



# Science, Technology & Innovation Policy Review

Ghana





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## FOREWORD

It is a time of renewed promise in Ghana. Steady economic growth throughout the past decade and the recent discovery of oil have raised hopes that Ghana is on track to join the ranks of the lower middle-income countries. The country is also making progress towards meeting many of its Millennium Development Goals.

But continued growth cannot be taken for granted. Long-standing challenges in Ghana include diversifying the economy beyond traditional exports such as gold, cocoa and timber. New sources of income from the oil and gas industry are welcome, but intensified specialization in natural resources production could affect the competitiveness of Ghana's other industries. This could undermine progress towards building dynamic competitive advantages in more knowledge- and technology-intensive activities. These risks make it very important to have public policies in place that help raise productivity in non-oil industries, build productive capacity, and promote economic diversification and structural change.

Ghana's Government has therefore renewed its commitment to harnessing science, technology and innovation (STI) to help meet its economic, social and environmental challenges and to promote inclusive and sustainable growth and development. As part of this commitment, a new national STI Policy was launched in March 2010 under the leadership of the Ministry of Environment, Science and Technology. The policy was prepared in a consultative manner, with expertise from the country's scientific, academic and business communities, and with attention to the views of Ghanaian citizens. Lessons from Ghana's past, and from the experiences of countries around the world, have been taken on board. The policy envisions a promising future for Ghana that builds on abundant modern advances in science, technology and innovation.

What matters now is how well this STI Policy is integrated into Ghana's national development strategy and translated into actions that will improve the quality of life for all Ghanaians in a sustained manner. Success would be reflected in better healthcare for the people, innovations to make Ghana's businesses more productive, the modernization of farming and agribusiness, and an improved ability to address the challenges of climate change. This report reviews Ghana's STI policies and is part of the Government's efforts to ensure that policy is supported by practical programmes. Initiated at the request of the Government, and prepared by a team of Ghanaian and international experts, the Review presents recommendations on measures to reform and strengthen Ghana's STI system.

The Review finds that many of the building blocks for fostering innovation and technological development – including reputable universities, research institutes, and a growing private sector – are already in place in Ghana. However, the STI system does not focus sharply enough on Ghana's socio-economic needs. Existing STI support programmes for the private sector do not appear to be encouraging technological upgrading or innovation. Resources are spread thinly across the system, and as a result, many of the country's important STI institutions are unable to effectively carry out their mandates. Funding allocations for STI are determined by the Government and donor programmes and often do not relate to the priorities of research institutes and universities, and much less to those of the private sector, farmers and informal enterprises.

The recommendations presented in the Review are centred on four main themes: (a) improving the leadership, coordination and management of STI; (b) developing programmes that encourage innovation and technology adoption by the private sector; (c) growing the science, engineering and technical workforce; and (d) creating incentives to align the public technology providers with the needs of the private sector. With the support of the World Bank and UNCTAD, the Government will work towards implementing these recommendations.

Additional partners will be needed to ensure a sustainable and successful effort at STI development. As the production of knowledge and technology becomes increasingly global and interconnected, Ghana must build strong partnerships with governments and organizations around the world. Universities in Ghana need to establish new connections with universities in countries such as Brazil, India, the Republic of Korea, and

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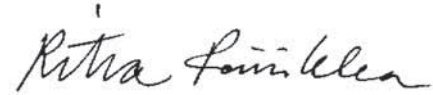
Viet Nam, in addition to strengthening existing partnerships with the United States and European countries. Entrepreneurs, scientists and engineers in Ghana must learn from – and share their own expertise with – their counterparts across West Africa and the world.

The spirit of cooperation underpinning the STI policy review process represents a constructive way forward for Ghana as it seeks to strengthen its development agenda by incorporating science, technology and innovation. This is an important step towards building human capital in Ghana and preparing the country for economic growth in the Africa of the twenty-first century. The Government of Ghana, the World Bank and UNCTAD are committed to working together on implementation of Ghana's STI Policy.

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## PREFACE

The Government of Ghana has ambitious plans for the country. On the back of strong economic growth throughout the past decade, it aims to graduate from low- to middle- income status in the next decade. To achieve this aim, economic growth will have to accelerate and productivity will need to rise. Achieving this ambitious goal will necessarily involve, among other things, a more effective application of science, technology and innovation (STI) in the economy in order to drive productivity growth and diversification in production. To date, however, the role played by STI in Ghana's development has been limited.

The Science, Technology and Innovation Policy (STIP) Review of Ghana was prepared at the request of the Government of Ghana. The Review is meant to offer an objective and critical look at the country's STI capacities and assess how these capacities are being translated into innovations that help meet the country's socio-economic development objectives, including supporting economic growth and poverty reduction as well as structural transformation of the economy. It sets out specific recommendations for practical actions and policy reforms to build STI capacity and to create a more dynamic economy that will move more quickly towards middle-income levels. The Review argues that policy action to promote STI development is required if Ghana is to achieve faster, more sustainable growth and development.

The Review has two parts. Part I is an overview of the full report that lays out the challenges that Ghana faces, and it summarizes the findings of the report. It is based on five background studies, which are presented in Part II of the Review. The two annexes provide a summary table of the recommendations of the Review and a brief summary of the African policy environment for STI-based development.

Part II contains the five background studies that were prepared for the Review. The topics were selected by a committee of Ghanaian stakeholders from science, academia, business and government at the outset of the STIP review process, in line with national priorities.

The first study (chapter 2) profiles the organizations, institutions, policies and linkages that characterize Ghana's national innovation system. The focus is on the overall strengths and weaknesses of the system and on the policy regime and institutional arrangements that Ghana needs in order to build a dynamic system of innovation.

The second study (chapter 3) looks at the performance of the research and development system, which has historically received the bulk of Ghana's STI investments and is a critical component in the innovation system.

Two studies focus on the role played by STI in particular industries of the economy: food and agro-processing (chapter 4) and traditional and herbal medicine (chapter 5). Modernizing agriculture is key, both because the majority of the population lives off it and because such a process will open up opportunities to change the relationship between agriculture and industry. Traditional and herbal medicine is an industry that may offer potential for economic gain, as well as contributing to improving the health of Ghanaians.

The fifth study (chapter 6) looks at the potential that information and communication technologies (ICTs) offer to transform education in Ghana. It focuses on providing access to education services and improving the quality of these services, so that Ghana's human capital can better contribute to achieving Ghana's vision of a modern economy more heavily based on the successful application of science and technology to production.

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## ACKNOWLEDGEMENTS

The STIP Review of Ghana was prepared jointly by UNCTAD and the World Bank in collaboration with the Science and Technology Policy Research Institute (STEPRI) of Ghana's Council on Scientific and Industrial Research, at the request of the Government of Ghana. The Review was prepared by a team including Michael Lim (UNCTAD), Michael Ehst (World Bank) and George Essegbey (CSIR-STEPRI), with overall guidance on the project provided by Mongi Hamdi (UNCTAD) and Alfred Watkins (World Bank). Officials at the Ministry of Environment, Science and Technology (MEST) (formerly the Ministry of Education, Science and Sports) were the main counterparts within the Government of Ghana. Contributions of background reports were provided by teams of experts including John Mugabe (Ghana's STI framework and national innovation system), Jo Lorentzen (Ghana's research and development system), Syed Rizvi, Michael Ehst, George Essegbey and Jonathan Agwe (science, technology and innovation-based development of food and agro processing), Kathryn Stokes (innovation in traditional herbal medicines) and Farouk Kamoun (ICTs in Ghana's education system). The Review benefited greatly from comments and suggestions provided by Kofi Agyen, Michael Crawford, Peter Darvas, Ishac Diwan, Mark Dutz, Angel González Sanz, Kurt Larsen, Anne Miroux, Kofi Tsikata and Michel Welmond.

Many people in Ghana, including government officials, university and research institute staff, private-sector representatives, development partner and civil society staff, and others gave generously of their time and insights to the research teams preparing each of the background papers. All of these contributors are gratefully acknowledged.

The STIP Review would not have been possible without collaboration at every stage by STEPRI. STEPRI's research team and support staff, and its director, Dr. George Essegbey, were all deeply committed to the project and deserve special recognition.

The Review was edited by Daniel Sanderson and Lucy Deleze-Black. It was desktop published by Monica Morrica and Philippe Terrigeol. The graphics and tables were prepared by Laurence Duchemin. The cover was designed by Nadège Hadjemian.

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## ABBREVIATIONS

AfDB	African Development Bank
AGI	Association of Ghana Industries
AIC	agribusiness innovation center
AIT	Accra Institute of Technology
AMCOST	African Ministerial Council on Science and Technology
ARI	Animal Research Institute
ARIPO	African Regional Industrial Property Organization
ASCO	Ayensu Starch Company
AU	African Union
BDS	Business development services
BOP	Balance of Payments
BRRI	Building, Road and Research Institute
CARGS	Competitive Agricultural Research Grant Scheme
CAS	Country Assistance Strategy (of the World Bank)
CBD	Convention on Biological Diversity
CENDLOS	Centre for National Distance Learning & Open Schooling
CGIAR	Consultative Group on International Agricultural Research
CIDA	Canadian International Development Agency
COCOBOD	Ghana Cocoa Board
CRI	Crop Research Institute
CRIG	Cocoa Research Institute of Ghana
CSIR	Council for Scientific and Industrial Research
CSRPM	Centre for Scientific Research into Plant Medicine
DE	Distance education
DFID	Department for International Development (of the UK)
DL	Distance learning
ECOWAS	Economic Community of West African States
EDL	Essential Drugs List
EML	Essential Medicines List
EU	European Union
FAO	Food and Agriculture Organization
FARA	Forum for Agricultural Research in Africa
FDA	Food and Drug Administration
FDB	Food and Drugs Board
FDI	Foreign Direct Investment
FORIG	Forestry Research Institute of Ghana
FRI	Food Research Institute
GAEC	Ghana Atomic Energy Commission
GDP	Gross Domestic Product
GEPC	Ghana Export Promotion Council
GER	Gross enrolment rate
GERD	Gross expenditure on R&D
GES	Ghana Education Service
GeSCI	Global eSchools and Communities Initiative
GFZB	Ghana Free Zones Board
GH¢	Ghanaian cedis (national currency)
GHS	Ghana Health Service
GICTeD	Ghana Information and Communications Technology Directorate
GIFTEL	Ghana Investment Fund for Telecommunications
GIMPA	Ghana Institute of Management and Public Administration

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GIPC	Ghana Investment Promotion Center
GNDP	Ghana National Drugs Programme
GDP	Gross Domestic Product
GNI	Gross National Income
GNP	Gross National Product
GOG	Government of Ghana
GPRS	Ghana Poverty Reduction Strategy
GRATIS	Ghana Regional Appropriate Technology Industrial Service
GSB	Ghana Standards Board
HDI	Human Development Index
IAG	Industry Advisory Group
ICMST	International Centre for Material Science and Technology
ICT	Information and Communication Technology
ICTE	ICT in Education
ICT4AD	ICT for Accelerated Development
IDRC	International Development Research Centre
IEDE	Institute for Educational Development (of UEW)
IFAD	International Fund for Agricultural Development
IFC	International Financial Corporation
IIR	Institute of Industrial Research
IMF	International Monetary Fund
IP	Intellectual property
IPR	Intellectual Property Rights
ISSER	Institute of Statistical, Social and Economic Research
ISI	Thomson Reuters ISI database
ISO	International Organization for Standardization
IT	Information Technology
ITU	International Telecommunication Union
KNUST	Kwame Nkrumah University of Science and Technology
MDGs	Millennium Development Goals
MES	Ministry of Environment and Science (former)
MEST	Ministry of Environment, Science, and Technology
MOES	Ministry of Education & Sports
MOESS	Ministry of Education, Science, and Sports (former)
MOFA	Ministry of Food and Agriculture
MOH	Ministry of Health
MOTI	Ministry of Trade and Industry
MSMEs	Micro, small and medium sized enterprises
NCA	National Communications Authority
NCTE	National Council for Tertiary Education
NDPC	National Development Planning Commission of Ghana
NEPAD	New Partnership for Africa's Development
NGO	non-governmental organization
NIA	National STI Implementation Agency
NIS	National Innovation System
NMIMR	Noguchi Memorial Institute for Medical Research
NNRI	National Nuclear Research Institute
NRC	National Research Council
NSI	National System(s) of Innovation
ODL	Open & Distance Learning
OPRI	Oil Palm Research Institute
OTC	Over the counter
PC	Personal Computer

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PGRC	Plant Genetic Resource Centre
PGRRI	Plant Genetic Resource Research Institute
PISM	Participatory Integrated Pest Management
PRI	Public research institute
PRSP	Poverty Reduction Strategy Paper
PSI	Presidential Special Initiatives
PSI-DL	The President's Special Initiative on Distance Learning
R&D	Research and Development
RTTCs	Regional Technology Transfer Centres
SADC	Southern Africa Development Community
SARI	Savanna Agricultural Research Institute
SET	Science, engineering, and technology
SME	Small and medium-sized enterprise
SOE	State-owned enterprise
S&T	Science and technology
SRC	Soil Research Centre
SRI	Soil Research Institute
STI	Science, technology and innovation
STIP	Science, technology and innovation policy
STEPRI	Science and Technology Policy Research Institute
STREFund	Science, Technology and Research Endowment Fund
TAM	Traditional and alternative medicine
TAMD	Traditional and Alternative Medicines Directorate
THM	traditional herbal medicine
TIA	Technology Innovation Agency
TICCG	Technology Innovation Center for Capital Goods
TM	Traditional Medicine
TMPC	Traditional Medicines Practice Council
TNC	Transnational corporation
TRIMS	Agreement on Trade Related Investment Measures
TRIPS	Agreement on Trade Related Aspects of Intellectual Property Rights
TVET	Technical & Vocational Education and Training
UCC	University of Cape Coast
UDS	University of Development Studies
UEW	University of Education Winneba
UN	United Nations
UNCTAD	United Nations Conference for Trade and Development
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commission for Africa
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNIDO	United Nations Industrial Development Organization
UOG	University of Ghana at Legon
VCTF	National Venture Capital Trust Fund
WRI	Water Research Institute
WFP	World Food Programme
WHO	World Health Organization
WIPO	World Intellectual Property Organization
WDI	World Development Indicators
WSIS	World Summit on the Information Society
WTO	World Trade Organization

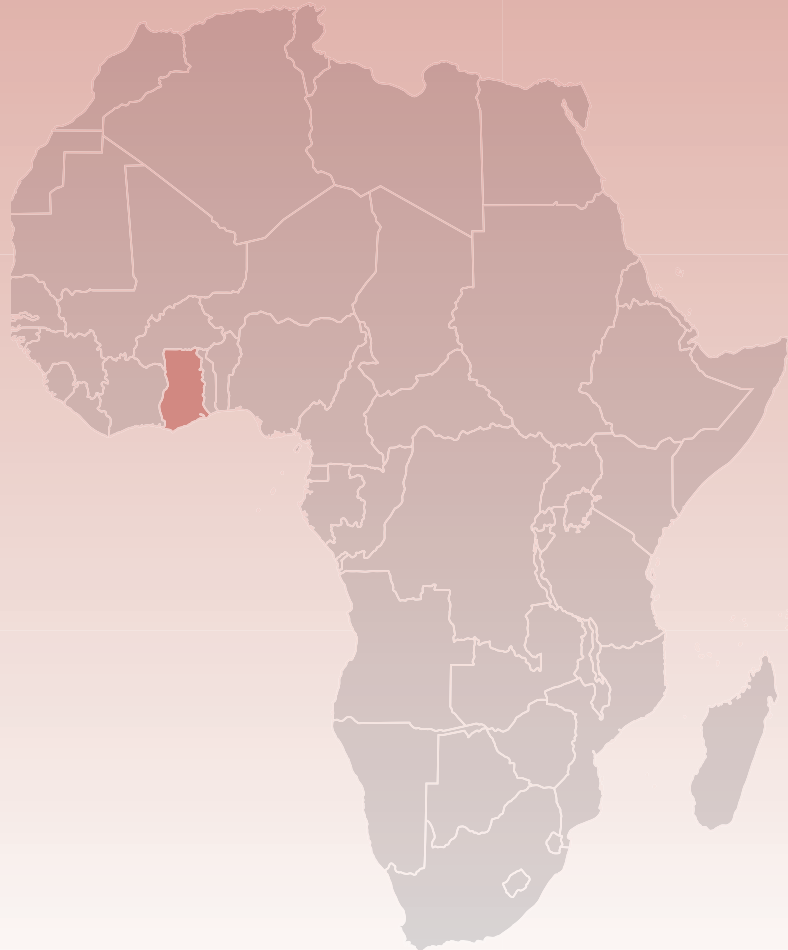
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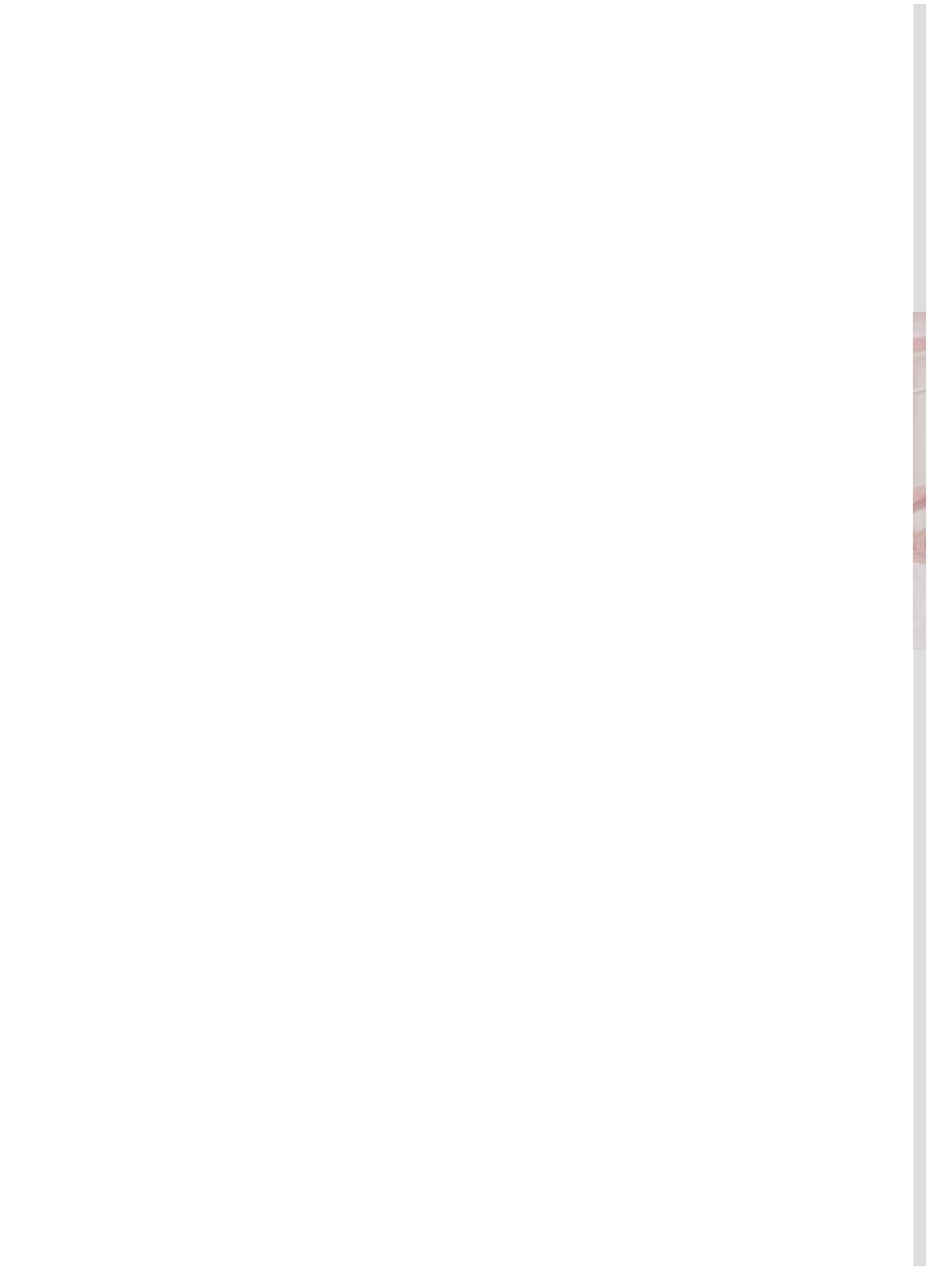
# PART 1



## OVERVIEW









## Overview

## I. GHANA'S SCIENCE, TECHNOLOGY AND INNOVATION CHALLENGE

The Government of Ghana has ambitious plans for the country. On the back of strong economic growth throughout the last decade, it aims to graduate from low- to middle-income status in the next decade. To achieve this aim, growth will have to accelerate and productivity will have to rise. In the terminology of Ghanaian planners, the country is ready to move from the economics of reconstruction and rehabilitation to the economics of accelerated growth (National Development Planning Commission, 2005). This implies diversification away from the cocoa-gold-timber structure and towards industrialization, technology and higher productivity, all with a view to achieving middle-income status by 2020.

Achieving these ambitious goals will necessarily involve, among other things, a more effective application of science, technology and innovation (STI) in the economy in order to drive productivity growth and diversification in production. To date, however, the role played by STI in Ghana's development has been limited.

Analytical work on Ghana's long-term growth concluded that up until 2000 it was mostly based on factor accumulation (Bogetic et al., 2007). Between 2000 and 2005, however, evidence of low productivity increases emerged, within which technological advances played at least a marginal role. This seems to have especially been the case in agriculture – notably in the cocoa sector and in fibre crops and cereals. The physical environment, farmers' socio-economic conditions, and poor infrastructure have unfortunately hampered faster productivity improvements, serving as a reminder that technological progress is merely one input to growth and is dependent on broader systemic conditions. The World Bank's Country Economic Memorandum concludes that accelerated growth will rely – among other things – on productivity improvements (especially in agriculture) and innovation, which “are possible...by widening the use of technology...” (Bogetic et al., 2007: 48).

The productivity gap that Ghana must overcome if it wishes to catch up with middle-income countries is illustrated in table 1.1. Value added per agriculture worker would have to increase by a factor of 3 to match the Philippines, or by a factor of 10 to reach

Brazil's productivity level. These are just two examples of countries with higher productivity that compete with Ghana on a range of agricultural products.

Table 1.1. Agriculture value added per worker

Country	Agriculture value added per worker 2008 or latest (in constant 2000 US\$)
Uganda	197
United Republic of Tanzania	326
Kenya	345
Ghana	401
Malaysia	611
Philippines	1,211
South Africa	3,839
Brazil	3,858
Costa Rica	5,457
New Zealand	25,712

Source: World Development Indicators 2010.

The World Economic Forum's Global Competitiveness Index also suggests that Ghana has limited capacity for harnessing technology and innovation to raise productivity and create industries with competitive advantage in international markets. Out of 133 countries, Ghana ranks 112<sup>th</sup> on technological readiness, 115<sup>th</sup> on innovation, 98<sup>th</sup> on business sophistication, and 108<sup>th</sup> on higher education and training (see table 1.2).<sup>1</sup> These relative positions are not particularly out of line for a country at Ghana's stage of development. Ghana is currently in the bottom tier of countries, along with other “factor-driven” economies, mainly in sub-Saharan Africa. These “factor-driven” economies have minimal capacity to innovate, do not add much value to the goods and services they produce, have unsophisticated local enterprises with limited managerial and organizational capacity and minimal commercial and technological links to the global economy, and use low-wage, poorly educated, unskilled labour to produce and export unprocessed raw materials. If Ghana wishes to transform itself from what the World Economic Forum calls a “factor-driven” economy into an “efficiency-driven” or “innovation-driven” economy, then it must begin to improve in these critical areas related to productivity and competitiveness.

Recognizing the important role that knowledge and innovation must play in transforming the economy

Table 1.2. Competitiveness rankings of Ghana

Pillars	Rankings in 2008 (out of 134)	Rankings in 2009 (out of 133)
<b>Basic requirements</b>		
1. Institutions	63	68
2. Infrastructure	82	87
3. Macro-economic stability	121	129
4. Health and primary education	115	115
<b>Efficiency enhancers</b>		
5. Higher education and training	111	108
6. Goods market efficiency	97	91
7. Labour market efficiency	108	100
8. Financial market sophistication	69	59
9. Technological readiness	115	112
10. Market size	86	86
<b>Innovation and sophistication factors</b>		
11. Business sophistication	98	98
12. Innovation	114	115

Note: The top ranking is 1, which means more competitive.  
Source: World Economic Forum. Global Competitiveness Report 2009–2010.

and reducing poverty, the Government of Ghana has placed STI development high on its list of priorities. This is reflected in various political and policy statements of the Government, including Vision 2020, the Growth and Poverty Reduction Strategy II (GPRS II), and the upcoming medium-term development plan. For example, GPRS II argues that the absorption and application of much more science and technology than is presently deployed is a critical ingredient for successful growth. The medium-term development plan, prepared by the National Development Planning Commission of Ghana, has a vision for Ghana in 2020 of a “modern economy based on the development of science and technology”.

Hence, at the level of policy intentions, things are happening. To date, however, Ghana’s dialogue around STI has often not been backed up by specific actions. There is clear awareness in Ghana that STI policies are essential in order to achieve accelerated growth and join the global knowledge economy. But there has not been practical planning and implementation of

STI policies and programmes to match the emphasis given in the policy statements. Even when policies do exist and are well conceived, there is dissatisfaction with the progress made to date in terms of effective planning and the active implementation of policies and programmes.

This is where this STIP Review comes in. Requested by the Government of Ghana, the Review is meant to offer an objective and critical look at the country’s STI capacities and how these capacities are being translated into modernization of the economy and innovations that help meet the country’s socio-economic development objectives. The Review sets out specific recommendations for practical actions and policy reforms to build STI capacity and create a more dynamic economy that will move more quickly towards middle-income levels.

The key industries and thematic areas of the Review were determined by a committee of Ghanaian stakeholders at the outset of the STIP Review process, to be in line with national priorities.<sup>2</sup> This overview is based on the resulting five background studies that are included in Part II of this report. These background studies provide a wealth of insight and practical policy advice that cannot be fully captured in a report overview, and are they are meant to be read individually in addition to this overview.

## II. THE STATE OF GHANA'S STI SYSTEM

Ghana has in place many of the individual components necessary for an efficient and effective STI system. This is an important strength to build upon. It has at least 16 research and development (R&D) institutes, seven public universities, about 40 private universities, 10 public polytechnics, many technical institutes, several technology support and regulatory agencies, and standardized intellectual property (IP) legislation. It has a relatively strong education system, generally stable macroeconomic political conditions, and a growing private sector. It also has a newly updated national policy framework on science, technology and innovation (the National Science, Technology and Innovation Policy), which in late 2010 was awaiting Parliamentary approval. The National Development Planning Commission has recently integrated STI policy into its national development plan.

However, the capacity of the STI system overall is limited in comparison to those of middle-income countries such as India or South Africa, and the system overall is not performing to a standard that will enable the country to achieve its aspiration of becoming a middle-income economy. Its policies and institutions for science, technology and innovation have not been modernized, nor have they been aligned to economic growth and human development goals. A key feature of Ghana's institutional landscape is the weak links and poor positive feedback between and among institutions, including the higher education and research institutes and the private sector. More importantly, there are no incentives to work together and few mechanisms to encourage communication and collaboration. A number of studies have identified these limitations and weaknesses in Ghana's STI system.

The STI system is far too supply-driven, owing to its overreliance on the public budget and on external sources of funding including donor-sponsored projects based on donor agendas. Funding allocations are determined by the Government and often do not relate to the priorities of the providers of science and technology services (i.e. the research institutes and universities) and much less still to the end-users of technology and research, such as the private sector, farmers, and informal enterprises. The result is a system not subject to competitive pressures to ensure quality, and not adequately focused on Ghana's own economic and social objectives.

The private sector has not been responding to the existing incentives to adopt new technologies, innovate, and raise productivity. The Government could improve fiscal and legal incentives for local entrepreneurship and promote innovation in private enterprises. Local private-sector firms are not really attuned to procuring and/or investing in innovations to improve their economic productivity. The adoption and adaptation of existing technology by firms should be encouraged, as the most logical focus for Ghana's technology and innovation efforts. Previously, Ghana was focusing its attention on promoting private-sector development and attracting FDI. There is now a need to focus on promoting technological innovation in and by the private sector.

The STI system is stretched thin and overburdened in relation to the level of resources available. This leaves many of the country's important STI institutions unable to effectively carry out their mandates. Current resource allocations cannot sufficiently support the

range of activities that the country assigns to the STI system. Ghana's expenditure on R&D is about 0.3 per cent of its gross domestic product (GDP), nearly all of which comes from government outlays equivalent to around \$49 million or 1.1 per cent of the budget (see table 1.3).

This does not compare well to South Africa, for instance, which spends 0.87 per cent of its GDP on formal R&D (OECD, 2007). Even with the establishment of the (minimally endowed) Science and Technology

**Table 1.3. Science and technology in Ghana's total budget, 2008**

Budget line item*	New Ghanaian cedis**	Percentage
Total government expenditure	4,292,084,203	100
Basic research	201,500	0.005
R&D General public services	151,412	0.004
R&D Economic affairs	44,314,486	1.032
R&D Health	3,942,081	0.092
Total S&T	48,609,479	1.133

\* Budget represents estimates, not actuals.

\*\* New Ghanaian cedis and United States dollars were close to a 1:1 exchange rate during the 2008 budget year.

Source: Republic of Ghana (2008b).

Research Endowment Fund (STREFund), there is no indication that allocations for STI activities will increase. Most of the funding that does exist goes on salaries and some operational costs (over 90 per cent at both the universities and the research institutes), with little left for actual research. The level of overall expenditure is not enough to support high-quality STI activities across the existing system. This does not necessarily mean that more resources are required, or indeed, would fix the problems. Rather, the Government must determine which areas and activities of the STI system are necessary and important, and must properly fund them to allow them to fulfil their mandates. Any proposed new resources should be accompanied by substantial improvements in efficiency and incentives to turn new expenditures into development gains.

Institutions of education and training are not producing enough graduates with the required skills to spur technological innovation for economic growth. This is a major barrier to improving the country's technological performance and to growing a national system of innovation. This has been recognized by the Government, and various reforms of the education and training system are being introduced. Public universities are under continuous strain to absorb

growing student populations, and are therefore devoting increasingly low or limited portions of their annual budgets to R&D and technical innovation activities.<sup>3</sup> Measures aimed at improving tertiary education should be part and parcel of overall national efforts to fight poverty, grow the economy, promote human development, and increase economic competitiveness. Science and mathematics should be emphasized at all levels of the education system. Overall, Ghana's educational system is not well aligned to its economic and industrial development aspirations.

The country does not have an adequate mechanism to fund innovation, technological development and research on a competitive basis. Ghana does not have the equivalent of South Africa's National Research Foundation (NRF) and its Innovation Fund to oversee the review and implementation of competitive research and innovation funding programmes. Furthermore, there is no horizontal coordination and no clear regime for setting research priorities. The newly established STREFund could potentially fill this void, but it has not been funded beyond a symbolic level (currently at \$500,000). It is also unclear whether the STREFund would be able to adequately attract private-sector and university participation in its funding programmes while being managed by the Council on Scientific and Industrial Research (CSIR). Though it is designed to have an independent board of directors, universities and firms may hesitate to apply for funding from a fund they see as under the influence of the research council. In the long term, to stimulate innovation and ensure a focused approach to strengthening the country's national system of innovation, Ghana should establish a specialized agency to fund research and technological development. In the short term, it should shift its funding away from budgetary allocations and towards competitive awards, through the STREFund or other mechanisms.

Most individual science and technology institutions – including, most prominently, the research universities and the public research institutes – are performing insufficiently to foster technological development in the economy. Faculty at the public universities publishes less than one article each per year in peer-reviewed journals (see table 1.4). The growth of enrolments and teaching load affects the universities across the board with respect to research productivity. Some positive developments are the dedication of some internally generated funds to research grants

at the universities, and the establishment of an office of research, innovation and development at the University of Ghana.

The CSIR and other publicly supported research institutes have pockets of excellence that produce important innovations (e.g. the improved cement from local materials commercialized by the Building and Roads Research Institute, and the crop disease control techniques pioneered by the Cocoa Research Institute), but in general they are producing little relevant output (see table 1.5). Low salaries, poor conditions, and limitations on professional advancement hamper the productivity of researchers. Poor research management means that opportunities to secure what funding is available for conducting research and purchasing equipment are frequently missed. The scientific and technical knowledge that is generated by public R&D institutes is not turned into products and services because of a lack of entrepreneurial culture and few incentives to link with the private sector. The picture that emerges of the CSIR is of a top-heavy organization that employs its staff without giving them the means to do what they are supposed to be doing, namely engage in research. Although the CSIR secretariat and the individual institutes have commercialization officers, they do not have dedicated positions for research project acquisition. Since this is upstream from commercialization, it is perhaps one reason why commercialization does not really work.

Problems internal to the organizations that the report analysed<sup>4</sup> include a dearth of professional (research) management, inadequate human resource development and misaligned incentive systems, and an absence of regular performance assessments. These are issues that the research institutes and universities can and must address themselves. One result is that the research system's most important capital – people – is shortchanged. It is no secret that university faculty make higher salaries than their peers at the CSIR, many of whom pursue additional income on the side through work unrelated to their technical expertise. But while universities appear to be relatively better off, they too count poor remuneration and poor service conditions for staff, together with inadequate funding and poor allocation of resources for academic programmes, and rundown infrastructure, among their major weaknesses. Core/support staff ratios in Ghana bear no comparison to those in similar organizations internationally.



Table 1.4. Ghana's universities: Basic indicators

	University of Ghana	University of Cape Coast	Kwami Nkrumah University of Science and Technology
Year established	1948	1962	1952
<b>Enrolment</b>			
Total	29,754	16,806	23,866
Male/female ratio	1.5	2.1	2.5
Postgraduate	1,816	394	1,597
Undergraduate	26,154	16,140	22,269
Sub-degrees	1,784	272	./.
Percentage of graduate enrolment	6.1	2.3	6.7
International students	1,142	./.	736
<b>Staff</b>			
Teaching and research	865	398	778
Academic staff with PhDs, percentage	46.8	./.	39.9
Admin. and professional	3,909	3,032	2,580
Ratio academic/support staff	0.2	0.1	0.3
<b>S&amp;T teaching</b>			
Ratio of science students (percentage)	19.9	26.0	48.8
Ratio of S&T graduates, 2007	8.5	23.6	63.5
Ratio of S&T PhD graduates, 2007	0.16	0.0	0.08
<b>Journal publications</b>			
Listed on university website	(2007) 1	0	(2007) 12
Annual Report	(2006) 230	(2006) 50	(2007) 165
Output per capita	0.27	0.13	0.21
ISI 2006	73	15	54
Ratio ISI/other journals	0.32	0.30	0.33

Sources: ISI, KNUST (2007a, 2007b); UCC (2007a, 2007b); UoG (2007a, 2007b); university websites.

Table 1.5. Selected indicators: Research institutes<sup>5</sup>

	ARI	BRRRI	CRI	FRI	FORIG	IIR	ISTI	OPRI	PGRRI	SARI	SRI	STEPRI	WRI	CSIR	CSPRM	CRIG
Staff	295	211	883	170	286	135	79	440	127	535	372	31	249	3813	180	147
of which: research	27	27	83	34	38	18	13	23	9	35	26	9	56	398	22	35
with PhDs	9	0	24	12	14	4	1	2	2	8	0	3	20	99	6	17
Journal publications in 2005	2	0	7	0	4	0	3	2	0	0	10	0	3	31	10	8
per capita	0.07	0	0.08	0	0.11	0	0.23	0.09	0	0	0.38	0	0.05	0.08	0.45	0.17
ISI (2006)	2	0	2	2	3	0	0	0	0	0	0	0	3	9	2	2

Sources: CRIG (2002), CSIR (2006) for publications, CSIR website, CRIG website for staff complement, CSRPM (n.d.) and ISI. Please see footnote 5 and table 3.3 (p. 47) for full names of organizations.

There are also problems that afflict the system at large: coordination failures, a dysfunctional intellectual property rights (IPR) system, and hesitance to being reviewed. Neither universities nor research institutes have central frameworks in place that would regulate how intellectual property is to be handled, how it is disseminated or transferred, who would be responsible for the cost of servicing patents, or how possible proceeds from its exploitation are to be shared between the inventor and the assignee. Agricultural research is no different. The Crop Research Institute (CRI) does not register the new seed varieties it develops; it merely records them in in-house journals.

The STI system is not adequately linked to international science and technology networks and funding opportunities. International cooperation offers a means to build Ghana's STI capacity by attracting talented entrepreneurs and innovators to work on Ghana's challenges and also to find resources from international research funders. For example, the European Union's Framework Programme, the United States' National Institutes of Health, and Canada's Grand Challenges programme all earmark funding for collaboration with African scientists. These international links should be developed and exploited. The country has entered into one international and several bilateral agreements that deal with science and technology cooperation, but the Government and individual institutions could do much more to pursue

international research and technology development collaborations.

