (Figure 1), along with needs assessment recommended establishment of a shared and common future, where existing capacities are exploited for national and regional solidarity engagements. Accordingly, joint regional higher education programmes were designed following the Centre of leadership model (Figure 2), in which one lead university provided training for others in the region (Okori, 2014). This design allowed for scaling out of jointly developed curricula and for building physical capacity, and renovation of infrastructure at participating institutions.

RUFORUM’s Regional training programmes. A guiding principle for the development of RUFORUM’s regional training programmes was the need to train Africa’s next generation of agricultural scientists needed to undertake and lead agricultural development. Indeed, the continent already had a low scientist-to-development population target ratio, with 91 Full Time Equivalent (FTE) available per million, well below a desirable target of 1 083, the gap being less in northern Africa at 495 FTE, and favourable for the Republic of South Africa (Soete *et al.*, 2015). Indeed, in 2011, SSA employed an estimated 14,300 agricultural researchers with most countries having less than 15 FTEs per 100,000 farming population

(Beintema and Elliott, 2016). Accordingly, RUFORUM efforts, amongst other initiatives in the continent are working to address this issue by strengthening postgraduate training to increase staff recruitment at its research and training institutions in the continent.

Africa’s low scientist-to-development target population, clearly required strategic investments, first to stop and or reduce the severe human resource attrition at that time due to socio- economic reasons and diseases such as HIV/AIDS and; secondly, initiate sustainable programming to rebuild capacity for training in the region for the region. Indeed, rebuilding the Africa’s human resources may require investment levels similar to what China, South-East Asia and the emerging economies of Brazil and Argentina undertook to strengthen innovations systems for agricultural sector expansion and science-led growth of their economies. RUFORUM responded by developing training programmes among its member universities to: (i) Build teaching and research capacity of member universities and the national agricultural research and extension systems; (ii) Enhance development relevance of training and research programmes to deliver science solution for their respective countries and; (iii) Build capacity in strategic science and development “challenges” especially of SSA’s Agri-food systems in line with the continental

and country aspirations as guided especially by the CAADP.

The design process of the new regional graduate programmes considered experiences from countries in and outside of Africa especially, Brazil, where significant science and technological innovation progress has been achieved through tri-partite linkage between universities, research institutions and the private sector. It also considered some of the key challenges faced by Higher Education Institutions (Table 1). Through a consultative process, seven doctorate and five master's programmes, that address challenges of agricultural tertiary education in Eastern and southern Africa, were developed (Njeru, 2014b) (Table 2).

Each programme was designed contextually to respond to demand in the country and region of operation. However, in general, programme designs considered the large science human resource gap in the region, and the fact that isolated cases of expertise existed across the region that could be harnessed to implement quality graduate programmes. Scoping visits and consultations were made with European, South African and USA universities and allied academic and research associations to learn about their institutional arrangements for delivery of quality PhD programmes. A key outcome of this process was the adoption of strong course-based PhD training that involved engagement with leading experts in the training from within and outside of the continent. Since PhD training programmes in African universities were mostly research based (Blackie and Woome, 2005; Nega and Kassaye, 2018), course-based training in targeted courses were integrated in the PhD training to complement knowledge and skills from research. Further, as learnt from benchmark studies in Europe and South Africa, each regional programme adopted benchmarks for research and quality training. For example in the Regional PhD for Plant Breeding and Biotechnology hosted by Makerere University,

the Swedish University Agricultural Sciences and Stellenbosch University and the African Centre for Crop Improvement at University of KwaZulu at Natal in South Africa, were the benchmarks. A regional academic advisory board was established for each programme comprising of lead scientists in and outside of the continent. Additionally, partnerships were established with national, regional and or international research agencies such as the CGIAR centers for student attachment and co- supervision. Initial intakes focused on rebuilding training capacity at member Universities and as such, faculty staff were prioritized for training at partner universities. To take advantage of the experience and expertise at leading member and non-member universities, national and international faculty from different universities were engaged in teaching delivery (Figure 3). The programmes covered several areas of specialization distributed among the 10 member universities and were introduced starting from 2008 (Table 2). The thematic areas for PhD Regional Programmes included Dryland Resource Management; Soil and Water Resource Management; Food Science and Nutrition; Plant Breeding and Biotechnology; Agricultural and Rural Innovation; Agricultural and Resource Economics; and Aquaculture and Fisheries (Njeru, 2014b). Additionally, regional masters programmes were developed and covered the areas of Research Methods; Plant Breeding and Seed Systems; Agrometeorology and Natural Risk Management; and Agricultural Information Communication and Management (Njeru, 2014a). The Masters programmes were developed as a rapid response strategy in areas that were deemed critical for supporting the PhD Programmes or required immediate human resource capital particularly to service the national agricultural research systems. Subsequent reviews led to development of a Masters programme in Monitoring and Evaluation and two PhD programmes, namely, PhD in Agroecology and Food Systems, and PhD in Food Systems and Agribusiness.

