



## **Role of higher education and science, technology and innovation in capacity development in Ghana**

L. K. SAM-AMOA, K. AGYEI FRIMPONG and F. KUMI  
School of Agriculture, University of Cape Coast, Cape Coast, Ghana

**Corresponding author:** lk-samamoah@yahoo.com

### **ABSTRACT**

Ghana has shown keen interest in promoting Science, Technology and Innovation (STI), and Higher Education (HE). However, the STI and HE systems do not seem to be adequately focused on Ghana's socio-economic needs. Furthermore, existing STI and HE policies and programmes do not appear to be motivating enough to drive investments and technological upgrading. Consequently, many of the country's important STI institutions are unable to effectively carry out their mandates. The study was undertaken to examine the role of STI and HE policies in capacity development in Ghana. The desk study showed that there has been a lot of investment in setting up STI and HE institutions which have yielded some positive outcomes especially in the country's recent research output. Progress on Ghana's capacity for STI looks encouraging, given that Ghana's overall Africa Capacity Index is Medium primarily because of a narrow financing base. The country also currently has a comprehensive STI policy draft to work with up to 2024. However, there is the need for Ghana to put in place workable monitoring and evaluation strategies on STI and HE policies and programmes. This will enhance the impact of STI and HE on the economy of the country.

Keywords: Education, Ghana, innovation, science, technology

### **RÉSUMÉ**

Le Ghana a montré un vif intérêt pour la promotion de la science, de la technologie et de l'innovation (STI) et de l'enseignement supérieur (ES). Cependant, les systèmes STI et ES ne semblent pas suffisamment focalisés sur les besoins socio-économiques du Ghana. En outre, les politiques et programmes existants en matière de STI et d'ES ne semblent pas suffisamment motivants pour stimuler les investissements et la modernisation technologique. C'est pourquoi de nombreuses institutions importantes du pays dans le domaine des STI ne sont pas en mesure de s'acquitter efficacement de leur mandat. L'étude a été entreprise pour examiner le rôle des politiques de STI et d'enseignement supérieur dans le développement des capacités au Ghana. L'étude théorique a montré que de nombreux investissements dans la création d'institutions de STI et d'ES ont donné des résultats positifs, en particulier dans les résultats de recherche récents dans le pays. Les progrès concernant la capacité du Ghana en matière de STI sont encourageants, étant donné que l'indice de capacité de développement du Ghana par rapport aux autres pays africain est moyen, principalement en raison de la base de financement étroite. Le pays dispose actuellement d'un projet de politique

complet sur les STI opérationnel jusqu'en 2024. Cependant, le Ghana doit mettre en place des stratégies de suivi et évaluation applicables aux politiques et programmes de promotion des STI et ES. Cela renforcera l'impact de la STI et de l'ES sur l'économie du pays.

Mots clés: Education, Ghana, Innovation science, technologie

## **INTRODUCTION**

**Role of Higher education (HE) and Science, Technology and Innovation (STI) in capacity development.** In many African countries, basic education is seen as a right and most children have access to it. However, Higher Education (HE) especially in Science, Technology and Innovation (STI) is more crucial for the development of African nations (Addo, 2010; Brito, 2014). Similarly, higher education in Africa has been identified and recognised as a significant tool in facilitating Africa's development process (NEPAD, 2005). Higher education is any form of formal training given by Universities, Colleges and other institutions established and approved by competent authorities and for which the basic entry requirement is the completion of secondary education (UNESCO, 1998). On completion of HE, students acquire honour certificates, diplomas or degrees. The role of higher education towards sustainability of Africa's social, political and economic development is not contestable (Jowi *et al.*, 2016). Countries which have expanded higher education systems with higher levels of investment in research and development (R & D) activities have higher potential to grow faster in the globalised knowledge economy (Varghese, 2013).

African countries are probably taking inspiration from China and Brazil which have given priority to and have established a strong link between HE and STI. They are typical models for consideration by policy makers. Current trends show rapid establishment of Universities and colleges in Africa with several of them offering programmes in engineering, technologies and the sciences. This trend is indicative of enhanced

wealth creation and improvement in the competitiveness of such nations and stimulates their attainment of the sustainable development goals of the United Nations (UNESCO, 2018).

**Historical background of Higher Education and STI in Ghana.** In 1995, a coordinated programme of economic and social development policies, dubbed Ghana - Vision 2020 was designed, which emphasized the need to promote a Science and Technology (S&T) culture at all levels of society and in all types of production to accelerate economic growth and improve the quality of life of the population. The potential for Science and Technology (S&T) to promote economic growth and poverty reduction was given prominence again in Ghana's Growth and Poverty Reduction Strategy (GPRS II - 2006-2009) (GoG, 2005). The policy document identified S&T as a key strategic support sector that needed to be developed to catalyse productivity in agriculture and agro-industry. Information and Communication Technology (ICT) was prioritized as an important sector to be developed to support economic growth.

In 2007, the National Development Planning Commission (NDPC) included STI development agenda in the long-term policy development framework for the country. Subsequently, in 2009, the Ministry of Environment, Science and Technology (MEST) initiated a process to prepare a Science, Technology and Innovation (STI) policy for Ghana. This process led to the development of an STI Policy in February 2010. A review by UNCTAD and other organisations in 2011 showed that most of the expected results from planned initiatives of the 2010 National STI Strategy were not achieved. To leverage on

the foundation laid by previous government policies and to accelerate the mainstreaming of STI in all sectors and interventions across the country, the Government of Ghana has developed a new STI Strategy (currently in draft). In addition, the Government is in the process of developing a new National Development Policy (NDP) that takes into consideration the social and economic context and the imperatives of Ghana's development over the period from 2017 to 2020. The new policy aims to enable the country to harness the development potential that STI offers in a constructive and structured manner. This NDP adequately highlights the role of STI and HE in national development and also points out that improvements in STI and HE are likely to promote better healthcare for the people, more innovative and productive businesses, the modernization of farming and agribusiness, and an enhanced human capital to address the challenges of climate change.

