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Overseas scientific capacity building initiatives in Africa - Are anticipated gains realised and/or sustained?

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Abstract
This paper, through a case study of Zimbabwe's SIRDC, critiques overseas scientific capacity building programmes relative to set goals and advocates for additional policy steps to concretise the noble initiative. Higher degree studies overseas are needed but more should be done for the expert to retain to base and stay for the benefit of African industries and respective economies. The operating ambience in Africa must be improved in terms of state-of-the art equipment in laboratories, resourcing for maintaining professional networks and study tours, remuneration that matches their status within the region and an appreciation of their contribution by industry and society. Execution of multi-country projects may mitigate skills flight as the international flair is maintained to some extent.

Keywords: Economies, resourcing, studies

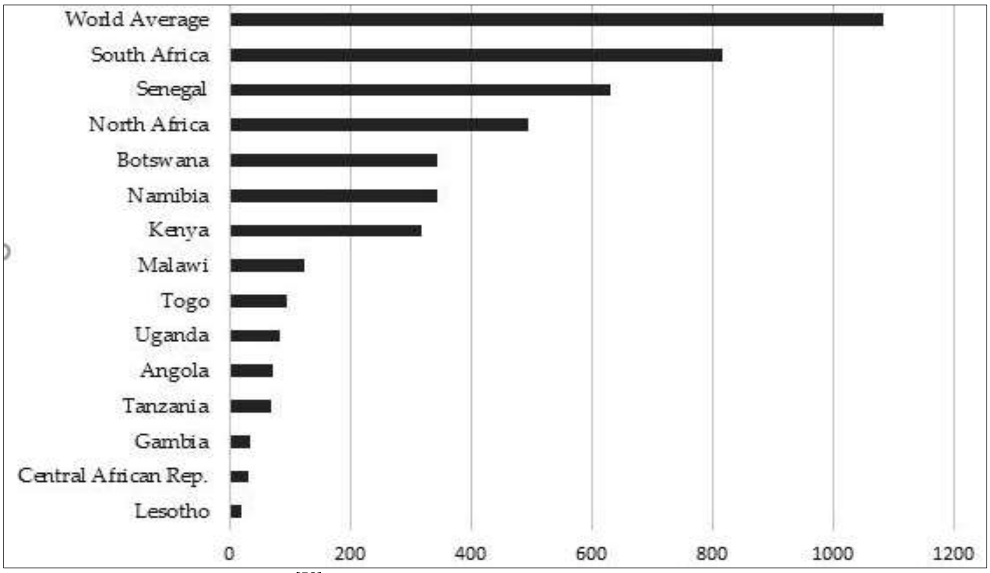
Introduction

Continental Africa has sent own young men and women to overseas centres of excellence (CoEs) to acquire knowledge and skills that are critically needed to move respective economies forward. This element has been deemed key for Africa to fight for global economic space under current circumstances where technology exploitation is the game changer. Such capacity building efforts covered disciplines like medical doctors, pharmacists, veterinarians, engineers, architects, geo-informatics/surveying experts, software developers, mining/metallurgical experts, economics, financial analysts among others. The centrality of the capacity building processes entailed:

- Training to gain knowledge for taking over roles once played by often white experts under the colonial era (Chetsanga, 2021; Simbi, 2020; Mukono, 2021) [6, 69, 50].
- Acquiring relevant skills to manage businesses and Government entities under Black Governance systems, taking over from predominantly white experts, after political independence of the African countries (Munyeza, 2019; Mukono, 2021) [51, 50].
- Acquiring new skills and expertise to enable African economies to compete globally (Mafoti, 2014; Chetsanga, 2021) [33, 6]
- In some cases, survival of experts after displacement by wars, economic downturns and those avoiding political challenges within Africa (Chetsanga, 2021) [6]; (Mukono, 2021) [50]
- Balancing benefits to host countries at the same time preserving scientific capacity for respective home countries (Michael Martin; Florence Chavernoff; Sloka Iyengar; Olga Palinkaser Gregorian, 2021) [38]

The overseas capacity building efforts attempted to mitigate gaps shared by Rafio Agoro (2018) [58] under figure 1.