Table 2. RUFORUM Regional Masters and Doctoral Training Programmes, Goals and Host Institutions: 2008-2020

Programme	Programme Goal	Year	Host University, Country
PhD Agricultural Rural Innovations	To produce top-level skilled professionals with interdisciplinary orientation to facilitate the development of institutions and structures for sustainable utilization of knowledge and technologies in agricultural and rural development in an integrated way	2012	Makerere University, Uganda
		2013	Sokoine University of Agriculture, Tanzania
		2012	Egerton University, Kenya
PhD Food Science and Nutrition	To build, sustain and strengthen human resources capacity for teaching, learning and practice of food and nutritional sciences for development and scientific progress	2009	Jomo Kenyatta University of Agriculture and Technology, Kenya
PhD Soil and Water Management	To develop and strengthen regional human resources and build institutional capacity in impact- oriented research in soil and water management issues primarily to enhance natural resources use and sustainability	2010	Sokoine University of Agriculture, Tanzania
PhD Aquaculture and Fisheries Science	To develop and build capacity for aquaculture and fisheries sector; equipping students with a deeper understanding of the theoretical framework underlying aquaculture and fisheries sciences and practices, and skills for articulating aquaculture and fisheries issues for public and private sectors as well as strengthening regional collaboration while rationalizing the use of existing resources (human and infrastructure) in the region	2009	Lilongwe University of Agriculture and Natural Resources, Malawi
PhD Agricultural Resource Economics	To meet regional as well as international demand for highly qualified and relevant professionals for planning and policy formulation in Africa	2009	Lilongwe University of Agriculture and Natural Resources, Malawi
PhD Plant Breeding and Biotechnology Programmes	To develop and strengthening the human resource and research capacity for Crop improvement and related development areas in Sub-Saharan Africa	2008	Makerere University, Uganda

PhD Dryland Resource Management Programme	To train a critical mass of doctoral cadre of experts in dryland resource management for the region, which will subsequently be utilized to address land degradation and climate change challenges	2008	University of Nairobi, Kenya
MSc Agrometeorology and Natural Risk Management	To produce a new cohort of professionals able to support agrometeorology services including early-warning systems and responsive capacity for disaster management	2010	Haramaya University, Ethiopia
MSc Monitoring and Evaluation	To strengthen the relevance, efficiency, effectiveness, impact and sustainability of interventions by governments, civil society and non-government organizations as well as development partners through the development and enhancement of capacity for monitoring and evaluation	2012	Uganda Martyrs University, Uganda
MSc Agricultural Information and Communication Management	To train professionals that would support dissemination of research information and knowledge and support agricultural institutions and processes for better communication of the sector's needs, opportunities and challenges	2009 2010 2008	Egerton University, Kenya Haramaya University, Ethiopia University of Nairobi, Kenya
MSc Plant Breeding and Seed Systems	To train a pool of middle career professionals (MSc graduates) able to initiate and manage plant breeding programmes and with a business orientation to ensure that their products (improved seed) reach the market	2009	Makerere University, Uganda University of Zambia, Zambia
MSc Research Methods	To develop a new cadre of professionals who are able to: i) Support scientists in the planning, implementation and reporting of effective research for development; ii) Train scientists in the research methods needed to work in emerging areas	2009	Jomo Kenyatta University of Agriculture and Technology, Kenya