#### **HE and STI Policy landscape in Ghana.**

Science, Technology and Innovation (STE) and Higher Education (HE) are critical drivers of rapid economic growth and development in every country. Since Ghana attained independence in 1957, conscientious effort and investments have been made to place STI and HE at the centre of the country's development agenda. All past governments of Ghana attempted to mainstream STI into their national development policies to drive socio-economic development of the country. However, the effort to use STI as a catalyst for the country's growth and development has not yielded the expected benefits regardless of the huge investment made in STIs over the years. Consequently, the desired economic transformation and growth has not been realised. Inadequate political commitment and financial support for effective planning and implementation of strategies have been identified as the main causal factors of the unsuccessful attempts to use STI and

HE as drivers of Ghana's socio-economic development agenda.

#### **Capacity development priorities for HE and STI.**

The major capacity imperatives for effective STI and HE in Ghana's context include the need for the Ghanaian Government to create institutional arrangements that promote STI and HE in accordance with the Sustainable Development Goals to solve capacity-related problems. Another major priority for STI and HE capacity development is the urgent need to build capacity among researchers, industry, communities, and individuals to tap into new and emerging opportunities in STI and HE. The 2017 ACR report indicates that Africa's quality of tertiary education is a major concern with only five of the world's top 500 universities in the continent, against six in Brazil and 32 in China. The report further stressed that the ranking of universities is of utmost importance as an indicator of university outputs, including numbers of papers published in top journals, of awards and recognitions received by universities, staff, and alumni, and of citations of published papers.

Furthermore, there must be strategic investments and capacity development in Science, Technology, Engineering and Mathematics (STEM), and in innovation systems to catalyze innovation, promote competitiveness, and nurture the next generation of innovators, entrepreneurs, and scientists. The 2017 ACR report noted that investment in science capabilities of countries, and development of STI institutional capacity are crucial to the application of STI in Africa, and are central to the provision and management of HE. Investments in STI and HE are fundamental to sound policy making, good governance, and economic transformation.

STI policies and their implementation must be inclusive and gender-sensitive to

deal with the low participation of women in STI and HE. In order to attract women and girls to STI and HE gender should be mainstreamed in STI policy and programs; fellowships, scholarships, and award systems; career guidance and mentoring in institutions of higher learning; adaptation of curricula; and continuous sensitization and lobbying of policymakers and legislators (ECA, 2011). Reducing the gender gap through the promotion of women's participation in STI development, and encouraging girls to pursue science and engineering programmes, have the potential to make African societies more vibrant and its institutions more resilient and responsive. Finally, it is imperative that the Government provides a conducive environment that propels creativity, innovation, and inventiveness and guides the acquisition and commercialization of R&D for sustainable growth and development. That way most of the nation's youth will be attracted to embrace STI and HE. Finally, Ghana should promote international collaborative bilateral and multilateral partnerships based on STI and HE best practices.

#### **Vision, Goal and Objectives of the STI and HE capacity policy**

**Vision.** The STI Policy should envision a Ghanaian economy transformed to world class standard with STI and HE as the key drivers. The policy should aim at building a strong STI capacity to drive the social and economic development for the sustainable transformation of the economy. The policy must target a country transformation from the current low science- and technology-poor practices in line with the global consensus on STI to knowledge-based society functioning within an economy based on high levels of productivity in all the sectors of the economy including agriculture, industry and services.

**Goal.** Given the historical background of Ghana's efforts in STI application and HE development, the STI and HE policy must be

properly contextualized, aligned with national development goals and fully integrated into a national development strategy to fully harness the nation's total science and technology capacity. That way, the national objectives for wealth creation, poverty reduction, enterprise competitiveness, sustainable environmental management and industrial growth will be achieved.

#### **Objectives**

##### **The STI and HE Policy should aim to:**

- Facilitate mastering of scientific and technological capabilities by a critical mass of the products of all institutions;
- Provide the framework for inter-institutional efforts in developing STI and programmes in all sectors of the economy to provide the basic needs of the society; create the conditions for the improvement of scientific and technological infrastructure for research and development and innovation;
- Ensure that STI supports Ghana's trade and export drive for greater competitiveness; and promote a science and technology culture in the society.

#### **Rationale and objectives of the study**

Science, Technology and Innovation (STI) and Higher Education (HE) have long been considered critical for the growth and development of Ghana. There is substantial evidence that STI and HE are instrumental to creating sustained economic growth and improving standards of living in Ghana. STI and HE are central to economic development, trade competitiveness, and social progress. Improvements in STI and HE are likely to promote better healthcare for the people, more innovative and productive businesses, the modernization of farming and agribusiness, and an enhanced human capital to address the challenges of climate change. Although HE and STI are universally recognized as critical drivers of economic development, a major challenge is how to identify the right matrix of factors

and policy initiatives that positively impact socio-economic development. In order to harness the potential that STI and HE offer for economic growth, Ghana Government needs to design comprehensive STI and HE policies, and support their deployment with adequate budgetary allocation, practical implementation strategies and monitoring and evaluation mechanisms.

In Ghana, many of the building blocks required to support STI and HE policy development including reputable universities, research institutes, and a growing private sector are already in place. However, the STI and HE systems do not seem to be effectively coordinated and adequately focused on Ghana's socio-economic needs. Furthermore, existing STI and HE policy and programmes intended to attract the private sector support do not appear to be motivating enough to drive investments and technological upgrading. Consequently, many of the country's important STI institutions are unable to effectively carry out their mandates. It was in recognition of the critical roles that HE and STI play in Ghana's economic development that the study was done to examine the role of STI and HE policies in capacity development in Ghana. Specifically, the objectives of the study were as follows:

- Conduct an overall assessment of Ghana's HE and STI policies and their integration into National Development Plans (NDP)
- Discuss the capacity development priorities for HE and STI
- Assess the role, status and key challenges of HE and STI environment in capacity development
- Identify and discuss related and complementary policies to HE and STI policies in Ghana
- Discuss policy monitoring aspects of STI and HE policies
- Present case studies of HE and STI

contribution to capacity development in Ghana

## RESEARCH METHODOLOGY

The study focused on the role of Higher Education and Science, Technology and Innovation in capacity development in Ghana. The study was done mainly as a desk study involving literature review and document analysis. The desk research helped in the retrieval of information on STI and HE policies of previous and present governments as well as other international documentation regarding Ghana's STI and HE policies among others. The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) provided copies of some documents and others available online were retrieved. The documents provided by RUFORUM included ACBF 2017 Report and UNESCO Science Report 2018. Furthermore, RUFORUM provided a template of specific issues to be addressed to serve as the main guiding tool for literature search for information that addressed questions posed therein. Data obtained during the study was analysed by descriptive statistics using Microsoft Excel.