Rafio Agoro (2018) [58] gives critical skills availability as: 91 researchers/ million inhabitants in Sub Saharan Africa (SSA); 495 researchers/million inhabitants for North Africa and 818 researchers/million inhabitants in the Republic of South Africa (RSA). With 21 researchers/million inhabitants in Lesotho, this was ranked lowest. Though Zimbabwe statistics was not given, it is presumably low, but above the Lesotho ratio. Michiharu Nakamura; Tateo Arimoto; Hirotaka Yamada; Ryuichi Maruyana (2021) [39] called for inclusivity in reshaping capacity in science and technology and urged Governments, industry, education and living systems to think and act together. The young scientists and engineers who are engaged in rapid development of frontier science and technology were expected to be active in key science-policy-society interfaces.



Source: Rafiou Agoro (2018) [58], based on UNESCO 2015 Statistics

Fig 1: Researchers per million inhabitants

Rafiou Agoro (2018) [58] acknowledged that less than 1% of GDP is spent on R&D by majority African countries. The same author also pointed out that the World's lowest private sector investment in R&D is indeed in Africa, worsening resource availability for R&D. Governments allocate far less than 1% on R&D and private sector least invests in R&D in Africa. This double blow is of concern to policy makers and needs redress as a matter of urgency. Driving technology development for economic growth was inadequate and the same followed on the ability to successfully respond to global threats such as climate change and emerging infectious diseases. The ability to fuse science, technology, innovation, governance and diplomacy remain weak in Africa. The global R&D Expenditure was given, Rafio Agoro (2018) [58] as: 1.3% Africa; 32.4% Americas; 42.2% Asia; 22.7% Europe; 1.4% Oceania; situations that require serious policy rethink.

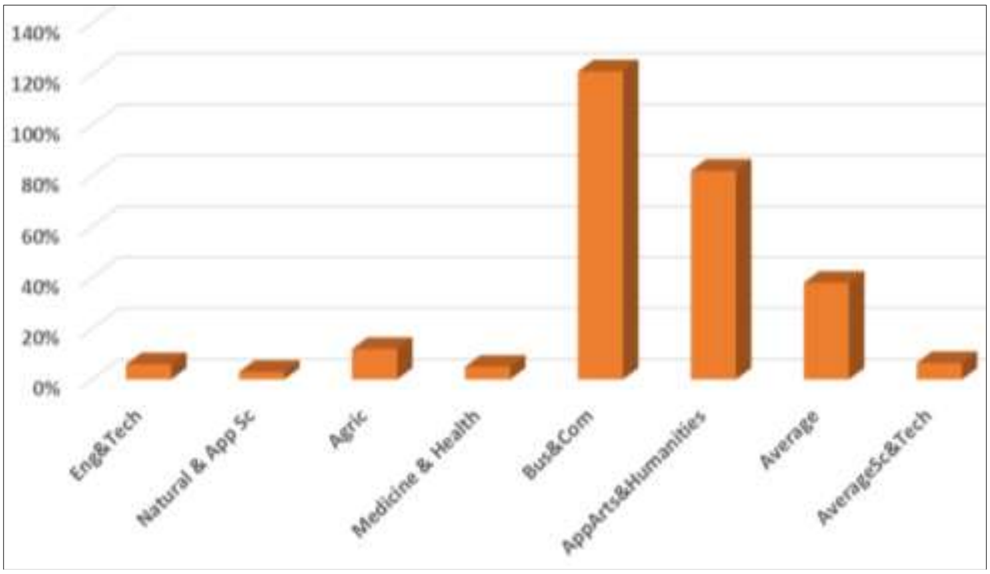
Ministry of Finance, Economic Development and Investment Promotion (November 2023)'s top 15 allocations for the year 2024 are given by table 1. Seven (7) technical ministries are found within this bracket and these broadly cover education, agriculture, health, transport/infrastructure, defence and public works.