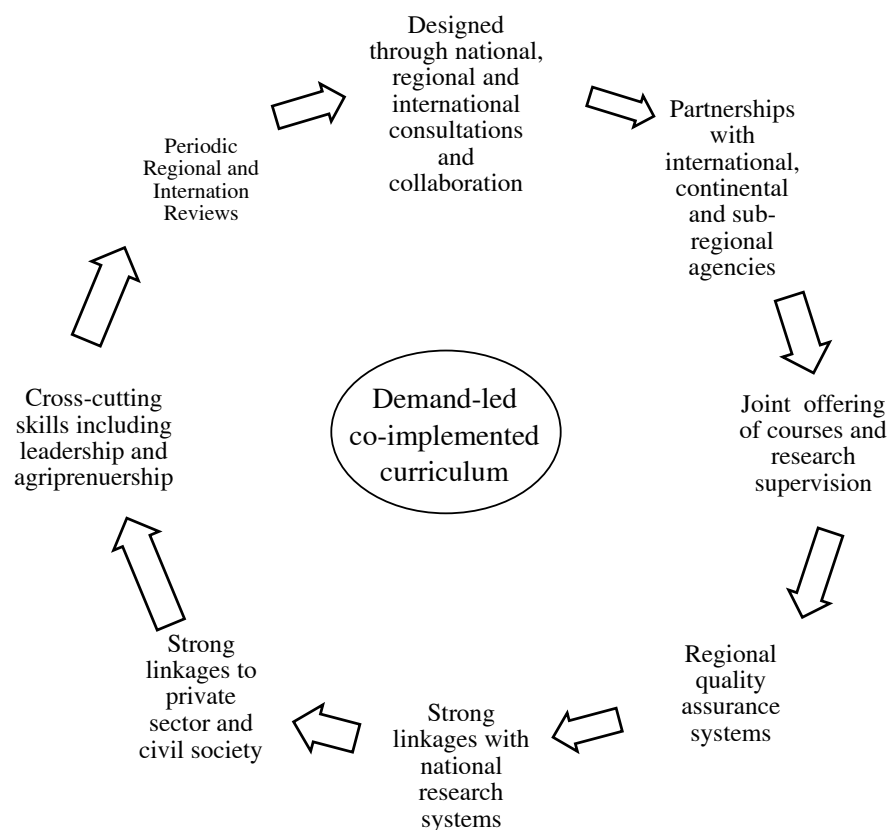


Figure 3. Curriculum development and implementation of RUFORUM regional graduate training programmes

Achievements, impacts and Lessons

The implementation of RUFORUM Regional Training Programmes since their introduction starting from 2008, has benefited the Network and the host universities as highlighted below.

Co-developed and implemented for common development goals. Most of the development challenges faced by the region are common. Thus development of the next generation of leaders trained using a shared curriculum such as implemented by RUFORUM are advantageous in that: (1) Joint curricula development ensures relevance to the broader development challenges of the region, in line with the current wave of economic integration; (2) Student and staff exchange creates regional professional teams, which start to work together, leveraging each other's strengths; (3) Completed and uncompleted research results especially for the PhD thesis, can be ultimately developed into technologies that are relevant to local needs; (4)

Once capacity is built, participating universities may initiate similar or other academic programs; (5) Hosting universities have an opportunity to strengthen their own curricula (Tizikara, 2020). By virtue of hosting the programs, universities have benefited from enhanced infrastructure, networks, income accrued from tuition and enhanced profiles by enrolling students from throughout the continent. Running the programs has resulted into beneficial changes in the host universities such as: the adoption of the wide use of modern and multiple learning approaches and tools; emphasis on practical components in training and attaching students in relevant institutions where mentoring and practical skills are enhanced; intergration of cross-cutting skills make the graduates more markatable; and, the consultative approach to curricula development and review promotes collaboraton and partnerships (Njeru, 2014 a). Over the years, RUFORUM has awarded Institutional Strengthening Grants to develop new graduate programmes and university

Table 3. Transformation of RUFORUM Regional Training Programmes into African Higher Education Centres of Excellence