## RESULTS AND DISCUSSION

**Assessment of Ghana's STI policies and their integration into national development plans.** The assessment of Ghana's STI capacity is summarized in Table 1. Overall, Ghana's HE and STI-driven capacity development profile is not very good (Table 1). The ACBF 2017 report indicated that Ghana ranked 94 out of 100, and 108 out of 141 countries in the 2013 and 2015 global innovation index rankings, respectively.

Establishing and maintaining a vibrant national research system can be a complex and costly undertaking for any country, but developing countries can encounter even more complex financial and structural constraints. The Gross

Expenditure on Research and Development (GERD) is one of the key indicators of how much money a country dedicates to research and development activity as a percentage of its GDP. The Frascati Manual (OECD, 2002) suggests that the appropriate expenditure data for computing GERD can be collected for four sectors: the business sector, government sector, higher education sector, and private non-profit organizations. African Union adopted a resolution that commits each African country to spend a targeted 1 per cent of its GDP on Research and Development. The 2015 UNESCO Science Report shows that Ghana spent 0.38% of its GDP on Research and Development in 2010. To put this into perspective, this gross expenditure on R&D is less than half of the overall African target of 1 per cent of the GDP. In comparison, Malawi spent 1.06% of its GDP while Nigeria spent 0.22% of its GDP (2007).

**Does Ghana have an STI Policy?** Ghana currently has an STI strategy document which was developed out of the result and lessons from

previous STI initiatives as well as a review by a cross section of the science and technology community including scientists and policy makers. Unlike previous documents, the concept of innovation is an integral part of the new framework of actions, policies and programmes to apply science and technology towards social and economic objectives. The policy which covers the period 2017 to 2020 seeks to harness Science, Technology and Innovation (STI) to address the country's development challenges. The National Science, Technology and Innovation policy has also been formulated to enable a constructive and structured implementation taking into account the social and economic context and the imperatives of Ghana's development.

**Justification for the STI Policy.** The priority themes underpinning Ghana's National Science, Technology and Innovation Policy drive the justification for the STI Policy. These are:

- Promoting competitiveness in the productive sectors of the economy

**Table 1. Ghana's Science, Technology and Innovation and Higher Education capacity profile**

| Indicator  | Year                      | data       | Source of Information      |
|--|---------------------------|------------|----------------------------|
| <b>Ranking : Global Innovation Index (GII)</b>   | 2013 ranking (out of 100) | 94         | ACBF report 2017, Annex 1  |
|  | 2015 ranking (out of 141) | 108        | ACBF report 2017, Annex 1  |
|  | 2017 ranking (out of 127) | Not ranked | GII Rankings 2017          |
| <b>Network Readiness Index Ranking</b>   | 2014 ranking (out of 143) | 96         | ACBF report 2017, Annex 2  |
|  | 2016 ranking (out of 139) | 102        |                            |
| <b>Gross expenditure on research and development in Africa as a percentage of GDP and per capita</b> | % of GDP                  | 0.38       | UNESCO Science Report 2015 |
|  | Per capita                | 11.3       |                            |
|  | Year                      | 2010       |                            |
| <b>GERD contribution</b>   | Business                  | 0.1        | UNESCO Science Report 2015 |
|  | Government                | 68.3       |                            |
|  | Higher Education          | 0.3        |                            |
|  | Private non-profit        | 0.1        |                            |
|  | Abroad                    | 31.2       |                            |

- Creating job opportunities and employment
- Expanding industrialization
- Enhancing the quality of life through innovation
- Developing world class scientific and technological human capital
- Expanding infrastructure for research and development
- Promoting an Information society
- Optimizing the sustainable use of environmental and natural resources
- Commercializing the research findings

Source: National Science, Technology and Innovation Policy (2017-2020) (In draft)

**Does Ghana have a Higher Education Policy?** Although Ghana currently does not have a comprehensive higher education policy document that guides, coordinates and harmonizes higher education, there are numerous Science and Technology - oriented education policies including the National Science and Technology policy which seeks to revitalize laboratories and workshops and increase investment in science and technology. Furthermore, the Education Strategic Plan I 2010-2020 targeted the mainstreaming of mathematics, science and technical education at all levels, as well as the extension and the diversification of post-graduate programmes, especially in the applied sciences. The Education Strategic Plan I 2010-2020 policy further outlined strategies regarding the promotion of ICT in education, by providing relevant opportunities for ICT skills development, and ensuring that science and computing students have access to relevant up-to-date teaching/ learning materials.

In a bid to achieving the goals of ICT in education policy objectives, a 3-phase strategy is to be used. Phase I aims to enhance a system-wide and institutional readiness to use ICT for teaching, learning and administration

(teachers' capacity building in ICT). Phase II is targeted to ensure a system-wide effective integration of ICT into teaching and learning. Phase III intends to integrate ICT at all levels of the education system, namely, management, teaching, learning and administration. The Government has also underlined the need to promote "collaboration between local and international educational institutions to facilitate educational exchange and the promotion of ICT education and training" (ICT4AD, 2003, p.39). The Education Strategic Plan II 2010-2020 has the objective of strengthening linkages between tertiary education and industry. Different strategies are identified, namely: the integration of "entrepreneurial training and career counselling." Ghana, as of 2017 has ten (10) public universities, and Seventy (74) private universities. In addition, there are eight technical universities, two polytechnics, over 500 senior high schools, 23 technical institutes, and a large informal sector where most artisanal skills training take place. Ghana can therefore be said to have a substantial education and training capacity for human resource development in STI.