Coordination across the entire STI system is inadequate, resulting in gaps in support and duplication of efforts. There is now a clear locus for STI policymaking with the reestablishment of the Ministry of Environment, Science and Technology (MEST), but STI policy is still implemented by a myriad of public agencies. For example, most agricultural research is funded by the CSIR, which is under the MEST, while agriculture extension services and food safety issues are under the Ministry of Food and Agriculture (MOFA), the Ministry of Trade and Industry (MOTI) supports agriculture processing programmes, and the Cocoa Board allocates funding for cocoa and shea research. These arrangements are not unusual in governments, and require coordination of efforts rather than a concentration of power. Ghana may find that a coordinating body for STI is necessary to avoid gaps and overlaps in its STI policies and programmes.

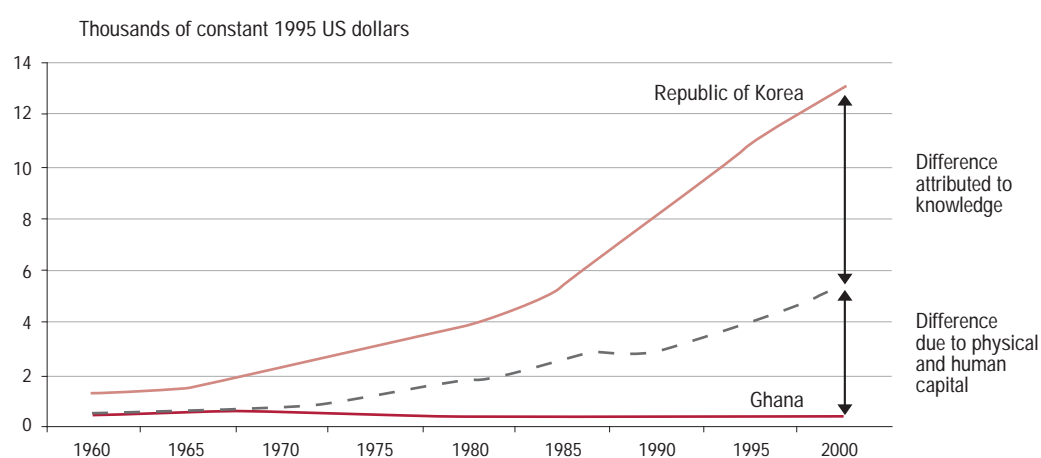
Inadequacies in physical infrastructure (e.g. unreliable and costly electricity) are a major barrier to technological innovation in both public and private enterprises. Poor physical infrastructure undermines the growth and performance of Ghana's system of innovation. The Government of Ghana should continue to invest more in infrastructure development as part of its poverty reduction and national economic development programmes.

### Box 1.1. Finding opportunities for technological catch-up

As a latecomer to the modernization process, Ghana has what has been called the “advantage of backwardness.”<sup>6</sup> In other words, in order to modernize, Ghana does not have to invent the technology for industry by carrying out research and development (R&D), but can adopt foreign technology from technologically advanced countries with relatively low risk and at relatively low cost. East Asian economies, including Japan and the four “tigers” (Hong Kong SAR, the Republic of Korea, Singapore and Taiwan Province of China), as well as China after the transition starting in 1979, all tapped into this advantage.<sup>7</sup> These countries then went on to establish their own endogenous STI capacity.

Ghana is eager to emulate this successful East Asian performance at catching up with the advanced economies. The Republic of Korea is a leading example of successful catching-up. In 1960, Ghana and the Republic of Korea had roughly comparable per capita incomes. But by 2000, the Republic of Korea’s per capita income was more than 25 times higher than that of Ghana (see box fig. 1.1.1).

Box figure 1.1.1. Republic of Korea vs. Ghana: Per capita income 1960–2000  
Knowledge makes the difference between poverty and wealth...



Source: World Bank Institute.

The Republic of Korea’s economic progress has been extremely rapid, by any standard. One important reason is that for more than 40 years, the Republic of Korea made a deliberate effort to invest heavily in science, technology, innovation and education, so that it could adopt and adapt foreign technologies into its own industrial base. Nonetheless, following this example is not easy. East Asian countries are highly diverse in terms of their natural resource base, cultural endowments and political institutions, and in their national development strategies.<sup>8</sup> On the surface, many of these countries bear little resemblance to Ghana or to each other.

However, despite their differences, East Asian national development policies had several common features which would be relevant for Ghana today. First and foremost was a series of pragmatically designed, thematically organized science and technology policies that were tenaciously pursued and explicitly designed to ensure sustained economic growth and social development. These policies included (a) a comprehensive focus on all levels of education and manpower training, spanning the range from technical and vocational education to engineering to doctoral degrees in science; (b) an emphasis on technology adoption and adaptation targeted at high-priority social and economic development challenges; (c) policies to ensure that education and R&D programmes reflect the needs and challenges of private-sector entrepreneurs and companies; and (d) private-sector development programmes that foster international competitiveness by improving the business climate, reducing the cost of doing business, and promoting the emergence of higher-value-added, knowledge-intensive export industries. Finally, these countries developed successful niches in product markets and within global supply chains that built on their existing comparative advantages, ranging from manufacturing in China to palm oil production in Indonesia. Ghana may have an opportunity to replicate these successes if it can find its own market niches and build its capacity to successfully adopt and adapt the existing and new technologies necessary to compete and to build a highly innovative and more dynamic economy.

### III. THE WAY FORWARD: BUILDING THE STI CAPACITY NEEDED TO TRANSFORM GHANA'S SOCIO- ECONOMIC DEVELOPMENT

Ghana will have to address four critical challenges if it is to emerge over the next five to ten years with a newly redesigned and more effective science, technology and innovation system – one that is capable of addressing the twenty-first century agriculture, industrial and human development challenges outlined in its development plans.

- Improving leadership, coordination, and management of STI
- Creating incentives and appropriate public support mechanisms for private-sector innovation, technology absorption, and industry-driven research
- Growing the science, engineering and technical workforce
- Aligning the research and development (R&D) system to socio-economic needs

A final critical task will be setting priorities to build around and drafting and executing a viable STI implementation plan that is integrated into its national development strategy.

#### Improving leadership, coordination, and management of STI

High-level political commitment will be required to establish a new political deal for STI. Ghana's STI system is currently trapped in a vicious circle. Funding for science and technology is relatively low by international standards, and is not sufficient to support high-quality, economically relevant STI institutions and the programmes that are needed to strengthen Ghana's productive sector. However, these low levels of funding may, in turn, be justified by the relatively low relevance and quality of the existing STI system. The renewed commitment to STI for Ghana's development that is displayed by Ghana's Government must be accompanied by a willingness to commit to reform of the existing system. This will require increasing support to areas of the STI system in line with national priorities and providing funding in the context of new programmes and policies designed to enhance the

relevance and quality of the existing STI system. At the same time, areas of the STI system that are not performing should be forced to reform if they are to continue to receive public funds.

Coordination and management across Ghana's entire STI system needs to be improved. STI touches and influences almost every industry and sector of Ghana's economy and society. Multiple ministries, departments and agencies have STI responsibilities, including not just the MEST, but also the ministries of trade and industry, health, energy, agriculture, education, communications, and others. The solution is not to centralize every STI asset under one ministry, but to improve the coordination of individual MDA decisions and ensure some general coherence to STI policymaking and implementation. The development of effective linkages between individual ministries, departments and agencies should be promoted for all STI activities that are multi-agency in nature.

The establishment of a coordinating body for STI (along the lines argued in chapter 2) should be considered. An STI coordinating body would work closely with all stakeholders involved in STI policymaking. This would include relevant line ministries, international agencies seeking to establish STI cooperation programmes with Ghana, public research institutes and research universities, education and training institutions, private sector representatives, standards bodies, and health and safety agencies.

A sustainable scheme for financing STI must be introduced. This should prominently feature competitive and matching funding designed to reorient the STI system to focus on the needs of research and technology users – that is to say, the private sector, farmers, and rural enterprises. Creating sustainable financing may mean redirecting some of the existing core funding of research institutes into competitive funding that will enable the productive areas of the STI system to thrive. This approach offers a promising way to enable necessary reforms at the research institutes within the existing funding envelope, without the politically difficult and perhaps counterproductive approach of eliminating research institutes. Additional financing mechanisms for STI should be introduced, such as industry funds, association-based financing, tax incentives, and other measures.

International linkages should be fostered across the STI system, especially at firms, universities and research institutes. Universities and research

institutes should increase the number of applications to international research tenders, as well as their overall presence in international research networks. This should be done in partnership with the private sector when at all feasible. There is significant funding from governments, foundations such as the Gates Foundation, organizations such as the Consultative Group on International Agricultural Research, and other sources of innovation targeted for African countries that goes unused each year and could provide new funding for Ghana's researchers and innovators.<sup>9</sup> Universities should continue foreign exchange and "sandwich" programmes for students.<sup>10</sup> Finally, programmes should target Ghana's diaspora in order to bring technology, technical knowledge, skills and entrepreneurial expertise to the private sector.

### Creating incentives and appropriate public support mechanisms for private-sector innovation, technology absorption, and industry-driven research

The orientation of Ghana's STI system should be actively shifted towards a demand-driven orientation. This means that the private sector (firms, farmers and rural enterprises) should be the main focus and driver of technological development, backed up by effective government support. Public funding should provide incentives to Ghana's STI institutions, universities and firms to concentrate on the concrete development challenges of the private sector. Government planners should set funding priorities and encourage the users of technology – especially entrepreneurs and firms – to define their own agendas within these priorities to the extent that they are able to do so (with support provided as needed). For example, farmers should identify their technology needs, whether for increasing crop production, improving harvesting or post-harvesting, or adding value to commodities. Government can provide support, especially for smallholder farmers, in providing information and in the identification of existing potentially useful technologies (e.g. through effective extension services). Funding could then be made available to these farmers to work with universities, research centres and other technology providers to help meet the needs that they have identified. Funding programmes, incentive schemes (e.g. R&D tax credits), other support for STI development, intellectual property legislation, university and research institute incentives at the individual and institution level, and all other STI policies

should have a primary focus on meeting the real STI needs of the firms, farmers and rural enterprises in Ghana.

The Government should improve fiscal and legal incentives for local entrepreneurship and the promotion of innovation in private enterprises. Local private-sector firms are not really attuned to procuring or investing in innovations to improve their productivity. There is a need to focus on promoting and supporting technological innovation in and by the private sector. High-performing enterprises – essentially innovators – should receive special recognition and incentives such as tax exemptions for expenditure on R&D, technology procurement, and innovation in general. Secondly, the Government should establish a national funding scheme or instruments to promote R&D and technological innovation in the private sector. This could take the form of competitive grants to private firms that twin or partner with public R&D institutes to conduct economic-oriented research or the development or adaptation of a particular technology. The Ministry of Trade and Industry is key to promoting technological innovation and industrial development. It should champion selected economic areas or projects as part of the country's efforts to raise industrial productivity, increase exports, and help attain middle-income economy status. The Government of Ghana could invest in promoting the country as a special location for a few selected foreign technology businesses in a targeted manner in activities where this could help to create local linkages and stimulate local upgrading.

New incentives should be put in place for private-sector innovation that supports the country's development priorities. Industries with high growth and job-creation potential – including agriculture, manufacturing, information and communications technology (ICT), construction and tourism – represent areas where incentives for innovation might offer high potential returns. Creating incentives for market-driven innovation and technology adoption, backed up by effective public support measures, should be a central focus of government policy, as should improved leadership, coordination and management of the country's STI system. Taking agriculture as an example, the Government should create the incentives for farmers, farmer-based organizations and agribusinesses to find and adopt the irrigation, cultivation, harvesting, post-harvesting and processing technologies that would benefit them

through higher productivity and increased profitability. The Government's role would be to provide pragmatic support measures needed to help farmers (particularly smallholders) and firms to overcome market and systemic failures.

Innovation should be recognized in government programmes to include "new-to-the-market" as well as "new-to-the-world" innovations. The appropriate focus for Ghana should, in general, be technology adoption together with innovation, given that developing countries typically have more to gain in terms of growth

and improved standards of living from the diffusion, adoption and assimilation of technology that already exists in the world as a basis for local innovation than from riskier and more costly invention and commercialization per se. Therefore, technology adoption and "new-to-the-market" innovation should be the prioritized targets of government incentives and support programmes. R&D should focus mainly on assisting enterprises to become more effective at adopting or adapting technologies, and on providing solutions to local problems.

#### Box 1.2. Using STI to develop Ghana's food and agroprocessing sector<sup>11</sup>

Science, engineering and technology (SET) institutions in many countries act as focal points for the translation of scientific and technical knowledge into useful agricultural products, processes and services. Developing countries such as Brazil, India and Malaysia that have made sustained commitments to investment in SET have had increasing success in agroprocessing industries.

Aided by the latest innovations in science, technology and engineering, and utilizing a diversity of resources to ensure the quality and safety of the products they produce, many established and emerging economies have created a unique competitive edge in lucrative markets for their products. And they have done it not on the basis of lower labour costs, but by capitalizing on state-of-the-art technologies, logistics, market intelligence and global alliances to manufacture and deliver products in a timely, cost-effective way. Malaysia's palm oil industry and Brazil's ethanol industry are examples of industries nurtured by successful SET institutions.

The food and agriculture processing industry offers similar opportunities for Ghana. Demand for food in sub-Saharan Africa is expected to reach \$100 billion by 2015, double its level of 2000.<sup>12</sup> However, there are technological constraints cutting across all the productive agriculture subsectors, including lack of technical and management skills in farm and off-farm workers, limited access to technology and extension services, and poor facilities for new product development and test marketing. Non-technological constraints exist too, including supply inconsistencies, poor infrastructure such as roads, irrigation, and cold chains, limited access to finance, land tenure issues, weak linkages to markets, lack of business development services, and trade barriers.

The background study on food and agro processing suggested the following strategies for developing the sector:

1. A public-private partnership should establish a network of two or three agribusiness innovation centres (AICs), distributed among the three major agricultural zones in the country and located at the premises of existing institutions of higher learning. The AICs would act as hubs for the economic clusters of the food and agro-processing industry. The objective of the AICs would be to catalyse and support new innovative business activity by offering firms an environment to experiment, test and pilot product innovations and business ideas.
2. The Government should encourage funding mechanisms for market-oriented research, development and innovation performed by Ghana's agribusinesses. Funding mechanisms could include commodity "check-off" fees to be collected and invested by industry associations, national competitive matching grants, tax credits for innovation-related activities, or the scaling-up of existing sources of funding including the national venture capital fund and the research endowment fund.
3. An industry advisory group should be established to guide the food and agro processing industry's development, composed of government, university, research institute, and industry representatives.



**Box 1.3. Innovation in Ghana's traditional and herbal medicines sector<sup>13</sup>**

Ghana has a long tradition of valuing and supporting the development of traditional medicine. Traditional medicine practitioners and traditional herbal medicines remain key elements in the provision of healthcare to around 60 per cent of the population, but still operate outside the public sector health system, despite long-held expectations that the two could be integrated. Traditional herbal medicine (THM) is also perceived as having the potential to make a contribution to the economy through the development of plant-based medicines for export.

However, despite over 40 years of efforts, long-held expectations about the role of traditional medicine in Ghana have not yet been met. Government efforts at the policy level to promote and mainstream THM in Ghana have intensified in recent years. Science, technology and innovation are seen as key factors in the development of THM, and have been given prominence in current policy objectives.

If efforts to bring about the commercialization of safe and effective packaged herbal products – either as medicines or food supplements – can be intensified, the country could set the standards for the integration of THM into both healthcare and the wider economy. A “big push” along these lines might give Ghana a competitive edge in foreign markets that are now, collectively, worth over \$60 billion, as well as fulfilling the long-standing goals of the healthcare system.

The background study on traditional and herbal medicine suggests eight policy changes should take priority for the future development of THM in Ghana:

1. A set of studies/meetings to evaluate, both qualitatively and quantitatively, the potential markets for THM should be given the highest priority in plans to develop the THM industry.
2. Develop a clearly articulated strategy to support micro and small-scale THM enterprises.
3. Consideration should be given to the introduction of a more gradual and inclusive process of herbal medicine registration, but with fixed phase-in schedules.
4. Strengthen the role of the Pharmacy Council to support regulatory compliance through pharmacists and chemical sellers, and the capacity of the Food and Drugs Board to handle a large increase in applications for approval of traditional herbal medicines.
5. Alleviate the potential distrust of regulatory science on the part of THM producers by means of standard letters of contract produced and signed by scientific institutions that carry out regulatory testing.
6. Strengthen the capacity of the Research Committee at the Centre for Scientific Research into Plant Medicine (CSRPM) to coordinate government-sponsored multi-disciplinary research programmes into traditional herbal medicine.
7. The Ministry of Health should establish a permanent mechanism for identifying, prioritizing, and funding public sector R&D programmes that support the development of THM products of interest to the country.
8. Consider establishing a THM development fund with the cooperation and participation of MOFA, MOTI and the Ministry of Health (MOH). A proportion of the fund should be ring-fenced for demand-driven R&D activities carried out by the private sector.

### Growing the science, engineering and technical workforce

Emphasis must be placed on education and training to meet the needs of a modernized economy. Support for science and engineering education should be increased at the undergraduate and postgraduate level. Innovative loan schemes, scholarships, and other means should be used to meet Ghana's stated goal of a 60:40 ratio of science and technology to social science students in public universities. In 2007, the share of S&T graduates in the total cohort ranged

from 8 per cent (UoG) to 63 per cent (KNUST). All universities graduated fewer than 1 per cent of their students with a PhD in S&T subjects, meaning that they contributed barely a handful of highly trained junior scientists or engineers to the country in a given year, including for the replenishment of their own faculty. Science and mathematics education should be emphasized at all levels of the education system, from primary to postgraduate. New technologies, including ICTs, offer the opportunity to improve both access to education services and the quality of these services.

Opportunities for improving training outside of the formal education system should also be encouraged. This means that technical education, apprenticeships, in-service training, and other means should be supported to ensure the workforce is appropriately skilled to master new technologies, and to meet the demands of jobs in modern-day industry, agriculture and services.

Priority should be given to attracting highly educated and skilled Ghanaians in the diaspora to contribute to Ghana's development. As is the case with many developing countries, a significant number of Ghanaians have been educated overseas, where they have stayed to become successful scientists,

engineers and business people. Attracting these Ghanaians to return and contribute to Ghana's development will do much more for the country than the remittances these émigrés might send home. However, experience from other countries suggests that it will take more than financial incentives to attract skilled returnees. Professional recognition, the opportunity to conduct high-quality research in top facilities, and incentives to start businesses that contribute to the country's development are equally important. Ghana can learn from countries such as the Republic of Korea, China and India, which have used a package of incentives to attract their diaspora to return to their country of origin.

#### Box 1.4. Using ICTs to improve education and training<sup>14</sup>

Since the early 1990s, Ghana has considered the use of ICT as a means to leverage the country's development process. The Ghana ICT for Accelerated Development Policy (ICT4AD), which was officially adopted in 2004, has an objective of transforming Ghana into an information-rich, knowledge-based and technology-driven economy and society.

Several resulting initiatives aimed at deploying ICT in schools and communities have been launched in partnership with the private sector and international organizations. These initiatives have created a momentum for the introduction of ICT in education and were therefore at the origin of the development of an ICT in education (ICTE) policy and strategy that embraces the ICT4AD vision for Ghana.

Ghana nevertheless faces major challenges in terms of slow growth of internet and PC penetration. In addition, despite Ghana's connection to an international fibre optic cable, broadband internet is still at an early stage of deployment within the country. In contrast, Ghana has experienced rapid growth in mobile telephony access since 2003.

The background study on ICTs in the education system put forward the following four key recommendations:

1. The Ministry of Communications should design and implement an internet development policy to accelerate internet deployment in order to reach a critical threshold permitting the country to take advantage of the full potential offered by the network. Consideration could also be given to creating innovative measures to promote the wider use of mobile telephones featuring e-mail and internet access, which are becoming increasingly functional.
2. The Ministry of Education should design plans of action that would ensure a clear linkage between the ICTE policy's thematic objectives and its implementation phases and specify clearly the role of the different actors and budget each of the actions.
3. Evaluation of distance learning programmes should be carried out and the evaluation outcomes should be considered carefully. The outcome of the evaluations of the distance learning programme for high schools and the Open Schooling in Technical and Vocational Education and Training (TVET) component should be studied carefully before considering their extension.
4. The universities involved with distance education with the support of MOE should consider combining their efforts and establishing a joint distance education programme. The joint programme could aim to lead to the eventual creation of an Open University. A major objective of this university would be to answer the unfulfilled need for university training, since only 42 per cent of qualified applicants (16,628 out of a total of 40,062 qualified applicants) were accepted at public universities to continue their studies in 2006, and the number of applicants will grow further in the future.

## Aligning the research and development (R&D) system to socio-economic needs

Ghana's public R&D institutes and research universities need to be strengthened so that they have the scientific capacity and equipment needed to conduct first-class, economically relevant scientific research. Much of the scientific knowledge generated by public R&D institutes is not turned into useful products and services because public R&D institutes lack the entrepreneurial culture and incentives to work closely with the private sector. Local private-sector firms do not see the advantage of investing in R&D or working with R&D institutes to improve their competitiveness and productivity. Foreign companies operating in Ghana also make little use of Ghana's domestic R&D institutes. Ghana will not be able to develop globally competitive agricultural and industrial enterprises without mobilizing the scientific knowledge and technological expertise in these R&D institutes.

R&D must become much more focused on Ghana's development challenges. Public research institutes should view themselves as "technological service providers" whose mission it is to support local firms, farmers, and other economic actors for the development of their local economies. Universities must be more fully utilized for development, not only by producing an educated workforce, but by working more closely with the private sector, modernizing agriculture and agribusiness, and undertaking problem-oriented research to support community needs. Accordingly, the next generation of faculty must be trained to take over from the large number of faculty nearing or having passed retirement age. This faculty must be able to work in multi-disciplinary teams and integrate research with teaching, whereas, at present, research gets limited attention in the activities of faculty.<sup>15</sup>

Existing areas (centres) of excellence in the research system should be identified and nurtured. To make this possible, the Government should abandon its zero-sum game approach whereby successful income-generation on the open market is penalized by reductions in the government subvention. Good performance should be rewarded at all levels, which means that for budget purposes the idea of co-funding should be introduced. If the Government wants Ghana to become a knowledge economy, it must realize that such a path will neither come cheap nor be short. Knowledge workers need to be well paid. They also need quality equipment and facilities.

The discrepancy in salary between scientists at the institutes and academics at the universities is not justified.

Likewise, at universities, an effort to attract top-notch scientists and to reward them with working conditions commensurate with their impact – a lighter teaching load, fully sponsored postgraduate assistants, acceptable lab facilities, and so on – would improve the ability of the universities to increase their presence, even if only selectively, in global knowledge networks. In these selected centres of excellence, it is important that rules and incentives facilitate a market for ideas, seed funding, and project execution, so that the most vibrant and relevant parts of the research infrastructure can grow while those that do not produce what is expected of them are allowed to close down.

The research system must become more efficient. This concerns staffing levels at the research institutes, in particular. Core/support staff ratios in Ghana bear little comparison to those in similar organizations elsewhere. Across the system, the management of research, technology, people, and their ideas must become more professional.

Research funding decisions should be shifted to an independent body that manages grant applications on a competitive basis, selected on an independent, peer-review and technical-review basis. Public funding for research should be increasingly shifted away from government subvention and to competitive schemes in order to ensure that the best ideas are getting support.

The research system must substantially increase its external income. This requires, first and foremost, a motivated scientific and academic workforce. Hence, powerful incentives must be put in place to encourage people to win (especially) international research tenders and to commercialize technological innovation. Secondly, it requires a supportive and professionally managed environment in which researchers can rely on upstream (e.g. tender opportunity scanning) and downstream (e.g. marketing, network-building, commercialization, IP management) services whose delivery is essential for the success of core activities.

Finally, the entire system should increase its self-reflexivity. Annual reports should be taken more seriously. Strategic plans that are not updated on a regular basis have little use. Reviews should be undertaken at regular intervals, including through external panels, in order to monitor whether the system

is on track. Ghana's research system is in general very poorly documented. Poor documentation comes at a cost to the system in terms of low (international) visibility, consequently fewer chances to get involved in global knowledge networks, and therefore foregone opportunities to exploit S&T for local development.

Experiences from CSIR, South Africa, India and Colombia (see box 1.5) show that CSIR's sister organizations have confronted – and adapted to – change in their economic environment. This has often entailed very considerable modifications to the way they operate. Along the way, their performance has improved. Hence, the way in which these systems are run determines in no small way what and how they deliver. Ghana can learn from these insights. For example, over a period of under a decade (1999–

2005), the Indian Institutes of Technology (IITs) went from an exclusive focus on training highly skilled people, to making use of their intellectual assets for economic development while also generating revenue for themselves. Whereas patent applications at the IITs did not even amount to a handful in the early 1990s, the three universities filed nearly 90 patents in 2005. Sponsored research and industrial consultancy projects more than tripled at the IITs over the same period. All of this happened in an institutional context comprising technology transfer offices (TTOs), industrial liaison agencies, entrepreneurship cells and incubation units. Perhaps most importantly, the spillovers associated with public–private collaborations led to more economic activity in the form of start-up firms and job creation.

#### Box 1.5. Modernizing public research institutes: A model from Colombia

The Colombian Plastic and Rubber Training and Research Institute (ICIPC)<sup>16</sup> was founded as a non-profit organization. Its mission is “turning knowledge into wealth” by contributing to technological innovation leading to increased productivity and competitiveness from the rubber and plastics cluster in Colombia. The Institute started its activities in 1993, and is now widely acknowledged as one of the most successful of the more than 30 technology development/transfer centres currently operating in various Colombian industries.

The portfolio of ICIPC activities is made up of applied R&D activities funded by government and international grants, as well as contracts with private firms (about 65 per cent), laboratory testing services (about 12 per cent), training activities (about 10 per cent) and specialized consulting services. The staff consists of just 20 people, of whom 13 have MSc or PhD degrees (mostly earned abroad). Employees must have multi-faceted skill profiles – for example researcher, professor and consultant combined with management and marketing skills. Modern equipment and infrastructure resources allow the staff to provide up-to-date technology-transfer, educational and consulting services to a large number of firms producing and using rubber and plastic products in Colombia and some neighbouring countries.

Besides the highly qualified personnel and the modern infrastructure, the secret of ICIPC's success is its active networking programmes with local as well as foreign academic, R&D and industrial organizations. For example, in addition to education and training collaboration with EAFIT University, ICIPC has working relationships with four other Colombian universities, as well as the University of Wisconsin (United States) and the Universidad del País Vasco (Spain). As a result, ICIPC is able to offer not only short-term seminars, workshops and customized training modules for plastic industry enterprises, but also the formal “Programme of Specialization in Plastic and Rubber Conversion Processes” and “Master's in Engineering of Polymer Processing” programmes (both jointly with EAFIT University). A postgraduate programme is likely to be offered in the near future.

Another secret of ICIPC's success is its active work with existing international databases, including those of the United States Patent and Trademark Office, Patent Abstracts of Japan, Dialogue, STN, Science Direct, and others. Performing extensive information searches prior to any R&D work has been a standard practice in ICIPC since 2003, and this service has become quite popular with its clients (in 2003–2005 it was used by 73 enterprises).

Searching for existing foreign technologies and adapting them to the needs of local enterprises probably makes up the bulk of ICIPC's R&D activities. This is an appropriate model for any technology dissemination agency, but particularly one in a small economy such as Colombia or Ghana where the absolute scale of national R&D will, by definition, be quite small relative to global R&D output. In addition, ICIPC also produces some original R&D results, as evidenced by the 9 patents which it has already applied for or received. It intends to license these patents to its client enterprises.

## Setting priorities and creating an implementation plan

Ghana should not begin by attempting to fix the entire STI system at once. Ghana's public STI investments, equivalent to about \$49 million per year (most of which goes on salaries and fixed costs at the public research institutes) are small in comparison to the size of Ghana's STI needs. Discretionary funding for R&D amounts to less than \$10 million annually. This is equivalent to only a few small research grants per institution if the funds were spread equally across Ghana's system of twenty to thirty research-focused institutes and universities. The private sector does not yet contribute significantly to STI investments. Therefore, the Government should set clear priorities for its STI budget and focus its resources on those areas. This is not the situation today. Currently the STI budget is spread thinly over the public institutes, leaving little funding to promote innovation and technological development in the private sector or even for research expenditures in the public system.

In the short term, Ghana must find existing sources of demand in its domestic market for technology around which to build its STI capacity. Examples of this might include planned investments in modernizing agriculture, ongoing investments in national infrastructure, oil and gas industry development, or investments in modernization of government. Similarly, Ghanaian firms can provide technologically-based services to donor agencies – Ghanaian firms competing for and

winning contracts to supply aid agencies in the areas of roads, health, education and communications.

Building STI capacity around existing demand offers both the opportunity for near-term productivity improvements and direct economic pay-offs, as well as an opportunity to generate the resources for long-term STI capacity-building. For example, a firm that finds a niche installing modern irrigation systems at farms builds up its own capacity to upgrade technology through its own earnings. This same firm then raises its own level of technology and innovation investments as it grows, and demands technology from equipment suppliers, research from agriculture-focused research institutes, and graduates from university agricultural engineering programmes. By focusing a government programme around this type of niche that has existing demand in the marketplace, it is possible to build up a critical mass of firms and providers and sustainable STI funding.

The country's newly updated national STI policy provides a basis for setting STI capacity-building priorities. This document should be supported by a practical implementation plan that sets priorities, measurable objectives, deadlines, and funding plans. To ensure that a national STI policy is implemented, Ghana needs to develop and use a clear multi-year (say, 10-year) rolling implementation strategy. The strategy should have clear benchmarks and articulation of institutional responsibilities. It should distinguish between short- and medium-term objectives and long-term capacity-building challenges.

## NOTES

- <sup>1</sup> The World Economic Forum's Global Competitiveness Report 2009–2010 is available at <http://www.weforum.org/pdf/GCR09/GCR20092010fullreport.pdf>.
  - <sup>2</sup> A list of the participants and minutes from the initial STIP Review planning meeting is available from CSIR-STEPRI. Stakeholders were drawn from business, academia, scientific bodies and civil society.
  - <sup>3</sup> President's Committee on Review of Education Reforms in Ghana (2002). Meeting the Challenges of Education in the Twenty-first Century.
  - <sup>4</sup> The research system review covered the following research and higher education institutions: the Council of Scientific and Industrial Research (CSIR) – specifically the Crop Research Institute (CRI, Kumasi); the Food Research Institute (FRI, Accra); the Institute of Industrial Research (IIR, Accra); the Oil Palm Research Institute (OPRI, Kade); the Centre for Scientific Research into Plant Medicine (CSRPM, Mampong-Akuapem); the Cocoa Research Institute of Ghana (CRIG, Tafu); the University of Ghana at Legon (UoG, Legon); Kwame Nkrumah University of Science and Technology (KNUST, Kumasi); and the University of Cape Coast (UCC, Cape Coast).
  - <sup>5</sup> CRIG publications are for 2000. The figure for CSIR ISI publications might partially overlap with those of the institutes; it is not the total for the entire organization.
  - <sup>6</sup> This terminology was popularized by economist Alexander Gershenkron.
  - <sup>7</sup> See, for example, Shanta Devarajan (World Bank Chief Economist for Africa) in *China's Miracle Demystified*, available at <http://blogs.worldbank.org/africacan/china-s-miracle-demystified>.
  - <sup>8</sup> Portions of this paragraph are adapted from "Science, technology and public policymaking in Ghana", a keynote address given by Professor Edward S. Ayensu at the eighth Public Service Commission Annual Lecture. May 2005.
  - <sup>9</sup> See, for example, <http://www.scidev.net/en/opinions/africa-analysis-lateral-thinking-for-research-funding.html>.
  - <sup>10</sup> Sandwich programmes most commonly support university students to train at foreign universities for the middle two years of their studies and at a home country university for the first and fourth years.
  - <sup>11</sup> See the background study on STI in Ghana's Food and Agro Processing Industry for a detailed discussion of this topic.
  - <sup>12</sup> Association of Ghana Industries (2007).
  - <sup>13</sup> For a detailed discussion of this topic, see the background study on innovation in Ghana's traditional and herbal medicine sector in part II of this report.
  - <sup>14</sup> For a detailed discussion of this topic, see the background study on ICTs in Ghana's education system in Part II of this report.
  - <sup>15</sup> The limited attention to research is the result of several factors, including the explosive growth in enrolments, limited research funding, few incentives to carry out peer-reviewed and published research at universities, and other factors. For further discussion of the topic, see the report of the University of Ghana Visitation Panel, available at [http://www.col.org/SiteCollectionDocuments/UofGhana\\_no%20picsweb.pdf](http://www.col.org/SiteCollectionDocuments/UofGhana_no%20picsweb.pdf).
  - <sup>16</sup> For additional information on ICIPC, see [http://www.wipo.int/sme/en/best\\_practices/icipc\\_colombia.htm](http://www.wipo.int/sme/en/best_practices/icipc_colombia.htm).
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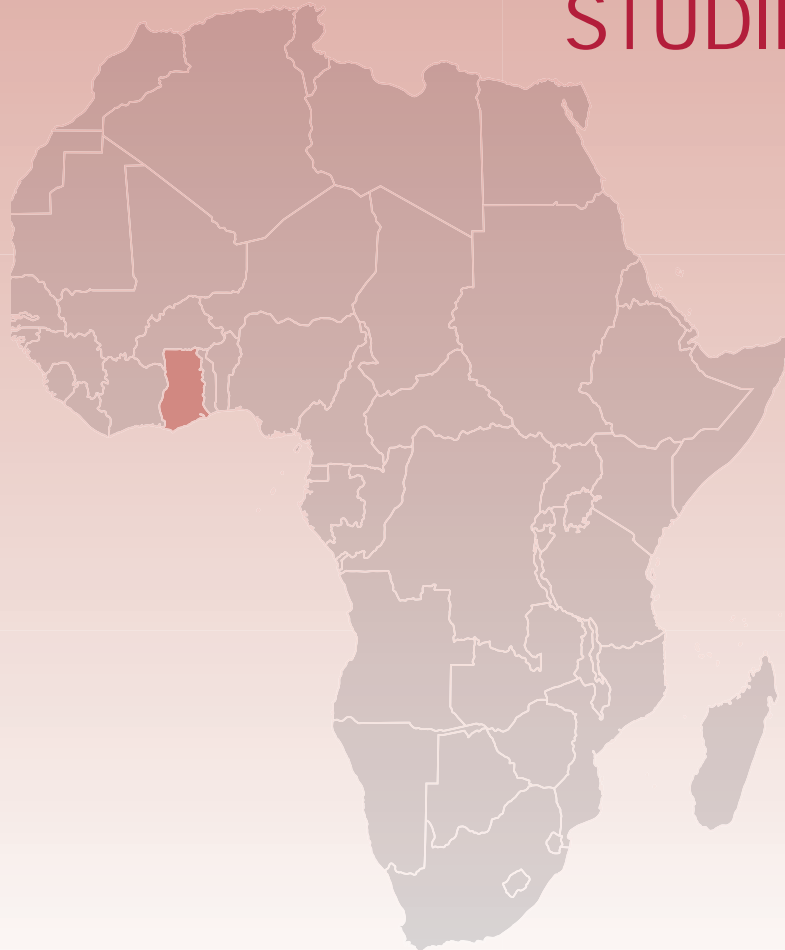