Name of ACE, Host	ACE Objective	Postgraduate Programmes under the ACE
Makerere Regional Center for Crop Improvement (MaRCCI), Makerere University, Uganda	To provide educationally innovative PhD and MSc programs that produce “fit-for-purpose” graduates with “market-relevant” skills that will drive economic transformation on the African Continent	MSc: Plant Breeding and Seed Systems PhD: Plant Breeding and Biotechnology
Africa Centre of Excellence in Aquaculture and Fisheries Science (AquaFish), LUANAR, Malawi	To foster innovation and entrepreneurship in the production of high skilled fit-for-purpose critical mass of agricultural scientists for improved aquaculture and fisheries management in order to enhance food, nutrition and economic security in Eastern and Southern Africa	MSc: Aquaculture; Agricultural Economics; Food Science and Technology; Agribusiness Management; Rural Development and Extension PhD: Aquaculture and Fisheries Science; Agricultural and Resource Economics
African Centre of Excellence in Sustainable Agriculture and Agribusiness Management, Egerton University, Kenya	To contribute to sustainable agriculture and agribusiness management through capacity development, research, innovation and technology transfer for enhanced food security	MSc: Livestock Production Systems; Animal Nutrition; Soil Science; Dry Land Farming; Horticulture; Agribusiness Management; Agri-Enterprise Development; Food Science; Agricultural Engineering; Agricultural Extension PhD: Soil Science; Agronomy; Animal Science; Plant Biotechnology; Agribusiness Management; Food Science
Africa Center of Excellence for Climate Smart Agriculture and Biodiversity Conservation (ACE Climate SABC), Haramaya University, Ethiopia	To improve the quality of postgraduate education and research in eastern and southern Africa to foster enhanced capacity to adapt and mitigate effects of climate change and weather variability, and ensure biodiversity conservation more effectively in the region	MSc: Climate Smart Agriculture; Biodiversity and Ecosystem Management PhD: Smart Agriculture and Biodiversity Management
African Centre of Excellence in Agro-ecology and Livelihood Systems (ACALISE), Uganda Martyrs University, Uganda	To streamline the production of high level, well-motivated and ethically conscious critical mass of Agro-ecology and Livelihood systems experts	MSc: MSc in Development Economics; Monitoring and Evaluation Agro-ecology; Bio Ethics; Livelihood Systems; Micro-Finance PhD: Management and Entrepreneurship; Agro-ecology and Food Systems

outreach to communities to strengthen universities (Tizikara, 2020).

Further, training has been done by teams of professionals drawn from multiple institutions and the knowledge pool has contributed to the high quality of training. Such networks of specialisation are recommended as a strategy for RUFORUM members to promote complementarity and synergy. The Programmes have facilitated the successful implementation of other Network initiatives such as the Intra ACP and Intra Africa Mobility projects, and the Graduate Teaching Assistantship Programme (Adidja *et al.*, 2019).

The attractiveness of RUFORUM regional programmes has resulted into their introduction and adoption by other universities. For example, the University of Nairobi started a PhD in Agricultural Information and Communication Management (AICM) and Masinde Muliro University in Kenya launched a programme on Research Methods. This is an indication of the potential for further scaling out of the programmes for greater impact. Some of the Regional Training Programmes transformed into African Centres of Excellence with the support of the World Bank under ACE II as shown in Table 3. The transformation of the Regional Training Programmes into ACEs has enhanced regional specialization among participating universities in areas that address specific common regional development challenges (ACE, 2020). The transformation has also expanded the admission base and the training coverage. It has also strengthened capacities of these universities to deliver high quality training and applied research as well as meet the demand for skills required for Africa's development. RUFORUM has remained supportive towards the development of new masters and doctoral programmes, and regional centres, such as African Centre of Excellence in Agro-ecology and Livelihood Systems (ACALISE) hosted at Uganda Martyrs University, Uganda.

Training the next generation of African scientists. The Programmes have remained popular for on-time completion and regional scope that has promoted networking. Figure 2 a and b show the contribution of the Regional Training Programmes to building continental higher-level skills. The programmes have had a wide admission base and have added value to a range of academic backgrounds. Academic staff and students have also realized enhanced networks. The programs have remained relevant and still meet the needs of professionals for discipline depth and fundamental skills needed for upward career mobility, and for expanding career opportunities and enhance performance in current positions.