Ghana's STI and HE policies are expected to drive the development of the country, given the pivotal role both STI and HE can and must play in: Promoting increased productivity; stimulating economic growth and reducing poverty in Ghana; leveraging opportunities associated with STI and HE to transform the economy; avoiding marginalization from the global economy, and ensuring global competitiveness of Ghana. The Government of Ghana launched the National Science and Innovation Policy (2010) as a key policy document to drive research and innovation programmes in the country. The relevance of STI is amply highlighted in previous policy documents including Ghana Poverty Reduction Strategy (GPRS II, 2006-2009)

and the Ghana Vision 2020. The Ghana Shared Growth and Development Agenda 2014–2017 contextualizes the sector-specific policies for HE defined by the National Science, Technology and Innovation Policy (2010) and the National Development Plan (2015-2020). The long-term goal of the policy is to create a STI culture oriented towards meeting Ghana's development-related challenges.

Ghana's STI policy is intended to use HE institutions to build a strong STI capacity to support the social and economic development needs as the country has attained a middle-income status. According to the national STI Policy, "Ghana intends to migrate from the low science and technology-poor practices and worldview associated with tradition-bound society to an STI and knowledge-based society with an economy based on high levels of production, processing, industrialization and manufacturing". Ghana's STI policy seeks for the country a future whose STI capability would enable it to produce and process maximally the natural resources that she is blessed with and also has the knowledge base to participate actively in the production of higher technology goods and services for local consumption and for export".

The draft STI policy is intended to be contextualized and fully integrated into a national development strategy which promotes the development of HE to fully harness the nation's total science, technology and innovation capacity. This will enable the country to achieve her objectives of wealth creation, poverty reduction, and competitiveness of enterprises, sustainable environmental management and industrial growth. In the short term (considered as the first five years in the national STI Policy), the STI policy objective is to restructure the entire science and technology machinery, infrastructure and programmes so as to make them more responsive to national needs and

priorities in all sectors of the economy including the HE system. To that end, emphasis is to be placed on:

- restructuring the National Science and Technology Advisory system;
- improving basic and applied research infrastructure;
- revitalizing the teaching of science and mathematics at the basic, secondary and tertiary levels of the education system;
- promoting the training of a critical mass of middle-level technical personnel;
- acquisition of skills in high technology areas such as ICT, biotechnology and nanotechnology and their integration into known technologies; and
- promoting mastery of known technologies and their application in industry.

**Actualizing Ghana's STI and HE capacity policy.** The key strategies to actualize Ghana's STI and HE Capacity development policies are summarized below:

- Improving science education at all levels and in all aspects of the educational system, especially at the basic and secondary levels with emphasis on creativity and innovation;
- Promoting technical and vocational education and training to enhance middle level management in science and technology delivery to all sectors;
- Promoting science and technology innovativeness within the educational system;
- Increasing the country's capacity in the training of personnel in emerging technologies such as biotechnology, nanotechnology and material science and engineering;
- Using the mass media to popularize STI;
- Enhancing collaboration between research institutions and universities to train high-level scientific manpower;
- Ensuring that adult literacy classes include studies into cause and effect relations and how things work;
- Facilitating regular review to identify skill



- gaps in STI (new emerging technologies);
- Revamping the practice of industrial attachments for technical, vocational education as well as science, technology and engineering students;
- Devising ICT-driven education and training programmes in science and mathematics in basic and second cycle education;
- Reviving the National Science and Technology Museum project which began as far back as 1965 to use it as a major instrument to promote science acculturation nationally. Regional Science and Technology Museums should be built nationally as a major project to promote science and technology education.

**Policies related and complementary to Ghana's STI and HE capacity policy.** In Ghana, the National Science, Technology and Innovation (STI) Policies such as the STI (2010) and now the STI (2017) are the main policy documents that drive research and innovation in Ghana. In addition, several major institutions have policies in place assist in the coordination of policy towards enhancing production and utilization of research and innovative outcomes to drive socio-economic development. These institutions include the National Development Planning Commission, The Ministry of Environment, Science and Technology, the Ministry of Education, the National Council for Tertiary Education (NCTE), the Research Institutions coordinated by the Council for Scientific and Industrial Research (CSIR), the Universities and other tertiary institutions. Additionally, Ghana has a stable macroeconomic and political conditions necessary for innovation and development technology support and regulatory agencies, and standardized intellectual property (IP) legislation (UNCTAD, 2011).

Indeed, STI has been highlighted in almost every recent Government vision and planning document, including Vision 2020, the subsequent Vision 2015, the National Science and Technology Policy of 2000, the GPRS II and the current STI policy (2017). For instance, the Ghana Poverty Reduction Strategy Paper I (1996 – 2005) (GoG, 2003) has a section on science and technology. Besides, Ghana's Growth and Poverty Reduction Strategy (GPRS II, 2006-2009) (GoG, 2005) also makes reference to the importance of Ghana's national development. The GRPS II makes it clear that science, technology, and innovation are to be key elements of Ghana's development strategy (National Science, Technology and Innovation Policy, 2010). Evidently, Ghana has over the years demonstrated an impressive sophistication in terms of STI policy frameworks and governance arrangements for the management of the national research and innovation systems. Again, all the policies emphasise on developing more effective national institutional arrangements to promote STI governance and nurture knowledge economies. The major and most persistent downside to these policies is the lack of national and institutionalized programmes that stimulate collaboration and knowledge exchange between research subsystems and the industrial and business subsystems.

**HE and STI institutions in Ghana.** Ghana has one of West Africa's most developed national innovation systems. There is a Council for Scientific and Industrial Research, established in 1958, with 13 specialized institutes for research on crops, animals, food, water and industry. Other scientific institutions include the Ghana Atomic Energy Commission, the Centre for Scientific Research into Plant Medicine and the Noguchi Memorial Institute for Medical Research at the University of Ghana.