Table 1: Top 15 expenditure allocations

Source	ZW$ Million	Weight
Primary and Secondary Education	7, 965, 973.00	13%
Health and Child Care	6,311,893.00	11%
Lands. Agriculture. Fisheries. Water and Rural Development	4, 285, 933.00	7%
Home Affairs and Cultural Heritage	3, 931, 884.00	7%
Defence	3, 637, 636.00	6%
Public Service. Labour and Social Welfare	2, 371, 042.00	4%
Higher & Tertiary Education. Science and Technology Development	2, 355,379.00	4%
Office of the President and Cabinet	2.157,038.63	4%
Finance, Economic Development and Investment Promotion	1,704,707.00	3%
Public Service Commission	1, 428,094.00	2%
Local Government and Public Works	1,220,136.00	2%
Transport and Infrastructural Development	1, 153, 233.00	2%
Justice. Legal and Parliamentary Affairs	1, 078,019.00	2%
Foreign Affairs and International Trade	976,004.05	2%
Parliament of Zimbabwe	475.112.47	I%
Other Allocations	18, 491,597.85	31%
Total	59,543,682.27	100%

Source: Ministry of Finance, Economic Development and Investment Promotion (203)

Zimbabwe's explicit position is given by figure 2 where skills availability is severely limited. Whilst overall availability is averaging 38%, skills availability for science and technology areas (Engineering and Technology; Natural and Applied Sciences; Agriculture; Medicine and Health Sciences) is averaging 6.5%. Overseas training of experts in Zimbabwe seemed logical.



Source: Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development Year 2018 Skills Audit

Fig 2: Skills Availability: Zimbabwe (2018)

Enter Scientific and Industrial Research and Development Centre (SIRDC):
Since inception in the 1990s, the Scientific and Industrial Research and Development Centre (SIRDC) of Zimbabwe had related programmes where young university graduates were financed to pursue overseas higher degree studies in specified technical disciplines pinning hopes on their return upon completion to serve at the Centre. Armed with Masters Degrees or Doctorates they were anticipated to play researcher roles across varying SIRDC institutes in energy, environment, production engineering, informatics, biotechnology, building technology among others. Even those already with such higher qualifications they were required to go through overseas short-term capacity building through twin arrangements with experienced overseas research centres.
Table 2 profiles some of the initiatives under SIRDC and anticipated results.

Table 2: SIRDC Overseas capacity building initiatives (1999-current)

Overseas scientific capacity building initiative	Brief Scope of training coverage	Number, Areas covered	Output, Outcome	Sustainability score 1=lowest; 5=highest
CIMMYT Mexico Maize Breeding using Molecular Markers Assisted Selection-MMAS (1999-2002)	Two (2) technicians Two (2) molecular biologists One (1) breeder Trained for periods ranging from six (6) months to two (2) years	On-the-job training (OJT) training in agricultural research management Molecular Marker Assisted Selection (MMAS) in breeding DNA finger printing	Five (5) experts 43 improved drought tolerant lines Six (6) insect resistant lines New technologies, Skills, acquired Crosses of lines led commercialised hybrids	Three (3)
SINTEF Norway (1999-2001)	On-the-job (OJT) training covering: Three (3) Core team members (2 engineers, 1 economist) One (1) Project Secretary 30 Scientists (Engineering, Food, Metallurgy, ICT, Business) 15 Artisans & Technicians Three (3) University Lecturers 30 university students (engineering food science, metallurgy) 14 manufacturing SMEs (foundry, food, horticulture processing, furniture production, manufacturer of transformers and electrical switch gear parts)	Project Management Quality Systems Development Production, Process Management Foundry Technology Business Strategy Effective Research Centre-University-Industry collaboration	Trained experts, who should train others Systems for managing research Effective teams Collaborations/ Partnerships that last longer Publications	Two (2)
Danish Technology Institute (DTI) 1999-2002	OJT training and mentorship in cleaner production technologies (CPT) for over 15 engineers and scientists	Cleaner production interventions in 21 cases Modelling impact Dissemination Conference participation	Trained experts Viability gains demonstrated	Two (2)
Rural Development	Over 10 Executives networked	Scientific exchange	Trained and networked	Five (5)