Because of their regionality, the Programmes have allowed students to be trained in Africa for a fifth of the cost of training one student abroad, while offering opportunities for international exposure. The Programmes have also provided opportunities for mature students to upgrade their qualifications while in-service. One of the strongest pillars of regionally hosted PhD training or their variants, where students conduct thesis research in their home countries is that the research can be carried out in ways that directly benefit surrounding communities and the African agenda. The applied and high quality research conducted by the Programmes has contributed significantly to the body of knowledge and remains relevant to the development of the continent. So far, it has contributed to the generation of over 300 technologies, innovations and management practices across the continent.

Science leaders for African research and training Institutions: Higher education is a vital aspect for building of State infrastructures through the teaching, research and outreach mandates. RUFORUM, through the Strengthening Capacity for Agricultural Research and Development in Africa (SCARDA) project supported strengthening capacity for the then fragile States of Rwanda,

Burundi and Sudan. This was undertaken by enabling research organizations to adopt and engage several tools and methodologies in capacity strengthening including, institutional analysis to identify capacity and resource gaps; gender analysis to identify opportunities for targeted gender support; change management for embedding new approaches and addressing systemic capacity issues; and, introducing additional skills such as proposal writing to help win new proposals. Through the project, 78 students from 15 countries in Eastern, Central, Southern and West Africa were trained in plant breeding, rangeland management and agricultural information and communication management. Several graduates developed and submitted publications in peer reviewed journals and were further provided opportunity to present some of their research findings in international conferences. Other graduates received support for doctoral studies, and this further increased their career opportunities as some of them received promotions to lead agricultural development programmes in the respective institutions. Thus, young graduates trained in the region are retained and deployed to serve

their countries, with about 98% retention in the continent (Tizikara, 2020). Graduates of the Regional Training Programmes are also serving their countries in different capacities, i.e., extension service, international organizations, in universities, private sector, NGOs, CGIAR and NARS, to mention a few. Generally, the programmes are perceived as positively impacting rural livelihoods and the continent's economy. The RUFORUM supported regional MSc and PhD programmes have responded and continue to respond to specific capacity gaps within the realm of agriculture in Africa (see Table 4) and especially in support of the Comprehensive Africa Agricultural Development Programme (CAADP). Of recent, students and staff exchanges have involved North Africa, turning the regional programmes into continental training centres.

Relevance to mitigating emerging global challenges. The ongoing COVID-19 Pandemic and climate change and variability have underscored the importance of multi-lateral approaches to combat such global challenges.