**Table 2. Higher Education and STI institutions in Ghana**

|                                      |   |    |
|--------------------------------------|---|----|
| Universities<br>(degree-granting)    | Total number in country (public)                    | 10 |
|                                      | Total number of Technical Universities/Polytechnics | 11 |
|                                      | Total number of private Universities                | 57 |
|                                      | Number of Agricultural Universities                 | 1  |
| Other post-secondary<br>institutions | Total number of Colleges (public)                   | 60 |
|                                      | Total number of Colleges (private)                  | 19 |
|                                      | Total number of Agricultural Colleges               | 6  |

National Research  
Councils

### **1. Ghana Academy of Arts and Sciences**

It is a learned society that aims to promote the pursuit, advancement and dissemination of knowledge in all branches of the sciences and the humanities.

### **2. Council for Scientific and Industrial Research (CSIR)**

The CSIR is mandated to perform the following functions among others:

- To pursue the implementation of government policies on scientific research and development;
- To advise the sector Minister on scientific and technological advance likely to be of importance to national development;
- To encourage a coordinated employment of scientific research for management, utilization and conservation of the natural resources of Ghana in the interest of development.

National Research  
Institutes

### **1. Animal Research Institute**

The Institute was established as Biological Research Institute in January 1957 as an agency of Tsetse Control Department of the Gold Coast Administration. In 1964 the name of the Unit was changed to ANIMAL RESEARCH INSTITUTE, when the research programme was widened from strictly animal health to include other areas of animal agriculture.

### **2. Building and Road Research Institute**

Mandate is to conduct research into building and road

constructions.

**3. Crops Research Institute**

Mandate is to develop and disseminate demand-driven technologies and build capacity for sustainable food and industrial crops productivity to enhance livelihoods. CRI has a broad research mandate covering all food and industrial crops.

**4. Food Research Institute**

Food Research Institute (FRI) is tasked to provide technical, analytical services, contract research and consultancy services to governmental agencies, micro-medium and multinational agro-food processing industries and international development agencies.

**5. Forestry Research Institute of Ghana**

The mandate is to assist in poverty reduction through the creation of opportunities for generating and increasing incomes within the SMEs; contribute towards food security, generate foreign exchange earnings and apply cost-effective industrial technologies that are both environmentally friendly and commercially viable.

**6. Institute for Scientific and Technological Information**

The Institute serves as the main STI resources clearinghouse for CSIR.INSTI's mandate is to develop national capacity and capability for the efficient and effective delivery of real-time scientific and technological information (STI) and customized knowledge on demand for the benefit of policy makers, research scientists, industrialists, and others in appropriately packaged form for national development.

**7. Oil Palm Research Institute**

The OPRI carries out research on Oil Palm and Coconut and offers technical backstopping to the oil palm and coconut industries.

**8. Plant Genetic Resources Research Institute**

PGRRI is mandated to collect and conserve PGR of Ghana and those from abroad to prevent their extinction.

**9. Soil Research Institute**

The Soil Research Institute has the mandate to undertake inventory of the soil resources of Ghana and carry out

scientific research to generate information and technologies for effective planning, utilization and management of the soil resources of Ghana for increased and sustainable agriculture, industry as well as ensuring safe and sound environment.

**10. Science and Technology Policy Research Institute**

The Science and Technology Policy Research Institute (STEPRI) was established in 1987 under the (CSIR) to act as a focal point to articulate policy on national Science and Technology (S&T) development.

**11. Water Research Institute**

WRI has a mandate to conduct research into water and related resources.

**12. Institute of Industrial Research**

The mandate of the Institute is to assist in poverty reduction through the creation of opportunities for generating and increasing incomes within the SMEs; contribute towards food security, generate foreign exchange earnings and apply cost-effective industrial technologies that are both environmentally friendly and commercially viable.

**13. Savannah Agricultural Research Institute**

SARI's mandate is to provide small scale farmers in the three regions of the northern Ghana (Northern, Upper East and Upper West regions) with appropriate innovation/option/technology to increase their food production base on a sustainable production system, which maintains and/or increasing soil fertility.

Large Research  
infrastructure

Number of facilities

1. Cocoa Research Institute
2. Ghana Atomic Energy Commission
3. Centre for Scientific Research into Plant Medicine
4. Noguchi Memorial Institute for Medical Research

Science Granting  
Council

Ministry of Environment, Science, Technology and Innovation

---

**Number of researchers and publications**

- Total number in the country and number per million of population  
**941 (2011)**
- Percentage of female researchers in country  
**18.3%**
- Profile of number of researchers by sector (Business, Higher Education and Government)

**Business: 1%; Higher Education: 59.9%; Government: 38.3%**

- Profile by field of science  
**Natural Sciences: 164; Engineering: 120; Med. & Health Sciences: 135; Agricultural Sciences: 183; Social Sciences: 197; Humanities: 118.**

**Table 3. Tertiary enrolment by level of programme**

| YEAR | Post-Secondary Non-Degree | Bachelor's and Master's | PhD | Total Tertiary |
|------|---------------------------|-------------------------|-----|----------------|
| 2006 | 27,707                    | 82,354                  | 123 | 110,184        |
| 2012 | 89,734                    | 204,743                 | 867 | 295,344        |

**Table 4. Total enrolment in Science, Engineering, Agriculture and Health**

| Year | Total    |   |     | Science  |   |     | Engineering, Manufacturing and Construction |   |     | Agriculture |   |     | Health   |   |     |
|------|----------|---|-----|----------|---|-----|---|---|-----|-------------|---|-----|----------|---|-----|
|      | Post-Sec | 1 <sup>st</sup> & 2 <sup>nd</sup> Degrees | PhD | Post-Sec | 1 <sup>st</sup> & 2 <sup>nd</sup> Degrees | PhD | Post-Sec                                    | 1 <sup>st</sup> & 2 <sup>nd</sup> Degrees | PhD | Post-Sec    | 1 <sup>st</sup> & 2 <sup>nd</sup> Degrees | PhD | Post-Sec | 1 <sup>st</sup> & 2 <sup>nd</sup> Degrees | PhD |
| 2008 | 64,993   | 124,999                                   | 281 | 6,534    | 18,356                                    | 52  | 7,290                                       | 9,091                                     | 29  | 263         | 6,794                                     | 32  | 946      | 4,744                                     | 6   |
| 2012 | 89,734   | 204,743                                   | 867 | 3,281    | 24,072                                    | 176 | 8,306                                       | 14,183                                    | 57  | 1001        | 7,424                                     | 134 | 38,430   | 10,144                                    | 69  |