Administration (RDA) South Korea (year 2010 onwards)	Over 20 scientists trained and networked (Agri-biotechnology, Engineering, Extension Networks across 22 African countries plus South Korea Several scientific and technology conferences within Africa and in South Korea One-year OJT for 1 economist	and capacity building in various disciplines of Agriculture Technology and germplasm transfer Capacity in development starting from lower/ village level Economic transformation through exploitation of technology	experts Exploitation of technologies for community development Exposure to international best practices Inspiration to develop through technology Better systems to manage research	
PTB Germany 2002 (various years) to date	Capacity building of scientists and technicians in various metrology disciplines (over 20) Equipping Laboratories Development, maintenance of laboratory quality management system (1SO17025)	Competence building Inter-laboratory proficiency testing Exchange conferences Networking in metrology	Over 15 trained experts Maintained regional presence Some now serving in senior positions within the SADC region Trade enabled for Zimbabwe	Four (4)
Bio-fuels (renewable energy) from selected sweet sorghum varieties using funding from Common Fund for Commodities (CFC)	Cowley and Keller sweet sorghum varieties were propagated and lab analysed Partners: SIRDC, King's College (London), Triangle Pvt Ltd, BUN, AGRITEX Chiredzi community Two (2) scientists; 1 extension officer; Two (2) technicians	Capacity building, Research-industry collaboration New product/ process development Technology transfer	Bio-fuels and sucrose yields were comparable Separation of green leaves (unlike can which dries and is burnt) was a challenge Small scale juice extraction plants were still under consideration	One (1)
All six (6) projects	122 experts	24 areas	70 output categories	Average: 3

Source: SIRDC Project Archives, Technology Monitor Magazine (Various editions) and Annual Reports (various years)

Theoretical Intentions

The ideas behind overseas staff development fellowships (SDFs) and twining arrangements with already established centres of excellence in such countries as UK, USA, Norway, Denmark, Finland, Sweden, Germany, Japan, South Korea and RSA were:

- Building capacity for SIRDC and Zimbabwe so that we leapfrog in development through the exploitation of latest technologies
- Assumed trained experts will be patriotic and serve their organisations and country of origin, Zimbabwe
- System building for better service delivery under SIRDC
- Hoped for ultimate financial independence through sustained income generation
- OJT had strong practical emphasis, capacity building was brought closer to reality
- Exposure to international best practice cases
- Hoped networks to remain active and remind trained experts to do good for their country

Table 3 gives theories that would have helped in keeping overseas capacity initiatives on track for SIRDC and Zimbabwe.

Table 3: Linking the selected Theories with technology-based development.

Theory	Key Elements	Implications for Zimbabwean Development
Stage-Gate	Market first before R&D Novelty and Prior art (literature, patents review) Teamwork and Excellent communication Excellent compensation for employees	These factors should have been part of the design, particularly retention upon completion of studies
Triple Helix	Functions, Level of interactions Enabling role Existence of shared interest for development	SIRDC, Government of Zimbabwe and industry should have acted together in resourcing and welcoming back the experts
Diffusion	Infrastructure and manpower for innovations Technology transfer Income and benefits flow	Retention and equipping laboratories should have been prioritised
Systems	Holistic view and management Extent and importance of feedback Interface options	A holistic was needed for the whole initiative
Business Ecosystems	Interconnectedness Extent of innovations and transfer from R to I or within R/I Level of productivity gains and Sustainability signals	Interconnectedness and sustainability dimensions should have been taken into account
3i-Framework	Interests, Ideas and Institutional norms balanced	Balancing ideas, interests and institutional goals was not done
"Trinity" Analytical Framework	Institute, Incubators, Industrial base linked effectively	This dimension was not given space
Policy mix for	Direct funding support and synergy with technology	Funding was partial (for studies); should have extended

commercialising university technologies	transfer demos, science parks Importance of high innovation capacity How the three key stakeholders (scientists, TTOs and private investors) relate	to retention, equipping and post-graduation networks

Source: Adapted from Kwaramba (2022) [31]

Whilst the overseas capacity building initiatives (table 2) were in line with theoretical expectations (table 3); the positive aspirations and/or goals were not sustained. The models need a review to add a skills retention element. This could be added to project designs or African Treasuries need to take over the retention. This becomes crucial for African economies to benefit from the new skills. Otherwise, better economies in Africa or outside the continent benefit freely, without having spent on training. They just harvest where they did not sow.