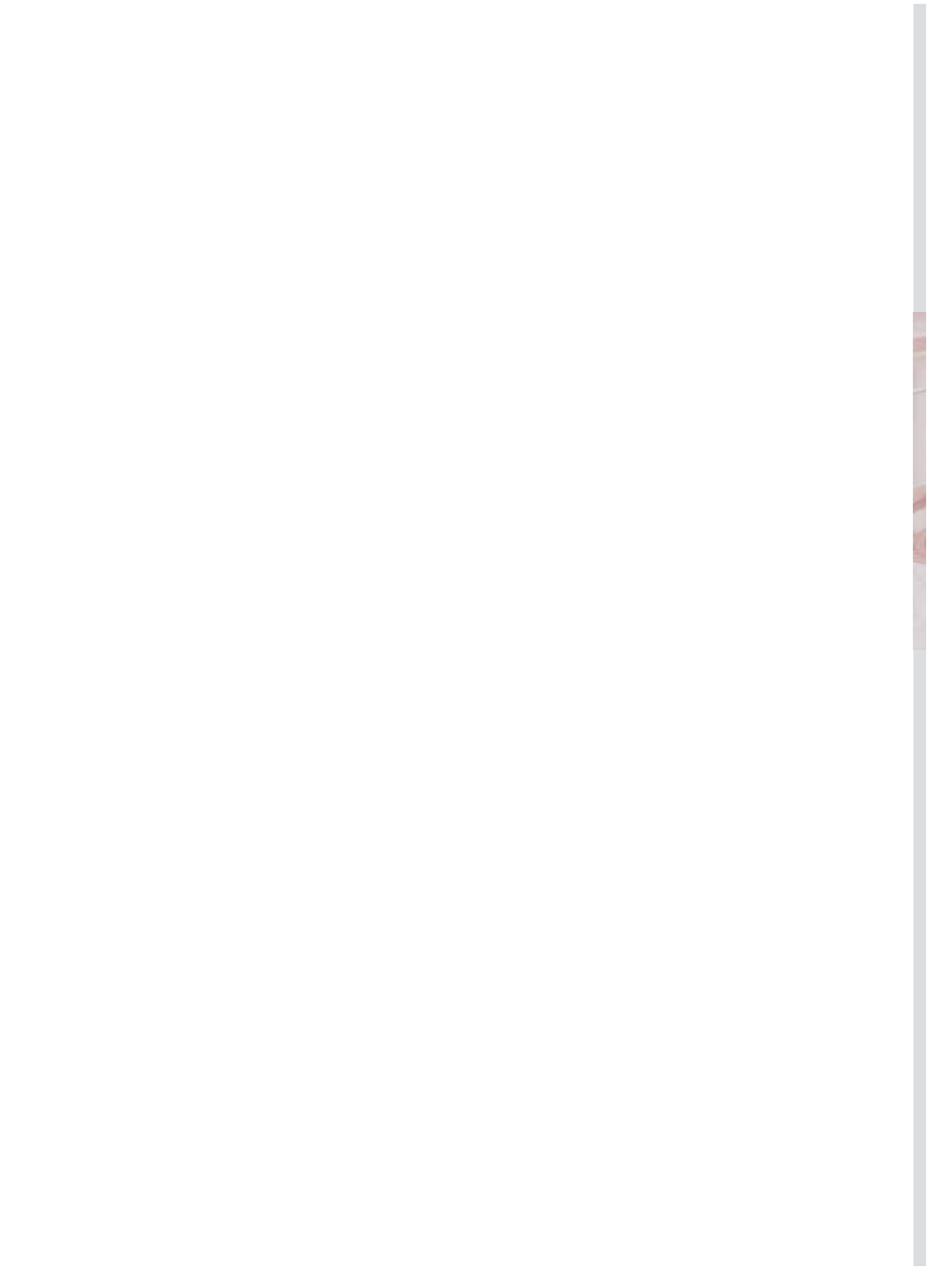


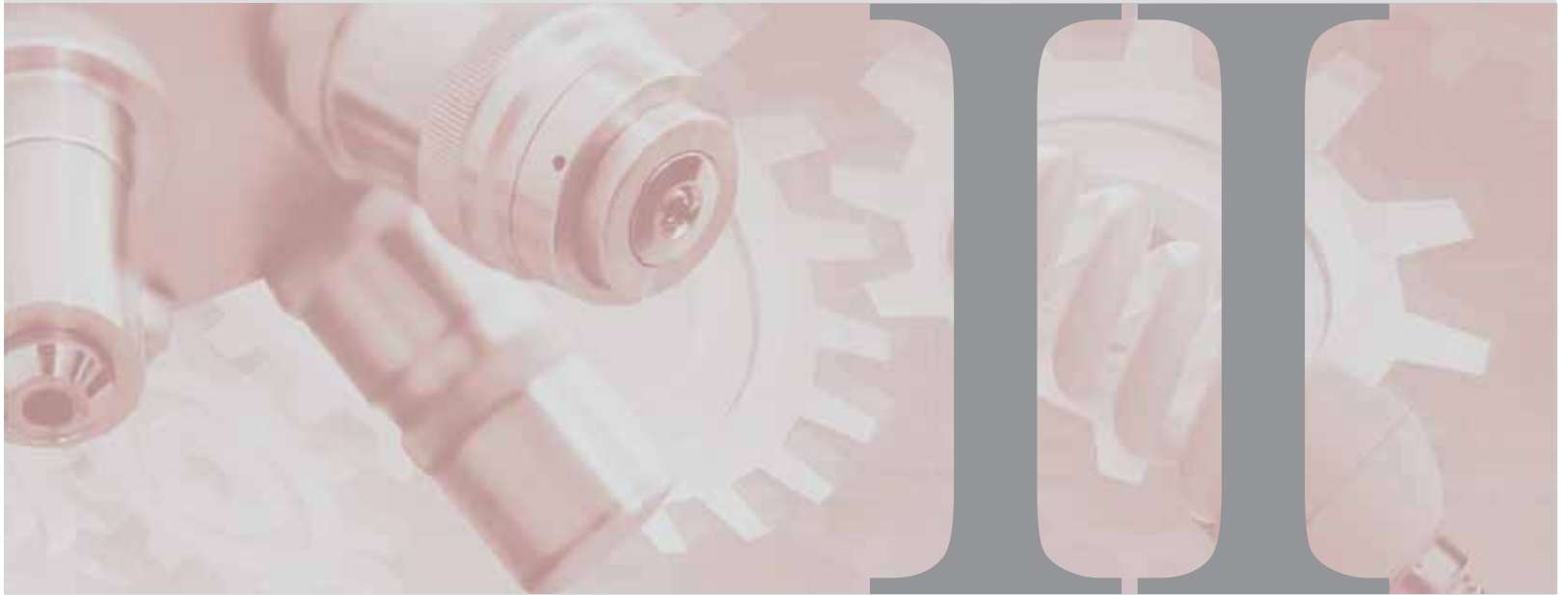
# PART 2



## BACKGROUND STUDIES







# Ghana's National Innovation System



## GHANA'S NATIONAL INNOVATION SYSTEM

### 2.1 Introduction

There is substantial evidence that technological development and innovation – the production and use of knowledge as well as the creation and adoption of new products (goods and services) and new ways of doing things – are keys to creating sustained economic growth and improved standards of living. They are central to the economic and social progress and trade competitiveness of nations, and to their development, although they are not on their own a panacea for growth and development. High-income and middle-income countries are largely characterized by high levels of innovative capacity and activities. The production and application of knowledge are also critical for poverty reduction and the attainment of the Millennium Development Goals (MDGs), and to face pressing environmental concerns such as adaptation to and mitigation of climate change.<sup>1</sup>

Ghana's Government recognizes the role of knowledge and innovation in transforming the economy, reducing poverty and increasing the country's competitiveness in international and regional trade. This recognition is reflected in various political and policy statements of the Government. For example, Vision 2020 – the country's long-term framework for development – prepared by the National Development Planning Commission of Ghana, lays emphasis on the role of local entrepreneurship and technological development in the attainment of sustainable development of the country. Ghanaian policymakers and politicians occasionally make reference to the roles that science, technology and innovation play in economic development, and why their country should invest more in research and development (R&D). However, these statements have often not been backed up by specific actions. The private sector remains relatively underdeveloped, and is unlikely on its own to be capable of generating innovation of the type – and on the scale – needed to create a dynamic engine of growth in the medium and longer term without a more supportive policy environment that promotes innovation.

The country's national innovation (NIS) system is relatively small and underdeveloped compared to those of middle-income countries, such as India.

While its overall economic and political governance framework has been improved considerably during the past eight years or so, its policies and institutions for science, technology and innovation have not been modernized or aligned to economic growth and human development goals. Some of its R&D institutes date back to (or were established during) the colonial period. These institutes have been instrumental in generating scientific knowledge and promoting the development of technology. However, there is still much more that the Government of Ghana needs to do to modernize them and stimulate the growth of a national system of innovation.

This chapter presents a profile of the institutions, policies and linkages that characterize Ghana's science, technology and innovation system. It focuses on the strengths and weaknesses of the nation's system of innovation. It examines the nature of the policies, programmes and institutions that Ghana has put in place in order to promote technological innovation for economic growth and development. The study places emphasis on the nature of the institutional arrangements that Ghana needs in order to build a dynamic system of innovation that stimulates innovation among enterprises and supports technological development. This is seen as important in order to provide an enabling environment that is supportive and helps stimulate technological development and innovation in the private sector, which, at present, remains underdeveloped and can be characterized as investing relatively little in adopting new technologies and in innovative activities. It is likely that an improved incentive structure that encourages the adoption of new technologies and investment in innovation, along with additional support measures, will be needed to stimulate increased private-sector investment in STI development, as the private sector itself grows and becomes stronger. It examines how R&D and technology institutions are organized, funded and used so as to contribute to the transformation of the economy into a middle-income one. Linkages among public institutions and between public-sector organizations and private firms are explored.

The first section is a brief overview of the country's economic setting. It discusses economic trends, foreign direct investment (FDI), and the trade policies and exports of Ghana. The second section focuses on the science and technology institutions, while the third section deals with related policies. The fourth section discusses the strengths and weaknesses of

Ghana's innovation system. The last section offers recommendations for building the national innovation system to enable Ghana to achieve the status of a middle-income economy.

## 2.2 Economic outlook and prospects

### 2.2.1 Macroeconomic performance and conditions

Ghana's economy has been experiencing growth since the early years of the new millennium. In 2007, real GDP growth reached an estimated 6 per cent.<sup>2</sup> The growth of Ghana's economy is largely due to good performance and higher productivity in the agricultural sector, as well as strong commodity prices for cocoa and gold. The upsurge in economic growth is also associated with improved or better economic policies, a stable political environment, increased domestic private-sector investment, and increased levels of FDI.

In common with most African countries, the economy of Ghana is largely based on natural resources. Agriculture is Ghana's main economic activity. Agriculture accounted for 34.7 per cent of GDP in 2007.<sup>3</sup> Cocoa is the main cash crop. It provides a large proportion of national revenue and forms a big share of exports. However, the agricultural sector's growth is constrained by poor infrastructure and technological backwardness. The country's agriculture is largely rain-fed. There is limited irrigation. Storage facilities are inadequate, and poor road infrastructure is a major barrier to increasing agricultural productivity.

Ghana's industrial sector is comprised of mining and quarrying, manufacturing, and construction subsectors. In 2007, the industrial sector accounted for 24.6 per cent of Ghana's GDP. In 2006, the manufacturing subsector grew by 4.2 per cent, compared to 5 per cent in 2005.<sup>4</sup> The decline in the growth of manufacturing and industrial output was largely caused by the 2007 energy crisis, which was associated with falling electricity output, high taxes, an influx of cheap imports from countries such as China and India, and poor transport infrastructure.

Services constitute the fastest-growing sector in Ghana, making up about 30 per cent of GDP. The services sector is comprised of the finance, tourism, and insurance subsectors. In 2007, the services sector grew by 8.2 per cent.<sup>5</sup> Tourism was the fastest-growing subsector. Between 2000 and 2006, tourism arrivals increased by 47 per cent, while tourist spending increased by 69 per cent.<sup>6</sup>

Ghana's strong recent growth performance has been accompanied by noticeable achievements in poverty reduction. According to Bogetic et al. (2008: 20), "Ghana is likely to face good growth prospects and is likely to achieve the poverty MDG well ahead of schedule... [M]icro-simulations show that the proportion of Ghanaians living below the poverty line could fall to 11.4 per cent, an impressive achievement for a country where more than half of the population lived in poverty in 1990." Nevertheless, poverty is still widespread, and some 45 per cent of the population lives on less than \$1 a day.<sup>7</sup> In addition, economic conditions have deteriorated in most countries since the start of the global financial and economic crisis in 2008 – including in Ghana (despite its apparent relatively strong resilience so far) – and will make achieving the MDGs an even greater challenge.

The Government of Ghana has adopted and pursued two growth and poverty-reduction strategies (GPRS and GPRS II), with the objectives of significantly reducing poverty, improving basic infrastructure (such as roads, water and sanitation), improving education, and accelerating private-sector development, inter alia. GPRS II expresses support for building science and technology capacity, but does not suggest programmes to directly promote this goal.

Despite the Government's efforts, prospects for long-term economic change and growth are undermined by Ghana's overreliance on exports of primary commodities. The economy's potential for higher performance will also continue to be constrained by the high cost and difficulty of obtaining financing, the underdeveloped transport infrastructure, unclear land ownership, frequent power and water cuts, and low levels of human capital development.

### 2.2.2 Foreign direct investment and private-sector development

The Government of Ghana has adopted a wide range of policy, institutional and legislative measures to attract FDI. The main foreign investors or sources of FDI are the United Kingdom, Malaysia, Germany, China, the United States, India, Nigeria and South Africa. Most of the investments are in mining and manufacturing.<sup>8</sup> In 1994, the Ghana Investment Promotion Centre (GIPC) was created to govern investments in all sectors except minerals and mining. GIPC has reduced the amount of bureaucracy for registering foreign companies and for the licensing of projects. Ghana was ranked 87<sup>th</sup> out of 181 countries by Doing

Business 2009 in the ease of doing business list (World Bank, 2008).

FDI flows to Ghana have contributed to the generation of employment and building of skills. According to UNCTAD (2003b), FDI has had direct and multiplier effects on the level of employment, its quality, and the skills of the labour force, but in some sectors this has not contributed to promoting labour-intensive activities. In mining, for example, capital-intensive production has created relatively few low-skilled jobs, but it has led to productivity improvements and skills upgrading. However, there is a skills shortage, which acts as a disincentive for FDI flows. Ghana's education system does not produce graduates who meet or have qualifications for foreign investors' qualification requirements (UNCTAD 2003b: 12). The Government of Ghana has initiated a number of reforms in the education sector in order to strengthen the technical content of teaching and training in Ghanaian institutions. Some of these reforms are discussed later in this study.

Related to efforts at attracting increased FDI flows are the Government of Ghana's efforts to promote development of the local or indigenous private sector. Private-sector development in the country has been sluggish. According to the African Development Bank (AfDB), "private-sector investment has fallen from about 57 per cent of aggregate investments in the early 1990s to below 50 per cent in 2004. The share of private fixed capital formation in GDP, which improved from 7.1 per cent in 1995 to reach 14.5 per cent in 2000, declined to 12.5 per cent of GDP in 2004."<sup>9</sup> Foreign-owned private-sector activities are concentrated in banking, food processing, refining, and aluminum-smelting.

The creation of free trade zones is one of the efforts to promote private-sector development. The zones are mainly located near the seaports of Tema and Takoradi, and near Kotoka Airport. However there are other firms, located in other parts of the country, operating under the free zone licence. Incentives such as a year's corporate tax holiday and zero duty on imports are provided to enterprises that export at least 70 per cent of their outputs. Foreign firms located in the free trade zones are expected to mentor local or indigenous businesses.

Despite the Government's efforts to stimulate private-sector development, there are still major constraints. These include poor and inadequate transport

infrastructure, inadequate and unreliable energy supply, and paucity of skilled labour. The GPRS and GPRS II outline some of the measures planned by government to remove these impediments.

On the whole, Ghana's Government has put a lot of effort into stimulating private-sector investment and infrastructure development. These efforts are crucial in creating an effective national system of innovation. The next section is a review of institutions and policies that have been established to promote the production and use of science and technology for Ghana's development.

## 2.3 Science and technology institutions

### 2.3.1 Public research and development institutions<sup>10</sup>

Ghana has many public institutions dedicated to R&D. The largest and oldest public R&D institution is the Council for Scientific and Industrial Research, established in 1968. It evolved out of the National Research Council, which had been established in 1958 to coordinate scientific research.<sup>11</sup> The overall mandate of the CSIR is to generate and apply science and technologies for the socio-economic development of the country. The CSIR coordinates all aspects of scientific research in the country, and aims to encourage and promote the commercialization of research results.

The CSIR has 13 research institutes covering agricultural, industrial, natural resources and policy research areas. These are the Science and Technology Policy Research Institute, the Animal Research Institute, the Crop Research Institute, the Food Research Institute, the Oil Palm Institute, the Savannah Agricultural Research Institute, the Building and Road Research Institute, the Institute for Scientific and Technological Information, the Soil Research Institute, the Plant Genetic Resources Centre, the Forestry Research Institute of Ghana, and the Water Research Institute. These institutes and the CSIR as a whole hold the biggest pool of scientists in Ghana.

In 1996, the legislation establishing the CSIR was amended in order to emphasize the importance of the Council and its institutes focusing more on working with the private sector, and taking on technological innovation activities – as opposed to a narrow focus on R&D. The CSIR is expected to generate part of its income through the development and sale of products and services.



Table 2.1. Research staff at CSIR Institutes and CRIG, 2007

Institution	Total Staff	Researchers (Senior members)	Senior Staff	Junior Staff	Others
CSIR	3,813	...	...	...	...
INSTI	79	22	36	31	...
SARI	535	42	35	458	...
OPRI	440	23	36	179	202
FRI	170	35	51	...	...
CRI	883	83	100	...	700
ARI	295	27	44	96	95
IIR	135	38	44	53	...
BRRRI	211	53	56	83	19
SRI	372	26	32	257	57
WRI	249	68	65	116	...
PGRRRI	127	10	12	54	51
FORIG	286	47	61	74	104
CRIG	147	35	...	112	...

Sources: UNESCO (2007: 15-16), CRIG website, CSIR website.

The Cocoa Research Institute of Ghana (CRIG), the Ghana Regional Appropriate Technology Industrial Service (GRATIS) Foundation, the Ghana Institute of Clinical Genetics, and the Centre for Scientific Research into Plant Medicine (CSRPM) are other national public R&D institutions forming part of Ghana's national system of innovation. CRIG was established in 1957, but its parent institution, the West African Cocoa Research Institute (WACRI), was established much earlier in 1938. It is located at Tafo, in one of the cocoa-growing regions of Ghana. The Institute has approximately 35 scientists, 112 technicians, and a large administrative and support staff. It has been instrumental in developing new varieties of cocoa which are resistant to swollen shoot virus and black pod infections.

The Ghana Atomic Energy Commission (GAEC) is another public institution engaged in R&D. The GAEC has three institutes: the Radiation Protection Institute (RPI), the Biotechnology and Nuclear Agricultural Research Institute (BNARI) and the National Nuclear Research Institute (NNRI). These are largely dedicated to nuclear research for agriculture, health and energy purposes.

The NNRI is also a public R&D institution. It employs approximately 60 scientists and engineers and 15 technicians. Its main source of funding is the International Atomic Energy Agency (IAEA), which provides about \$500,000 per year. The Government

of Ghana contributes funds for salaries and some of the running costs. The Institute's programmes focus on the application of atomic and nuclear techniques to solve agricultural, health and industrial problems in Ghana.

The GRATIS Foundation evolved out of the GRATIS Project. The project was established by the Government of Ghana in 1987 to promote small-scale industrialization in Ghana through the creation of technology-transfer units in universities and other R&D institutes. The GRATIS Project was transformed into a private company – the GRATIS Foundation – after the establishment of regional technology transfer centres in nine regions of Ghana to transfer appropriate technologies to small-scale industrialists through training, manufacturing and the supply of machine tools, plants and equipment. The Foundation coordinates the activities and provides backstopping to its network of regional technology transfer centres. Funding for the establishment of regional technology transfer centres was provided by the Government of Ghana, the European Union (EU), and the Canadian International Development Agency.

One of the leading medical research institutes is the Noguchi Memorial Institute for Medical Research. It is a semi-autonomous institute established in 1979 as a constituent member of the College of Health Sciences, University of Ghana. The Institute was built and donated to Ghana by the Government of Japan. It



is the leading biomedical research centre in Ghana specializing in communicable diseases and nutrition. The Institute also provides postgraduate training in medical research. It has state-of-the-art laboratories, including a P3 laboratory, and nine research units covering bacteriology, clinical pathology, histopathology, epidemiology, immunology, laboratory animals, nutrition, parasitology and virology. More than 45 senior research scientists are employed by the Institute.

Public R&D is also conducted in public universities. Leading Ghanaian universities with R&D programmes are the University of Ghana (Legon), the Kwame Nkrumah University of Science and Technology, the University of Cape Coast (Cape Coast), the University of Mines and Technology at Tarkwa, and the Ghana Telecom University College. These universities work closely with the CSIR and the other public R&D institutions. Although teaching constitutes a major part of their programme, they are devoting some resources to R&D activities.

### 2.3.2 Higher education and training institutions

Ghana has seven public universities. These are the Kwame Nkrumah University of Science and Technology, the University of Ghana (Legon), the University of Cape Coast (Cape Coast), the University of Mines and Technology (Tarkwa), the Ghana Telecom University (Tesano), the University for Development

Studies (Tamale) and the University of Education (Winneba). There are 22 private universities and colleges accredited with the National Accreditation Board. Of the private universities, only a few have degree courses in science and technology – for example, the Regent University College of Science and Technology, Ghana Telecom University, and Central University College.

The Kwame Nkrumah University of Science and Technology was originally established in 1951 as the Kumasi College of Technology. The College was upgraded in 1961 to university status. In 1998, it was named the Kwame Nkrumah University of Science and Technology. The aim of the university is to produce high-calibre graduates with knowledge and expertise to contribute to the industrial and socio-economic development of the country. It has research and teaching programmes in agriculture, mining, energy, ICT and engineering. The University has a technology transfer centre to promote the commercialization of research results and technologies, particularly to industry. About 76.6 per cent of the teaching staff at KNUST have science and technology backgrounds and 23.4 per cent have arts and social science qualifications. The University has the highest enrolment in science and technology courses in Ghana.

The University of Ghana is another of the country's major educational and training institutions. Founded during the colonial days, the University has established

Table 2.2. Graduate Enrollment in S&T courses in KNUST – 2005/2006

Science Programs	First degree		Post graduate		Total
	Male	Female	Male	Female	
Electrical & Computer Engineering	848	103	0	0	951
Civil & Geodetic Engineering	949	143	42	3	1134
Mechanical & Agric Engineering	804	85	36	0	925
Chemical & Material Engineering	617	139	27	6	789
Physical Sciences	1728	416	52	3	2199
Biosciences	763	518	47	18	1346
Pharmacy	344	267	6	6	623
Allied Health Sciences	277	202	18	8	505
School Medical Sciences	979	739	78	52	720
Agriculture	551	142	44	6	743
Renewable Natural Res.	580	226	27	9	842
Architecture & Building Technology	792	218	64	25	1099
Planning & Land Economy	678	292	54	22	1046
Total	9910	3490	495	158	12922

Source: KNUST Basic Statistics, 2005-2006.

Table 2.3. Students' enrollment in Science and Technology Courses at the University of Ghana, by gender 1999-2006

Year	Humanities			Science			Total		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
1999	1705	870	2575	547	223	770	2252	1093	3345
2000	2633	1279	3912	554	213	730	3187	1492	4679
2001	2797	1543	4340	496	211	707	3293	1754	5047
2002	3061	1769	4830	711	331	1042	3772	2100	5872
2003	3769	2444	6213	1343	733	2076	5112	3177	8289
2004	3743	2626	6369	823	394	1217	4566	3020	7586
2005	3920	2839	6759	631	365	996	4551	3204	7755
2006	3387	2403	5790	819	390	1209	4206	2793	6999
Total (1999-2006)	25015	15773	40788	5924	2860	8747	30939	18633	49572

Source: University of Ghana Basic Statistics, 1999- 2007.

teaching and research programmes in basic sciences, engineering, agriculture and medicine. It also has a strong orientation to humanities and social sciences.

The University of Cape Coast, established in 1971, has research and teaching programmes in agriculture, physical sciences, and biological sciences. However, most of its resources are devoted to undergraduate and postgraduate teaching.

The country has 10 public polytechnics, one in each of its 10 provinces or regions. These are Accra Polytechnic (Accra), Kumasi Polytechnic (Kumasi), Cape Coast Polytechnic (Cape Coast), Ho Polytechnic (Ho), Koforidua Polytechnic (Koforidua), Bolgatanga Polytechnic (Bolgatanga), Sunyani Polytechnic (Sunyani), Tamale Polytechnic (Tamale), Wa Polytechnic (Wa) and Takoradi Polytechnic (Takoradi).

Student enrolment in the universities and polytechnics has increased considerably in the past five years. In 1997, about 33,000 students were enrolled in the universities and polytechnics. In the 2006/07 academic year, an estimated 135,000 students were enrolled in tertiary education, mainly in the universities and polytechnics.<sup>12</sup> However, enrolment in science and engineering courses has not increased to meet demand. A study conducted in 2002 showed that "enrolment in bachelor of arts and management programmes as a percentage of total enrolment in the universities has been above 65 per cent and is increasing, from 65 per cent in 1994/95 to 68 per cent in 1999/2000. During the period 1994/95–1999/2000, the share of total courses increased by 4.1 percentage points, while courses in medicine, engineering and other sciences declined by 0.3, 0.5 and 3.3 points respectively."<sup>13</sup> This is a worrying trend in the context

of attempts to build a capable scientific and technical workforce.

The private sector is starting to play a major role in education service delivery in Ghana. There is an increasing number of private tertiary education and training institutions in the country. There is a general view that it has increased in response to excess demand for higher-level education and training in such areas as ICT.

### 2.3.3 Funding research and development in Ghana

Research and development (R&D) in Ghana is largely funded by the Government. The Government has annual budgetary allocations for MOE, MEST, and other line ministries, through which most of the public R&D is funded. This amounts to at least 70 per cent of the funding for public R&D institutions. The country does not have a specific institution dedicated to financing science, technology and innovation or R&D programmes. Some of the public R&D institutions rely on grants from international donors in order to conduct R&D activities. Often such activities are project-based or project-oriented and the funding is short-term in nature.

Although there are no reliable up-to-date statistics or data on public expenditure on R&D, most estimates indicate that the country spends less than 0.3 per cent of its GDP on R&D. This is well below the African Union's agreed-upon target of 1 per cent of GDP to be spent on R&D by every member State. A study undertaken by UNCTAD (2003a) noted that "allocations to the Ministry of Environment, Science and Technology constitute only about 0.25 per cent of the GDP, a reflection of the importance accorded to science and technology and the environment.

Moreover, only about two fifths of the Ministry's budget is used for research."

Funding to R&D has not been predictable. According to Adarkwa (2008), "over the years, R&D funding as a percentage of GDP has been erratic in Ghana. Ghana achieved the highest funding as a percentage of GDP in 1986. Generally, R&D funding as a percentage of GDP was relatively better from 1975 to 1986. Since then, the country's performance has slackened. Overall, support in terms of research funding has largely been inadequate. For example, in 2004, 81 per cent of the Ghanaian Government's budgetary allocation to the CSIR was for personnel emoluments, with only 9 per cent for research activities."<sup>14</sup> Funding levels for research activities continue to be low, as described in detail in chapter 3.

In mid-2008, the Government of Ghana announced the establishment of the national Science and Technology Research Endowment Fund (STREFund), with initial capital or seed money of approximately \$500,000 (500,000 Ghanaian cedis). This Fund will operate as an independent funding mechanism, registered as a private company, with legal flexibility to receive funds from private companies. Private companies contributing to the Fund will get a tax incentive package to be determined by the Internal Revenue Service. The Fund will be governed by a board of trustees of nine persons, representing the CSIR, the Association of Ghana Industries, the Ministry of Finance and Economic Planning, universities, the National Council of Tertiary Education, the Ghana Academy of Arts and Sciences, and the Ghana Atomic Energy Commission. The CSIR is expected to coordinate and administer the operations of the Fund.

Private-sector funding for R&D in Ghana is relatively small, too. It is estimated that the private sector accounts for only 2 per cent of the total funding for R&D in Ghana (UNESCO, 2007). Most of the multinational companies conduct or support R&D in their home countries (UNCTAD, 2003a). Local private companies rely on R&D undertaken by institutions such as the CSIR and public universities.

Ghana has many financial institutions. Most of them are commercial or development banks. There are also many registered rural banks in the country. Most of these financial institutions are not directly involved in financing R&D and technology-development projects. The exceptions are the Agricultural Development Bank

and the National Investment Bank. The Agricultural Development Bank has in the past contracted the CSIR to undertake agricultural research, while the National Investment Bank has contracted the Ghana Atomic Energy Commission to conduct research on the industrial use of atomic energy.

### 2.3.4 Technology support and regulatory agencies

Ghana's institutions for technology development and support include the Ghana Standards Board (GSB), the Food and Drugs Board (FDB), and the Environmental Protection Agency (EPA). The FDB is responsible for regulating the manufacture of food products, pharmaceuticals, cosmetics and chemicals. All food products must be registered by the FDB before they are placed on the market. The Board is also responsible for approving clinical trials and testing of pharmaceuticals.

The Environmental Protection Agency is responsible for assessing the environmental impacts of technologies and of innovation activities. The EPA plays a major role in licensing new projects in mining and manufacture. The National Biosafety Committee (now placed under MEST) is the focal body for biosafety issues. The EPA and the National Biosafety Committee therefore both have a crucial role to play in determining the development, diffusion and adoption of modern biotechnology.

The Ghana Standards Board is responsible for the overall management and coordination of standardization issues in Ghana.<sup>15</sup> GSB deals with quality standards for foods, metals, pharmaceuticals and other products. It conducts quality tests and issues quality assurance certificates. The GSB has some modern facilities for testing and metrology. Some private companies seek calibration services from GSB. One of the challenges that GSB faces relates to the low levels of awareness of the importance of product quality and standards. Generally, Ghanaian public and private institutions are unaware of the various quality standards and the importance of meeting standards in order to be competitive in international markets. GSB has a public outreach programme that is aimed at raising awareness about the importance of quality standards and the role of the Board.

The Ghana Investment Promotion Centre (GIPC) is another key player in promoting technology development and innovation activities. It is responsible for coordinating and monitoring all investment activities. GIPC supports both domestic and foreign

investors to identify and initiate new projects. It supports technology development projects by collecting, analysing and disseminating information about investment opportunities and sources of investment capital. It also provides advisory services on the choice or suitability of partners in joint-venture projects. GIPC registers and keeps records of all technology transfer agreements relating to FDI.

The Registrar-General's Department is the custodian of intellectual property law and the register of companies in Ghana. It houses industrial property information and information on the nature and operations of foreign and local companies. It is thus a source of information on technologies and on innovation activities in Ghana.

The Ghana Free Zones Board (GFZB) is responsible for promoting commodity-processing/manufacturing activities, by establishing export processing zones. It also encourages the development of commercial and service activities within the ports of Ghana. GFZB is thus an important institution to support the diffusion of innovations and promote procurement of new technologies. In 2007, there were 170 enterprises in Ghana's four export processing zones, involved in a wide range of innovation activities – particularly agro-processing, textile and garment production, and the production of plastics.

The National Board for Small-Scale Industries, established in 1981, focuses on promoting the development of micro and small-scale enterprises. It has a range of programmes for enterprise improvement and runs district-based business advisory centres to promote entrepreneurship.

Other institutions for technology development and innovation support in Ghana are the Public Utilities Regulatory Commission, the Ghana National Procurement Agency, and the Ghana Export Promotion Council. In collaboration with the United Nations Industrial Organization (UNIDO), the Government of Ghana is establishing the national Technology Innovation Centre for Capital Goods (TICCG). TICCG will focus on promoting technology prospecting and emerging technologies, by providing mechanisms for bridging the gap between market demands and existing technologies, and on promoting public-private partnerships for the development of the capital goods industry in Ghana. It will provide existing and new firms with information and know-how to enhance (a) technological performance in manufacturing; (b) quality of goods; and (c) competitiveness. This will be

achieved through the transfer of advances/innovations in related capital goods technologies.

### 2.3.5 Advisory and policymaking institutions

The Ministry of Environment, Science and Technology (MEST) is the main institution responsible for the formulation of policies for scientific research and technology development. Until 2009, science and technology policy formulation and coordination were under the Ministry of Education, Science and Sports (MOESS). To a large extent, MOESS's STI policies focused on R&D.

There are a number of other key government ministries and public institutions that play a prominent role in policy formulation and implementation. These include the Ministry of Trade and Industry, the National Development Planning Commission, the Ministry of Finance and Economic Planning (MOFEP), and the Ministry of Food and Agriculture. MOTI is responsible for formulating and overseeing the implementation of Ghana's industrial policy. The industrial policy aims at adding value to the country's natural resources, and at promoting an increased industrial share in GDP. MOFEP influences R&D and innovation policies mainly through budgeting. For example, in 2007, the Ministry allocated funds for a Science, Technology and Research Endowment Fund.

The National Development Planning Commission is largely an advisory body, charged with a wide range of policy areas. It is responsible for Ghana Vision 2020 and for such other policy initiatives as the preparation of poverty reduction strategies. It has a mandate to advise the President on development planning policy and strategy, and is therefore expected to play a major role in the formulation of innovation policy.

There is also the Parliamentary Committee on Environment, Science and Technology, which has a mandate related to policymaking and to monitoring the implementation of research and innovation programmes. This Committee lacks research support and an information base. It has tended to be reactionary rather than responsive and anticipatory. The Committee has not been able to ensure that science, technology and innovation issues to receive enough attention in the proceedings of Parliament.

The CSIR's Science and Technology Policy Research Institute plays a major role in policy-making in Ghana. STEPRI's mandates include undertaking science and technology policy studies; facilitating the commercialization of technological innovations; conduct-



ing innovation studies with an emphasis on biotechnology and ICT; and assessing and monitoring the implementation of science, technology and innovation policies. STEPRI has designed and implemented a number of projects that have contributed to shaping government policies. It has also been contracted or funded by international organizations such as the World Bank, UNDP, and the United Kingdom's Department for International Development (DFID) to implement projects relating to science and innovation policy.

The Ghana Academy of Arts and Sciences is another key institution whose work pertains to science, technology and innovation policy. Established in 1959, the Academy has a membership of leading Ghanaian academics that aim at promoting the pursuit, advancement and dissemination of knowledge in all fields of sciences and the humanities. It has been a source of scientific advice to the Government, and particularly the presidency, on a wide range of policy issues such as biosafety, biotechnology, climate change, and biodiversity conservation.

## 2.4 Science, technology and innovation policy regimes

### 2.4.1 Science and technology policy

Ghana's National Science and Technology Policy of 2000 has recently been revised. The new National Science, Technology and Innovation Policy, finalized in 2010, drives a vision of achieving a middle-income country based on STI application, adoption and development. The STI policy broadly aims at harnessing the nation's total STI capacity to achieve national objectives for wealth creation, poverty reduction, competitiveness of enterprises, sustainable environmental management and industrial growth. The basic objectives of the policy (among others) are to:

- (a) 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;
- (b) Create the conditions for the improvement of scientific and technological infrastructure for research and development and innovation;
- (c) Ensure that STI supports Ghana's trade and export drive for greater competitiveness; and
- (d) Promote a science and technology culture.

The effective implementation of the STI Policy will be guided by the key principles of relevance, cost-effectiveness, realism, synergy, and partnerships, among others. The principal thrust of the national science, technology and innovation policy is that advances, insights, tools and practices that derive from science and technology will be sought and applied in all ministries, departments and agencies – indeed, in all sectors for social and economic development. Thus, STI will be the driver for the achievement of sectoral goals, objectives and programmes.

A general view held by many people interviewed in the course of preparing this study is that weak institutional capacities – particularly within the MOESS – have accounted for poor progress in policy implementation. There has not been enough political and administrative leadership to spearhead the implementation of the National Science and Technology Policy. The reestablishment of S&T responsibilities in 2009 under the MEST offers an opportunity, but not a guarantee, of improvements in policymaking coordination and leadership for the implementation of a national STI policy.

The Government of Ghana has adopted a National Science and Technology Education Policy that expands on the education section of the National STI Policy. It outlines measures for improving vocational and technical training, increasing science literacy, building a science and technology culture, improving laboratories in schools for the teaching of science subjects, and encouraging the writing and production of science textbooks. Science and technology policies are also contained in other policy regimes such as the Education Policy, the Ghana ICT for Accelerated Development (ICT4AD) Policy of 2003, the Trade Policy for Ghana approved by Cabinet in 2004, and in sectoral policy statements covering agriculture, health, the environment, private-sector development, education and tourism.

### 2.4.2 Intellectual property protection legislation<sup>16</sup>

Ghana's laws for the protection of intellectual property are the Patent Act of 2003, the Industrial Designs Act of 2003, the Copyright Act of 2005, the Trade Marks Act of 2004, the Geographical Indications Act of 2003, and the Layout Designs of Integrated Circuits Act of 2004. The Registrar-General is the focal point for intellectual property protection matters pertaining to patents, industrial designs, and trademarks, while the

Copyright Office is responsible for issues related to copyrights.

Ghana is a member of the World Trade Organization (WTO), the World Intellectual Property Organization (WIPO) and the African Regional Industrial Property Organization (ARIPO). It is a signatory to various intellectual property protection treaties such as the Patent Cooperation Treaty, the Paris Convention (industrial property) and the Berne Convention (literary and artistic works).

The number of patent applications filed in Ghana increased between 2004 and 2006. In 2004, 12 patent applications were filed; this increased to 22 in 2006. There were 317 applications for industrial designs in 2006, mostly related to textiles. Trademark applications in 2006 increased to 1,946 – from about 1,000 in 2004 (WTO, 2008). However, the number of patents granted and in force is low. In 2005, there were only 4 patents in force in Ghana (WIPO, 2007). During the same year, there were only 3 non-resident direct patent filings. The estimated cost of filing a patent application in Ghana is between \$2,000 and \$2,200.

Ghana's capacity to manage and use intellectual property – particularly patents – is limited. The Registrar-General's office, responsible for patent applications and information, is generally understaffed and under-equipped. The use of patent information by Ghanaian scientists, engineers and companies is limited, too. This is mainly due to low levels of awareness of intellectual property protection in general. The enforcement of intellectual property protection is another challenge faced by Ghana.