The number and percentage of publications that focus on agriculture, and number and percentage that focus on other life sciences are 255 (10.6%) and 85 (3.5%) respectively. Ghana has a total number of 941 researchers (105 per million population in 2011), and they are increasingly publishing in international journals. Ghana's scientific publication record almost tripled between 2005 and 2014 (208 to 579). This performance is all the more noteworthy in that Ghana devoted just 0.38% of GDP to GERD in 2010. Between 2008 and 2014, the total number of research collaborations with other countries

was 2273. The countries involved were: USA (830); UK (636); Germany (291); South Africa (260); and Netherland (256).

Between 2004 and 2011, Ghana invested 6.3% of GDP in education, on average, and between one-fifth and one-quarter of this in higher education. The number of students enrolled in degree courses shot up from 82 000 to 205 000 (12% of the age cohort) between 2006 and 2012 and the number of PhD candidates from 123 to 867 (Table 3).

**Table 5. Participation in Centres of Excellence (CoE)**

| Centre of Excellence  | Host university  | Funder/Sponsor                      | Other Collaborators |
|---|--|-------------------------------------|---------------------|
| West Africa Centre for Crop Improvement (WACCI)<br>Training Plant Breeders, Seed Scientists and Technologists   | University of Ghana  | World Bank                          |                     |
| West Africa Centre on the Cell Biology of Infectious Pathogens  | University of Ghana  | World Bank                          |                     |
| Regional Water and Environmental Sanitation Centre  | Kwame Nkrumah University of Science and Technology (KNUST) | World Bank                          |                     |
| African Institute of Mathematical Sciences (AIMS)<br>It is a pan-African network of centres of excellence for postgraduate education, research and outreach in mathematical sciences. | Affiliated to KNUST  |                                     |                     |
| Petroleum Engineering<br>A hub for developing Africa's capacity in the Oil and Gas value chain.   | KNUST  | Ghana Government and the World Bank |                     |
| Noguchi Memorial Institute for Medical Research   | University of Ghana  | Ghana Government and Japan          |                     |

**Key challenges in the STI and Higher Education environment in Ghana.** Since independence, Ghana has made significant investment towards harnessing the potential of STI and optimizing the benefit of HE. However, according to the 2011 STI Policy Review by United Nations Conference on Trade

and Development (UNCTAD) and the Draft National Science, Technology and Innovation Policy (2017-2020), Ghana has not been able to fully exploit the enormous potential of STI and the benefits of Higher Education (UNCTAD, 2011). The review delineates the following eleven challenges as key constraints in the STI

and Higher Education environment in Ghana:

- i. Inadequate funding and resourcing of the sector;
- ii. Weak linkage between policy formulation and national development planning;
- iii. Weak linkage between universities, industry and the R&D system;
- iv. Inadequate scientific capacity in the country;
- v. Lack of effective advocacy for STI at the highest political and policy levels;
- vi. Low science and technology culture among the populace;
- vii. Weak structures for the management of STI;
- viii. Ineffective coordination of the STI system
- ix. Weak implementation and lack of robust monitoring and evaluation mechanism;
- x. Weak linkages and coordination of activities and programs of various agencies and organizations in STI;
- xi. Over reliance on the use of foreign expertise to the neglect of the use and development of local expertise;

As posited by Sawyerr (2004), the challenge has been exacerbated by deteriorating working conditions of practitioners in the field; worsening academic quality standards in the light of rapid increase in enrolment against inadequate teaching and learning infrastructure.

**Case studies.** Despite these shortcomings, however, the following two case studies showcase some successes that Ghana has achieved regarding STI and HE capacity development.

**1. Building leadership skill for Africa's Transformation: The GIMPA / PSMTP model.** The Ghana Institute of Management and Public Administration (GIMPA) is the leading management development institution

in Ghana with a vision of becoming a world class Centre of Excellence for training in Leadership, Management and Administration, Policy Analysis, Consultancy and Research, Distance Learning, Gender and Development programmes and to create a forum for discussions and resolutions of important contemporary national and international issues. Over the years, GIMPA has demonstrated remarkable consistency of purpose through the provision of high quality programmes and services, skilled faculty, customized educational approaches and the cultivation of a client-centred learning environment.

In September 2005, GIMPA and the Africa Capacity Building Foundation (ACBF) signed an agreement by which the ACBF supported GIMPA to host the Public Sector Management Training programme (PSMTP) for Anglophone West Africa. Under this agreement GIMPA set up a Master's Degree programme in Public Sector Management in partnership with the five Anglophone West African countries - Nigeria, Ghana, Liberia, Sierra Leone and The Gambia.

The main goal of the PSMTP was to enhance the performance of the public sector through the provision of a balanced, academic and professional training in Public Sector Management to promote a more effective and efficient leadership for socio-economic development in the Anglophone West African countries. Participants were drawn from the middle to senior level managers that have practical experience in public sector management.

Every year, a selected number of participants from the five (5) Anglophone West African countries are offered scholarships to participate in the programme. The governance structure of the PSMTP is composed of a Project Steering Committee (PSC) that provided oversight and

policy direction and a management team that is responsible for the day to day management of the program. The governance structure is designed to ensure effective delivery and ownership of the program by the targeted countries.

To ensure effectiveness and impact of the programme GIMPA with support from ACBF provided all the necessary physical facilities and teaching resources: both material and human, including appropriate instructional equipment and tools as well as regular collection and integration of stakeholder feedback to ensure continuous improvement of the program.