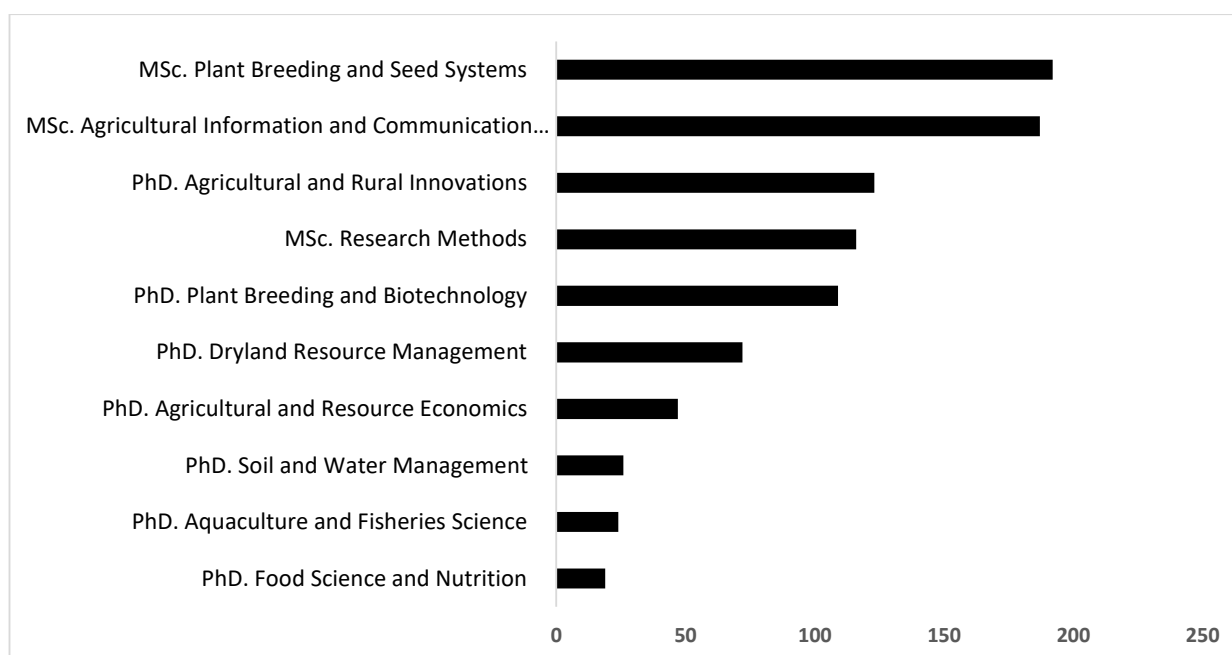


Figure 2a. Number of Masters and Doctoral Graduates from RUFORUM Regional Training Programmes: 2008-2020



Figure 2b. Quality outcomes of RUFORUM graduates from the regional training programmes

Some are fast spreading giving very limited room to wiggle. The COVID-19 first reported in Wuhan, Hubei Province, China in the last quarter of 2019 and declared a pandemic by WHO in March 2020, spread rapidly globally and the World reacted by shutting down economies with disastrous effects. According to the International Monetary Fund (IMF), the global economy is projected to shrink by 3.2% mostly due to COVID 19 lockdown effects. In the case of Africa, the region is expected to experience its first recession in 25 years (IMF, 2020). This will affect various sectors of the economy thus slowing down progress made especially over the last decade. Equally important is the threat posed by climate change and variability, especially the combined effects of drought and excess water. According to the Intergovernmental Panel on Climate Change (IPCC) Working Group, III temperature increase in the region is projected to be higher than the global mean temperature increase; regions in Africa within 15 degrees of the equator are projected to experience an increase in hot nights as well as longer and more frequent heat waves (Shepard, 2019). Climate change will also amplify existing stress to water, negatively affect both terrestrial and ocean ecosystems

which will impact agriculture especially in semi-arid ecologies and fisheries (inland and ocean) and ecotourism, an important emerging sector (Niang *et al.*, 2014). African Universities must invariably be part of the solution to these major threats including other potential ones. In fact, Africa is the source of three major zoonotic diseases with Ebola hemorrhagic fever (Pourrut *et al.*, 2005) being the most recent. Others include Zika virus disease (Anonymous, 2014), and West Nile virus disease (Mackenzie *et al.*, 2004). Additionally, the increasing outbreaks of army works in the Horn of Africa and North Africa, crop diseases outbreaks, and very frequent pandemics of Transboundary animal diseases call for new initiatives to develop response capacities in the continent. Part of this will require rebuilding capacities in foundation or frontline sciences such as Epidemiology, Plant Pathology, Entomology, Virology, Genomics, etc and emerging needs such as molecular diagnostics, among others. A key strategy will be to take advantage of institutions with comparative advantages, and promoting joint regional initiatives as done under the RUFORUM Regional Training programmes.

The African University is pivotal to generating

Table 4. Contribution of RUFORUM's Regional Training Programmes to Africa's science leadership for research and human capacity development

Project Name	Type	MSc	PhD	Staff	Total Mobility
Sharing Capacity to Build Capacity for Quality Graduate Training in Agriculture in African Universities (SHARE)	Intra-ACP	52	17	8	77
Inter-University Cooperation to Train Crop Scientists for Enhancing Agriculture in Africa (CSAA)	Intra-ACP	43	20	10	73
Mobility to Enhance Training of Engineering Graduates in Africa (METEGA)	Intra-ACP	44	20	8	72
Partnering for Health Professional Training in African Universities (P4PHT)	Intra-ACP	43	18	8	69
Collaborative Training in Fisheries and Aquaculture in East, Central and Southern Africa (COTRA)	Intra-ACP	24	12	10	46
Regional Academic Exchange for Enhanced Skills in Fragile Ecosystems Management in Africa (REFORM)	Intra-Africa Mobility	23	11	6	40
Partnership to Train Scientists in Crop Improvement for Food Security in Africa (SCIFSA)	Intra-Africa Mobility	24	12	4	40
Mobility of African Scholars for Transformative Engineering Training (MASTET)	Intra-Africa Mobility	22	12	6	40
Mobility for Innovative Renewable Energy Technologies (MIRET)	Intra-Africa Mobility	33	12	5	50
RUFORUM Graduate Teaching Assistantship programme	RUFORUM	21	119	-	140
		329	253	65	647
Total					