## 2.5 Assessment of the national system of innovation

### 2.5.1 Innovation systems as an analytical framework

The concept that innovation is created within systems of innovation has gained currency and is now widely used in academic and policy circles as an analytical framework for studying the technological and innovative performance of countries at the national, subnational or industry level. A national system of innovation is a network of institutions that are organized through linkages "to relate to each other as elements of a collective system of knowledge creation and use as well as the technologies they use" (OECD, 1997: 9). Innovation systems analysis can be used to

evaluate the effectiveness of the interactive activities of organizations and other key actors in a system or network in accessing and diffusing knowledge and in generating innovation (new products, processes and organizational practices). It can be used as a tool to help identify areas of weakness that may warrant attention. The main institutional actors in the national system of innovation are universities, public R&D institutes, policymaking bodies and government in general, private enterprises, financial institutions such as commercial banks, and technology support agencies. Well-functioning innovation systems can quickly diffuse new information, ideas and technologies among enterprises and other actors in the system. They are needed to promote a more dynamic and innovative private sector and drive growth in an industry and in the economy more broadly.

Understanding the linkages among the institutional actors involved in innovation activities or processes is key to improving a country's technological and economic performance. Linkages in a national system of innovation usually take different forms, including joint research projects among public institutes, joint technology development and transfer activities between public-sector and private-sector institutions, exchange and mobility of scientists and engineers, technology licensing agreements, and sharing of information and technology infrastructure. Assessing the performance of a national system of innovation entails tracing the various institutional links and measuring the intensity of the interactions among various knowledge producers and economic actors. The interactions are supposed to be continuous and characterized by positive feedback.

The linkages and interactions among the various institutions in a national system of innovation can be purposefully stimulated and nurtured by public policies and various incentives that government puts in place. Public policies pertaining to STI development, intellectual property protection, competition, FDI, trade, taxes, mobility of scientists and engineers, and technology regulation and licensing can all influence the evolution and growth of a national system of innovation.

### 2.5.2 Characteristics of Ghana's system of innovation

Ghana's national system of innovation is characterized by the existence of many R&D institutions, several technology support and regulatory agencies,

institutions of higher learning and training, many small and some medium-sized and large-scale enterprises, several foreign companies, and a good number of financial institutions, particularly commercial banks. There are also government ministries dedicated to public policymaking and coordination. A profile of the country's institutional profile is provided in sections 2 and 3 of this study.

Generally speaking, Ghana's institutional landscape is quantitatively rich.<sup>17</sup> The country has at least 16 R&D institutes, seven public universities, a number of private universities, 10 polytechnics, several technology support and regulatory agencies, and at least a dozen commercial and development banks. Some of the R&D institutions are well endowed in terms of infrastructure (laboratories and equipment). For example, the Noguchi Memorial Institute for Medical Research has state-of-the-art laboratories and equipment for medical biotechnology research. Some of the the CSIR's institutes also have good laboratories. The Ghana Standards Board has modern equipment for meteorology and product testing.

A key feature of Ghana's institutional landscape is the weak links and poor positive feedback between and among institutions. A number of studies have identified these limitations and weaknesses in Ghana's national system of innovation. Zachary G (2003), UNESCO (2007) and UNCTAD (2003a) all find weak links between research institutions and the private sector to be one of the sources of Ghana's poor technological performance and relatively low innovative capacity. For example, UNCTAD (2003a: 55) notes that Ghana's main institution for industrial research – the Institute of Industrial Research – “does not have a strategy for reaching out to a broader range of businesses and entrepreneurs, or for linking its programme activities to the needs and demands of the industrial production sector. Its activities are essentially supply-driven and dictated by the limited range of in-house expertise.”

Zachary (2003) also notes poor links between university faculties and the private sector. While some of the universities (for example the Kwame Nkrumah University of Science and Technology) have created offices dedicated to forging corporate partnerships or alliances, many companies do not seem to be interested in or to value R&D-type partnerships. Most small and medium-scale enterprises largely rely on old technologies for production, while foreign large corporations conduct R&D in their home countries.

Very few of the foreign or local companies in Ghana have established linkages to research institutes and universities.

Ghana's public R&D and higher education institutions also have weak links and limited interactions between and among themselves. There are very few joint or collaborative projects between public research institutions such as the CSIR and universities. According to at least 90 per cent of the people interviewed for this study in 2007 and 2008, Ghanaian universities tend to perceive of institutions such as the CSIR as competitors for limited funding.<sup>18</sup> The few joint activities that are undertaken between the institutes of the CSIR and the public universities tend to be ad hoc and not necessarily focused on technological innovation. They tend to be limited to universities promoting student internships at the CSIR and other research institutes.

Public universities and the polytechnics have made major contributions to the national system of innovation by producing scientists and engineers. However, the country has not really built a critical mass of scientists and engineers. A recent government report notes that although the official policy is to attain a 60:40 ratio sciences-to-humanities manpower base by 2020, the education system is not adequately responding to the target, and the country as a whole lacks a strategic approach for scientific and technological development.<sup>19</sup> A study by Boateng and Ofori-Sarpong (2002) estimated a 10 per cent deficit in the supply of engineering and technical graduates, and a 66 per cent deficit in the supply of medical and health graduates. There are also concerns regarding the quality and relevance of education in Ghana. UNCTAD (2003b: 13) concluded that the “coverage and technical content of education does not respond to investors' requirements.”

Ghana has a shortage of science teachers in primary and secondary schools. According to a recent report by the Ghana Education Service, the country has a shortage of at least 3,500 teachers for 35 subjects. Statistics for the 2007/08 academic year showed that there was a shortage of 532, 502, 207, 134, 129, and 8 teachers for mathematics, integrated/agricultural science, physics, chemistry, biology, and technical/vocational skills, respectively.<sup>20</sup>

UNDP's Human Development Report 2001 ranked Ghana 67<sup>th</sup> out of 72 countries based on a technology achievement index. Ghana had a 0.3 per cent



gross tertiary science enrolment ratio (1995–1997), compared to 1.7 per cent for India, 3.4 per cent for South Africa, and 3.3 per cent for Malaysia over the same period (UNDP, 2001).

Ghana's Government has made efforts at reforming its policies for science, technology and innovation. Success has been achieved in certain areas. For example, the country has modern intellectual property legislation and has met most of WTO's requirements (WTO, 2007). Its policies and legislation for attracting and regulating FDI are modern, too (World Bank, 2005). FDI flows have increased over the past decade.

The previous policy regime, under the National Science and Technology Policy of 2000, focused on promoting scientific research with limited emphasis on the role of innovation (i.e. on the creation and adoption of new products, processes, practices and services) in stimulating economic growth. Policy reform has, in the past, been characterized by discontinuity and inertia. There was a common view that science and innovation policymaking did not have a champion or institutional leader. Encouragingly, the newly re-established MEST has produced a revised science, technology and innovation policy intended for parliamentary approval. The National Development Planning Commission also prepared a chapter on STI (during 2009) for the national development plan that proposes a set of institutional and policy reforms that should be considered for implementation.

Ghana's efforts at promoting technological innovation are fragmented and diffused across the institutional terrain. Research and development programmes are developed and implemented in an uncoordinated manner, with no or only limited focus on firm-level innovation. The MOESS tended to focus narrowly on policies for science (educating scientists, and funding research), whereas the Ministry of Trade and Industry (MOTI) has a focus on adding value to Ghana's traditional exports using existing technologies. There are no deliberate national efforts at technology prospecting, procurement and promotion. Furthermore, there is no horizontal coordination and no clear regime for setting research priorities. MOESS did not seem to have much influence on the setting of research priorities in the R&D institutes, and MOTI does not have a strategy for promoting technological innovation in the private sector. To overcome these prior deficiencies, the revised STI policy produced under the MEST aims to increase the focus of STI policy on innovation and improve the coordination of

STI across public and private institutions.

The institutional set-up for science and technology policymaking and coordination has been under continuous flux and inertia. Since 2001, the responsibilities for coordinating science and technology (including overall policymaking) have moved from ministry to ministry. Until 2009, there was no single ministry dedicated to science and technology issues. Science was under the MOESS, while technology was under the Ministry of Communications. "The confusion in the institutional governance structure as far as science and technology line ministry is concerned has been very uncertain, and for most observers, the current Government does not give priority to science and technology to promote socio-economic development and transformation as it [is] made to believe."<sup>21</sup>

The country's R&D and innovation efforts are underfunded. As indicated earlier, Ghana's expenditure on R&D is about 0.3 per cent of its GDP. It does not compare well to South Africa, which spends 0.87 per cent of its GDP on formal R&D (OECD, 2007). Most of Ghana's expenditure is on salaries in the R&D institutes. Even with the establishment of the Science and Technology Research Endowment Fund (STREFund), there is no indication that allocations for R&D and innovation activities will increase.

There is no specific institution dedicated to the funding of R&D and innovation activities. The country does not have the equivalent of South Africa's National Research Foundation (NRF) and Innovation Fund.

Most of the companies in Ghana are not adequately investing in innovation. Although data and information on R&D in the private sector are scarce, there is a general view that its investment in research is very limited. Private-sector enterprises in Ghana do not have R&D programmes or activities. The private sector's contribution to national R&D and technology-development funding is estimated at 2 per cent, while more than 75 per cent is from government, and the rest from international donors (UNESCO, 2007). Most companies in Ghana do not have in-house R&D capabilities. There are no private biotechnology companies in the country. Companies dealing with ICTs are largely involved in the application of the technologies, and not in R&D or technology development.

Ghana has a relatively small manufacturing sector. In 2006, there were 25,931 companies active in manufacturing.<sup>22</sup> Of these, 85 per cent were small-

scale enterprises employing up to 9 persons. "Only 41 manufacturing firms employ more than 500 people.... It can be concluded that the manufacturing industry is dominated by small and medium-sized enterprises..."<sup>23</sup> The high costs of raw materials, lack of credit, lack of modern equipment, inadequate skilled labour and power outages are some of the causes of the underdeveloped manufacturing base. Approximately 65 per cent of capital goods, including manufacturing equipment, are imported. Local companies, particularly small and medium-sized enterprises, use second-hand equipment. According to Biggs et al. (1995), most of the machinery used by firms in Ghana is more than 20 years old. It is mainly in the telecommunications sector that there have been significant imports of new machinery in recent years.

One of the oldest foreign companies operating in the country is Alcoa's Volta Aluminium company (VALCO), an aluminium manufacturer. It was established in Ghana in the mid-1960s and employs about 1,000 people. According to Zachary (2003: 7–8), "Alcoa's operation is essentially the same today as it was 40 years ago. The company makes no 'downstream' products from the raw aluminium it produces in Ghana, and it imports virtually everything required prior to the stage where massive application of electricity to aluminium smelting occurs." VALCO's electricity production and supply levels have stagnated, despite the potential to raise its capacity. The company has locked itself into a particular technological system, and fails to increase local content and to use new technologies. There is, therefore, an opportunity for the Government to conduct or commission innovation audits of companies, including foreign ones, operating in Ghana.

Poor infrastructure is widely reported by local actors to be one of the main barriers to technological innovation and development in Ghana. The high cost and unreliability of such public services as electricity and telecommunication services undermine the country's potential to become a middle-income economy. Transport costs are generally high in Ghana, because of a poor road and rail network. The country's ports of Tema and Takoradi are poorly equipped and managed, too. Many of these constraints have now been singled out for action by the Government. Despite efforts over the past five years or so to improve infrastructure, poor physical infrastructure continues to undermine the growth and performance of Ghana's system of innovation.

### 2.5.3 Participation in bilateral, regional and international programmes

Ghana has bilateral science and technology cooperation programmes. It participates in regional and international programmes of the Economic Commission for West African States (ECOWAS), the New Partnership for Africa's Development (NEPAD), the African Union (AU), UNESCO, the International Atomic Energy Agency (IAEA) and the European Union. The country hosts regional and international research institutions, such as the Forum for Agricultural Research in Africa, as well as outposts of the Consultative Group on International Agricultural Research.

The country has entered into many bilateral agreements that deal with science and technology cooperation. It is an active member of the African Laser Centre, and has a bilateral science and technology cooperation agreement with South Africa. Ghana has bilateral investment agreements with countries including Benin, Burkina Faso, China, Côte d'Ivoire, Cuba, Denmark, Egypt, France, Germany, Guinea, India, Malaysia, Mauritania, the Netherlands, South Africa, Switzerland, the United Kingdom, the United States and Zambia (WTO, 2007). Many of these agreements put emphasis on measures to strengthen technical cooperation. They cover such aspects as mobility of capital, including skills and information, and the protection of intellectual property. They are important instruments for promoting technology transfer and procurement.

Ghana is an active participant in the African Ministerial Council on Science and Technology of the AU and NEPAD. Its government officials played a major role in the development of the AU/NEPAD Africa's Science and Technology Consolidated Plan of Action. In 2007 Ghana chaired the AU, a period that African leaders declared to be a year of promoting science, technology and innovation. With support from NEPAD, Ghana has expressed its intent to conduct national R&D and innovation surveys.

As a member of ECOWAS, Ghana has actively participated in the development of the ECOWAS framework for science and technology. Between 2003 and 2007, it hosted at least three regional workshops on biotechnology and biosafety. Ghana is a champion of biotechnology in the ECOWAS region.

At the international level, Ghana participates in the Network for the Coordination and Advancement of

sub-Saharan Africa–EU Science and Technology Cooperation (CAAST-Net). CAAST-Net is financed by the EU to increase cooperation in science and technology between Europe and Africa.

#### 2.5.4 Overall assessment of Ghana's national system of innovation

Ghana's national system of innovation has the potential to grow and become dynamic. It has some institutional infrastructure for R&D, a growing private sector, some policy instruments, a new mechanism for funding R&D, universities dedicated to producing scientists and engineers, and institutions to support and regulate technology development. However, the national system of innovation is underdeveloped, and not performing to the level at which it will enable the country to achieve its aspiration of becoming a middle-income economy by 2020. A strengths, weaknesses, opportunities and threats (SWOT) analysis of Ghana's system of innovation is summarized in table 2.4.

The main weaknesses of Ghana's system of innovation have been discussed above. In summary, they are:

- (a) Poor institutional configuration and leadership – the country has traditionally not had a sufficiently capable and respected lead institution to orchestrate technological innovation for economic change and growth. There is no agency for promoting the procurement and use of old and new technologies in fields such as biotechnology, ICTs and nanotechnology. Its institutions are neither well connected nor communicating to effectively drive technological development in economic activities under the President's Special Initiatives.
- (b) Lack of an explicit national innovation policy and related strategy. As stated before, Ghana's science, technology and innovation policy measures have to a large extent been – until the new policy of 2010 – implicit and scattered in many government documents. There was a lack of policy coherence and focus on innovation.
- (c) Limited funding is channelled to the country's science, technology and innovation programmes – Ghana's budget and expenditure on R&D and related innovation activities are too limited. Most of the funding goes to R&D institutes for salaries and some operational costs. Currently, the country is not sufficiently targeting innovation in either the public or the private sector.
- (d) Institutions of education and training are not producing human resources of the required quality and quantity to spur technological innovation for economic growth.
- (e) Inadequacies in physical infrastructure (e.g. unreliable and costly electricity) are a major barrier to technological innovation in both public and private enterprises.

Indeed, the current state of underdevelopment of Ghana's system of innovation is in part accounted for by the inadequate political support for science, technology and innovation at the highest levels in the past. Policy reform in STI has been subject to a high degree of discontinuity and inertia, and there is a common view that science and innovation policymaking needs a champion and more active and effective institutional leadership. Ghana's political parties and the legislature have not, to date, really given adequate attention to science, technology and innovation issues, despite their potential role in accelerating growth and development and in this way helping to reduce poverty (Zachary, 2003). Therefore, action has not been stimulated to create a truly enabling and supportive environment for private-sector investment in technological upgrading and innovation.

A large body of scientific knowledge generated by public R&D institutes is not turned into products and services, mainly because of a lack of entrepreneurial culture in public R&D institutes. Local private-sector firms are not really attuned to procuring and/or investing in R&D to improve their economic productivity. Foreign companies are less engaged in domestic R&D and are largely dependent on research undertaken in their countries of origin (UNCTAD, 2003a). Most of their innovative activities are conducted in their home countries.

Ghana's educational system is not well aligned to its economic and industrial-development aspirations. The country's universities and polytechnics have relatively weak research capacities, and most of them lack an entrepreneurial culture.<sup>24</sup> Public universities are under continuous strain to absorb growing student populations, and devote increasingly low or limited portions of their annual budgets to R&D and technical innovation activities. Ghana performs poorly in terms of technical education. There is a big gap between education and human capital development (UNCTAD, 2003a).

Table 2.4. SWOT analysis of Ghana's System of Innovation

Strengths	Weaknesses	Opportunities	Threats
Political stability, openness and improved democratic governance	Political parties and parliament do not give adequate attention to science, technology and innovation issues in their practices and policies	Potential of peer influence and review through the African Union, APRM and NEPAD; and potential to strengthen Parliamentary Committee on Environment and Science	
Good macroeconomic conditions and performance	Economy relies on narrow range of traditional exports	President's Special Initiatives (PSI) good basis for economic diversification; increasing FDI inflows	Global economic recession and financial crisis
Existence of R&D institutions	R&D institutes under-resourced	Newly established Science and Technology Endowment Fund, and increasing ODA	Lack of clear strategy and institutional leadership to build or improve the R&D institutes
Existence of several technology support and regulatory agencies	Technology support and regulatory agencies not adequately resourced and linked to R&D institutes	Government recognises the need to strengthen institutions such as GSB and the Registrar-General	Absence of specific budgets dedicated to institutional strengthening
A wide range of implicit science, technology and innovation policies exist	No explicit innovation policy; current policies scattered in many documents, and the National Science and Technology Policy 2000 outdated	Efforts to renew national science and technology policy made; new National STI Policy drafted	Weak institutional leadership of MEST and lack of deliberate executive or cabinet champion for science and innovation policy
Bilateral FDI agreements increasing and country participates in regional and international programs	Lack of strategy and institutional leadership to use bilateral, regional and international cooperation to link up to national systems abroad for purposes of learning and technology prospecting	Initiatives such as NEPAD, AU and CAAST-Net focusing on Ghana; and improving conditions for FDI and technology cooperation	Lack of institutional leadership from Ghana to tap the regional and international opportunities
Existence of science and engineering faculties in four public universities; and 10 polytechnics in the 10 provinces of Ghana	Science and technology faculties and the polytechnics under-resourced; and declining enrollment in science and engineering courses	Education and training system being reformed to put emphasis on science and engineering; and a new science and technology education policy adopted	No budgets dedicated to science and engineering training; and no clear strategy to improve infrastructure for R&D and engineering
Existence of vibrant financial institutions, particularly commercial and development banks			
	Financial institutions are not strategic involved in or linked to R&D and technology development programs	Increasing recognition by government of the need to promote venture capital, R&D in enterprises; and the new Science and Technology Endowment Fund	Lack of institutional leadership to stimulate interest and promote engagement of financial institutions in R&D and technological innovation
Private sector is growing; increasing number of small and medium scale enterprises; and presence of a good number of foreign companies in mining, agriculture and ICTs	Poor links between private companies and public R&D; and limited in-house R&D and innovation activities in private sector	Government's efforts to promote private sector development, and recognition by government to encourage commercial use of R&D	Poor physical infrastructure particularly costly and unreliable electricity
Existence of MEST, Ministry of Trade, Industry, Private Sector Development and President's Special Initiatives; Ministry of Communication	Poor coordination among and between ministries; weak policy analysis capacity	Existence of CSIR's Science and Technology Policy Research Institute	No budget dedicated to science, technology and innovation policy programs



On the whole, Ghana does not have a strong national system of innovation. However, it has the potential to improve its innovative capacities and technological performance. The next section of this study offers some suggestions and recommendations on measures that will improve the country's system of innovation and its overall technological performance to enable it to achieve higher levels of economic growth. Emphasis is placed on measures that will build and/or strengthen links between R&D, the science and technology system, and the productive sectors.

## 2.6 Recommendations

### 1) Establish an agency to oversee coordination and implementation of STI policy

This review has shown that one of the challenges to the growth of Ghana's system of innovation relates to the absence of a clear focal point for the implementation of innovation policy and programmes. The MEST is organized and capacitated to be the focal point for designing national innovation policy and programmes. The CSIR, research institutes, and universities are capable of carrying out R&D. However, none of these are appropriate entities for overseeing implementation of STI programmes.

To stimulate innovation and ensure a focused approach to strengthening the country's national system of innovation, Ghana should establish a specialized agency – a National STI Implementation Agency (NIA) – to implement STI programmes. The main goals of the NIA would be to:

- (a) Spearhead the formulation and implementation of an explicit coherent national innovation policy;
- (b) Promote and nurture university–industry research and technology development partnerships, as well as partnerships between polytechnics and local businesses;
- (c) Promote knowledge and technology transfer from laboratories to businesses, and encourage technology-based entrepreneurship in small and medium-scale companies;
- (d) Conduct and use firm and farm-level innovation audits to improve policies and strategies for technological innovation; and
- (e) Create and use appropriate funding mechanisms or instruments for innovation in public and private enterprises.

There are many benefits to establishing a National STI Implementation Agency. A new agency would start off without many of the structural rigidities that characterize the current institutions. It would be established as a legal person, by means of an Act or Bill of Parliament. Ghana's NIA could be autonomous and explicitly focused on promoting technology-based economic activities. In order for it to be sustainable, its funding would have to be expressly determined by Parliament. The law establishing an NIA would set a specific budgetary target (e.g. a percentage of GDP or a percentage of the total revenue of government) for the agency. The NIA would need an independent board of directors with representation from the private sector, academia, civil society, and political institutions.

A growing number of countries are establishing national innovation agencies. Ghana should draw lessons from these countries. South Africa is one example. In 2007, South Africa enacted specific legislation to establish a technology innovation agency (TIA). The goal of the TIA is "to support the State in stimulating and intensifying technological innovation and invention in order to improve economic growth and the quality of life of all South Africa by developing and exploiting innovations and inventions."<sup>25</sup> TIA is being created as an autonomous institution, but is affiliated to the Department of Science and Technology. It will have links to the Department of Trade and Industry and other government departments. It is expected to co-evolve with the National Research Foundation, science councils such as the Council for Scientific and Industrial Research (CSIR), higher education institutions, private companies and financial institutions.

### 2) Design an explicit innovation or STI policy and a multi-year implementation strategy

The creation of an NIA would need to go hand in hand with the design of an explicit national innovation policy and strategy. As has already been stated, Ghana's National Science and Technology Policy 2000 was outdated and largely focused on promoting scientific research. It was weak on measures to promote technological innovation in public and private enterprises for economic growth. In order to have a sharp national focus on innovation, the country needs a policy regime that guides it to (a) make strategic choices for R&D; (b) take a long-term anticipatory approach to technology development; (c) invest in technology foresights, prospecting and procurement; and (d) create

appropriate incentives for private-sector in-house R&D. The newly drafted national STI policy represents a major improvement.

A good national innovation policy should also contain specific measures to promote long-term capability-building in industrial firms and society as a whole. It should encompass “a wide range of policies including social policy, labour market policy, educational policy, industrial policy, energy policy, environmental policy, and science and technology” (Lundvall et al., 2002). In this way, a national innovation policy is a regime. Its coordination requires high-level executive authority. For the innovation policy to be effective, leadership for coordination should be vested in the Presidency of the country. The STIP Review of Ghana recommends that the NIA should be located in the Office of the President of Ghana but with autonomy and authority to execute its programmes.

To ensure that a national innovation policy is implemented, Ghana needs to develop and use a clear multi-year (say, 10-year) rolling implementation strategy. The strategy should have clear benchmarks and should articulate institutional responsibilities. The Office of the President of Ghana should spearhead the design of such a strategy.

The establishment of the NIA and the formulation of an innovation policy should be accompanied by reforms and strengthening of many of the country's institutions for policymaking. The focus and capacities of the education, labour, trade and industry, and finance ministries, and of the entire government machinery, should be reorganized around the goal of building a national innovation system for growth. For example, the Ministry of Trade and Industry needs to also focus on new technology areas, in addition to giving priority to Ghana's traditional exports. The Ministry of Labour should expand its mandate and activities to do more than managing industrial disputes. It should be another locus for skills development through lifelong training programmes in areas such as quality management.

### 3) Strengthen the legislature in innovation policymaking

Ghana's political institutions have not really done much to promote the building of a national system of innovation. The Parliamentary Committee on Environment, Science and Technology tends to operate in an ad hoc way. It does not have a research infrastructure or proper support. As such, it is not

actively informed on or involved in science, technology and innovation policy issues.

The establishment and operations of the proposed NIA would need support and oversight from the country's parliament and political parties. As suggested earlier, Ghana's Parliament would need to pass legislation to establish the NIA, and would also be responsible for determining – or at least influencing – budgetary allocations to the agency. Furthermore, Parliament will also be called upon to make decisions pertaining to technology, for example by considering legislation for such aspects as biosafety, environmental impact, FDI, and clinical trials. In this way, Parliament will be an important institution for innovation policymaking. If Parliament is not adequately informed, its decisions could derail technological innovation and undermine the growth of the country's system of innovation.

There are two specific ways of strengthening Ghana's legislature to play an active role in innovation promotion. The first is to establish a specific parliamentary committee for science and innovation. This would replace the current Parliamentary Committee on Environment and Science. It would be an arm of the legislature that would ensure that Parliament's decisions did not undermine efforts to build a national system of innovation and to improve the country's technological performance. The parliamentary committee on science and innovation would also be a watchdog for the NIA budget, and would promote implementation of the innovation policy through other parliamentary bodies such as committees for education, finance, and constitutional matters.

The second way is to establish a research and policy analysis support mechanism for Parliament as a whole, and for the committee for science and innovation in particular. The mechanism could be either a multi-disciplinary unit or a team of researchers working for Parliament. Such a unit or team would gather evidence and provide policy options for improving the country's innovative capacities through various policy and legislative reforms. It would need to be resourced with funds, library access and other means, in order to be effective.

### 4) Build skills and entrepreneurial culture

As stated above, Ghana's educational and training institutions are not producing enough skilled manpower to meet market demand. There is a shortage of skilled scientists, engineers and technicians.

This is a major barrier to improving the country's technological performance and growing a national system of innovation. This has been recognized by the Government, and various reforms of the education and training system are being introduced. A national science and technology education policy was recently adopted. It puts emphasis on improving the education curriculum to increase and improve the science and engineering content, on doubling the number of science teachers in primary and secondary schools, on promoting science clubs in schools, and on equipping laboratories in the schools. There is a need to introduce similar measures in universities.

A wide range of measures is also required in order to increase enrolment in science and engineering courses in Ghanaian universities and other institutions of higher learning. The measures include increasing universities' capacities by building more and better laboratories, increasing the numbers of lecturers and technicians in science and engineering faculties, and encouraging private universities (e.g. through special tax relief) to develop and offer science and engineering courses.

There is a need to take a long-term approach to building science and engineering skills in Ghana. Single short-term interventions will be inadequate. For example, putting emphasis on increasing student enrolments without adequate focus on creating employment opportunities in businesses is unlikely to work, at least in the long run. Increasing investment levels in science and engineering training should go hand in hand with concerted efforts to develop the private sector, improve physical infrastructure, create more jobs, and grow the economy as a whole. Thus, Ghana should avoid taking single isolated interventions in its efforts to improve science and engineering skills production. A suite of well-organized or sequenced measures is necessary in order to improve the whole system of science and engineering training.

A recent study by the World Bank puts emphasis on an integrated approach to strengthening tertiary education and training in Africa (World Bank, 2009). This report argues that measures aimed at improving tertiary education should be part and parcel of overall national efforts to fight poverty, grow the economy, promote human development, and increase economic competitiveness. Investments in tertiary education, particularly in science and engineering, should be treated as part of building national systems

of innovation and promoting technological catch-up in Africa.

A key aspect of building science and engineering skills in Ghana should be the promotion of entrepreneurship. Studies such as Boateng and Ofori-Sarpong (2002), Zachary (2003) and UNCTAD (2003) have all identified a weak entrepreneurial culture among Ghanaian graduates as one of the barriers to increased business development and job creation. Many graduates of Ghana's universities and polytechnics get to the labour market not really well prepared to manage businesses and take risks. Universities, polytechnics and other institutions of higher learning need to introduce courses in entrepreneurship in their curriculums. They could team up with businesses and business schools to design and offer such courses.

Ghana needs a clear strategy for building and utilizing science and engineering skills. This should be an integral part of an explicit national innovation policy and implementation strategy. As part of the process of designing an explicit national innovation policy and implementation strategy, a comprehensive assessment of the science and engineering capacity needs of the public and private sectors, including those of the training institutions, should be conducted. Such an assessment would provide a clear picture of disciplinary gaps (whether in electronics, mechanics etc.) and of the potentials of specific universities and polytechnics. The NIA could be responsible for conducting the proposed assessment.

##### 5) Sharpen economic targets and technology focus

Vision 2020 and GPRS II are important frameworks for economic targeting and the promotion of the country's self-discovery. They put emphasis on the country focusing and building on those areas where it has accumulated experience and capacities for economic production. However, as a recent study by the World Bank has shown, initiatives such as the President's Special Initiative on Cassava did not generate innovation because the R&D institutions brought to it a narrow focus on old techniques (World Bank, 2006b). A key lesson from this is that frameworks such as the President's Special Initiatives need to have a clear technology focus, as opposed to a commodity approach. Having a clear technology focus should also be linked to explicit poverty reduction and economic productivity targets.

Economic targeting and technology focus can be improved through exercises such as technology



assessments and technology foresights. We recommend that Ghana should devote some attention to conducting technology assessments and technology foresights in fields such as biotechnology and ICTs, and in specific sectors such as agriculture, energy and mining. This would be part of the core functions of the proposed NIA.

In addition to improving economic targeting and technology focus, the Government of Ghana should invest in promoting the country as a special location for a few selected foreign technology businesses. It should identify two or three promising technological innovations in areas such as biotechnology and ICTs, in each of its 10 regions, and promote these as part of challenge programmes run by regional polytechnics and universities, linking these to local enterprises.

#### 6) Do more to develop the private sector and promote innovation in businesses

Previously, Ghana's Government had focused attention on promoting private-sector development and attracting FDI. It put a wide range of policies in place, and it reformed institutions, in order to improve conditions for enterprise development and for investment. For example, intellectual property legislation was reformed and strengthened in 2003 and the security of private property enhanced. There are many businesses operating in Ghana, and FDI has increased. These developments have contributed to the economic growth of Ghana. They are an important part of building the country's system of innovation. However, much more needs to be done.

There is now a need to focus on promoting technological innovation in and by the private sector. Some of the actions or measures that should be taken include conducting innovation audits of firms and farms and then using these to reward innovating enterprises. High-performing enterprises (essentially, innovators) would receive special recognition and incentives – such as tax exemption for expenditure on R&D, technology procurement, and innovation in general. Secondly, the Government should establish a national funding scheme or instruments to promote R&D and technological innovation in the private sector. This would take the form of competitive grants to private firms that twin or partner with public R&D institutes to conduct economic-oriented research or the development of a particular technology. Examples of such funding instruments are South Africa's Technology and Human Resources for Industry Programme (THRIP) and Innovation Fund, both

administered by the National Research Foundation. In the case of Ghana, the funding scheme or instruments would be administered by the NIA.

#### 7) Continue to increase investments in building infrastructure

There has been considerable investment in improving physical infrastructure in Ghana during the past five years or so. The road network in Accra has been improved. Infrastructure at the main airport has been improved too. There are also efforts to build more roads in other cities and districts of Ghana. In the case of telecommunications infrastructure, there are public-private partnerships (Ayogu, 1999). However, there is much more to be done over the medium and longer term to get the country's infrastructure of roads, telephones, electricity, water systems, and other utilities developed to be able to make the national system of innovation dynamic and productive. If the country does not invest in building its energy base – particularly the production and supply of electricity – its aspiration to become a middle-income economy will not be realized.

#### 8) Promote stronger executive leadership through an STI council

Ghana's cabinet, the presidency, and other parts of the executive branch of the State hold the keys to its entry into middle-income economy status. They will determine whether the country's national system of innovation grows to be mature and dynamic. The executive branch of the State is not currently configured to be actively engaged in the promotion of building a knowledge economy and a strong system of innovation. Ghana's Presidency should do more and become the locus of building and organizing the country's system of innovation.

What needs to be done? We recommend that the Office of the President of Ghana should spearhead the creation of the proposed NIA and strongly consider the implementation of the related recommendations of this study. It should become the nucleus for strengthening the country's system of innovation by establishing a high-level Presidential Council or Committee on science and innovation. Such a council or committee would be led by a science and innovation policy advisor to the President of Ghana.

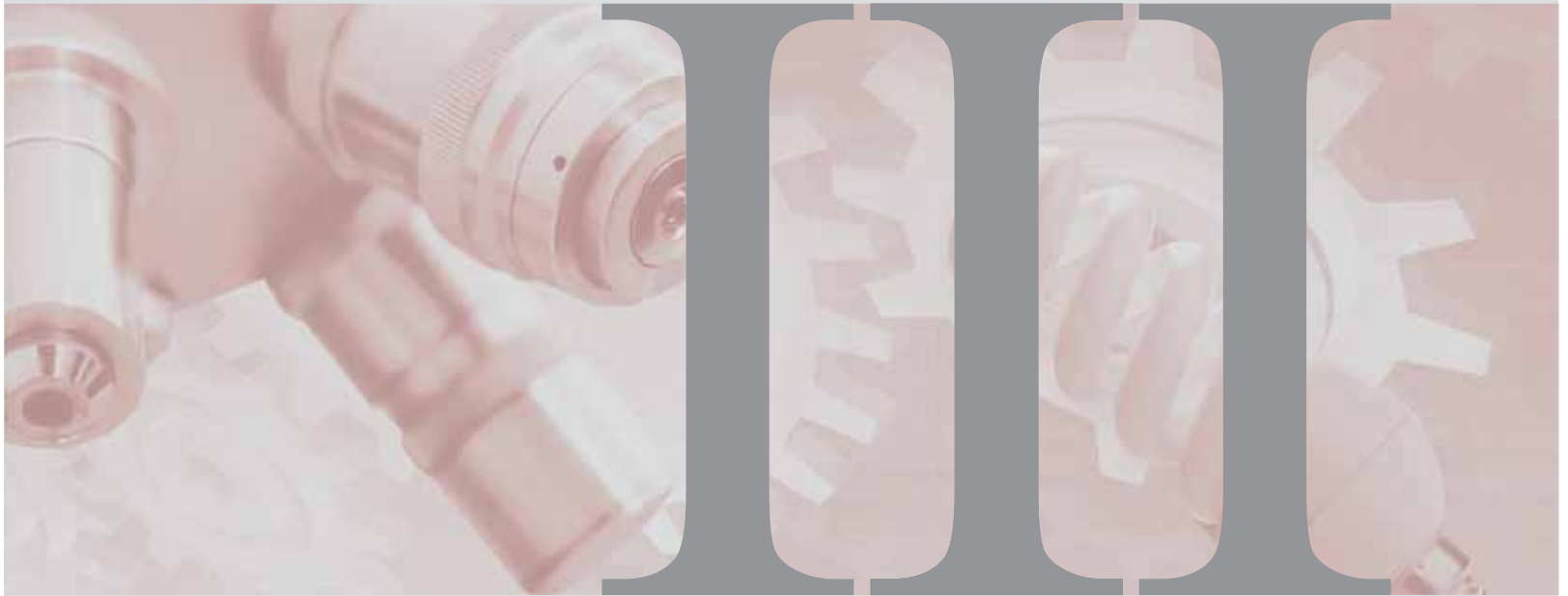
This study shows that Ghana has some of the institutional arrangements, policies, and programmes to develop a dynamic and productive system of innovation. The country's aspiration to become a

middle-income country and achieve the Millennium Development Goals depends on what it does to improve its technological performance and on the dynamism of its system of innovation. Deficiencies in STI capabilities and inadequate technological upgrading are key constraints on creating faster economic growth and accelerating economic and social development. Public policies need to do more to build a relevant skills base and strengthen institutions of higher education and training, design an explicit national policy regime for innovation,

increase investment in building and improving physical infrastructure, promote innovation in private enterprises, and generally focus on other measures to build a knowledge economy. The NIA could orchestrate and provide institutional leadership to promote the development, over time, of a dynamic system of innovation. The country needs executive and political leadership focused on the role of innovation in national development from both Parliament and the Presidency if the recommended measures are to be adopted and effectively implemented.