The PSMTP curriculum includes: Background and Perspective on Africa's Public Sector; Strategic Planning and Management in the Public Sector; Public Sector Resource Management and Global and Regional Perspectives and Experiences in Public Sector Management, which relates to areas of critical manpower needs of the participating countries. To ensure effective assimilation and value addition to client's skills and competencies, the programme used a combination of training methods which included regular lectures, participatory class discussions and hands-on exercises, seminars and individual case studies.

Overall, the PSMTP made sufficient progress towards its three key objectives, namely, (i) strengthen the Masters' Degree programme in public sector management to meet the current and emerging issues in the public sector; (ii) enhance the institutional and human capacity of GIMPA to meet the current and emerging public sector issues; and (iii) strengthen the institutional and human capacities of IPAs to deliver in country PSMTPs.

The impact of the PSMTP programme on leadership capabilities on the continent is demonstrated by the skills and competencies acquired by graduates and their ability to

initiate and mobilise stakeholders towards the achievements of national development priorities. A significant number of the PSMTP graduates are occupying leadership roles in their respective countries and are leading and managing a number of strategic national policy processes and programmes (ACBF, 2010)

## **2. Teaching and Learning Innovation Fund (TALIF)**

The Teaching and Learning Innovation Fund (TALIF) was the third component of Ghana's Education Sector Project (EdSeP) launched in March, 2004. TALIF Operational Manual (Version 2.B, August 2005) described the Fund as "a development tool designed to enhance the ability of the country's tertiary institutions to fulfil their primary responsibilities" of teaching, learning and extension of knowledge to the wider community. TALIF was planned to last five years, 2004-2009 and was the second major joint initiative of the Government of Ghana and the World Bank in the tertiary education sector within the past 20 years. At the request of the Government of Ghana, the International Development Association (IDA) of the World Bank, once more, agreed to provide assistance to the Education sector and preparatory work began on the Education Sector Project (EdSeP) of which the Teaching and Learning Innovation Fund (TALIF) was a component.

TALIF was designed as a medium term instrument of tertiary education policy to:

- raise the quality of tertiary level teaching and learning;
- sharpen the relevance and skills content of technical education;
- improve the efficiency by which polytechnics, universities and system supervisory institutions manage their academic programmes;
- open greater access to tertiary level academic education through the combined effect of the above; and



- tackle the problems of HIV/AIDS by assisting institutions to develop institutional policy and framework for managing HIV/AIDS on the campuses.

TALIF was funded with \$33.4 million credit from the International Development Association of the World Bank group. The Government of Ghana contributed the equivalent of 10%. In addition, the institutions were requested to contribute the equivalent of 10% in kind, time and effort.

### **The organisation and management of TALIF**

TALIF was managed by the National Council for Tertiary Education (NCTE), the body responsible for the coordination of tertiary education in the country on behalf of the Ministry of Education and Sports. The Fund was designed as a collaborative venture involving the NCTE and seventeen (17) tertiary level institutions in the public sector in the country at the time - made up of ten (10) polytechnics and seven (7) university institutions. TALIF was organized and managed at the two levels - the NCTE and institutional levels. By 2011, TALIF had supported 412 sub-projects and over 80% of the sub-projects had been completed.

### **The three biggest problems the Fund encountered in its first year were:**

- (i). Inadequate staff and lack of dedicated offices for the Fund. The absence of dedicated offices for the Fund and the inadequate staff limited the ability of the TALIF Unit to meet deadlines.
- (ii). Slow pace of accessing approved project funds because of the inability of the institutions to follow procurement procedures introduced by the Public Procurement Act, Act 663. It took not less than five weeks for institutions to return Performance Agreements and additional three weeks to submit approved Procurement Plans. The implementation of TALIF Projects coincided with the coming into effect of the Public Procurement Act 2003, Act 663. The Act seeks to streamline procurement procedures

in public institutions and many of the tertiary institutions found it difficult to comply with the requirements of the Act. In addition, it took between three and four months to go through the National Competitive Bidding process and for items to be received by institutions when some projects were expected to be completed within 12 months. The Proposal Originators had little time to implement projects.

- (iii) There was also the need to improve proposal writing skills particularly for Polytechnic staff on continuous basis.

### **Lessons learnt from the two case studies**

A number of lessons were learnt from the initiatives implemented, foremost being the need for reliable financing, commitment and government support. The GIMPA programme was hugely successful as it was very well thought through before implementation. Besides, the necessary physical facilities and teaching resources, both material and human including appropriate instructional equipment and tools were provided in adequate and timely manner. Furthermore, during the implementation phase, there was regular collection and integration of stakeholder feedback to ensure continuous improvement of the programme. The GIMPA / PSMTTP case showed that the programme depended significantly on funding from ACBF. However, only a few private sector or non-governmental organisations are available and willing to provide funding for STI and HE interventions in Africa. It is therefore imperative for African governments to increase their commitment and financial support to sustain STI and HE development initiatives.

Another important lesson is that the success of any policy including STI and HE policies is incumbent on regular consultation among key stakeholders. For instance, the design of TALIF allowed the TALIF Unit to consult the stakeholders on regular basis, and the constant interaction and pooling of ideas together

enabled the Unit to deal very quickly with the emerging issues. Thus, although there were initial problems, eventually, processes and procedures were clearly appreciated by key actors and end-users of the Fund as adequate education and information were provided to the institutions. Moreover, the procedures and processes and, in particular, the TALIF Operational Manual and Proposal Submission Form were regularly reviewed to ensure that they were well understood by all stakeholders. The two documents were revised three times. Furthermore, the design of the project as a collaborative venture involving the NCTE, the tertiary institutions and the World Bank was helpful in managing the novel concept in Ghana.

#### **Comparison with the key lessons learnt and capacity imperatives in the 2017 ACR report**

In accordance with the 2017 ACR report which states that 'African countries should develop and implement policies inspired by STISA-2014, as well as create institutional arrangements that promote STI in solving problems aligned to the Sustainable Development Goals', the success of STI and HE interventions in Ghana is hinged on the coherence among the local policies and regional, and international policies. Similar to the Ghana STI policy, in the 2017 ACR report, gender issues have been strongly emphasized in the same way as they have been highlighted in the Action Plan for the implementation of the Second Decade of Education for Africa (2006–2015), Africa's Science and Technology Consolidated Plan of Action, and the AU's progressive gender policies. The 2017 ACR report revealed that Africa's share of the world's research output does not reflect its population size largely due to a lack of state-of-the-art R&D laboratories and facilities, poor transport systems, and inadequate energy and communications infrastructure.