Positive Reality

On a positive note, there were outputs and outcomes that moved from research organisations into industry under varying scales of operations. These are summarised below:

- Drought tolerant maize lines were further crossed leading to at least six (6) hybrid maize varieties, now on the market. R&D output was commercialised with positive impact on the seed industry, farmers and income generation efforts for a research centre.
- Capacity was built for over 122 experts in more than 24 technical areas for moving R&D output into industry, through practical cases
- Over 70 novel products and/or processes were developed for SIRDC and Zimbabwe to exploit commercially. Examples were drought tolerant and insect resistant maize lines. Processes entailed optimised foundry (cupola technology) processes including skilled reject analysis in foundries. Enhanced production management including statistical process skills were also transferred. ISO 9000:2002 registration was also set-up up to 80%.
- Thematic industrial research teams built were built embracing SIRDC, UZ, industry and SMEs and these covered: Production Management/Process Improvement; Foundry Technology and Quality Systems Development
- An In-house School was initiated for capacity building to new employees on essential dimensions such as Project Management; Quality Systems Development; Costing and development of Bankable Business Plans.
- Cleaner Production Technologies (CPT) and utilisation of GIS were introduced to SIRDC and the Zimbabwe industry
- Networks were created for Zimbabwe's SIRDC to partner Danish Technology Institute (DTI) of Denmark); Foundation for Scientific and Industrial Research (SINTEF) of Norway; Germany National Metrology (PTB) and Fraunhofer of Germany and the Rural Development Administration (RDA) of South Korea. This afforded Zimbabwe to access the latest technology, ideas and systems for possible inclusion in local development initiatives
- Laboratories were equipped to varying extent
- Gains of scientific intervention were demonstrated at industry and community levels; development was extended beyond theory to actual practice
- Models of development such Saemul Udong (South Korea) and commercialisation of research from Norway were adapted for Zimbabwe

Negative Reality

- When donor funding stopped, there was no local continuity and the gains at both institutions and industry levels drastically went down
- Skills flight followed as trained experts went for greener pastures away from Zimbabwe. The trained engineers found lucrative jobs in RSA where there were preparations for the 2010 Soccer World Cup
- Donor programmes did not include commercialisation of developed products and many initiatives were left at prototype stage
- There was limited continuity as subsequent leadership had own approaches to running R&D projects and programmes
- The concepts were arguably accepted by participating scientist and engineers (for Norwegian SINTEF) but the rest appeared not to. There were perceptions that only a few benefitted. As soon as they were concluded, equipment was taken away from the trained experts and triggering resignations from positions of employment.

Critical skills gap has remained within Zimbabwe despite donor efforts and Government policy shift towards Education 5.0 which added innovation and industrialisation dimensions. Despite literacy rate above 90%, development through utilisation of high technology and the harnessing of emerging innovations has remained a pie in the sky. Training and attraction of skills are important but retention and subsequent utilisation of skills needs more policy attention.

Policy improvements

- Authorities need a serious re-look and focus attention on the retention of trained experts. This assumes two dimensions: incentives and access to tools of trade (Equipped laboratories) so that they practice what they were trained it.
- Real Research-Industry Synergy needs attention. Joint funding packages, retention of skills and dissemination of realised benefits are important. This leads to local best practices which can be expanded for wider demonstration of fruits emanating from exploitation of research results.
- Pursuit of Regional Projects, multi-country initiatives that will be immunised from shifts to donor policies. When such projects are executed funding can be disbursed from a "favourable country" to the rest of participants whilst guaranteeing continuity in participation. The output can also be disseminated beyond borders.

Conclusion

Enhanced Research-Industry Synergy, skills retention schemes, equipping laboratories and continuity guarantee through multi-country execution are elements that need addition to the overseas higher degree/special skill training. Government, within means, should promote continuous North-South networks for the smooth flow of good ideas. The path to harnessing skills, technology leading to research output that feeds into industry must be clear and funded. The processes needed timely management so that obstacles are addressed before skills fly away.

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