## NOTES

- <sup>1</sup> See United Nations (2005) for detailed discussion of how science, technology and innovation are critical to the attainment of the MDGs.
  - <sup>2</sup> AfDB/OECD (2008).
  - <sup>3</sup> Ibid.
  - <sup>4</sup> Ibid.
  - <sup>5</sup> Ibid.
  - <sup>6</sup> AfDB/OECD (2007).
  - <sup>7</sup> Based on United Nations Development Programme (UNDP) data for 2005 (UNDP, 2007/2008 Human Development Report). In terms of human development, Ghana is ranked by that report 135th out of 177 countries.
  - <sup>8</sup> The United Kingdom is the largest investor, with investments of more than \$750 million through Lonmin plc. Other large foreign firms in Ghana are Valco of the USA, AngloGold of South Africa, ExxonMobil, Chevron Texaco, Pioneer Foods (Star-Kist Tuna), Coca-Cola Company, Phyto-Riker (Pharmaceuticals), Westel (ICT), Teberebie Goldfields Limited and Union Carbide.
  - <sup>9</sup> AfDB (2005).
  - <sup>10</sup> A detailed review of the efficiency and effectiveness of the country's research institutes can be found in chapter 3 of this report.
  - <sup>11</sup> During the period 1968 to 1979 the CSIR was under the supervision of the Ministry of Finance and Economic Planning. In 1979 it was transferred to the new Ministry of Industries, Science and Technology. It was next under the Ministry of Education, Science, and Sports (MOESS) until the recent ministerial restructuring in 2009 placed it under the Ministry of Environment, Science and Technology (MEST)
  - <sup>12</sup> Republic of Ghana (2008). See also Adu, Kingsley and François (2006).
  - <sup>13</sup> Boateng and Ofori-Sarpong (2002).
  - <sup>14</sup> Adarkwa (2008).
  - <sup>15</sup> A new Standards Bill specifying new roles and responsibilities of the GSB is in Parliament for enactment into legislation.
  - <sup>16</sup> Chapter 3 includes a review of the IP management system at universities and public research institutes.
  - <sup>17</sup> See chapter 3 of this report for a detailed review of individual R&D institutions in Ghana.
  - <sup>18</sup> Thirty-seven people were interviewed during this period.
  - <sup>19</sup> Republic of Ghana (2008).
  - <sup>20</sup> Ghana Education Service (2007).
  - <sup>21</sup> UNESCO (2006: 7).
  - <sup>22</sup> UNIDO and Government of Ghana (2006).
  - <sup>23</sup> Ibid.
  - <sup>24</sup> Report of the President's Committee on Review of Education Reforms in Ghana (2002).
  - <sup>25</sup> Republic of South Africa (2007).
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# Ghana's Research and Development System



## GHANA'S RESEARCH AND DEVELOPMENT SYSTEM

Linking knowledge and productive activities must prominently involve the research capacity embodied in Ghana's universities and public research institutes. This chapter provides an assessment of the effectiveness of Ghana's research system. The overarching question guiding the analysis is whether the system is geared in such a manner that research outcomes can advance Ghana's development agenda. To this effect, it investigates funding, performance, governance, and incentive alignment, including intellectual property rights and regulations. With regard to the public research institutes, the report was also expected to draw on comparative insights from Colombia, India, and South Africa.

In order to meet the key data requirements for this task, the institutions were contacted with a request for specific material that the team wished to access.<sup>1</sup> In parallel, their websites were consulted and site visits were organized in order to interact with senior management, and with junior and senior researchers.

### 3.1. Inputs, outputs and outcomes

#### The funding of Ghana's research system

The discussion that follows is based on the Medium-Term Expenditure Framework for 2008–2010 and the annual estimates for 2008. This warrants a caveat. How much money Ghana actually invests in its research system is not something one can glean from budget documents. In the past, the discrepancies between estimates and between approved and disbursed funds in the research system were very significant. Finance administrators of individual research institutes interviewed for this study were adamant that the annual estimates should not be used as a planning tool and thus not to be relied on. Perhaps more importantly, discrepancies between approved and disbursed funds within a budget year, usually to the disadvantage of the latter, clearly require unconventional efforts to reconcile income and expenditure items.

In effect, this means that the information referred to below paints a picture of the Ghanaian research system that is rosier than the reality. Data about the share of spending on research and development

(R&D) in the national budget estimates should be read against past allocations to come to grips with how much or how little investment there is. Since the African Union has committed to devoting a specific share – 1.0 per cent – of gross domestic product (GDP) to R&D – and since other entities such as the European Union make considerable efforts to attain international competitiveness through an increase in its members' R&D outlays – it is curious that such a figure, both its current value and where one would want it to be in the future, is not a household indicator in Ghana. Surely if the commitment to science and technology were taken as seriously as policymakers indicate, the informed public could be expected to know the amount of public funds involved.

The Ghanaian budget amounts to some ₵4.3bn in 2008 (see table 3.1). Just over one per cent is devoted to R&D. Most R&D is devoted to economic affairs that include many of the applied research activities carried out by the Council for Scientific and Industrial Research (₵44.4 million), followed by health R&D (₵3.9 million). South Africa, one of the few sub-Saharan economies with middle-income status, currently spends 0.6 per cent of its budget on R&D. However, business sector funding of R&D is substantial, so that South Africa is on target to achieving 1 per cent of GDP investment in R&D by 2009. This is meant to increase further in the future. To the extent that South Africa is a model to emulate – something which many researchers we interviewed seconded – it will be difficult for Ghana to graduate to middle-income status without increasing the resources devoted to R&D both in relative and in absolute terms.

Table 3.1. Science and technology in Ghana's total budget, 2008 (in GH₵)

Budget Line Item*	GH₵**	%
Total government expenditure	4,292,084,203	100
Basic research	201,500	0.005
R&D General Public Services	151,412	0.004
R&D Economic Affairs	44,314,486	1.032
R&D Health	3,942,081	0.092
Total S&T	48,609,479	1.133

\*Budget represents estimates, not actuals.

\*\*New Ghanaian Cedis and USD were close to 1:1 exchange rate during the 2008 budget year.

Source: Republic of Ghana (2008).

### Box 3.1. A Lack of Data and Documentation at Ghana's Universities and Research Institutes Represents Larger Costs to the Research System

Some remarks about data availability are necessary. First, Ghana's research system is in general very poorly documented. For example, the most recent annual reports of the CSIR's 13 institutes made available by the CSIR secretariat in July 2008 were as old as 2003 (SARI) or 2004 (IIR, OPRI, WRI), though several institutes (INSTI, STEPRI) not covered by this review did have more recent annual reports. For one institute, there was only a quarterly report (PGRRI), and for another (ARI) there was none at all. Likewise, the webpage entitled "achievements" on the CSIR's website was empty when accessed in July 2008.

Second, the quality of this documentation needs improvement. For example, when comparing annual reports, institutes often neglect the guidelines for these reports and omit essential information such as publications output. By contrast, a few universities report output under "journal publications" that has neither been published nor accepted by a journal, but merely submitted, or was published in another medium.

Third, some data seem contradictory. For example, there is often little correspondence between information captured in hard copies and data uploaded onto websites. In July 2008 the University of Ghana listed one journal publication for 2007 on its website, and reported 514 articles that had been published or accepted for publication in its annual report.

Fourth, some data are jealously guarded. This primarily concerns information about funding and external income. Even senior management at many institutes and universities refused to make budget information available without the consent of the respective director general or vice chancellor – consent which was not always forthcoming. In some cases, information is genuinely unknown. For example, UoG has no idea how much external research income it generates because to date there has been no central body capturing such data.

The information one does find, although relevant, may not strictly be statistically representative. Therefore, at times this report illustrates larger insights with case studies that exemplify micro problems of Ghana's research system without having systematic evidence to prove that these micro problems cumulatively translate into a macro weakness. However, since this report draws on very extensive interaction with stakeholders, we are confident that its principal conclusions are correct.

The above problems reflect the entire system in a bad light. A technology manager of a subsidiary of a foreign multinational who might be interested in exploring the outsourcing of a certain component development to local suppliers would be unlikely to learn much useful information about technological capabilities in the public research sector from readily accessible sources. Likewise, a laboratory in Europe without prior contacts in Ghana that is looking for an epidemiologist to integrate into a global research consortium might not be able to identify a suitable candidate without physically visiting the country.

Hence poor documentation comes at a cost to the system in terms of low (international) visibility, consequently fewer chances to get involved into global knowledge networks, and thus foregone opportunities to exploit S&T for local development.

Also, the regular evaluation of system performance is problematic with such incomplete data resources, especially if the assessment were to be done over time. This can only result in a lack of transparency which in turn impacts on the ability of all concerned stakeholders to engage (self)critically in a discussion of how the system could be improved and what value this would bring to society.

Although these remarks go for the system at large, there are important differences between the universities, the CSIR, and other research institutes, as well as across the CSIR. The universities provide in general much better and professionally packaged information than the research institutes. The one exception to this is the Cocoa Research Institute of Ghana (CRIG) whose documentation matches that of the universities. This raises the question of a possible correlation between research performance on the one hand, and the completeness and quality of documentation on the other. Clearly, an institution that is proud of its achievement would have more of an incentive to report this to its stakeholders. Likewise, an institution which faces competition in the demand for its products or services would likely also be more inclined to pay attention to how it documents itself. These questions are taken up later in this report.

About three quarters of these funds come from the government budget, while the remainder results from contract work, commonly referred to as internally generated funds (see table 3.2). Health research

attracts 75 per cent of its funding from external contracts, economic affairs R&D, only 29 per cent. The average share of internally generated funds for the entire research system is 23 per cent.



Table 3.2. Source of funds, 2008 (in GH¢)

	GoG	IGF	Total	IGF/Total (%)
Total government expenditure	2,279,679,879	299,184,430	4,292,084,205	7.0
Basic research	201,502	2	201,502	0.0
R&D General Public Services	151,414	2	151,414	0.0
R&D Economic Affairs	31,414,490	12,900,000	44,314,488	29.1
R&D Health	994,385	2,947,699	3,942,083	74.8
Tertiary education	107,068,534	26,169,190	133,237,722	19.6
Total S&T	139,830,317	42,016,885	181,847,201	23.1

Source: Republic of Ghana (2008).

Note: Figures include only GoG and IGF (i.e. without debt relief and donor support, etc.).

The large majority of these funds is spent on salaries (personal emoluments) (see table 3.3). In the universities, the share is over 80 per cent; at the Council for Scientific and Industrial Research, it is 76 per cent on average. The two institutes with the lowest relative staff costs are the Science and Technology Policy Research Institute (51.3 per cent) and Plant Genetic Resources Research Institute (48.6 per cent). Administration costs account for 10.7 per cent at the universities and almost twice that much (20 per cent) at the Council for Scientific and Industrial Research, where they range from 15 per cent (Oil Palm Research Institute) to 36 (Sustainability Research Institute) per cent. By far the largest line item in the administrative budget is “other allowances”, covering on average more than two thirds of this budget category and reaching as high as 92 per cent (Sustainability Research Institute). Hence, in either case, staff and administrative expenses make up more than 90 per cent of the budget, leaving between 4 per cent (Council for Scientific and Industrial Research) and 8 (universities) per cent for operational and capital expenses related to research. Capital expenses tend to be even lower than operational expenses.

The situation at the Cocoa Research Institute of Ghana is similar. The only institution that is markedly different is the Centre for Scientific Research into Plant Medicine, where personal emoluments make up a third of the budget, and research and capital expenditure, 43 per cent.

Operational research funding is recorded as “service funds” (see table 3.4). At the Council for Scientific and Industrial Research, it is noteworthy that the Secretariat, which is not directly involved in the exercise of research, utilizes almost a third of the service funds of the entire Organization. Of these, it spends 70 per cent on seminars, conferences,

workshops, meetings, and stationary, and thus not on actual research. Surprisingly, research is underfunded both absolutely and relatively in an organization whose principal remit is research.

Likewise, most of the very low investment is used for the rehabilitation of buildings and related expenses. The Secretariat spends significantly more than a third of all investment outlays for the entire organization on itself. Investment in equipment features hardly at all across the organization (see table 3.5).

The picture that emerges of the Council from these figures is therefore of a top-heavy organization that employs its staff without providing the means to engage in research. Apart from some building rehabilitation, much of which benefits its headquarters, the Council is clearly running down its assets. Annual reports made available for this report noted the challenges of inadequate research funding, especially to equip labs and workshops,<sup>2</sup> inadequate funding (along with late release of funds) from the Government,<sup>3</sup> and insufficient resources for infrastructure and farm machinery,<sup>4</sup> to name just a few. This is not new. A review of Ghana’s agricultural research system undertaken in the late 1980s criticized the deterioration of the physical research facilities and the decline in the operational funding per scientist. Despite the different proportion of the total budget going into research, the situation at the Centre for Scientific Research into Plant Medicine is essentially the same – in fact, the roof leaks every time it rains and the electrical wiring is so old as to pose a “danger to life and property”.

Indeed, researchers at the institutes we visited complained about outdated or badly maintained and broken equipment in their labs. According to some accounts, research staff had to subsidize basic office supplies such as printer cartridges and stationary in order to have access to such material.

Table 3.3. Allocation of funds, Universities and Research Institutes (in GH¢)

	GOG PE	Admin.	Service	Investment	Total	IGP PE	Admin.	Service	Investment	Total	TOTAL	PE. Total (%)	Admition Total (%)	Service Total (%)	Investment Total (%)
Universities	81,324,165	6,596,529	967,305	2	88,887,995	2	4,069,775	4,002,349	2,710,656	10,782,776	99,670,769	81.6	10.7	5	2.7
CSIR	17,611,490	4,647,002	571,002	445,002	23,274,490						23,274,490	75.7	20	2.5	1.9
of which															
Secretariat	1,848,996	617,203	172,981	169,385	2,808,559						2,808,559	65.8	22	6.2	6
Crops Research Institute	1,430,888	297,902	31,034	22,104	1,781,922						1,781,922	80.3	16.7	1.7	1.2
Animal Research Institute	1,139,280	293,202	29,993	27,147	1,489,616						1,489,616	76.5	19.7	2	1.8
Soil Research Institute	1,414,417	359,002	32,934	22,104	1,828,451						1,828,451	77.4	19.6	1.8	1.2
Soil Research Centre	166,009	98,002	8,379	2	272,386						272,386	60.9	36	3.1	0
Building, Road and Research Institute	1,330,060	272,402	25,207	17,654	1,645,317						1,645,317	80.8	16.6	1.5	1.1
Food Research Institute	978,749	237,102	26,893	17,544	1,260,282						1,260,282	77.7	18.8	2.1	1.4
Water Research Institute	1,447,779	346,702	28,569	30,410	1,853,454						1,853,454	78.1	18.7	1.5	1.6
Institute of Industrial Research	691,911	301,702	29,002	26,999	1,049,608						1,049,608	65.9	28.7	2.8	2.6
INSTI	509,183	200,302	19,003	14,835	743,317						743,317	68.5	26.9	2.6	2
Oil Palm Research Institute	1,489,307	274,402	26,726	17,802	1,808,231						1,808,231	82.4	15.2	1.5	1
Savanna Agricultural Research Institute	1,332,038	299,602	27,468	25,960	1,685,062						1,685,062	79	17.8	1.6	1.5
Ghana Grains Development Project	1,486,631	324,702	25,804	2	1,837,133						1,837,133	80.9	17.7	1.4	0
S&T Policy Research Institute	200,087	155,702	19,490	14,835	390,108						390,108	51.3	39.9	5	3.8
Forestry Research Institute	1,241,577	271,302	29,071	17,802	1,559,746						1,559,746	79.6	17.4	1.9	1.1
Plant Genetic Resource Research Institute	578,918	578,918	12,807	20,447	1,191,084						1,191,084	48.6	48.6	1.1	1.7
Root & Tuber Crops Project	325,692	103,402	21,493	2	450,583						450,583	72.3	22.9	4.8	0
ICMST	2	2	4,191	2	4,191						4,191	0	0	100	0
CSRPM (2006), Old Ghana Cedis	3,574,300,002	2,952,000,002	1,339,500,002	3,637,500,002	11,503,300,002						11,503,300,002	31.1	25.7	11.6	31.6
CRIG (2005-06), Old Ghana Cedis	56,905,277,002	5,107,525,002	2,208,480,002	2,336,630,196	72,183,625,002						72,183,625,002	78.8	7.1	3.1	3.2

Note: INSTI is the Institute for Scientific and Technological Information; ICMST is the International Centre for Material Science and Technology.

Source: Republic of Ghana (2008); CRIG, CSRPM (2006).

Table 3.4. CSIR Service Funds, 2008

Column A	Column B	Column C	Column D	Column E	Column F
	Service	Drugs, chemicals and consumables	C/B (%)	Rent of plant and equipment	E/B (%)
CSIR	571,002				
of which:					
Secretariat	172,981	51,002	29.5	...	...
Crops Research Institute	31,034	20,234	65.2	...	...
Animal Research Institute	29,993	10,993	36.6	...	...
Soil Research Institute	32,934	30,002	91.1	...	...
Soil Research Centre	8,379	1,002	11.9	...	...
Building, Road and Research Institute	25,207	10,002	39.7	...	...
Food Research Institute	26,893	6,902	25.7	...	...
Water Research Institute	28,569	23,202	81.2	...	...
Institute of Industrial Research	29,002	15,002	51.7	...	...
INSTI	19,003	2	0		...
Oil Palm Research Institute	26,726	10,002	37.4	...	...
Savana Agricultural Research Institute	27,468	7,802	28.4	6,308	23.0
Ghana Grains Development Project	25,804	9,802	38.0	...	...
S&T Policy Research Institute	19,490	2	0	...	...
Forestry Research Institute	29,071	10,071	34.6	...	...
Plant Genetic Resource Research Institute	12,807	7,202	56.2	...	...
Root&Tuber Crops Project	21,493	5,493	25.6	...	...
ICMST	4,191	502	11.9	...	...

Source: Republic of Ghana (2008).

Table 3.5. CSIR Investment Funds

Column A	Column B	Column C	Column D
	Investment	Purchase of plant and equipment	C/B (%)
CSIR	445,002		
of which:			
Secretariat	169,385	0	0
Crops Research Institute	22,104	0	0
Animal Research Institute	27,147	0	0
Soil Research Institute	22,104	0	0
Soil Research Centre	2	0	0
Building, Road and Research Institute	17,654	0	0
Food Research Institute	17,544	0	0
Water Research Institute	30,410	0	0
Institute of Industrial Research	26,999	0	0
INSTI	14,835	0	0
Oil Palm Research Institute	17,802	0	0
Savana Agricultural Research Institute	25,960	0	0
Ghana Grains Development Project	2	0	0
S&T Policy Research Institute	14,835	0	0
Forestry Research Institute	17,802	0	0
Plant Genetic Resource Research Institute	20,447	10,002	48.9
Root&Tuber Crops Project	2	0	0
ICMST	2	0	0

Source: Republic of Ghana (2008).

The high share of salary costs in the research system raises the question of whether researchers are adequately paid. This is of course paramount for their motivation, especially since they are confined to working under less than optimal conditions.

The Council for Scientific and Industrial Research currently employs just over 3,800 staff. Average per capita staff cost in 2008 was ₵4,607, or ₵384 per month. It is instructive to compare that with one of the large universities. For 2008, Kwame Nkrumah University of Science and Technology devoted ₵28,342,882 to staff compensation. With 3,358 total staff, this amounts to a per capita cost of ₵8,440, more than 80 per cent higher than at the Council. To some extent this is due to the fact that the universities generally have higher core/support staff ratios. At the Council for Scientific and Industrial Research, on average, one in ten employees is a researcher. At Kwame Nkrumah University of Science and Technology, this ratio is about one in three. Since core staff are better paid, the two ratios are to be compared with caution.

However, it is no secret that university faculty make higher salaries than their peers at the research institutes. More importantly, our interviews indicate that while university salaries do guarantee sufficient incomes, the majority of Council researchers moonlight because their compensations cannot sustain themselves and their families. Moonlighting typically does not take the form of professional assignments on the side, but rather activities such as taxi driving, retail activities, broiler farming and the like.

While universities appear to be relatively better off, they also count poor remuneration and poor service conditions for staff, alongside inadequate funding and poor allocation of resources for academic programmes, and run-down infrastructure among their major weaknesses.<sup>6,7</sup> For example, at Kwame Nkrumah University of Science and Technology, laboratories set up in the 1960s largely host the original equipment and facilities, which have not been updated.<sup>8</sup> The vice-chancellor of the University of Ghana told the annual congregation that “the University particularly requires equipment and chemicals for its laboratories to enable students in the Sciences to carry out meaningful practical sessions to support their theoretical lessons”,<sup>9</sup> without which it would be impossible to turn out first-class graduates.

In terms of governance and financial administration, the universities differ from the Council for Scientific

and Industrial Research. Whereas university senior management is unaware of the exact size of potentially sizeable external research income, at the Council, it is mostly the researchers that are in the dark about research volumes in what is a highly centralized system.

In conclusion, this section showed that the inputs to Ghana's research are inadequate. What about the outputs and the outcomes?

### Outputs and outcomes

Table 3.6 shows basic indicators about Ghana's largest universities. On the input side, it is evident that graduate enrolment is relatively low, especially at the University of Cape Coast. In 2007, the share of science and technology graduates in the total cohort ranged from 8 per cent (University of Ghana) to 63 per cent (Kwame Nkrumah University of Science and Technology). This clearly reflects that the latter was from its inception a university mandated to focus on science and technology subjects. More importantly, however, all universities turned out less than 1 per cent of their students with a PhD (Doctor of Philosophy) in science and technology subjects, meaning that they did not contribute many highly trained junior scientists or engineers to the country in a given year, including for the replenishment of their own faculty. Since an increase in the output of students in science and technology-related courses has been an explicit aim of the University of Ghana since at least the early 1990s,<sup>10</sup> its performance to date in this regard is disappointing.

Information concerning publications output taken from the respective annual reports is not entirely reliable. This is, for example, because the 2007 documentation lists articles with a publication date of 2006 as “forthcoming” which logically means that one of the two pieces of information supplied is not correct – either the paper was published in 2006 or it is still forthcoming in 2007 onwards. Also, some articles registered as published do not signal a year of publication; since the annual reports for some reason report publications not strictly for the previous year only, but over a range of two to three years, date allocation is thus not possible. In addition, since co-authored articles are listed under the name of each author, there is some overcounting.

In 2006 and 2007, it took between seven and four academics at the three universities to publish an article in a peer-reviewed journal. Many papers were published in in-house or other Ghana-based journals.

About every third paper was published in a journal recognized by the Thomson Reuters ISI database. The quantity of publication output does not sit easily with claims to academic excellence. For example, in its strategic plan, the College of Science of Kwame Nkrumah University of Science and Technology refers to the quality of academic staff as one of its strengths. "Most of them have attained high reputation in their fields of study and rank among some of the best scientists in the world. Quality research findings by faculty members are published in reputable journals..."<sup>11</sup> In 2007, the 123 lecturers published 56 articles in peer-reviewed journals.<sup>12</sup> Although this makes for a better ratio than the average, it does not compare well with research output elsewhere, not to mention top science universities.

Academics tend to blame a heavy teaching load for their low research output. In fact, enrolments in all universities have increased dramatically. In 2007, the

University of Ghana admitted 2.7 times more students than a decade earlier. The University of Cape Coast and Kwame Nkrumah University of Science and Technology increased their intake over the same period by a factor of 2.3 and 2.1, respectively. Since this occurred without a concomitant increase in the number of teaching staff, student/faculty ratios rose, thus making the teaching load heavier.

While the growth of enrolments thus affects the universities across the board, there are differences across departments with respect to research productivity. Why this might be the case is taken up later in this report. Differences across the universities are also evident. For example, in terms of its core staff complement, Kwame Nkrumah University of Science and Technology runs a much leaner organization than the University of Ghana and especially the University of Cape Coast, which has nine administrative staff for every academic.

Table 3.6. Ghana's universities: Basic indicators

	UoG	UCC	KNUST
Year established	1948	1962	1952
<b>Enrolment</b>			
Total	29,756	16,808	23,868
Male/female ratio	1.5	2.1	2.5
Postgraduate	1,818	396	1,599
Undergraduate	26,156	16,142	22,271
Sub-degrees	1,786	272	./.
% of graduate enrollment	6.1	2.3	6.7
International students	1,144	./.	738
<b>Staff</b>			
Teaching and research	865	398	778
Academic staff with PhDs, %	46.8	./.	39.9
Admin. and professional	3,911	3,034	2,582
Ratio academic/support staff	4	4	4
<b>S&amp;T teaching</b>			
Ratio of science students, %	19.9	26.0	48.8
Ratio of S&T graduates, 2007	8.5	23.6	63.5
Ratio of S&T PhD graduates, 2007	0.16	0.0	0.08
<b>Journal publications</b>			
Listed on university website	(2007) 1	0	(2007) 12
Annual Report	(2006) 230	(2006) 50	(2007) 165
Output per capita	0.27	0.13	0.21
ISI 2006	73	15	54
Ratio ISI/other journals	0.32	0.30	0.33

Sources: ISI, KNUST (2007a,b); UCC (2007a,b); UoG (2007a,b); university websites.

Table 3.7 provides similar information about the Council for Scientific and Industrial Research and its institutes, plus the Centre for Scientific Research into Plant Medicine and the Cocoa Research Institute of Ghana. Measured in publication output in refereed journals, the Council's research productivity is lower than that of the three large universities. In 2005, 6 of its 13 institutes did not publish any papers at all. The remaining 7 accounted for a total of 31 publications, making for a Council-wide publication output ratio of 0.08, thus ranging from 0 to 0.38. Albeit evidently very low, this is not seen as a problem either at the corporate level or by the individual institutes, none of which identified this as a challenge in their annual report. It might be argued that limited publishing reflects the Council's mission to undertake applied R&D meant for practical aims, rather than advancing frontier science and technology. However, in its Strategic Considerations 2005–2009, the Council underlined its ambition to "extend our impact beyond our walls through scientific publications that will showcase our achievements and our role as thought leaders of the African scientific community".<sup>13</sup> At the beginning of this planning period, the Council was this aim was still out of reach, which suggests a steep hill ahead.

The per capita publication output of the Cocoa Research Institute of Ghana is comparable to that of the universities, while the output of the Centre for Scientific Research into Plant Medicine exceeds it. Since publications covered by the Thomson Reuters

ISI database are from a different year, these two series are not strictly comparable. The data also do not capture other outputs, such as consultancy reports, extension services and the like. This is not because they are irrelevant, but because they cannot readily be compared across institutes, let alone internationally, insofar as the quality of individual products is not transparent. By comparison, scientific publications are not only an internationally accepted method of benchmarking research institutions, they are also a benchmark that both the universities and the Council for Scientific and Industrial Research have set themselves and against which they can therefore be evaluated. In conclusion, based on the output data available, it is incorrect to associate research mainly with the research institutes and perceive the role of the universities as primarily in teaching. Although these data do not capture all research achievements – especially technological developments – and thus underreport on the achievements of the institutes, it is clearly important to regard the universities as central actors in Ghana's research system.

The United States Patent and Trademark Office registered 10 patents to Ghanaian inventors between 1977 and 2008. Four of these were granted to people associated with the University of Ghana, and three to people associated with Kwame Nkrumah University of Science and Technology. It is likely that these patents represented team efforts headed by multinational firms, with the Ghanaian inventor one of several team members. Thus the assignee was in every case

Table 3.7. Selected indicators: Research institutes

	ARI	BRI	CRI	FRI	FORIG	IIR	ISTI	OPRI	PGRI	SARI	SRI	STEPRI	WRI	CSIR	CSPRM	CRIG
Staff	295	211	883	170	286	135	79	440	127	535	372	31	249	3,813	180	147
of which: research	27	27	83	34	38	18	13	23	9	35	26	9	56	398	22	35
with PhDs	9	0	24	12	14	4	1	2	2	8	0	3	20	99	6	17
Journal publications in 2005	2	0	7	0	4	0	3	2	0	0	10	0	3	31	10	8
per capita	0.07	0	0.08	0	0.11	0.00	0.23	0.09	0	0.00	0.38	0	0.05	0.08	0.45	0.17
ISI (2006)	2	0	2	2	3	0	0	0	0	0	0	0	3	9	2	2

Note: Cocoa Research Institute of Ghana publications are for 2000. The figure for Council for Scientific and Industrial Research and publications covered by the Thomson Reuters ISI database might partially overlap with those of the institutes; it is not the total for the entire organization.

Sources: CRIG (2002), CSIR (2006) for publications, CSIR website, CRIG website for staff complement, CSRPM (n.d.) and ISI. Please see table 3.3 for full names of organizations.



a foreign entity in the United States of America or Europe, meaning that no intellectual property from this patenting activity resides in Ghana itself

Accessing domestic intellectual property information proved difficult. Patent records are not available in electronic form or publicly accessible via a website. Consultations at the Registrar General's Department merely yielded information about the number of patents and trademarks assigned. Patent applications filed in Ghana increased between 2004 and 2006. In 2004, 12 patent applications were filed. The applications increased to 22 in 2006. There were 317 applications for industrial designs in 2006, mostly related to textiles. Trade mark applications in 2006 rose to 1,946 from about 1,000 in 2004.<sup>14</sup> However, the number of patents granted and in force is low. In 2005 there were only 4 patents in force in Ghana.<sup>15</sup> During the same year there were only 3 non-resident direct patent filings. The estimated cost of filing a patent application in Ghana is between \$2,000 and \$2,200.

Patent data have well-known drawbacks as a measure of technological innovation. This is especially the case for countries whose firms and research institutes do not generally operate at the technology frontier. However, even for countries at relatively low levels of capability accumulation, it is important to recognize both the opportunities and the constraints emanating from the international intellectual property rights regime. It is not evident that this is the case in Ghana which is a point taken up below.

In sum, Ghana's research system is underfunded and does not perform to the standard it set itself. The two are clearly related – performance relies on resources and, when lacking, can only be poor.

### 3.2 Staff upskilling and career progression

Any research system is only as good as the human capital on which it is based. Harnessing that capital is therefore of utmost importance. This refers to the competence of the scientific workforce, its motivation to excel and the incentives the system provides to encourage such dedication.

Human resource management at the Council for Scientific and Industrial Research is regulated in its Conditions of Service.<sup>16</sup> This provides for, inter alia, annual appraisal reports, promotions, sabbatical leave and scientific visits, and study leave. According

to these provisions, research staff are obliged to submit annual appraisal forms that are reviewed by the Director General, who is supposed to communicate issues arising from the report to the researchers concerned. Information obtained in interviews with researchers suggests that this is not a moderated process which accompanies agreed performance targets that progress – or the lack thereof – can be measured against. Instead, the process is perceived as a bureaucratic one-way chore that has little to do with the career progression of the individual concerned.

Promotions to higher levels of seniority depend on minimum requirements such as academic qualifications, which may be waived in case of assistant scientific officers who have not had the opportunity for post-graduate training; a certain number of publications, including technical reports; and – for levels above scientific officer – a minimum number of years spent at the respectively lower level. This last condition may be waived in exceptional circumstances. The logic of this provision is questionable. Star scientists who fulfil all conditions for promotion except the time factor are unlikely to perceive such a system as truly meritocratic. Also, staff members, who in year 1 of their tenure at a given level publish the three to five articles required for promotion to the next level, have no incentive to continue to publish in years 2–5, as their research productivity does not affect their career progression.

Scientific officers and above can apply for a one-year paid sabbatical after five years of service.<sup>17</sup> All scientific and technical staff can apply for paid study leave for periods up to five years, implying that the Council for Scientific and Industrial Research is an organization committed to capacity upgrading. In order for such applications to be granted, however, there must be adequate provision in the respective institute's approved budget to cover the expenses. This is rarely the case. Study leave occurs only in the presence of foreign funding. As a result, many staff, especially junior staff, not only have little information about this opportunity, but are discouraged about their chances of ever being able to take advantage of it.

In its strategic document covering 2005–2009, the Council for Scientific and Industrial Research<sup>18</sup> acknowledged the need for highly motivated staff and world-class skills and competencies to meet the needs of its target markets. It announced that by

2005 it would review and enhance incentive packages for staff and revise promotion criteria to encourage accelerated promotion at all levels. Three years later, it is not clear that this has actually happened.

The individual institutes share a recognition of the key role their human resources play. The Oil Palm Research Institute in 2002 underlined the need for an effective human resources development programme for the renewal of institutional expertise through training and retraining, which it predicted would have borne fruit by 2007 in terms of new competencies in biotechnology, information technology and other disciplines.<sup>19</sup> Such a programme was to address the perceived lack of motivation of staff which led to high turnover and to moonlighting. Since the strategic plan did not identify operational targets against which progress could have been measured, it is not clear how close the Institute has come to achieving its goals. The Crops Research Institute also acknowledged that staff capacity-building, coupled with periodic in-depth reviews of divisions, is an essential ingredient to improved research and service delivery.<sup>20</sup> One of the three key goals set by the Centre for Scientific Research into Plant Medicine is to make it an attractive place to work.<sup>21</sup>

The Cocoa Research Institute of Ghana, while priding itself on a strong human resource base, acknowledged that the competences of its staff were in need of upgrading.<sup>22</sup> Its strategic plan laid out the need for new or updated human resource systems, utilization and development. This included reward management, appraisal systems, performance management, career planning and development, work study and other types of development. The Institute is the only establishment that in the absence of performance or productivity indicators admitted not being able to identify areas of over- or understaffing. It also questioned whether its low labour turnover was an unambiguous strength of the institution, in the sense that the long service duration of senior staff prevented talented younger researchers from a rapid career progression. In addition, there are practically no direct financial incentives for good performance at the Institute. Since it is undoubtedly one of the better organized research institutes in Ghana and since its strategic plan is among the more solid analyses undertaken in the country's research system, it is likely that these difficulties reflect a larger problem with incentive alignment for human capital in the system, even if not all institutes are as vocal about it.

This contention is also borne out by strategic reflections undertaken in the universities. The Visitation Panel that reviewed the University of Ghana in 2007 recommended strengthening the faculty through the systematic mentorship of young lecturers, including induction and orientation programmes for new appointments.<sup>23</sup> It also recommended introducing a two-track salary system where research competence and output would determine differential remuneration in order to provide incentives for highly productive academics to commit to a university career. It concluded that, in the absence of an up-to-date staff establishment, performance management had been compromised. The University of Ghana largely accepted the recommendations emanating from the report.<sup>24</sup> Since it had declared as early as 1994 that the development, utilization, and retention of a high-calibre faculty was an essential stepping stone to achieving its mission, one wonders what happened in the decade and a half that passed between its strategic plan for the new millennium (University of Ghana, 1994) and the engagement of the Visitation Panel. Many of the Visitation Panel's recommendations, such as the introduction of reward systems and staff development programmes, were already part and parcel of the earlier plan. Hence it is not correct to say that solutions to human resources development problems elude the universities; rather it seems to be an unwillingness or an inability to implement them that is the problem.

The University of Cape Coast, while less detailed, also regards the poor service conditions of staff as a major threat to its performance.<sup>25</sup> In its ten-year plan going to 2014, Kwame Nkrumah University of Science and Technology determined that the high level human resource capacity it needed to fulfil its mission required among other things the introduction of a package of motivational incentives tied to performance and outstanding achievement, plus the provision of clear guidelines for career progression and the creation of awareness on upward mobility.<sup>26</sup>

In sum, the analyses embedded in the various strategic plans reviewed here suggest that human resource management and development have either not been pursued systematically or have become a bureaucratic routine that has not adapted to changed circumstances. The result is that the research system's most important capital, people, is short-changed. Inputs from scientists interviewed for this study, independent of seniority, bear this out. This is an

enormous problem because highly trained knowledge workers will continue to opt for careers in science and academia – which are less well remunerated than positions in industry – only if their motivation and ambition is matched by organizational practices and policies that are receptive and supportive of their expectations.

### 3.3. Intellectual property rights in the research system

The impact of intellectual property rights on developing countries, especially subsequent to the Agreement on Trade-Related Aspects of Intellectual Property Rights of the World Trade Organization (WTO), has been hotly debated. In theory, more intellectual property rights protection should lead to more innovation in the long run, although this clearly imposes costs on the laggards in the short run. However, there are differences among more and less advanced developing countries, and how such costs and benefits exactly manifest themselves is essentially an empirical question. Stronger intellectual property rights are generally associated with a rise in knowledge flows to affiliates of transnational corporations and in inward foreign direct investment to middle-income and large developing countries, but not to poor countries.<sup>27</sup> Patents do not seem to influence the incentive to innovate in developing countries themselves, but other forms of intellectual property rights, such as utility models, do.<sup>28</sup> In other words, in countries with weaker R&D capacity, what matters for innovation, technological diffusion and growth may be the protection of minor, incremental innovations rather than strength of protection.<sup>29</sup>

The purpose of this section is not to verify the issue of benefits and costs in the case of Ghana, although this is of course an important issue. The point is rather to relate intellectual property emanating from the country's research system to its emerging intellectual property rights framework (Industrial Designs Act 2003, Patent Regulations 1996, Trade Marks Act 2004). This matters because the existence of a legal framework does not preclude that innovations are insufficiently protected. Reasons for such a disjuncture can be manifold. In Chile for example, particularly in biomedical research, indigenously developed ideas end up being owned and commercialized by United States companies simply because the country's researchers and institutions are steeped in a non-patenting culture.<sup>30</sup> In addition, the tension between

systems designed to protect codified knowledge and attempts to regulate access to and exploitation of traditional knowledge is not well resolved.<sup>31</sup>

These last observations are very relevant to Ghana, at least at three levels. First, individual researchers are rarely familiar with intellectual property rights legislation. They often do not appreciate what actually constitutes a novelty or why it might make sense to protect it. They also suspect that registering a patent might be cumbersome and costly, even if this is not based on direct experience. Some argued that scientists were prevented from registering patents as private persons. Further, patents do not figure prominently in the rules governing promotion. Second, neither universities nor research institutes have central frameworks in place that would regulate how intellectual property is to be handled, how it is disseminated or transferred, who would be responsible for the cost of servicing patents, or how possible proceeds from its exploitation are to be shared between the inventor and the assignee. Third, the government as a funder of public research in the country has not made intellectual property rights, in whatever form, an explicit yardstick against which it measures the performance of the system. In sum, there are no incentives inherent in the system that would encourage anyone to take the national or the global system of intellectual property rights protection seriously.