#### **Key messages from the study**

The key messages from the study are:

1. Ghana has generally shown renewed commitment and enthusiasms toward STI and HE development. This has culminated in very comprehensive STI policies such as the Ghana draft STI policy for 2017 to 2024.
2. Building STI capacity is a key driver and enabler in achieving economic transformation and development goals, such as food security, poverty eradication, job creation and access to energy and health.
3. Progress on Ghana's capacity for STI looks encouraging, given that Ghana's overall Africa Capacity Index is Medium. Ghana has a strategy for promoting STI, including capacity development, although capacity to implement it remains a challenge, given a narrow financing base.
4. Ghana has one of West Africa's most developed national innovation systems. There is a Council for Scientific and Industrial Research, established in 1958, with 13 specialized institutes for research on crops, animals, food, water and industry.
5. Ghana has only a small pool of researchers (39 per million population in 2010) but they are increasingly publishing in international journals. Ghana's scientific publication record almost tripled between 2005 and 2014. This performance is all the more noteworthy in that Ghana devoted just 0.38% of GDP to GERD in 2010.
6. Investment in education has not lived up to expectations, as it has not acted as a stimulus for R&D. This is because science and engineering are accorded insufficient status in Ghana. Government scientists and academics (who perform 96% of GERD) receive an inadequate budget and private sector opportunities are rare.
7. Ghana needs to strive to achieve critical mass in human resource development in STI through substantial investment in research institutions, universities, laboratories, ICT infrastructure, and research-funding

- mechanisms.
8. There is a persistent and systemic weakness in monitoring and evaluation on STI and HE projects and programmes.

**Recommendations for policy action**The following are the policy recommendations:

1. Ghana needs to increase capacity support for the development of STI and HE through international partnerships and linkages among researchers, academia, government, industry, and civil society actors.
2. Closing the socio-economic development gap between Ghana and the developed world will depend on Ghana's commitment to closing the STI investment gap. Countries with strong and effective STI systems invest up to 3.5 percent of their GDP in R&D, a rate far higher than Ghana's. To break the poverty cycle and rise above the low rankings on technological and innovation capabilities, Ghana must strive to meet its 1 percent of GDP STI target and even set a more ambitious target of up to 3 percent of GDP in STI.
3. There is a need for a co-ordinated collective effort (from skills surveys and diagnostic analysis) to be mounted across countries to identify the critical STI skills essential for the country's economic growth – and the current gaps – depending on their resource endowments and national development plans. This exercise should involve government, the private sector and academia.
4. Ghana should set up sustainable financing mechanisms for STI. The private sector and development partners should support and complement the government's efforts by providing funding, investing in critical skills (education, training and so on).
5. Ghana should develop and implement sensitization and capacity building programmes that promote and facilitate

gender mainstreaming in STI for decision makers.

6. STI and HE policies should also be aligned with long term International policies to enable the nation to attract the required support for implementation.
7. Finally, the nation should strengthen its monitoring and evaluation components of their STI and HE interventions.

**ACKNOWLEDGEMENT**

The authors thank the Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) for funding this study.

**STATEMENT OF NO-CONFLICT OF INTEREST**

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

**REFERENCES**

- African Capacity Building Foundation (ACBF). 2010. Project Completion Report- GIMPA Public Sector Management Training Program. Harare, Zimbabwe. July 2010.
- Sawyer, A. 2004. Challenges facing African universities: Selected issues. Association of African Universities, Accra, Ghana.
- Addo, P.K. 2010. The contribution of Higher Education in national development. *International Journal of Educational Leadership* 2 (2): 81-87.
- Brito, L. 2014. The role of science, Technology and innovation policies and instruments for a paradigm shift towards sustainable development. pp. 13–19. In: *Technologies for sustainable development*. Springer International Publishing. Switzerland.
- Economic Report of Africa (ECA). 2011. <https://www.uneca.org/publications/economic-report-africa-2011>. Accessed on March 16, 2018.
- Government of Ghana. 2003, Ghana Poverty Reduction Strategy (2003-2005): An

*Role of higher education and science, technology and innovation in capacity development in Ghana*

- Agenda for growth and prosperity. Volume I: Policy and Analysis Statement. Government of Ghana, National Development Planning Commission. 2005. Growth and Poverty Reduction Strategy (GPRS II): 2006-2009.
- Jowi, J. O., Obamba, M., Sehoole, C., Alabi, G., Oanda, O. and Barifaijo, M. 2016. Governance of higher education, research and innovation in Ghana, Kenya and Uganda. OECD Programme on Innovation, Higher Education and Research for Development (IHERD).
- McWilliam, H.O.A. and Kwamena-Poh, M.A. 1975. The development of education in Ghana. London: Longman
- The Ghana ICT for Accelerated Development (ICT4AD). 2003. <https://www.ghanahealthservice.org/downloads/Ghana%20ICT4AD%20Policy.pdf>. Accessed on March 16, 2018
- UNCTAD. 2011. Science, Technology and Innovation Policy Review, Ghana. UNCTAD Switzerland.
- UNESCO. 2018. Higher education and the sustainable development Goals. Available at <https://en.unesco.org/themes/higher-education/sdgs>. Accessed on March 16, 2018.
- UNESCO.1998. Proceedings of the World Conference on Higher Education: Vision and Action. Available at <http://www.unesco.org/education/educprog/wche/diaz-e.htm>. Accessed on March 16, 2018.
- Varghese, N. V. 2013. Governance reforms in higher education: A study of selected countries in Africa. IIEP/SEM334/Theme paper. Policy Forum on governance reforms in higher education in Africa. Nairobi Safari Lodge, Kenya, 16 May 2013.