science solutions to mitigate existing and emergent threats. The Universities must also develop contemporary systems of operation including new-normal operations such as ICT underpinned training. The RUFORUM model builds on a proven approach of collective

engagement through multilateralism to address cross-national challenges. This approach still remains relevant and in fact is more than ever before necessary given the multi-country and multi-sectoral nature of today's development threats.

Looking Ahead

While the Regional Training Programmes have trained students from across the continent, they have been hosted mainly in the Southern and Eastern Africa regions of the continent. With RUFORUM's expansion into other regions of the continent, an opportunity exists to sprawl and scale out into West, Central and Northern parts of the Continent while in the process address the needs of universities at different levels of development. This scaling out could now take into consideration Africa's very poor performance in science, technology and innovation (ST&I). This is especially so in terms of ICT readiness, Science, Technology, Engineering and Mathematics (STEM), staff capacity to deploy ST & I to support agriculture, science education, emerging fields, such as data science and genomics, and the need to increase technical skills for the attainment of the aspirations of Agenda 2063. Efforts in these direction must give emphasis on training female scholars and building capacities for fragile States.

Accordingly, RUFORUM's new initiatives: Strengthening Africa's Innovation and Entrepreneurship Capacity (SASTIE); Building Africa's Science, Technology and Innovation Capacity For Economic Growth (BASTIC); Africa Digital Agricultural Programme: Digital Technologies for Agricultural Transformation (AfriDAP); and, the Regional Initiative to Strengthen Staff Capacity and Increase the Pool of Women Scientists in African Universities (RISSCAW) and their various components should inform the next needs assessment and gap identification for developing Regional Training Programmes. The proposed Regional Training Centres embedded in the new initiatives aim to support development of relevant human resources across continent, and foster learning and collaboration within the continent. In addition, using the RUFORUM's fifth initiative - Strengthening Higher Agricultural Education in Africa (SHAEA), the approach could be

used to strengthen linkages between selected African universities and regional agricultural sector/ actors including policy to develop required human and research capacities to spur agricultural transformative in the continent. All these initiatives recognize the need for private sector and other stakeholder involvement in curriculum development, strengthening university-industry linkages especially to turn university research into business opportunities, and subsequent 'fit for purpose' human capital development in a feedback mechanism.

In order for these and other initiatives to take full effect and support the development of the required capacity for Africa's advancement, there is a need to address challenges that still hamper delivery of high quality education and learning experiences in African universities, such as limited funding and human and infrastructural capacity. There is therefore urgent need for increased short and long term funding towards higher education on the continent. At their Conference on Higher Education in Agriculture in Africa (CHEA) held in Kampala, Uganda, 15th – 19th November 2010, the Ministers committed to increased investment in higher education in agriculture in Africa and for higher agricultural education to be included as an integral part of agricultural development investment in the CAADP Country Compacts (investment plans) and Medium Term Agricultural Productivity Programmes. Further Ministries responsible for higher education, education institutions and other relevant actors committed to creating conducive and friendly environments for women and girls education and career advancement at all levels (CHEA, 2010). More recently, during the Ministerial meeting held on 5th December 2019 at RUFORUM Annual General Meeting in Ghana, the Ministers endorsed RUFORUM's five (5) continental initiatives for strengthening Africa's innovation capacity, increasing its competitiveness, enhancing youth employability and entrepreneurship. These, and

other commitments need to be fully actualized by Member States to support higher agriculture education, science, technology and innovation in order to achieve the continental goals and aspirations for Africa's own development as enshrined in Africa Agenda 2063.

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STATEMENT OF NO CONFLICT OF INTEREST

The authors declare that there is no conflict of interest in this publication

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