There is an intellectual property rights office in the Patent Information and Documentation Centre which is located at the Institute of Industrial Research. This was set up with support by the World Intellectual Property Organization (WIPO), the European Patent Office, and the International Development Research Centre. Its sustainability became endangered when donor support was withdrawn. The Centre was meant to provide legal and technical information and advice. There are no user records so it is not clear who makes use of this facility, or how often its services are being requested. Although it is staffed by only one person, one cannot therefore conclude understaffing in the sense that demand for its services might actually be rather low. In the middle of the decade, the Secretariat of the Council for Scientific and Industrial Research commissioned the Centre to write a paper about intellectual property rights, but reportedly this was never followed up.

The absence of institutional intellectual property rights management systems leads to a situation where no one knows whether there is any intellectual property

worth protecting in the country, how best to do it and what degree of locally developed ideas potentially leave the country to be exploited by anyone who was not involved with their development. For example, scientists at the Institute of Industrial Research developed a pilot cassava processing plant. This aimed at the minimization of post-harvest losses, value addition, the facilitation of downstream linkages and export markets. The scientists did not know whether their technological development was new to market or new to the world, even though they worked in the very same institute that houses the Patent Information and Documentation Centre. It was therefore not clear what type of intellectual property rights protection, if any, would have been most appropriate. This makes it impossible to calculate a return on this investment, for example because one cannot assess its viability on export markets.

Agricultural research is no different. The Crops Research Institute does not register the new seed varieties it develops; it merely records them in in-house journals. This is not the outcome of an explicit policy – that is, to make the results of publicly funded research freely available to any takers – but merely the default practice of selling physical commodities without considering the intellectual capital they embody. This benefits farmers who obtain affordable access to improved seed varieties; however, it also benefits industrial customers, such as breweries, which privatize the gains from public research. To be sure, this is not necessarily negative. The inclusion of quality protein maize in locally brewed beer may well earn a social return in excess of the investment made into developing the quality protein maize. The issue is that because this is not properly evaluated, no one is in a position to estimate how much the Institute contributes to development in Ghana. In this particular instance, its effect is likely underestimated.

The safeguarding of indigenous knowledge is a particularly sensitive issue. There are instances of biopiracy in the developing world. More importantly, in the absence of a framework that ensures a fair sharing of the gains from the exploitation of traditional knowledge, the poor are most in danger of being adversely affected, whereas control over these assets might actually help them achieve sustainable livelihoods. The Centre for Scientific Research into Plant Medicine operates without a national bioprospecting framework. The only way it protects its intellectual property is by keeping the

dosage of its concoctions confidential, although most pharmaceutical laboratories can figure out both the ingredients and their respective quantities. Hence if any products of the Centre were to be widely successful, it might lead to a search for active ingredients by foreign firms that are currently not regulated by benefit-sharing arrangements to ensure that local communities are not left out.

The situation in the universities is similar. None have an intellectual property rights office, and faculty, like their peers in the research institutes, are similarly confused about intellectual property rights. The University of Ghana is addressing this issue by sourcing technical assistance from Oxford University and collaborating with the West African Innovation Management and Research Association.

### 3.4. Coordination failures and functionality

The institutes and universities are only a part of Ghana's research system. Hence when assessing their performance, it is important to distinguish between them and the system at large. There are instances where relevant knowledge was produced but left unutilized – not because of something the universities or institutes did or did not do – but because of what Gerschenkron termed “missing prerequisites”. A few examples illustrate this.

In a project funded by the Canadian International Development Agency, scientists at the Institute of Industrial Research developed a cassava processing plant. In contrast to traditional practice, it utilized all inputs from the root, including peels. Nonetheless, it is challenging for mechanized processing to be cost competitive, because rural women undercost their labour input. According to the scientists involved in the project, the plant was viable. It produced a range of inputs both for the food processing industry and for industrial purposes. After it was completed, it would have required some form of funding so that rural communities could afford to purchase and use it. Since its operation required professional management, it would also have required the setting up of a structure whereby community ownership, for example, through shares, was reconciled with the employment of a professional manager. Yet this funding was not forthcoming. Banks are reluctant to invest in agricultural projects, and there was likewise no other credit facility available from the Ministry of



Food and Agriculture, for example. The lack of credit also prevented entrepreneurs from acquiring the plant. Therefore this plant now sits idle, with little prospect of generating an income stream that would ultimately justify the initial investment in the technological development.

It does not fall within the remit of this study to assess the viability of this and other projects. But taking the scientists' account at face value suggests that there are very considerable coordination failures in the system. Foremost among them is the absence of credit to facilitate the uptake of developments produced by the country's knowledge infrastructure. The developers would reportedly be interested in commercializing the pilot themselves, but to date the Council for Scientific and Industrial Research has no policy on spin-offs, and it is not clear how they would fund the purchase. Since no one has checked for potential international interest in the facility, it appears to be essentially a wasted opportunity.

In another example, the Food Research Institute was involved in a ten-year effort to increase the quality of local rice so as to substitute imports from Asia and elsewhere, funded by Department for International Development of the United Kingdom of Great Britain and Northern Ireland, and the Food Security and Rice Producer Association. In principle, certain areas of Ghana, especially in the north, lend themselves well to rice cultivation. However, the quality of local rice has traditionally not been high, in terms of purity, appearance, and so on. This partly depended on inputs such as land and seeds, but post-production methods were also a problem. This refers to late harvests from water-logged fields that lead to cracked grains, threshing on the bare ground without a tarpaulin and the like. The cracks are difficult to avoid, which is why farmers parboil the rice. The Institute designed a vessel for parboiling that reduced water and fuel input. They also made arrangements for farmers to receive training in good practices. However, local rice production did not ultimately go up, rice is still largely imported and the project was therefore not a success. The Food Research Institute's version of why that is the case hinges on the cost of high-quality seed that the farmers cannot afford as soon as the international funding runs out and they face market costs for inputs.

A very senior manager at the Council for Scientific and Industrial Research expressed no sympathy for these problems. He argued that research design

must de rigueur include and ensure that technological development goes all the way to commercialization, thus hoisting the entire responsibility onto the shoulders of the scientists in charge of the project. This implies that in the above examples, scientists at the Institute of Industrial Research and the Food Research Institute should have solved failures in the market for credit in Ghana. This comment illustrates a profound misunderstanding of how research and innovation systems work and a lack of responsibility for the very support systems that the Council's management should put at the disposal of its core staff.

In the Ghanaian research system, the whole does not seem to be more than the sum of its parts. As these examples show, even when the parts are working, there is not necessarily a positive outcome, simply because information exchange, coordination and monitoring within the system do not take place. This means that underperformance or failures go unnoticed, resulting in a great deal of inefficiency and, thus, wastes of potential.

It is important to assess the performance of Ghana's research system in the context of the institutional limitations that constrain key linkages in the system. As the above examples show, it would be inappropriate to hold the Council for Scientific and Industrial Research or the universities responsible for low performance when the system itself does not provide the prerequisites that are necessary conditions for that performance to materialize.

### 3.5. Governance and accountability

The legal framework within which Ghana's research system operates provides for regular performance reviews, at least for some of the actors in the system.<sup>32</sup> For example, the Act establishing the Council for Scientific and Industrial Research (1996) identifies the following as one of the Council's functions:

To review, monitor and periodically evaluate the work of the institutes administered by the Council in order to ensure that research being carried out by the institutes directly benefits identified sectors of the economy and is within the national priorities.<sup>33</sup>

There is no written evidence that the Council actually performs this function. None of the institutes we visited had been subjected to such a review. This means that neither the Council nor the individual institutes are used to self-evaluations, engaging with peer reviews,

and the like; in short, no institute has a transparent process of accountability geared toward rectifying undesirable developments and generally improving system performance.

It is probably no coincidence that in the absence of such a culture of reviews, be they internal or external, the Council has resorted to – or been subjected to – evaluations by outsiders. This is not a bad thing per se, except that ad hoc external reviews of systems or institutions that do not systematically monitor and evaluate themselves can be brutal affairs. For example, the Government commissioned a study into the partial commercialization of the Council Secretariat, the Water Research Institute, and the Institute for Scientific and Technological Information.<sup>34</sup> It essentially wanted to find out how these three institutions could meet their 30 per cent target of internally generated funds. But the consultants did not mince words. They argued that the Government was wrong in presupposing that the Council was a fundamentally sound institution that only needed some streamlining. They concluded that there were “deep-seated and system-wide constraints” and that “the ability to manage efficiently and optimize commercial operations is significantly curtailed by inherent bottlenecks of the existing system”.<sup>35</sup> They recommended to pare the number of institutes from 13 to 5 and to prepare for sizeable staff layoffs. It is rare that such radical proposals are implemented, if only because they face fierce resistance from many quarters. But to the extent that their underlying analysis has merit, not engaging with the recommendations – which a culture that neglects self-evaluation and regular internal reviews indirectly promotes – is clearly a problem.

Perhaps the lack of regular self-evaluation and internal assessments is one reason why some institutes have outsourced their strategic plans to consultants. This has yielded rather mixed results. Some plans diligently elaborated the “how?” after stating the “what?”. For example, the strategic plan of the Cocoa Research Institute of Ghana incorporates an analysis of strategies for services and technology, marketing, human resources and organization, finance and general development.<sup>36, 37</sup> Similarly, the Crops Research Institute matches its strategic direction with a plan of operation that codifies milestones against which the achievements of targets can be assessed.<sup>38</sup>

Strategic documents of other institutes that should serve as a guide for their work, partly well into the next decade, are problematic. The strategic plan of

the Centre for Scientific Research into Plant Medicine devotes roughly two pages to each of the years the plan covers.<sup>39</sup> The Institute of Industrial Research recently released a strategy document that is so ambitious as to require a complete re-engineering of the entire institute. The many actions it recommends read a bit like a shopping list whose feasibility remains unclear because implementation extends to the entire duration of the plan, namely five years, which – since it does not specify milestones – means that monitoring and evaluation are restricted to declaring success or failure only at the very end of the planning period.<sup>40</sup> By not agreeing on performance indicators and not making them public at its institutes, the Council for Scientific and Industrial Research as a whole undermines its ability to substantiate any claims of a strong performance.

The situation in the universities reflects a similar diversity. Universities are mandated to organize reviews on a regular basis. For example, paragraph 5(5) of the University of Cape Coast Law (1992) stipulates that “[t]he Chancellor shall once in every five years appoint a visiting committee to inspect the work of the University and report to him”.<sup>41</sup> But whereas this procedure appears dormant at the University of Cape Coast, the University of Ghana made use of a similar provision in the University of Ghana Act 79 of 1961 to recruit the services of an international visitation panel in 2007. Although the resulting report is not the same as a strategic plan, the reaction of the University's leadership shows that the report will in key ways inform its strategic thinking.<sup>42</sup> A review clearly raises the bar for the quality of self-reflection, thus making for more realistic takes on how desirable goals can best be matched with available resources within a specific time horizon.

Kwame Nkrumah University of Science and Technology undertook a situation analysis followed up by a strategic plan in 2005. This process was implemented at the corporate level and by the individual colleges.<sup>43</sup> It started from a number of well-defined challenges, for example how to diversify its sources of income and reduce its dependence on government. The objective to increase its contribution to recurrent funding through internally generated funds to 50 per cent was translated into a number of strategies, such as to reappraise existing income generating units and appoint a resource and development officer to promote and coordinate fund-raising activities.<sup>44</sup> The University of Cape Coast performed a similar



exercise, albeit without proper costing (University of Cape Coast, 2003).

What matters is that Kwame Nkrumah University of Science and Technology and to a lesser extent the University of Cape Coast put a system in place that allowed them to monitor their own performance and, insofar as they made this information publicly available, gave external stakeholders the opportunity to judge the universities' progress as well. This increases accountability in the system.

### 3.6. Negative examples

Ghana's research system has many practices that affect its performance negatively. It also lacks practices that would allow the constituents of the system to function more professionally. A few examples illustrate this.

Young scientists entering the system might spend years in the library and spend little time in a research lab, let alone conduct experiments. This affects their competence and negatively impacts their ability to assemble data so as to live up to their publication requirements. What they share with senior staff is that laboratory equipment is often so outdated that journals reject submitted papers because of experimental methodologies that are regarded as outmoded by the profession.

Although there is a system-wide absence of professional research management systems and skills, researchers complain that they are actively discouraged from obtaining training in project management or other forms of strategic management. One scientist reported that he attended a project management course on his leave time for which he paid himself because his institute saw no point in supporting such an initiative. Since many institutes evidently suffer from capacity constraints in formulating strategic or business plans, as shown in the previous section, it makes no sense to prevent staff with an interest in management to acquire requisite skills.

Industry representatives remarked that institutes did not do proper costing, which suggests that general business skills are weak. As a result, their services are sometimes not competitively priced. Furthermore, in the absence of proper marketing, the institutes do not necessarily have a public profile such that potential clients are aware of what their capabilities are.

Although the Council for Scientific and Industrial Research Secretariat and the individual institutes have commercialization officers, they do not have dedicated positions for research project acquisition. Since this is upstream from commercialization, it is perhaps one reason why commercialization is not effective. As a result of the absence of research support services, much international work is bilateral, rather than multilateral, because the former is easier to organize. Of course, highly motivated individuals can still seek international research funding. But they are competing against peers with much better developed support systems, and this clearly affects their competitiveness. It is curious that not all institutes practice an award system for staff who bring in large international research projects, since this directly affects the core activity of the institutes.

Management boards of at least some Council for Scientific and Industrial Research institutes, which among other things are a key interlocutor with the private sector, met so rarely as to be unable to fulfil their supervisory and advisory role. In one institute the board had not been convened at all in the first semester of 2008. Unfortunately, the institutes often cannot afford to pay board members their allowances.

Unless staff have acquired their degrees abroad, they tend to have little international exposure. Since research is increasingly performed in large, international networks, this is a problem because it impedes integration into such consortia. The research system does not support scientists and academics directly (through active marketing, systematic intelligence on tender opportunities and the like) or indirectly (for example, through informative and functional websites), exacerbating the situation.

In the key health field, the Centre for Scientific Research into Plant Medicine has no lab facilities to isolate active ingredients or marker compounds. The focus is therefore on qualitative work and preclinical evaluations. Compounds must be sent abroad for testing. Hence there is as yet no proper drug-making capability. Because of the lack of linkages to established institutions – and thus international exposure – of collaborations with pharmaceutical or biotech companies, and of scientists with expertise in molecular biology and nanotechnology, there is no local presence in third generation biotechnology.<sup>45</sup> Not surprisingly, biotechnology and pharmaceuticals exports based on Ghana's abundant biological diversity have not materialized.

The Crops Research Institute does not have an irrigation system to allow it to run two or three planting cycles per year. It relies entirely on precipitation. This affects its ability to earn internally generated funds. Its deficient lab facilities compromise its work in more than one way. Its biofortification research requires testing that can only be done abroad. And since there are centres, including in Africa, that are much better equipped, such as the Consultative Group on International Agricultural Research, major international crop research contracts tend to go there, while the Crops Research Institute has to content itself with the spoils from the high table,<sup>46</sup> although it used to host big projects in the past, for example, the CIDA- funded Grains Development Project from the 1980s. Given that the Government of Ghana requires that donor funding for agriculture must go through the Ministry of Food and Agriculture – which has no institutional responsibility for the Institute – scientists at the Institute often do not learn about new funding opportunities. Money always goes to the Government from where it must be released, therefore introducing red tape and delays into the system.

In essence the whole system suffers from systemic failures and works poorly. Without external partners and international partners it would not work at all. This underlines the strategic need to invest in these relationships to pre-empt donor fatigue in economically difficult times. In the long term, unless Ghana offers specific knowledge competences, the country will not be able to run the system on a shoestring as it has in the past, even if only to forestall a total shutdown.

The Government of Ghana seems to have viewed the research system primarily as a cost item. This partially explains why some parts of the system are reluctant to divulge information on external income. There have been instances when government “rewarded” an increase in internally generated funds through a decrease in its subvention, for example at the Cocoa Research Institute of Ghana. This is the exact opposite of the idea of co-funding, which is the norm in much global research funding. However, when internally generated funds become a substitute for government contributions to the budget, the resulting trade-off greatly undermines whatever incentive there may have been to raise external funds.

However, not all problems with the system lie on the supply side. Much of Ghanaian industry produces primarily for the domestic market, where

it does not face the kind of competition that would make technological upgrading an imperative. If manufacturing firms were forced to export more, then perhaps this would be different. The demand for higher levels of technological sophistication would also rise if there were more standards in the country. In turn, this would likely increase demand for science and technology graduates.

### 3.7. Positive examples

On the whole, this study shows that the Ghanaian research system does not perform well. However, this is an assessment on average. There are also examples of research activities followed by technology developments that have influenced growth and development in the country, or have the potential to do so. It is important to identify such examples both so that their lessons can be absorbed and because they might be the most realistic points for policy intervention to improve the system. It is clearly easier to improve performance on the basis of something that is already working well, as opposed to something that does not work at all.

#### Research management

Until recently, the University of Ghana did not have a central office to coordinate research at the institution. This changed with the recent creation of the School of Research and Graduate Studies, which is headed by a dean and supported by a dedicated research administrator, and who are tasked with developing a professional research management system. To date their activities have included a research proposal writing workshop through which they began to mentor junior or otherwise inexperienced staff in accessing international research contracts. Research support further includes the provision of a list of interested donors; more systematic scanning of tender opportunities on a regular basis will become possible once the School manages to hire dedicated research facilitators for each college.

The incentives for faculty to compete for external research funds are both direct and indirect. Some projects allow for salary top-ups. As importantly, externally funded projects allow the purchase of equipment and facilities that under other circumstances would never become available. In turn, this facilitates research whose successful pursuit ultimately decides about promotion.

What might emerge out of this are strategic research agendas that not only relate to national and international priorities, but establish viable activities on the ground. At some Council for Scientific and Industrial Research institutes, such endeavours to obtain external research contracts seem largely absent.

#### Research design and implementation

The Food Research Institute, in conjunction with the Forestry Research Institute of Ghana, has been involved in a multi-year project, funded by the Department for International Development, the Agricultural Services Sub-Sector Investment Project, and more recently, the Gates Foundation, that tried to absorb regularly occurring cassava surpluses by expanding markets for the root.<sup>47</sup> Relevant products included high-quality cassava flour as a substitute for imported wheat, glucose syrup, and industrial alcohol. The rationale behind these products was that the traditional food market was largely saturated. Interest from industry existed but there were bottlenecks in the supply for cassava flour. The solution to this problem originated at the Food Research Institute and was implemented in conjunction with private manufacturers. It consisted of increasing yields by removing suboptimal farming practices, setting up decentralized processing plants that reduced transport costs and guaranteed fresher products, and utilizing a new dryer technology developed with partners in Nigeria. This reduced the total cost/kg from ₵10 to ₵6.60, but with an acceptable margin for the farmers who have to trust the level of demand and rely on a certain price stability in order to harvest this crop. End-users were given performance guarantees and processors could draw on a credit facility to ensure the sustainability of the project. This created an entirely new value chain for the industrial use of cassava and is a good example of how technology can be used to the benefit of poor people.

#### Commercializing research results

The Oil Palm Research Institute is one of the few Council for Scientific and Industrial Research institutes whose internally generated funds approach the 30 per cent target. This is because it has a domestic monopoly on planting material and, thanks to almost four decades of breeding trials, there is international demand for its high-yielding parentals. Yet like all other institutes of the Council, it faces problems covering operational expenditures (e.g.

for fertilizer) and equipment (e.g. a mill for palm fruit processing) that negatively impact on its revenue. Since the Institute is not allowed to apply for credit and the Secretariat has not shown any interest to engage in loan activities, the board of the Oil Palm Research Institute is considering a joint venture with a private company to finance the mill while sharing the proceeds from the processing activity.

More interestingly, at least from a research point of view, is another joint venture for seed production with a transnational corporation from Indonesia. The purpose of the partnership is the sharing of germ plasm, of which each partner has a good stock. With export markets in mind, this requires high-quality seeds, which is why the agreement also provides for the maintenance of a minimum research infrastructure. To bolster this effort, the Oil Palm Research Institute aims at International Organization for Standardization (ISO) certification.

Further opportunities for partnerships exist in biofuels, which is being investigated by potential foreign investors. Hence the Institute has looked for, and partially found, ways out of its predicament of underfunding.

#### University-industry linkages

The Tema Oil Refinery, which had supported activities at the Department of Physics at the University of Cape Coast, approached the Department with a request for help to measure oil pollutants in the atmosphere because the Refinery could not afford the necessary equipment. The Department managed to use its good contacts with the academic physics community in Italy to source a monitoring device that it installed and that now measures pollutants at 10-km heights. This example illustrates that the availability of equipment is a precondition for engagement with industry.

#### Capabilities and competences

The recent ISO accreditation of the laboratories of the Food Research Institute is proof that Ghana's research system in select areas can operate at world-quality standards.

### 3.8. Lessons from elsewhere

Between 2010 and 2016, Kwame Nkrumah University of Science and Technology, the University of Cape Coast, and the University of Ghana will enrol students in science and technology subjects roughly in the following proportions: two fifths of undergraduate

students, and one half of postgraduate students. There are approximately 1.7 postgraduate students to every undergraduate. The rise in the proportion of postgraduate students over time has allowed the universities to expand their research and innovation base. During this period, 78 per cent of the students enrolled in each new cohort leave the universities as graduates. Around half of faculty members are full professors. The faculty/student ratio is 1:10. In 2010, the average per capita journal publication output in Web-of-Science-accredited journals is 0.825. By 2016 this will rise to 1.82. While few patent applications were filed in the early 1990s, the three universities will file close to 90 patents by 2015. Sponsored research and industrial consultancy projects will more than triple over the period under consideration.

All of this takes place in an institutional context comprising technology transfer offices, industrial liaison agencies, entrepreneurship cells and incubation units. Their remit includes the framing of innovation-specific guidelines, of revenue sharing policy and of intellectual property rights policy. This yields direct economic benefits for the universities. Perhaps more importantly, the spillovers associated with public-private collaborations lead to more economic activity in the form of start-up firms and job creation.

Academics enjoy these new arrangements. The universities encourage them to participate in these activities as a means to supplement their salaries. Departments are happy as well because a certain share of the royalty stream accrues to them. Technology transfer office staff are very enthusiastic about commercializing inventions, both in low R&D-intensive applications and in high-tech fields. They, too, are rewarded for successful performance.

Many students are involved in these activities as well. Their initial contact with the world of industry and agriculture comes through a compulsory course on entrepreneurship that all universities have made part of the undergraduate curriculum. Students collaborate with faculty, technical staff and outside researchers in so-called entrepreneurship cells on campus. These cells serve as an inducement to take on entrepreneurial challenges and assist those involved with launching and running a business venture.

During this period, the share of externally sponsored research and industrial consultancy will grow more

than two and a half times and reach 44 per cent of the Government's contribution to the universities' budget, although the majority of earnings continue to derive from government-sponsored research projects. The increase is higher for research than for consultancy projects, reflecting an academic environment that is naturally research driven. In a decade and a half, the universities have spun off more than 80 companies. The university community generally concurs that an explicit policy in support of spin-offs is behind this success.

In sum, whereas in the past the universities almost exclusively focused on training highly skilled human capital, over about a decade they now have started to make use of their intellectual assets for economic development, while generating revenue for themselves.

All that is required to turn this tale from fiction into fact is to change the names of the three universities for the following Indian Institutes of Technology: Bombay, Delhi, Kanpur, Kharagpur, and Madras. In terms of faculty size, the five Institutes are comparable to the three large universities in Ghana. The period from which the above performance indicators are drawn is 1999–2005.<sup>48</sup>

The point of telling this story is that miracles do happen. What is not possible is to replicate the above experience in its totality in Ghana. But surely one could begin emulating the Indian success in strategically chosen areas of excellence, with a view to letting the whole university system benefit over time from such an experiment.

Councils for Scientific and Industrial Research in South Africa and India, and a science and technology development agency in Colombia

A useful point of departure for any attempt to tackle these problems is to appreciate that Ghana's research institutes are in good company – their sister institutes in other parts of the world have problems, too. The panel that reviewed the South African Council for Scientific and Industrial Research in 2003 summarized its findings as follows:

"Thus, the major finding of the Panel is that the science and technology base is currently not strong and that, in some significant areas, the science and technology base has been considerably weakened since the last Review in 1997. [...]"



Strengthening the science and technology base will therefore depend, importantly, on considerable enhancement of human resources. ... the Panel made a number of proposals that are designed to advance the development of young researchers. At the other end of the spectrum, there is a need to recruit a few very high-quality scientists who could act to galvanize the organization and provide a new sense of excitement and purpose and who could serve to attract others. This will require that the Council for Scientific and Industrial Research carefully consider how it could best create the conditions that would allow such persons the space to exercise the initiative that will be necessary for high-quality science to grow and flourish."<sup>49</sup>

The Panel went on to recommend a new business model, which, inter alia, was meant to ensure that earnings be deployed to strengthen the science and technology capacity and to achieve a consolidation of certain business units, that is, the equivalent of institutes in Ghana. These recommendations were taken on by the Council for Scientific and Industrial Research. A member of the Council's senior management interviewed for this report underlined the importance of a strong science and technology base without which engagement with the private sector was impossible and made no sense. Thus, the Council recently created a new nanotechnology lab that provides a world-class infrastructure. Young researchers associated with its facilities are provided opportunities to attend international conferences. Through studentships, the Council involves people in the pursuit of MSc (Master of Science) or PhD degrees in project work. This not only gives these students an exposure to practical research they are unlikely to experience in their university. It also affords senior scientists the chance to enlarge research teams, co-publish with research assistants, establish links with universities, possibly teach part time, and so on – all activities that support research productivity.

The South African Council for Scientific and Industrial Research has less baggage than the Ghanaian Council for Scientific and Industrial Research identified in this report. Its core/support staff ratio is higher than 2:1, compared with roughly 1:10 in Ghana. However, in the past it had a very inflated overhead, which suggests that engineering more reasonable staff complements is eminently doable. It is much better funded. Its current annual turnover of approximately Rand 1.3 billion – most of which is of national origin –

is funded 40 per cent by a parliamentary grant. This represents about 15 per cent of total government expenditure and 4 per cent of national expenditure on R&D. The parliamentary contribution, although not its share, tends to rise over time; from 2006 to 2007 the gross increase was 17 per cent. About half of its external income supports relevant national strategies and technology missions. Importantly, it not only sells research but also intellectual property – in 2007, license income exceeded Rand 22 million. The Council also generates income from companies that it owns.

In 2007, almost 7 per cent of its revenue was ploughed back into scientific equipment. Stringent reporting requirements to parliament and the Department of Science and Technology try to ensure that these investments are in relevant areas. Its technological output included 12 international, 91 foreign, and 81 domestic patents, along with 49 technology demonstrators. However, its research output amounted to only 129 peer-reviewed articles, making for a very low per capita figure of 0.8. This implies, as suggested above, that there are certainly areas of improvement – and this is perhaps the most important difference between the Council for Scientific and Industrial Research in South Africa and in Ghana. Not only does the former undergo regular external reviews in relatively short intervals, that is, every five years, it also subjects itself to constant internal reviews – there is an annual review enveloped by a three-year rolling strategic plan. As a result, there is much more organizational change, such as the creation of new units or the closure of others that have exhausted their usefulness.

The reform of the Indian Council for Scientific and Industrial Research preceded the new (1996) Council for Scientific and Industrial Research Act in Ghana by ten years. The Review Committee recommended an external funding target of 30 per cent. Which part of the organization contributed how much to this overall goal, was for the Council to decide internally, that is, in relative autonomy from the Department of Science and Technology to which it reported. A one-time grant helped update essential equipment, while overall modernization proceeded in a phased manner. Resource allocation took place on the basis of specific programme needs, as opposed to some aggregate formula. Staff might be encouraged to follow the technology they developed to the industry where it would be applied. Red tape was removed from the

relationship between the individual labs – institutes in Ghana – and headquarters, by some degree of decentralization in the areas of finance, recruitment and administration. Scientists with expertise in areas of strategic concern to the organization were rewarded 50 per cent above their peers at the same rank. Of concern was the size of non-science and technology staff; it was recommended that the core/non-core ratio be reduced to 1:1.5.<sup>50</sup>

In 1996 the Council for Scientific and Industrial Research in India published a strategy paper that was supposed to take it into the new millennium.<sup>51</sup> How well the Organization lived up to the goals enunciated in this document is somewhat controversial.<sup>52</sup> However, in the current decade, many performance indicators have improved. Staff cuts went hand in hand with an increase in outputs. For example, publications, patents, and external income all rose.<sup>53</sup> Thus, in 2002, the Council's 38 labs were ranked top Patent Compliance Treaty applicants from the developing world, jointly with Samsung, whose research budget was 10 times larger.<sup>54</sup> They also considerably devolved decision-making processes to the individual labs.<sup>55</sup>

However, headquarters retained key units of importance to the entire Organization, such as the Intellectual Property Management Division, the International Science and Technology Affairs Directorate, and the R&D Planning Division, none of which have a counterpart in Ghana. Twice a year the Human Resource Development Group advertises junior research fellowships which total 7,000–8,000 beneficiaries. The human resources development unit identifies and nurtures new talent, funds extramural research, recognizes excellence and encourages interaction between scientists. Altogether it runs 18 such programmes. The core/non-core staff ratio is 2.7:1.

Colombia has had a science and technology development agency called Colciencias that in early 2009 was transformed into the Administrative Department of Science, Technology and Innovation. Its remit is none less than to create a national system of science, technology and innovation. It oversees and funds a series of research themes, currently hosted in seven research institutes, ranging from biodiversity to life sciences and new materials. In addition, it puts a premium on human resources development. To this end, it has set up the National Council for Economic and Social Policy, or CONPES 3179, to improve

national doctoral capacity by providing a competitive fund for scientific and technological equipment. This programme is the first of its kind in Latin America. Colciencias has also been funding masters and doctoral studies abroad since 1992, using loans from various sources. Currently 500 students are enrolled in this programme. In addition it runs a science awareness programme in the country's schools.

The experiences from South Africa, India, and Colombia show that the sister organizations of the Council for Scientific and Industrial Research have confronted, and adapted to, changes in their economic environment. This often entailed very considerable modifications to the way they operated. Along the way, their performance improved. Hence the way in which these systems are run determines in no small way what and how they deliver. Ghana can learn from these insights.

### 3.9. Recommendations

This assessment has discussed the question of whether Ghana's research system advances its developmental agenda. The answer is no. Undertaking the analysis also raised the question of whether it could in principle do so. The answer is yes. This concluding section summarizes what is wrong with the system and how it could be improved.

Figure 3.4 depicts a stylized version of the research system and its problems. It focuses on processes, functions, and institutions rather than individual organizations. A few themes emerge. The system receives little by way of inputs and produces little by way of outputs. Problems internal to the organizations that the report analysed include a dearth of professional research management, inadequate human resources development, misaligned incentive systems and an absence of regular performance assessments. These are issues that the research institutes and universities can and must address themselves. Then there are problems that afflict the system at large: widespread coordination failures, a dysfunctional intellectual property rights system, and again no openness to being reviewed. These are issues external to the organizations reviewed here and must be tackled primarily by government.

It is not possible unambiguously to infer causality from figure 3.4. For example, directors of research institutes might argue that if only they had more and better resources, their output would increase and



become more relevant. Detractors, in the form of other claims on public resources, might counter that the nature of the internal problems is such that more inputs would at best be an inefficient way to allocate resources to spur growth and development, and at worst, a total waste of money. One might also question how realistic it is to fix problems at the micro, or organizational, level if macro coordination and steering remain problematic or are lacking. Or conversely, what sense it would make to improve overall system capacity if the major knowledge-producing organizations in the country cannot work effectively?

This means that piecemeal approaches will not work. They are equivalent to the lip service that Ghana has been paying to the role of science, technology and innovation, which is acknowledged but never made explicit. This applies to policy, strategy, implementation, and monitoring and evaluation, supported by performance reviews. In sum, although many components of Ghana's research system perform suboptimally, it is the system at large – in other words the effective interaction between its various components – that does not work. Fixing things here and there is necessary but not sufficient when the whole system needs an overhaul.

The most important problem of the system is underfunding. This must not be misunderstood to imply that more funding will by itself quick-fix the system; as pointed out, there are other serious problems. Without better resources, however, none stand a chance of being sustainably solved. This section first discusses what should be done to tackle this problem, and then how.

The lack of resources can be solved in four complementary ways.

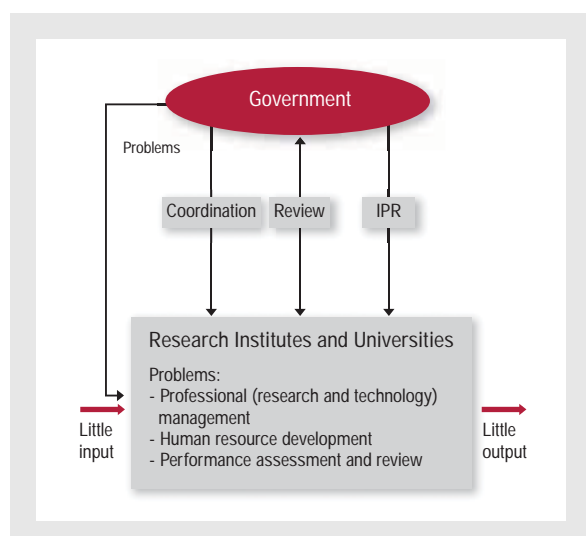
### 1) Increase budgetary allocation to STI

The government must increase its budgetary allocation to science, technology and innovation in order to give meaning to its commitment to that area. If it wants Ghana to become a knowledge economy, it must realize that such a path is neither cheap, nor short. Knowledge workers need to be well paid. They also need quality equipment and facilities. The discrepancy in salary between scientists at the institutes and academics at the universities is not justified. Since higher education always implies a subsidy to the middle classes, treating students and faculty as somehow deserving better than other members of the knowledge infrastructure merely acknowledges the lobbying power of an influential group in society. All this means that very substantial monies must be released for science and technology and that such investments only make sense in the context of long-term commitments that transcend electoral cycles. An increase in spending for a few years, followed by cutbacks, is counterproductive. In such a case it would be more logical to settle for a more or less permanent low-income status of the country at large.

### 2) Review institutional management

The Government should consider keeping the entire science and technology system under one ministerial roof, as has been the case since 2009. This assessment has failed to turn up any evidence that having three ministries rather than one to which the research institutes and universities report somehow benefits the system. Instead it makes coordination even more difficult in a system that on current standing is not particularly adept at ensuring relevance, efficiency, and effectiveness. It would be easier for one ministry to identify and address coordination and other failures, as opposed to several departments overcoming silo mentalities and bureaucratic obstacles. It bears emphasizing

Figure 3.1. Problems in the Ghanaian research system



Source: the authors' elaboration

that if the knowledge economy is as important for Ghana as some key policy documents make it seem, such a ministry must enjoy considerable clout. This is even truer in an economic environment that has considerably deteriorated since when this review was first conceived, and where fewer resources will lead to more conflict over their distribution.

### 3) Improve efficiency

The research system must become more efficient. This concerns staffing levels at the research institutes, in particular. This study has shown that core/support staff ratios in Ghana bear no comparison with those in similar organizations elsewhere. People concerned about job security, especially for non-core staff, or about the cost of severance packages resulting from massive redundancies, must be reminded about the opportunity costs of keeping these people employed in essentially non-productive positions. The Council for Scientific and Industrial Research should take a hard look at its entire business model in each institute, at the Secretariat, and for the Organization as a whole. It may have to employ an outside agency to conduct such a review.

### 4) Boost external income

Lastly, the research system must substantially boost its external income. This requires first and foremost a motivated scientific and academic workforce. Motivation results prominently from the satisfaction and reward one derives from one's job. Hence powerful incentives must be put in place to encourage people to win international research tenders and to commercialize technological innovation. Next, it requires a supportive and professionally managed environment in which researchers can rely on upstream (for example, tender opportunity scanning) and downstream (for example, marketing, network building, commercialization or intellectual property management) services, whose delivery is essential for the success of core activities.

### 5) Facilitate institutional and organizational experimentation

In an ideal world, these measures could be directed at the entire system contemporaneously. In the real world, this is impossible. What is possible is to open up space for experimenting with institutional and organizational alternatives in select areas. This must be guided by the need to focus on those activities where certain prerequisites exist and where

interventions have a better than even chance of succeeding. Such a search for excellence would be based on key factors, such as the quantity and quality of highly skilled human capital and an incipient infrastructure that has supported above-average research or technology performance over the last few years. This study has referred to differentials in research productivity, both across and within institutions. Such information provides an entry point for discussions of which parts of the system to select for an experiment.

To make this possible, the Government should not take an approach whereby successful income generation on the open market is penalized by a reduction in the government subvention. Good performance should be rewarded at all levels, which means that for budget purposes the idea of co-funding should be introduced.

Not all feasible solutions will be politically palatable. For example, the centralized regulation of academic user fees in the universities prevents the cross-subsidization of study courses that are important for the development of the country, namely in science and engineering, through income from subjects such as business or law. Likewise, the reluctance to attract top-notch scientists and to reward them with working conditions commensurate with their impact – a lighter teaching load, fully sponsored postgraduate assistants, acceptable lab facilities, and so on – curtails the ability of the universities to increase their presence, even if only selectively, in global knowledge networks.

### 6) Promote more professional management

Across the system, the management of research, technology, people and their ideas must become more professional. This is an area where decentralization would likely be inefficient, at least as far as performance review and promotion procedures are concerned. They should be standardized and adhered to across the system so that the best researchers can be associated with, or even migrate to, the most interesting research projects, regardless of whether such projects are hosted by an institute other than their own. In essence, it is important that rules and incentives facilitate a market for ideas, seed funding, and project implementation so that the most vibrant and relevant parts of the research infrastructure can grow, while those that do not produce what is expected of them are allowed to

close down. In contrast, the administration of research projects, regardless of size, should be as close as possible to the people performing the research.

### 7) Increase self-reflexivity

Finally, the entire system must increase its self-reflexivity. Annual reports should be taken more seriously. Strategic plans should be updated on a

regular basis and contain measureable milestones. Reviews should be undertaken periodically, including through external panels, in order to monitor whether the system is on track.

None of this is easy. But this can be achieved with strong political commitment and the collective determination of key role players.

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## NOTES

- <sup>1</sup> This review was mandated to cover the following research and higher-education institutions: the Council for Scientific and Industrial Research, specifically the Crops Research Institute (Kumasi), the Food Research Institute (Accra), the Institute of Industrial Research (Accra) and the Oil Palm Research Institute (Kade); the Centre for Scientific Research into Plant Medicine (Mampong-Akuapem); the Cocoa Research Institute of Ghana (Tafu); the University of Ghana at Legon; Kwame Nkrumah University of Science and Technology (Kumasi); and the University of Cape Coast (Cape Coast).
- <sup>2</sup> Institute of Industrial Research (2004), ISTC (2006).
- <sup>3</sup> Forestry Research Institute of Ghana (2005), Water Research Institute (2004).
- <sup>4</sup> Savanna Agricultural Research Institute (2003).
- <sup>5</sup> Centre for Scientific Research into Plant Medicine (2007: 19)
- <sup>6</sup> Kwame Nkrumah University of Science and Technology (2005a), Report of the Visitation Panel to the University of Ghana (2007), University of Cape Coast (2003).
- <sup>7</sup> The 2007 Visitation Panel to the University of Ghana seemed in two minds about the issue of faculty remuneration. On the one hand it warned that the ratio of remuneration to per capita income was already exceptionally high and possibly beyond what is socially acceptable (Report of the Visitation Panel to the University of Ghana (2007, 13–14)). On the other hand it bemoans low salaries and generally unattractive conditions that are nowhere near world-class levels (ibid, 44).
- <sup>8</sup> Kwame Nkrumah University of Science and Technology (2005b).
- <sup>9</sup> University of Ghana (2007: xxxi).
- <sup>10</sup> University of Ghana (1994).
- <sup>11</sup> Kwame Nkrumah University of Science and Technology (n.d.: 5).
- <sup>12</sup> Kwame Nkrumah University of Science and Technology (2008b: section 6).
- <sup>13</sup> Council for Scientific and Industrial Research (n.d.: 8); emphasis is in the original document.
- <sup>14</sup> WTO (2008).
- <sup>15</sup> WIPO (2007).
- <sup>16</sup> Council for Scientific and Industrial Research (1996a, b).
- <sup>17</sup> The current designation of scientists or researchers working in the Council for Scientific and Industrial Research is "Research Scientist". The respective higher ranks have Senior, Principal and Chief prefacing this.
- <sup>18</sup> CSIR (n.d.).
- <sup>19</sup> Oil Palm Research Institute (2002).
- <sup>20</sup> Crops Research Institute n.d.
- <sup>21</sup> Centre for Scientific Research into Plant Medicine n.d.c.
- <sup>22</sup> Ghana/EU Cocoa Sector Support Programme (2003).
- <sup>23</sup> Report of the Visitation Panel to the University of Ghana (2007).
- <sup>24</sup> Council of the University of Ghana (2008).
- <sup>25</sup> University of Cape Coast (2003).
- <sup>26</sup> Kwame Nkrumah University of Science and Technology (2005a, b).
- <sup>27</sup> Comin and Hobijn (2004).
- <sup>28</sup> Utility models are also referred to as petty patents. They fulfil essentially the same function as patents but are easier to acquire, have a shorter protection term, are usually not examined and thus faster to register, and are cheaper to obtain and maintain. See [http://www.wipo.int/sme/en/ip\\_business/utility\\_models/utility\\_models.htm](http://www.wipo.int/sme/en/ip_business/utility_models/utility_models.htm).
- <sup>29</sup> Kim, Lee, and Park (2008).
- <sup>30</sup> Krauskopf and Méndez (2007).
- <sup>31</sup> For example, Augusto (2002).
- <sup>32</sup> No review is foreseen in the founding act of the Centre for Scientific Research into Plant Medicine (Centre for Scientific Research into Plant Medicine Decree 1975).
- <sup>33</sup> Ibid, 3.
- <sup>34</sup> Natural Resources Institute n.d.
- <sup>35</sup> Ibid, 2.
- <sup>36</sup> Ghana/EU Cocoa Sector Support Programme (2003).
- <sup>37</sup> The Institute's founding act also does not include a review provision (Ghana Cocoa Research Institute Decree 1979).

- <sup>38</sup> Crops Research Institute n.d.
- <sup>39</sup> Centre for Scientific Research into Plant Medicine n.d.c.
- <sup>40</sup> Institute of Industrial Research n.d.
- <sup>41</sup> University of Cape Coast Law (1992: 3).
- <sup>42</sup> Council of the University of Ghana (2008).
- <sup>43</sup> Kwame Nkrumah University of Science and Technology (2005a, b, n.d.).
- <sup>44</sup> Kwame Nkrumah University of Science and Technology (2005a: 1,8).
- <sup>45</sup> The Crops Research Institute has just received funding to set up a lab with third-generation biotech equipment.
- <sup>46</sup> The Crops Research Institute is, however, part of the West African Agricultural Productivity project, working with Mali and Senegal. The Project is expected to net some \$14–15 million over five years. Yet individual scientists in Kumasi know little about the project scope, do not feel ownership and are resigned to the fact that key decisions, including about disbursements, are taken by people in Accra.
- <sup>47</sup> C:AVA (2008), Graffham and Dziedzoave n.d.
- <sup>48</sup> For more detail, see Chandra (2008), and also Locket, Wright, and Franklin (2003) and Siegel, Waldman and Link (2003).
- <sup>49</sup> A Summary of the Main Findings and the Main Thrust of the Council for Scientific and Industrial Research Review Report n.d., 1,3; confidential document.
- <sup>50</sup> Husa (1986).
- <sup>51</sup> Council for Scientific and Industrial Research India (1996).
- <sup>52</sup> See, for example, Abrol n.d.
- <sup>53</sup> Dahlman, Goel, and Dutz (2007).
- <sup>54</sup> Bound (2007).
- <sup>55</sup> Wessner and Shivakumar (2007).
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# Ghana's Food and Agro-Processing Sector



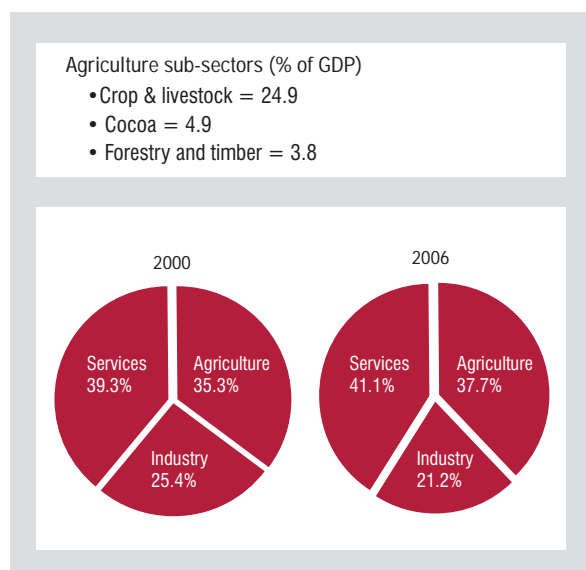


## GHANA'S FOOD AND AGRO-PROCESSING SECTOR

### 4.1. Introduction

The cornerstone of economic progress of any nation is the judicious development and utilization of its natural resources, and Ghana is no exception. Today, Ghana stands on the threshold of abundantly rich but largely underutilized agricultural natural resources. Agriculture is its dominant economic activity, accounting for 37.7 per cent of gross domestic product (GDP) in 2006. Since 2000, the shares of agriculture and services in national GDP grew, while the industrial component declined. From the agriculture sector, crops and livestock contribute about 25 per cent to GDP, cocoa, 5 per cent, and forestry and fishing, 4 per cent each (figure 4.1).

Figure 4.1. Contributions to GDP, by sector and agriculture subsectors



Sources: World Development Indicators, Ghana Data Profile and Details of the Agriculture sector, Bank of Ghana Annual Report 2006.

Modern agricultural practices have boosted the indigenous production of food crops in the country. However, expanding agricultural production has not been accompanied by an equivalent expansion in Ghana's food and agro-processing sector.<sup>1</sup> This weakness in Ghana's post-harvest agricultural system not only negatively affects food security,

safety, and price to consumers, it also results in missed opportunities for economic growth and job creation in one of Ghana's most important sectors. Demand for food in sub-Saharan Africa is expected to reach \$100 billion by 2015, double its level of 2000,<sup>2</sup> facilitating private sector development and regional trade. This offers a unique opportunity for Ghanaian farmers, processors, and entrepreneurs to become major regional players. For a successful and growing economy, Ghana needs its primary industries to be successful and the role of food and agro-processing in that mix cannot be overstated.

A well-developed food and agro-processing industry serves as a buffer against fluctuating food prices and minimizes the impact of volatile global prices on domestic markets. While recent high food prices in Ghana reflect shortages in global production, some agricultural commodities in Ghana are produced well in excess of consumption.<sup>3</sup> This is evident in the short-term gluts seen during harvest seasons while shortages of the same commodities are experienced between harvests. Recent surges, followed by volatile food prices and farm inputs, including energy, underline the importance of a stable domestic food supply. Increasing the output and capitalizing on the locally focused food and agro-processing industry can promote stable and year-round food supply for the country and the region.

Weakness in the post-harvest agricultural system also results in missed opportunities for economic growth and job creation in one of Ghana's most important sectors.<sup>4</sup> Ghana produces a wide variety of agricultural products, including cereals, starchy crops, horticulture, fish and seafood, that serve as the raw materials for transformation into an abundance of value-added products. Not many agricultural products leave the farm in the form in which they are utilized by the consumer; food and agro-processing are invariably necessary to extend the use of perishable commodities beyond the season in which they are produced and to help meet the dietary needs of increasingly urbanized populations that are separated from the food source both in time and in place. Increasing the production of non-food items from farm commodities for use by non-agricultural industries also plays a crucial role in a country's general economic development, especially when most of the employed labour is involved in agriculture. This requires a sophisticated and innovative agro-processing sector. High value-added products are witnessing a constant product differentiation and innovation worldwide;

as a result, agriculture has changed from a sector characterized by the production of undifferentiated bulk commodities to one of specialized markets driven by new end-user demands. Value-added and safe products with enhanced quality, added health benefits or extra convenience for consumers also tend to require more complex technologies and a technically competent, skilled workforce.

Since local food processing remains too small to meet local demand, high-value food imports are on the rise. A recent study points out that although the growing middle-income households are poised to provide a significant consumer base for locally processed agriculture, Ghana is currently producing less than 30 per cent of the raw materials required by its food and agro-processing industries. This is not the result of underproduction per se, but is largely a result of an inconsistent and poor quality supply.<sup>5</sup> As agricultural production increases, small and medium-sized agribusinesses can work closely with local farmers to ensure that farm output is of the consistent and high-quality nature needed by these businesses.

Overall, there is a very small link between the agricultural production sector and the market, and small farmers have hardly any access to local and international markets. In order to better exploit its own post-harvest opportunities in agriculture, Ghana must generate a dynamic and fast-growing set of agribusiness firms. To do so, Ghana would need to accelerate its entrepreneurial engine in the food and agro-processing sector through judicious investments in capacity development to support innovative enterprises. This would require a substantial investment of resources in the food and agro-processing infrastructure. If Ghana is successful in this endeavour, a robust food-processing industry would serve to enhance food security by preventing the waste and spoilage of commodities, while at the same time capturing more value from the raw materials.

A critical aspect of accelerating entrepreneurial growth and successfully linking producers to markets is the capacity of science, technology and innovation related to food and agro-processing. Ghana needs to create national infrastructure and mechanisms to support the development of businesses that generate innovative products from its agricultural production base. This would require significant strengthening of its science, engineering, technology and entrepreneurial human capacity through programmes that build manpower

capacity in science, technology and engineering of relevance to agribusiness.

This chapter proposes a package of three complementary actions to fill the gap in science, technology and innovation capacity in the food and agro-processing sector. These actions were identified, designed, and recommended by a diverse set of food and agro-processing stakeholders that met in Accra at a stakeholders workshop in July 2008:

(a) Establish a network of two or three agribusiness innovation centres (AICs), distributed among the three main regions in the country and located at the premises of institutions of higher learning and research. These centres would act as the hubs for economic clusters of the food and agro-processing industry. The major activity of AICs is to spur home-grown innovations and developments in food and agro-processing technologies to convert raw commodities into products that face barriers to commercialization. These AICs should be modelled on similar centres that have worked successfully to stimulate entrepreneurship and agribusiness innovation in a diverse set of countries. A derivative undertaking would entail adding business incubators that offer tenant space to start-ups for short-term entrepreneurial and commercial use to process, distribute and sell value-added farm products that meet market needs. The centres would offer opportunities to provide workers with practical skills and produce students and entrepreneurs who will be job creators and not job seekers. The centres and the related regional infrastructure would target a set of commodities offering high potential for exploitation in each region.

(b) Improve funding mechanisms for market-oriented research, development and innovation performed by Ghana's agribusinesses. In order to develop the agro-processing sector Ghana must provide ways to support research and development (R&D) and low and high-tech innovation by agribusinesses and entrepreneurs. Investments in facilities and equipment made by businesses, research institutes and innovation centres will be wasted if businesses lack the financial resources to undertake innovation. Funding mechanisms could include commodity check-off fees to be collected and invested by the industry, national competitive matching grants, tax credits for innovation-related activities or scaling up of existing sources of funding, including the national venture capital fund and the research endowment fund.

(c) Establish an industry advisory group, composed of government, university, research institute, and industry representatives, to guide the development of the food and agro-processing industry. The advisory group – based on similar bodies in other countries – would seek to provide coordination, direction, and practical and systemic solutions for developing the food and agro-processing industry in Ghana. This group would seek to create a climate hospitable to the kinds of private enterprises that can stimulate change from a subsistence farming economy to an integrated, market-oriented, agricultural-based economy.

These efforts would be undertaken with public and private participation and guided by the industry advisory group. In this way, government, industry and academia could be aligned in their efforts to nurture current and emerging areas of agribusiness. Investments related to these efforts would be focused on Ghana's unique agricultural strengths, including commodity groups that hold high potential for exploitation by Ghana's food and agro-processing industries. A successful pursuit of these efforts would be expected to achieve the following main outcomes:

- Accelerated development, scaling up and commercialization of viable and competitive products and processes based on Ghana's agricultural feedstock;
- Better opportunities for partnership with food and agro-processing institutions and enterprises worldwide;
- Enhanced human science, engineering and entrepreneurial capacity in Ghana;
- Improved and state-of-the art systems and infrastructures to support linkages among R&D, business and capital stakeholders in Ghana;
- Increased input of stakeholders in policy making, market intelligence and regulations to foster domestic and global competitiveness;
- Nurturing of an entrepreneurial culture that produces job creators, not job seekers.

This chapter (a) describes the current state of Ghana's food and agro-processing sector, (b) evaluates the role that science, technology and innovation can and should play in the development of Ghana's food and agro-processing sector and (c) describes in more detail the set of recommended actions.

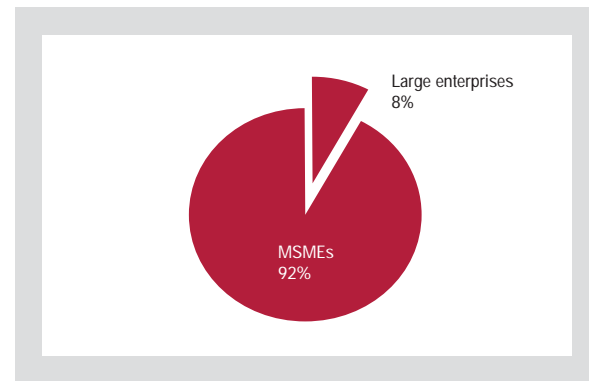
## 4.2. Status and challenges of the food and agro-processing sector

This discussion of the food and agro-processing sector includes products originating from agriculture and fisheries only; it excludes forestry.

### 4.2.1. Food-processing sector

At present, Ghana has a very small food-processing sector. The sector is characterized by microenterprises and small and medium-sized enterprises (SMEs) that constitute about 92 per cent of the industrial set-up and mostly operate in the informal sector (see figure 4.2).<sup>6</sup>

Figure 4.2. Share of microenterprises and small and medium-sized enterprises in the food-processing sector



Note: MSMEs – microenterprises and SMEs

Source: The authors.

These enterprises are mostly family-owned businesses that handle locally grown foods such as tubers, fruits and vegetables, fish and nuts. Traditional processing methods such as the conversion of cassava into fufu and gari using rudimentary techniques, such as pounding, drying and grating, dominate the sector. Since these methods are carried out within the ambit of laborious and uncompetitive cottage industries using simple and age-old tools, in general very limited value addition is achieved and the final product remains undifferentiated and only slightly improved over the raw feedstock.

Beyond these family-owned businesses, a small number of firms have been established that use more modern processing techniques. A few successful local establishments include Cowbell and Fan Milk, which produce dairy products and juices, and Athena Foods and Pinora, which have set up pineapple and

orange juice concentrate manufacturing operations. Blue Skies Company has started to export freshly cut fruits and sells processed fruit juices in the domestic markets. There are also big local companies, such as the Ghana Cocoa Processing Company, and multinationals, such as Nestle and Cadbury, that operate in the formal sector.

A survey of the current status of food-processing activities within the country indicates large differences in the types of value chains in the various geographic regions of Ghana.<sup>7</sup> Figures 4.3 and 4.4 illustrate the distribution of the food-processing plants and activities by region. Overall, the central and southern

regions were relatively more active in grain milling and fisheries processing, and the northern and western regions were more focused on malting, dairy and animal products, and fats and oil processing. As expected, these differences were dictated by the availability of commodities based on the geology and climate of the region. In general, the activities of these firms have not gone much beyond the mere transformation of local commodities into tradable, minimally processed end products.<sup>8</sup> These SMEs face market constraints, including the lack of technological support, insufficient market intelligence and limited support services.

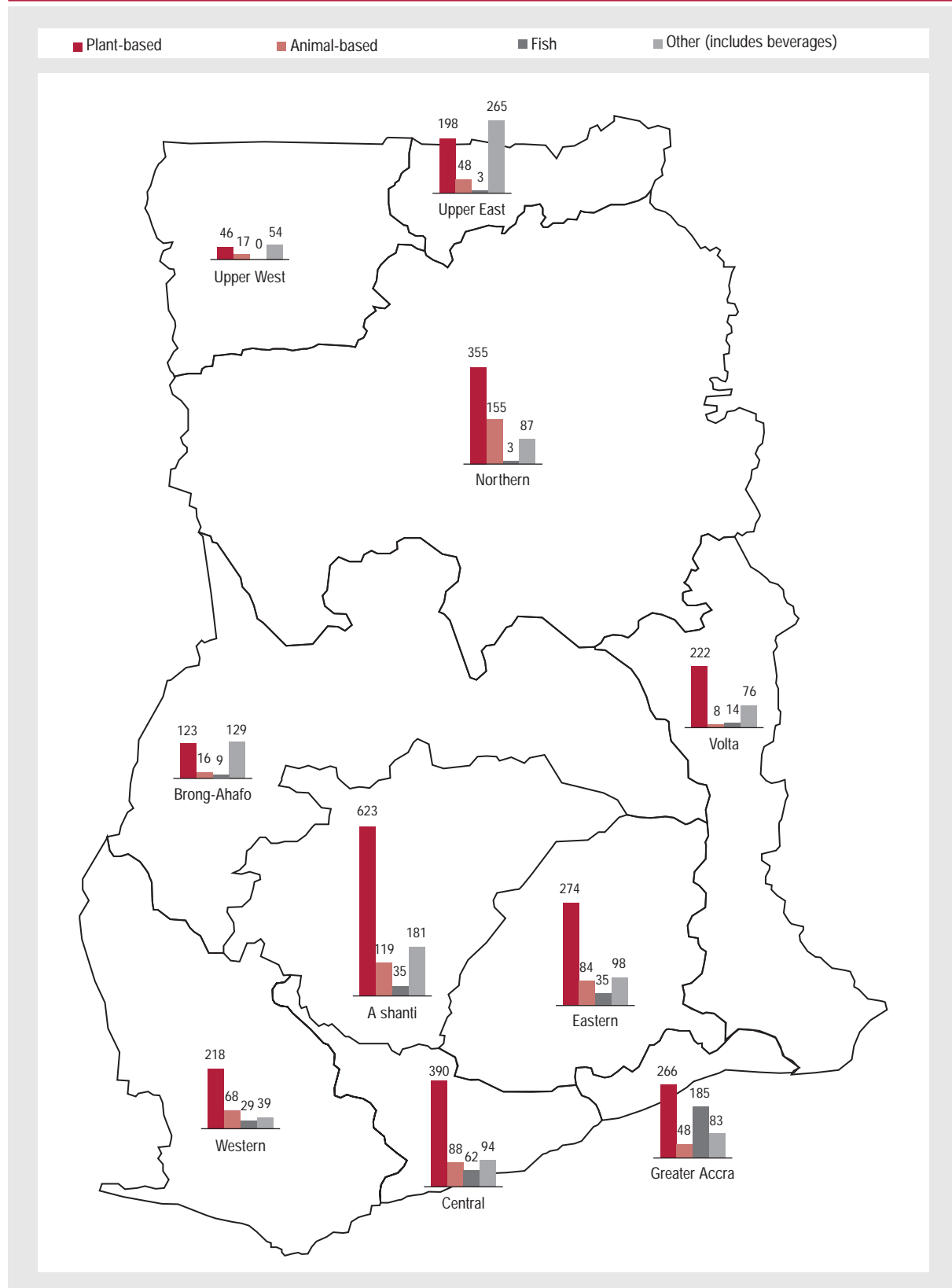
**Table 4.1. Value of Main Agricultural Non-Traditional Exports: (US \$ thousands)**

Commodity	1998	1999	2000	2001	2002	2003	2004	2005	2006	% Change (05-06)
<b>Horticultural</b>										
Pineapple	8,769	13,055	11,853	13,450	15,520	14,378	22,069	13,430	19,086	42.1
Cotton Seed	578	1,250	855	2,588	363	220	1,965	1,762	11,795	569.4
Kola nut	771	1,151	755	663	1,122	948	1,893	125	944	655.2
Yam	4,756	6,497	7,172	4,739	2,428	4,442	8,400	10,951	141	-98.7
Vegetable/Condiment	620	272	431	348	521	726	2,536	3,976	2,444	-38.5
Orange (Fresh)	78	141	249	126	672	329	94	3,865	462	-88.0
Tinda	355	445	474	532	587	636	-	-	-	-
Tomatoes	125	128	446	757	1,096	427	56	-	39	-
Pepper (Chilies)	880	1,221	1,255	1,938	1,782	1,822	107	-	-	-
Garden Eggs	468	596	434	519	455	522	260	66	40	-39.4
Banana	2,688	3,220	3,695	3,189	3,250	227	209	489	10,330	2,012.5
Mangoes	110	103	118	78	70	108	164	135	83	-38.5
Pawpaw	725	1,218	161	993	864	737	1,267	1,081	937	-13.3
<b>Fish &amp; Seafood</b>										
Tuna Fish	7,018	8,715	5,437	10,291	12,191	8,901	23,620	14,978	32,148	114.6
Frozen Fish	8,390	6,176	5,586	8,088	6,205	10,659	21,108	26,386	29,693	12.6
Lobsters/Shrimps, etc	911	1,604	902	975	1,051	2,612	1,013	843	1,780	111.2
Processed Fish	1,577	9	19	2,695	4,397	3,304	1,479	25,394	25,915	2.1
Processed Tuna	77,283	61,890	65,101	50,398	71,048	64,051	-	54,850	55,520	1.2
Cuttle Fish/Octopus	3,021	29,923	3,997	17,973	636	1,378	2,898	2,918	4,124	41.3
<b>Processed &amp; Industrial:</b>										
Cashew Nuts	1,187	3,798	2,553	89	1,450	2,599	18,759	5,498	11,975	117.8
Cocoa Waste	3,608	3,713	2,021	4,739	2,728	2,590	-	2,288	709	-69.0
Processed Cocoa	74,221	56,596	60,636	69,320	86,041	136,024	-	71,741	152,237	112.2
Raw/Lint Cotton	8,535	8,415	9,904	8,530	6,143	46,051	3,773	4,053	4,427	9.2
Robusta Coffee	8,253	7,678	5,174	2,051	643	365	481	256	133	-48.0
Sheanuts	7,892	6,804	4,674	6,654	6,125	16,746	2,463	28,969	27,249	-5.9

Source: Ghana Export Promotion Council (GEPC) (2007).

(-) Figures not available

Figure 4.3. Number of food processing firms in Ghana, by region and commodity group



Source: the authors, based on Ministry of Trade, Industry, and Private Sector Development (2008).

Table 4.2. Retail food sales by value for 2006

Type of food product	% of total sales	US \$ million
Imported*	32	384
Partly processed & packaged in Ghana	8	96
Totally processed in Ghana	15	180
Locally produced & consumed	45	540
Total	100	1200

Sources: Ghana exporter guide 2007. USDA FAS. Gain report GH7005, 2007.

\* 45% from Europe, 40% from Asia, 5% from USA and 10% from South Africa & other countries.

Ghana produces a wide range of possible feedstock that could and should be profitably converted into value-added and diverse products by its agribusinesses. Over the past two decades, food production in Ghana has undergone significant growth and diversification. Major food crops consist of cereals, including maize, rice, millet, guinea corn and sorghum; as well as starchy crops, such as cassava, yam, cocoyam (taro) and plantain. These staples are still sold mostly in raw form, mainly because of a very rudimentary national food-processing industry that lacks the technological base to help maximize the profits that could be derived from value-added processing and manufacturing on large commercial scales.<sup>9</sup> It is estimated that about 30 per cent of Ghana's annual food production currently is wasted, primarily due to underinvestment in the food

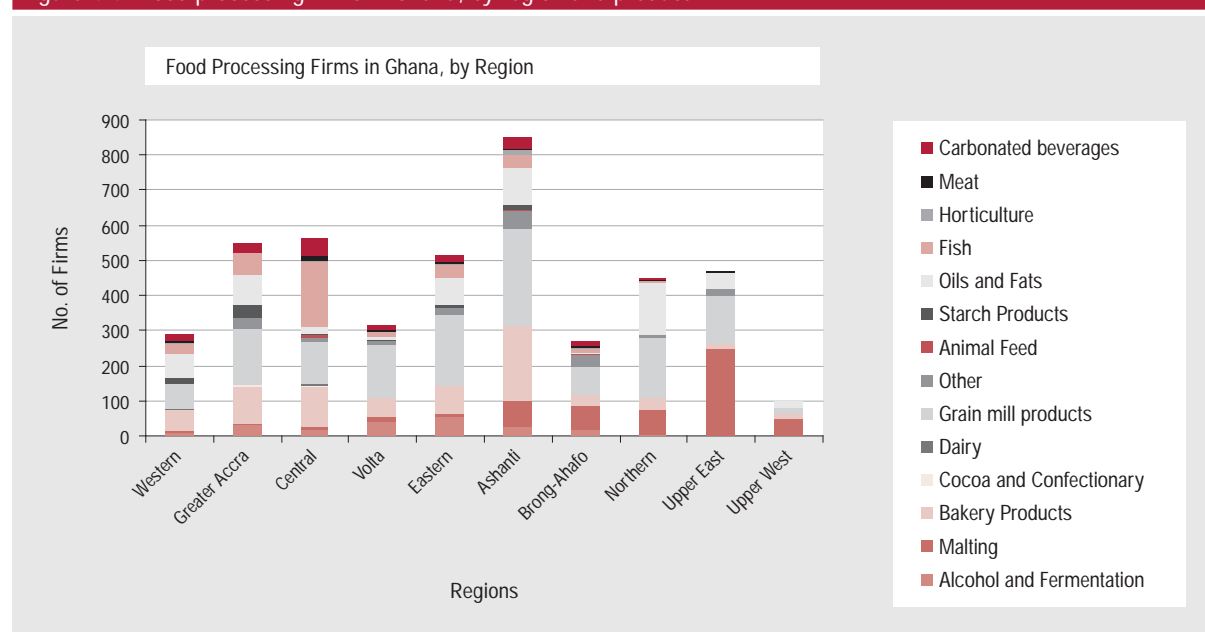
and agro-processing sectors.<sup>10</sup> Agricultural farming is frequently viewed as an independent, stand-alone sector with a major emphasis on the production of raw commodities, often devoid of industrial underpinning.

Significant gains in some agricultural exports have accompanied increases in food production. The variety of commodities featuring on the export list is broad. Table 4.1 (page 73) highlights the variety of commodities covered under the horticultural, fish and seafood, processed and industrial categories. As may be deduced from the increases in value across progressive years, some are becoming major foreign exchange earners. For example the export value of vegetables grew from \$620,000 in 1998 to \$3,976,000 in 2005, dropping to \$2,444,000 in 2006, as shown in table 4.1. The export of frozen fish has also shown a similarly remarkable upward surge. From \$8,390,000 it rose to \$10,659,000 in 2003 to \$21,108,000 in 2004 and to \$29,693,000 in 2006. Product variety is evidently broad and shows positive development.

The strong growth of the horticultural non-traditional exports is illustrated in figure 4.5.<sup>11</sup>

Pineapple continues to be the leading horticultural export commodity, with a total export value close to \$20 million. The production of pineapple is mainly dominated by big commercial farms, such as Jei Farms Limited, Georgefields Farms, Prudent Export Farms, Bomart Farms and Golden Exotics. The Export Development and Investment Fund is offering a grant

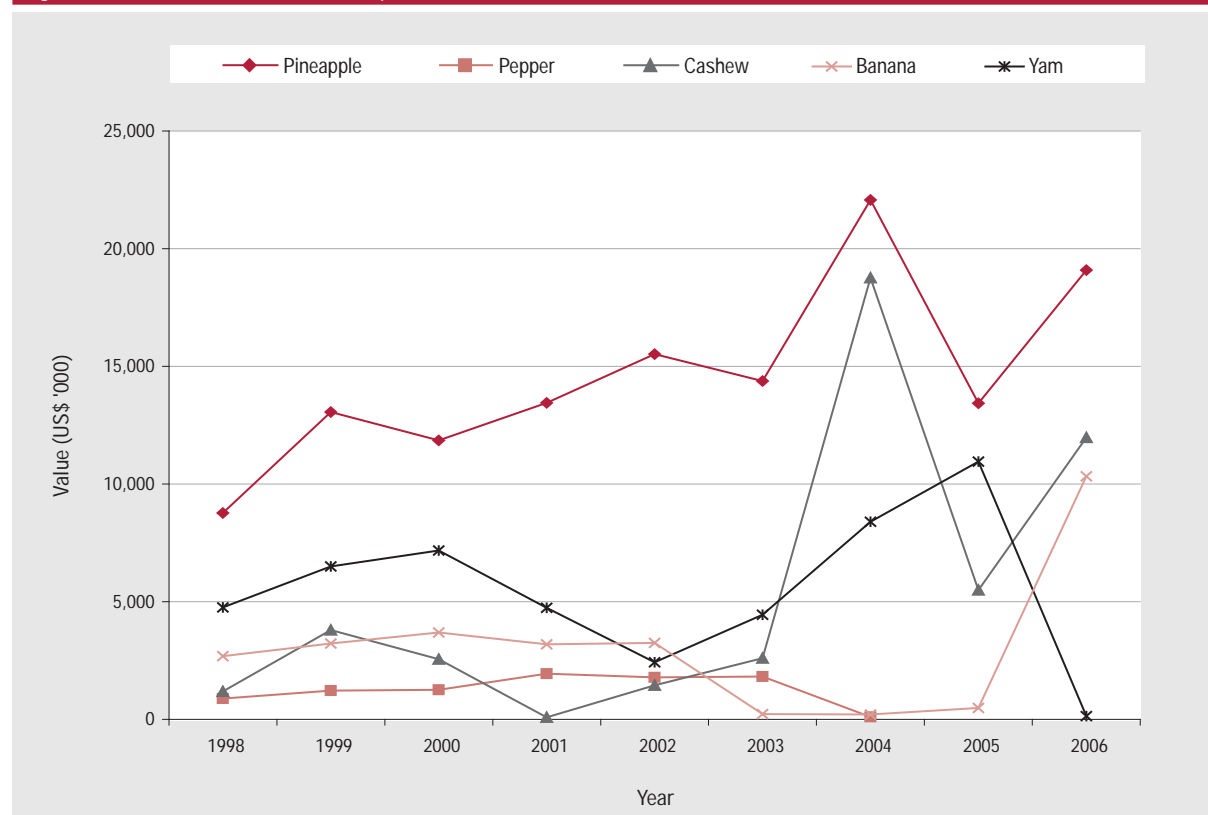
Figure 4.4. Food processing firms in Ghana, by region and product



Source: the authors, based on Ministry of Trade, Industry, and Private Sector Development (2008).



Figure 4.5. Value of horticultural exports of Ghana



Source: Essegbey (2008).

to supply specialized machinery and agricultural inputs to further boost pineapple farming. Private investment is also significant. For example, a leading fruit-processor, Blue Skies, commissioned a second factory, boosting its total daily export capacity from 10 to 30 tons. The firm exports fresh processed mangoes, organic coconuts, pineapples, banana and fresh fruit juices to the European Union. Marks and Spencer,

Woolworth's, Waitrose and Sainsbury are some of the large supermarkets selling Blue Skies' products.

Demand within Ghana for high-value food products has increased with improved earnings and living standards, together with a growth in expatriate population. Retail food sector sales in 2006 were about \$1.2 billion, as shown in table 4.2 (page 75).

Table 4.3. Key Constraints in the Food and Agro-Processing Sector

Supply of Raw Materials	Post-Harvest
<ul style="list-style-type: none"> <li>• Supply inconsistencies (volumes and quality)</li> <li>• Infrastructure – roads, irrigation, cold chain</li> <li>• Access to medium-long term finance</li> <li>• Land tenure system</li> <li>• Access to production technology (weak extension services)</li> </ul>	<ul style="list-style-type: none"> <li>• Weak capabilities of firms to undertake value-added activities</li> <li>• Weak linkages to markets</li> <li>• Workers and entrepreneurs lack practical skills (both business and technical skill sets)</li> <li>• Lack of business development services for firms to access</li> <li>• Limited facilities for R&amp;D and for accessing technology</li> <li>• Infrastructure – roads, ports (now improved), energy</li> <li>• Perceived weak access to finance for business development</li> <li>• Trade barriers</li> </ul>

Source: the authors.

Figure 4.6. Share of Processed Foods in Ghana's Total Food Trade – 1981-2004



Source: UN Trade Data.

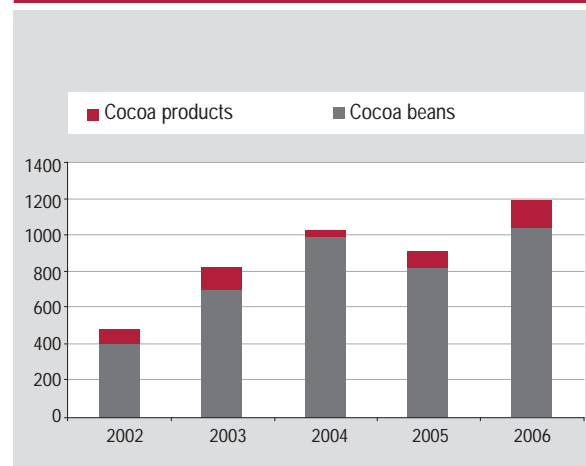
Domestic demand for processed foods has risen along with the share of imported food, as local food processing remains too small to meet domestic demand. A very small part of retail food exports is in processed food (figure 4.6), compared with a very significant portion of imports is in that area.

When the many and diverse assets of the country are examined in combination, an impressive environment for pursuing food and related bio-product development emerges. A case illustrating both potential and missed opportunities for value-addition is cocoa, a traditional cash crop. Africa produces approximately 75 per cent of the total world cocoa output, but processes only about 15 per cent. Europe, however, produces no cocoa, yet it processes over 42 per cent of the total output and thus captures the benefits of value addition. In Ghana, production over the past five years has averaged about 700,000 tons of cocoa beans per year. Yet, the share of processed and value-added cocoa in the total export is still relatively low, constituting only about 20 per cent of the total, as shown in figure 4.7. The reality is that vigorous and ongoing support for research, education, entrepreneurship and innovation will be needed to make inroads into the value-added areas of agribusiness that often face trade and other barriers, including in the cocoa industry.<sup>12</sup>

#### 4.2.2. Ghana's main advantages in food and agro-processing

Ghana's geographical location in West Africa and on the Atlantic coast and its tropical climate, prevailing over forest and grassland ecological systems,

Figure 4.7. Total cocoa exports of Ghana (U.S. \$Millions) – 2002-2006



Source: Essegbey (2008).

creates a comparative advantage for the production of a diversity of agricultural commodities and tropical horticulture. There are wide expanses of available and unused agricultural land; about 6.3 million hectares of land remains uncultivated. Of the 500,000 hectares of irrigable land, only 11,000 hectares have been irrigated. The potential for more irrigation is vast, given the availability of rich water resources.

Water resources also offer geographical advantages that can be exploited further. There are significant fish and seafood harvests for both domestic consumption and exports. Aquaculture fits very well into the mould of inland fish production. Some companies have ventured into that kind of enterprise. However, much of the fish harvest under 100,000 tons comes from the catches of small-scale fisher folks.

The liberalized economic environment sustained by democratic governance is another advantage. Ghana offers a gateway – a “Golden Gateway” as the advertisers put it – to the West African market of 250 million consumers. The road network linking the neighbouring countries is well developed and in recent years, domestic airlines have been expanding operations into the subregion, complementing the operations of the established international airlines.

The ports and harbours at Tema and Takoradi have been modernized in recent years and are handling increasing volumes of cargo. Tema Port handles about 80 per cent of the country's import and export cargo and has seen substantial increases in cargo with its modernization.

#### 4.2.3. Major constraints of Ghana in food and agro-processing

Despite the apparent steady progress in the export business, constraints emanating from both the domestic and the external environments can be discerned. These constraints are highlighted in table 4.3 (page 76).

The infrastructural support for agricultural production still requires improvement. For example, roads to the commodity production points, which are invariably located in the rural areas, need upgrading. The often untarred roads not only increase transportation costs but also overextend the transport time for some of these commodities and, as in the case of some of the horticultural commodities, there is a risk of spoilage.

The land tenure system can be a disincentive for investment and business ventures. Ghana's lands are vested in chiefs, clan heads, family heads and individuals, with only a small portion coming under State ownership. The challenges in land administration in Ghana have included the lack of formal documentation of customary holdings and uncertainty regarding the boundaries of private and other land holdings. For the food and agro-processing industries, which can involve the acquisition of large tracts of land to produce raw materials or even to establish factories, land acquisition is a major constraint. It increases the cost of land acquisition and in some cases protracts the process for assuming ownership. Against this background, the Government fashioned out the National Land Policy in 1999, and in October 2003, the Government launched the Land Administration Project to translate the policy into concrete action.

Though progress has been made, energy supply has also posed challenges in recent years to local industries, as the main source of supply of hydro-electricity from the Akosombo dam has become unreliable. The water level in the dam is dropping below operational levels because rainfall patterns are becoming more unpredictable. Thermal plants are becoming important sources of power generation, but then industries have to pay more for this.

There are technological constraints as well, cutting across the productive agriculture subsectors. The fact that just about one per cent of the country's arable land has been weaned off the vagaries of rainfall and other weather conditions shows the extent to which Ghana's agriculture is less technologically dependent.

In the end, the production constraints lead to an inconsistent supply of commodities for the food and agro-processing industry. Ghana's agricultural production currently meets only half of its domestic cereal and meat needs and 60 per cent of domestic fish consumption, according to the Ministry of Food and Agriculture. Self-sufficiency is achieved only in starchy staples such as cassava, yam and plantain, while rice and maize production falls far below demand (Ministry of Food and Agriculture, 2007). The success of the food and agro-processing industry will rely on an improvement in the consistent supply of commodities.

Ghana's agro-processing industry also suffers from a North-South divide. The southern region, comprised of seven states — Ashanti, Brong-Ahafo, Central, Eastern, Greater Accra, Volta and Western — is where most of the development projects and programmes are concentrated. The northern region, consisting of three states — Northern, Upper East and Upper West — lags behind. This can be explained by the geographic and climatic advantages of the south, but the gap is narrowing. Development in the food and agro-processing industries is relevant in both regions, exploiting their strengths in the production of raw agricultural commodities.

#### 4.3. Food and agro-processing institutions

A number of institutions, both public and private, are involved in agricultural production, processing and marketing. These include government ministries, departments and agencies; R&D institutions, such as the universities and the Council for Scientific and Industrial Research; and the private sector. The Ministry of Food and Agriculture, and the Ministry of Fisheries are the central government bodies in charge of agricultural and fisheries production in Ghana, while the Ministry of Trade, Industry and Private-Sector Development, and the President Special Initiatives have oversight responsibility for the processing and marketing of the products. In addition to these three ministries are numerous other public and private agriculture and agricultural-related bodies. The success of these ministries, departments and agencies, and private institutions, relies on their human resources capabilities and therefore on the production of qualified technical personnel from the country's universities and polytechnics. The public institutions in support of food and agro-processing related activities are described in table 4.4.

Table 4.4. Major Public Food and Agro Processing Institutions

Food Research Institute (FRI)	FRI is one of the thirteen affiliate institutes of the Council for Scientific and Industrial Research (CSIR). Its mandate is to conduct market-oriented applied food research and provide outreach services to the industry in the areas of processing, preservation, storage, marketing, distribution and utilization. It also advises GoG on food policy. Since its establishment, the Institute has produced a number of food technologies which have been transferred to a wide range of clients. Important clients included Cadbury Ghana Ltd, Pioneer Food Company Ltd., Beverage Investment Ghana Ltd., GAFCO, Unilever, Food and Drugs Board, UNHCR and Burger Peanut Industry. FRI is now an accredited ISO member for food safety. FRI presently has seven divisions: Food Chemistry, Food Microbiology, Food Processing and Engineering, Nutrition and Socio-economics, Commercialization and Information, Administration and Accounts. While the Microbiology and Chemistry Divisions provide technical support to both research and industry, the Food Processing and Engineering Division maintains a pilot plant unit and conducts pilot scale studies on products developed by FRI. Though some products and processes developments have been successful, the unit is inadequately integrated with food processors and entrepreneurs, partly due to the poor state of facilities. Apart from the new malting and brewing units, most of the other equipment in the pilot plant are old, outdated, and in need of replacement.
Crop Research Institute (CRI)	CRI is mandated to undertake research into food crops to develop improved varieties of crops and improved production technologies to increase agricultural productivity and ensure food security. CRI has developed and released a variety of improved seed varieties to farmers for cultivation including four cassava varieties, two improved varieties of pepper, one improved variety of garden egg were developed, two high-yielding varieties of cowpea, two high-yielding, early-maturing, and bold - seeded varieties of soybean with tolerance to virus, anthracnose and nematodes, and four high-yielding varieties of groundnut. Some potential uses of these varieties include improved suitability for confectionery and pastries, for fodder and cover crop and for production of cooking oil, food and drinks.
Animal Research Institute (ARI)	ARI is mandated to develop and transfer technologies aimed at promoting sustainable animal agriculture, improving livestock production and productivity to reduce poverty and enhance commercial production, while improving natural resource management. The Institute offers advisory services to small, medium and large-scale farmers in Ghana, and offers advice to Government on policies concerning the animal industry in Ghana. ARI's recent activities include developing production packages for small ruminants in rural Ghana, developing feed packages with local foodstuffs and agro-industrial by-products, developing nutritional packages for livestock; developing treatment strategies against the effects of animal disease, and developing herbal drugs for animal healthcare. Yet its efforts are not fully integrated in the production and value chain of the country.
Institute of Industrial Research (IIR)	IIR is mandated to undertake research in process and product development and to promote technology transfer to enhance the efficiency and competitiveness of the Ghanaian industry for sustained growth. In recent times, the IIR has worked under the Presidential Special Initiative (PSI) on cassava, oil palm, salt, and textile. The Agriculture Machinery Research Division conducted research into developing palm kernel shell separator, under a Competitive Agricultural Research Grant Scheme (CARGS) project funded by the World Bank through the Ministry of Food and Agriculture (MoFA). The project was aimed to design and build a mechanized palm kernel shell separator and to transfer the technology to micro-scale producers in the oil palm industry. This technology would replace the existing traditional method of separation that uses sledge. There are other projects currently going on in agro-processing, bio-sanitation and energy technologies. The overall impact of research done at this institute remains to be fully realized and translated into practice.
Oil Palm Research Institute (OPRI)	The mandate of this institute is to carry out research and provide the needed technological and scientific support to the oil palm and coconut industries in the country. It has the following divisions or unit: Breeding, Agronomy, Entomology, and Pathology Divisions. As part of the commercialization program OPRI produced 3409.62 tonnes of fresh fruit bunches, an increase of 18 % over 2003 production. In 2003, OPRI established 12 decentralized nurseries under PSI on oil palm which has now become fully operational. These 12 nurseries produced about 870,000 transplantable seedlings with a market value of ₵13 billion in the year 2004. In 2004, eight new decentralized nurseries were established, bringing the total number of nurseries to 20. The Institute continued its supervision, monitoring and evaluation functions over all the 20 established nurseries. The effect and quality, yields and processing capacity of the oil palm industry in general still remains to be fully exploited.
Savanna Agricultural Research Institute (SARI)	<p>The mandate of SARI is to conduct agricultural research and assist farmers in the three northern regions of Ghana (Northern, Upper East and Upper West) with technologies to increase sustainable food production. SARI has been working on crops improvement programs, such as groundnuts, sorghum, cowpea, and cassava. The institute's achievements include: five outstanding groundnut varieties developed and released to farmers. SARI has developed four breeding lines of sorghum, namely, Sarsorg M16, Sarsorg E1, Sarsorg E8 and Sarsorg E11, throughout the ecological regions under the Sorghum Improvement Program.</p> <p>The launching of the President's Special Initiative on cassava prompted further research into developing varieties with high starch content that are suitable for the northern zone. It led to the development and release of three improved varieties of cassava (Filindiakong, Eskamaye and Nyerikobya). One of the varieties has the highest starch content of all the varieties of cassava released in the country. Additionally, the varieties are high-yielding. The Institute is also developing a Participatory Integrated Pest Management (PIPM) for cotton in Ghana, as part of its Cotton Improvement Program. While high starch yielding cassava is indeed desirable, yet the benefits to farmers and processors from these improvements have not accrued to any significant level.</p>

Universities	All the three oldest public universities – the University of Ghana, the Kwame Nkrumah University of Science and Technology (KNUST), and University of Cape Coast (UCC) – have departments, colleges or schools of agriculture where they train graduates in food and agriculture including agro-processing. For instance the University of Ghana has a Department of Nutrition and Food Science. The major activities of the Department cover teaching and research on problems relating to health, nutrition and food technology. The expertise of the department is sought after for National Committees, Boards, and International meetings. The Department was also engaged in restructuring some of its courses to meet the development needs of the country. KNUST and UCC on the other hand have an agricultural college and a school of agriculture respectively that produce graduates in agriculture including food science and technology. The University of Ghana has recently started a program in food process engineering.
Polytechnics	There are 10 polytechnics in the country spread evenly in the 10 regional capitals, Accra, Cape Coast, Koforidua, Kumasi, Ho, Tamale, Takoradi, Sunyani, Wa and Bolgatanga. These polytechnics provide the bulk of the country's middle-level manpower producing graduates obtaining the Higher National Diploma in engineering and management studies. Some of the polytechnics have introduced first degree programs but have very limited programs on food and agro-processing technologies.
Agricultural Extension Services (AES)	AES is the extension wing of the Ministry of Food and Agriculture (MoFA) and is a publicly funded department. Geographical reach is the biggest strength of AES. It has about 15 officers per district but the number is fewer for the three northern regions with about 8 officers per district whilst down south, particularly in larger cities, the number is higher. AES uses radio programs for public education and awareness creation. Of late, it has tried to reach the public by entering into public-private partnerships with the private sector. For instance, under the Extension Development Fund, AES gives part of its facilities to private concerns in collaborative public-private partnerships. An example is in cocoa rehabilitation projects, particularly in the Suhum area, where AES collaborates with the private sector. In the food production value chain, the AES collaborates with the CSIR to disseminate technologies generated by the latter to farmers. Yet the impact factor of AES efforts remains generally low.
Safety, Standards, and Regulatory Bodies	<p>There are many public and private institutions involved in aspects of food and agro-processing including the following two more prominent boards. Ghana Standards Board (GSB) and Food and Drugs Board (FDB) are also the two main bodies involved in safety and regulation of food processing. Since 2008, the Food Research Institute is also involved in food certification. In 2008, the FRI got a South African ISO certification, which empowers the institute to certify food export from or imports into the country. Below is a brief description of GSB and FDB. The strength and weaknesses of the three food safety and regulatory institutions lies principally in their human and financial resources, and laboratory equipment. The GSB for example has strength in general standards certification. However, the FRI as a research institute, has advantage in research related certification for standards. In terms of personnel, and laboratory equipment, the FDB is the least endowed. However, in terms of political clout, the FDB has the edge. Currently, it is the most powerful of the three bodies.</p> <p>The Ghana Standards Boards (GSB) was established in 1973 and is solely vested with the responsibility for preparing standards for products and processes and for ensuring compliance with government policies on standards, testing and quality assurance of both locally manufactured and imported products and services throughout the country. For example in Section 2 (2) (e) the mandate is 'to recommend to the Ministry responsible for Trade and Industry to prohibit the importation into Ghana for the purposes of sale, use or human consumption of any goods, unless same have been certified by the Board as complying with standards set up by the Board'. The role of GSB at the ports is therefore to ensure compliance of imported goods with established technical standards/specifications (conformity assessment) in order to prevent the importation/distribution of substandard products into the Ghanaian market. The Ghana Standards Board in particular is equipped with facilities to control quality of locally manufactured food and drugs.</p> <p>The Food and Drugs Board was established under the Food and Drugs Law (PNDCL 305B). The Food Division contributes to safeguarding public health and safety by ensuring that all food products meet the appropriate standards of safety and quality by evaluating all samples submitted in the registration process, inspection, and meeting labeling requirements. The Food Division is also mandated to undertake inspection of food or systems for control of food, raw materials, processing and distribution, including in-process and finished product testing, in order to verify conformance to Good Manufacturing Practices. Moreover, the Division ensures that all imported and locally produced food products are of good quality and wholesome.</p>

#### 4.4. Public policy regime for food and agro-processing innovation

Ghana has a range of policies and programmes in place to support innovation in the food and agro-processing sector. In addition to the policies discussed in this section that have an explicit effect on innovation, many public policies have an implicit effect on innovation. These include trade and investment policies, food and agriculture sector policies, infrastructure programmes, and others. Many of these implicit

policies have been reviewed and discussed at length in existing agriculture reports.

With a view to promoting innovation, three areas of policy should be examined:

- a) Entrepreneurship and the business development environment;
- b) Technical workforce development; and
- c) Incentives for innovation and R&D.



#### 4.4.1. Entrepreneurship and the business development environment

Innovation and entrepreneurship are efforts led by private firms but influenced by the enabling environment for business and innovation. This is as much the case for agribusiness firms as it is for firms in any other sector of the economy. Ghana has made progress in its business environment in the last decade (it ranked 87 out of 181 countries on the World Bank's 2009 Doing Business Indicators).<sup>13</sup> It trails some competitor countries (e.g. Malaysia which ranked twentieth) and leads others (e.g. Nigeria at 118 and Costa Rica at 117).

In an attempt to attract foreign direct investment to boost the country's push for industrialization, the Government of Ghana created export-processing zones and established the Ghana Free Zones Board, driven by the private sector, to oversee it. It is an integrated programme designed to promote the processing and manufacturing of goods and to encourage the development of commercial and services activities at seaport areas. Companies operating in export-processing zones have incentives, such as the exemption from payment of income tax on profits for a period of 10 years, exemption from dividend taxes and no import-licensing requirements. Currently, there are over 190 approved enterprises under the Ghana Free Zones Board, of which 58 are food-processing companies. In terms of geographical diversification, the number of food-processing companies in these zones is not evenly spread. Most of the companies, particularly those with high-level science and engineering manpower and large capital resources, are concentrated in the Accra-Tema enclave, while the three northern regions have the least number of companies. The Ghana Investment Promotion Centre, central to the implementation of these policies, was ranked average in a recent benchmarking of global investment promotion agencies.<sup>14</sup>

The Presidential Special Initiative is the Ghana government body with oversight responsibility for marketing of agro-processing products, with the exception of cocoa products which to a large extent come directly under the Ministry of Finance and Economic Planning. There are a number of marketing boards in the food-processing sector,<sup>15</sup> among which are the Cocoa Marketing Board, which handles cocoa, coffee, and shea nut purchases and marketing. Until recently when it contracted privately licensed

agencies to buy the produce on its behalf, the Board was involved in all aspects of cocoa production and marketing, even though the actual production of cocoa has remained a private enterprise. The various cocoa processing companies buy the cocoa beans from the Board for their operation.

Perhaps the main characteristic of the overall economic public policy is an orientation towards exports, which is evident in the various sector-specific policies for agriculture, trade and industry, rural development and local government. Government initiatives coming in the name of private-sector development and presidential special initiatives are policies and programmes aimed at boosting the country's export sector. Along with these policies, others are focused on key strategies such as an export-free zone policy and various programmes aimed at promoting non-traditional exports. However, in view of the lagging growth in agricultural and industrial productivity as well as the limited evidence of value addition in agriculture, the results of these programmes and policies can be considered inadequate. Renewed and creative efforts in developing food and agro-processing are clearly necessary.

#### 4.4.2. Technical workforce development

As noted above, several of Ghana's universities, for example, the University of Ghana, Kwame Nkrumah University of Science And Technology and the University of Cape Coast, provide training in agricultural sciences and food-processing engineering. A recent addition is the development of the food-processing engineering programme at the University of Ghana that is now turning out graduates. This programme plans to introduce master's level degrees in the coming years.

The graduates from these university programmes offer a natural source of entrepreneurs and skilled workers for the agribusiness sector. However, challenges limit the impact of these graduates on the sector. Deans and professors of these programmes acknowledge the lack of practical opportunities for their students. This is for two reasons. Firstly, there is a lack of modern equipment or a pilot plant at these universities on which students could train. Secondly, only a very few companies offer internship programmes for students, perhaps the best opportunity for students to gain hands-on experience in the food and agro-processing business. Outside the private sector, the Food Research Institute offers internships for



university students. However, the Institute faces the problem of poor and outdated equipment, a shortage of mentors and a limited number of projects in support of the industrial sector.

The current situation is one in which graduates have theoretical knowledge, but little practical experience. Clearly, these students must be provided additional opportunities for hands-on experience with modern equipment and real-world projects.

#### 4.4.3. Incentives for innovation

Overall, Ghana lacks meaningful policies encouraging businesses to invest in innovation. Lowering barriers to private-sector development is important, but experience suggests that many successful innovation efforts are often accompanied by government support. For example, many countries provide a tax credit allowing firms to deduct investments in R&D. The government forgoes a small portion of tax revenues with the hope that the R&D efforts will lead to productivity and competitiveness gains that generate additional profits, jobs, and government tax revenues.<sup>16</sup> Tax credits are just one of a variety of policy tools available for incentivizing investment in innovation.

Ghana's intellectual property regime is a critical aspect of putting in place an environment conducive to innovation. Since 2001, Ghana has adopted new legislation in most areas of intellectual property rights with a view to being fully compliant with the Agreement on Trade-Related Aspects of Intellectual Property Rights. Patents, copyrights and related rights, trademarks, industrial designs, geographical indications, layout designs of integrated circuits and undisclosed information are all legally recognized and protected in Ghana.<sup>17</sup> Compliance with the Agreement may help attract foreign investment, as it is reassuring to investors who bring proprietary technologies into Ghana. However, other aspects of intellectual property rights should be considered. The assignment of intellectual property rights can have meaningful effects on business development. For example, a researcher in a government lab that develops a new machine for processing fruit in Ghana may not be able to license the machine or use it in his or her business. Rather, the researcher must freely give away the technology since it was developed under a public research grant. Recently, many countries have developed laws allowing researchers to profit from the results of publicly funded research (often

set as a percentage of the licensing fees recovered by the licensing institution). This has the potential to encourage technology-based business spinoffs from labs and universities. However, this type of legislation should be carefully considered to both encourage innovation and protect the public's investment in research.

Firm-led R&D into new and improved products is a critical element for sustaining a vibrant agro-processing industry. Countries such as Malaysia, Brazil and New Zealand have benefited from investments in applied R&D as part of a package of measures that led to diversification into a variety of high-value processed agricultural products. Unfortunately Ghana lacks any significant support in this area. In 2006, ₵1,670,000 from the public budget went into supporting the agriculture-focused institutes of the Council for Scientific and Industrial Research.<sup>18</sup> However, only a small portion of these funds is used for research activities (the largest portion goes to salaries and upkeep of the institutes) and the few research projects that do receive adequate support are not generally projects targeting new product development.<sup>19</sup> Rather, most agriculture research projects are geared towards increasing yields, quality, and other aspects of on-farm production.

The recently completed Agricultural Services Subsector Investment Project largely followed this model. The Ministry of Food and Agriculture, with loan funding from the World Bank, supported this competitive agricultural research grants programme. While providing much-needed support to research and access to technology, it largely focused on production agriculture. Specific aims of the programme's agricultural research component were (a) to improve research governance, management and financial accountability; (b) to introduce sustainable and competitive research financing, including competitive research grant schemes and voluntary contributions from research users; (c) to mainstream gender and equity considerations in extension services; and (d) to forge strong linkages with sources of agricultural technology.

Alternatively, the National Venture Capital Trust Fund became operational in December 2005 and is focused on enterprises. The purpose of the Fund is to provide financial resources for the promotion of venture-capital financing for small and medium-sized enterprises in the economy and to stimulate the emergence of a sustainable privately owned venture

capital industry in Ghana.<sup>20</sup> However, it has had trouble finding acceptable equity investments, is investing in generally safe, rather than innovative ventures,<sup>21</sup> and is a limited source of capital of about \$44 million.

The Science, Technology and Research Endowment Fund was set up in 2008 with an initial fundraising target of \$500,000. The proceeds will fund research on a competitive basis. However, even at an optimistic 10 per cent annual return, the Fund would yield only \$50,000 in new funding for research. This is clearly not large enough to provide a sustained source of funding for product research and experimentation in the agro-processing or any other sector.

In the medium and long term, Ghana must encourage multiple sources for funding agro-processing innovation at all stages of product and business development if it hopes to create a sustainable pipeline of value-adding agribusinesses. In the short term, at least one source of significant funding should be created, whether it is a public or donor-supported fund, an innovative loan, a venture financing scheme or another option.

#### 4.5. An innovation-based strategy for development of the food and agro-processing sector

This study finds that while Ghana's current efforts to promote food and agro-processing are laudable, they cannot bridge the gap between production agriculture and the marketing of finished products and cushion the economy against the vagaries of the import markets and fluctuating food prices. Therefore, to accelerate growth in its agro-processing sector, successful and substantively new initiatives that can transform economic activity and livelihoods over the next decade are needed. Examining the approaches taken by successful agribusiness economies of the world, it is clear that the Ghanaian Government can and must play a pivotal role in the sector.

Development of production agriculture and the industrialization of food and agro-processing industries must be viewed as a joint and continuum process that generates an entirely new type of industrial sector. It has proven to constitute a sector that serves as an engine of aggregate growth of an economy. Beyond providing the farmers the means and new skills to process food crops post-harvest into better value added and nutritionally superior products, it will also generate new employment opportunities

with guaranteed income for the rural population. Depending on the strategies and implementation tactics used, concomitant developments in access to markets, infrastructure, standards and capacity-building would indeed have a multiplier effect on agro-business profitability, as well as food security.

However, development of the food and agro-processing sector as a business enterprise linked to agriculture has often been overlooked by policy planners. This has held back agriculture-based industrialization of many developing countries and Ghana is no exception. In many developing countries, including Ghana, upstream food-processing industries, such as cassava and flour milling, oil pressing, and fish canning, prevail in their most rudimentary form. However, sophisticated downstream industrial processing with both forward and backward linkages is needed. The multiplier effects throughout the economy based on upstream and downstream linkages in the food and agro-processing industry can be observed in many developing and developed countries, such as Chile, Argentina, Turkey and the Netherlands.

A holistic approach to agriculture is needed that includes the entire spectrum of the agricultural product value-chain, from production through processing and distribution to consumption (figure 4.8, page 85).

Aided by the latest innovations in science, technology and engineering, and utilizing a diversity of resources to ensure quality and safety of the products they produce, many countries with established, as well as emerging, economies have created a unique competitive edge in lucrative markets for their products. They have done it simply not on the basis of lower labour costs but by capitalizing on state-of-the-art technologies, logistics, market intelligence and global alliances to manufacture and deliver products in a timely, cost-effective way. However, countries that have sought to promote value-addition projects through state-owned enterprises have in many cases ended up in creating white elephants. Often designed by foreign consultants and funded by aid, such projects are too frequently not commercially viable because of a lack of technological capacity both in terms of manpower as well as R&D within the country. Box 4.1 offers some lessons, both positive and negative, from a recent experience in Ghana with state support to agribusiness. Today's food processing is relentlessly competitive and global. About 70–80 per cent of the new products introduced in the market

#### Box 4.1. The Ayensu Starch Company (ASCO) -- Positive and negative lessons on providing government support for agribusiness

The Ayensu Starch Company (ASCO) was the first cassava production and starch processing company to be established under the President's Special Initiative (PSI) on cassava starch. At government's initiative, the US\$7 million processing factory was established in 2001 in the Central region. A group of four banks were backed by the government to support ASCO's establishment. Other government assistance included support for research to produce cassava that produces the highest possible yield in starch, resulting in Ghana's cassava starch being acclaimed as top grade cassava starch. Government also gave assistance to ordinary farmers with funds for clearing land, planting, maintaining machinery, and for helping to evacuate cassava crops to the factory.

The company was built around what seemed to be a clear comparative advantage for Ghana in cassava growing. In 2000, total world cassava production stood at 175.6 million tons out of which Ghana produced about 8.1 million tons. Nigeria produced 33.9 million tons, Thailand 18.8 million with Brazil producing about 23.8 million. The national average yield of 12 tons per hectare was low and raised the question of whether Ghana could rely on cassava as a wealth-creating crop. However, cassava has the highest output of all of Ghana's crops with an annual production estimated at 12 million tons and is grown in almost all the regions of Ghana and could therefore be a source of reducing the incidence of poverty in rural areas if properly developed. Cassava annual production surpasses that of maize (1.4 million tons) and paddy rice (280,000 tons). Cassava is the largest contributor to agricultural GDP at 23%.

Initially, the company was a success, recording \$300,000 USD profits in its first year of operation. It boasted sales agreements for further production with customers including Unilever, Nestle, Dera of the Czech Republic, and ELSA Foods. The 7,000 contract farmers supplying cassava were guaranteed year-round purchase of their cassava crop. However, things quickly turned for the worse after 2002. In fact, from 2006 to 2008 the factory operated at only 20% of its installed capacity. ASCO blamed this on an inadequate supply of roots and low export prices obtained from the European market. Many reasons, including low cassava yields, falling international starch prices, high perishability, and a rising local demand for cassava for gari are said to be the major constraints bedeviling the company. The European market, which is a major consumer of starch, proved hard to infiltrate. Dominated by potato and corn starch and highly protected by high tariffs ASCO has managed to sell only about 2000 tons of cassava starch to the European market at \$200 per ton. This price falls short of the 1995 price of \$358 per ton. In Asia too, Ghana's starch was non-competitive because Thailand, a commercial and low cost producer of cassava starch, has captured the market and is said to have the advantage of closeness and high operational efficiency. Though ASCO's starch has comparative advantage in the ECOWAS sub-region, Nigeria, which has the largest market demand for starch in the region has also banned imports of starch from Ghana.

Another major problem confronting the company is farmers' dissatisfaction with prices they receive for their produce. They threatened to stop supplies to the factory. The open market value for a 50kg bag of cassava was said to be higher than the price the factory could afford, causing diversion to the parallel market for processing into gari.

By December 2008, the factory had reopened with new investment from the Export Development Investment Fund (EDIF). A new nucleus farm was established to provide for 70% of the company's raw material, to overcome the problems with supply. Whether this new investment will finally prove the profitability of this government-backed venture or prove to be a case of throwing good money after bad remains to be seen.

##### Lessons

The ASCO story demonstrates the difficult balancing act between supporting promising industries and keeping government out of the way of private enterprise. Some key lessons from the ASCO case might include:

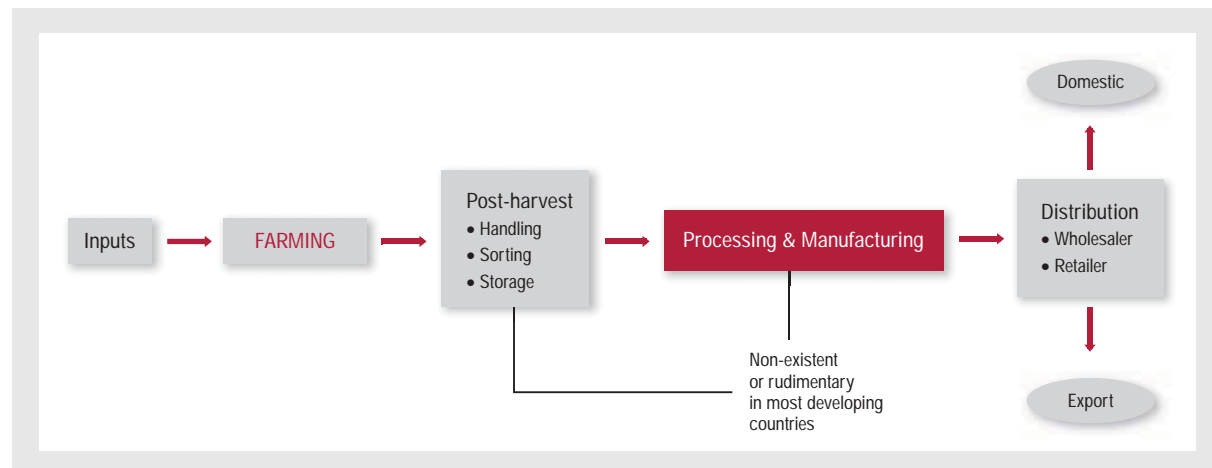
- The value of pilot projects or the difficulty with managing large-scale, very ambitious projects
- The criticality of ensuring a consistent supply of raw materials for the agribusiness in spite of price fluctuations, land-use and other restrictions
- The promise of income, poverty reduction, and export growth from agribusiness when the business model is successful

Is there an alternative model?

The actions proposed in this chapter offer an alternative model for incubating and scaling-up agribusiness. Instead of supporting government conceived businesses, they seek to provide private entrepreneurs and existing businesses access to the same ingredients the government provided to ASCO – research facilities and expertise, new technology, opportunities to pilot new business ideas, and access to finance – along with additional support for accessing markets, incubating businesses, and tools for working with farmers supplying the agribusiness with raw materials. Instead of building state-sponsored businesses, the mechanisms proposed in this chapter aim to build local expertise and institutional capacity so that these services can be readily provided to any business or entrepreneur that seeks them out.

Sources: Public Agenda, GhanaNews, personal interviews.

Figure 4.8. Important Stages of the Value Chain



Source: the authors.

each year fail to survive for any significant length of time. Value-added food products of today are the results of major R&D efforts, as well as increasingly sophisticated individual and collective preferences regarding nutrition, health and the environment. Only fiercely innovative products last longer before they, too, become imitated and commoditized. To stay ahead and maintain their market share, it becomes

necessary to continually move up the value chain more innovatively.

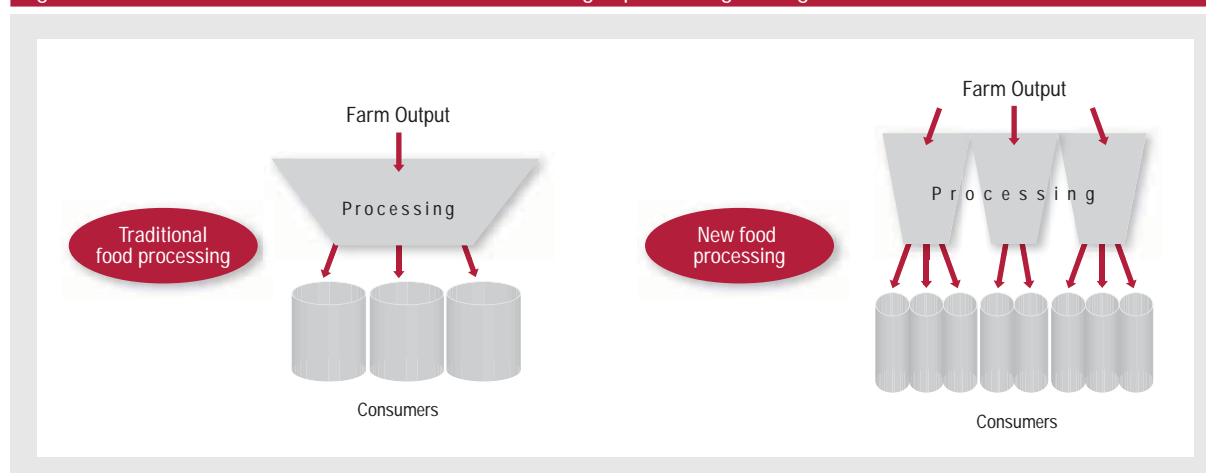
Furthermore, agricultural raw materials are no longer traded as commodities but rather as a stream of value-added products and ingredients. As illustrated in figure 4.9, unlike traditional processing of raw agricultural commodities into a few staple foods, numerous food and non-food ingredients are now

#### Box 4.2. Recommendations of the Food and Agro Processing Stakeholders' Meeting

In July 2008, a food and agricultural processing stakeholders meeting was held in Accra, Ghana as part of the STIP Review process. Participants were invited from the government of Ghana, academia, research institutes and the private sector to deliberate on the role of science and technology in the development of a viable food and agricultural processing sector in the Ghanaian economy. The following recommendations emerged from the meeting:

- Establish state-of-art “living laboratories”, or innovation centers, with defined mandates and expected outcomes to study and practice food and agro-processing innovation and entrepreneurship. These must have strong leadership, transparency, and accountability. To maximize their utility, these should be located in areas of a suitable range of crops maturing in different seasons and preferably within a university system with a strong track record of food and agro-processing research and development that would carry out research and development alongside industry under appropriate conditions in compliance with scientifically verifiable principles. The centers should also produce highly trained students with hands-on experience and entrepreneurial skills that will expedite industrial development and will become job creators, not job seekers.
- Develop and strengthen manpower capacity and science, technology, and engineering training facilities dedicated to food and agro-processing in the country.
- Enhance industry-academia-government partnership for their mutual benefits.
- Provide incubator facilities and funds to SMEs for start-up food businesses and assist the growth of innovative firms. Competitive markets drive enterprises to scout for leading edge strategies, technologies and policies.
- Assist in harmonizing standards and safety protocols to international standards so Ghana’s industries can become more integrated in the global food and agriculture system.
- Formulate policies for IP protection and institute an innovation and reward system.
- Align and intersect domestic and international marketing of Ghanaian food products and processes with other value chain activities to maximize investment returns.
- Encourage, facilitate and reward innovation and entrepreneurship.

Figure 4.9. Illustration of traditional and new food and agro-processing strategies



Source: the authors, based on Ministry of Trade, Industry, and Private Sector Development (2008).

commonly produced from many of the crops of today. Table 4.5 gives some examples of product streams produced today from staple crops. This creates a multiplier effect in terms of both profitability and employment.

To achieve its objectives, Ghana will need to decisively leverage its existing advantages in agriculture, including strengths in production agriculture, by bringing actors in government, industry and the research sector together to promote innovation at all stages of the value chain. A lack of processing infrastructures and trained manpower are often the most obvious missing elements in transforming the

raw commodities into value-added products. Short-sighted national policies and the lack of commitments for pertinent and adaptive R&D also hamper the creation of partnerships with the private sector of industrialized nations. Such linkages between developing and industrialized economies have been well documented as a means of accelerating economic development and integration with the global trading system in many parts of the world (World Bank, 2008). Deliberate attempts are needed to improve science and technology-based innovations throughout the value chain.

Science, engineering, and technology institutions act as a focal point for the translation of scientific and technical knowledge into useful products, processes and services. Agribusiness innovation centres help accelerate commercialization of technologies for the value chain. To meaningfully contribute to the socioeconomic development plan of a country, a virtuous circle of support for these institutions and activities from various sources, both public and private, is essential. It is schematically illustrated in figure 4.10 (page 88). This strategy is effective to the extent that all the identified elements are in place and work in harmony.

The countries that invest and produce new scientific knowledge in this fashion derive the most benefit from its use by producing wealth and improving the quality of life for their citizens. To date, examples of such successful set-ups are mostly limited to developed countries. However, developing countries such as India, Malaysia, and Brazil that have made sustained commitments to investment in science, engineering,

Table 4.5. Examples of commodity conversion into multiple product streams

Commodity	Derived Products
Maize	<ul style="list-style-type: none"> <li>• Starch and Glucose (over 40 types)</li> <li>• Corn starch</li> <li>• Latex paint</li> <li>• Dyes</li> <li>• Beer</li> <li>• Chewing Gum</li> <li>• Aspirin</li> <li>• Wallboard</li> </ul>
Fish	<ul style="list-style-type: none"> <li>• Gelatin</li> <li>• Fish oil</li> <li>• Animal feed</li> <li>• Frozen fish</li> </ul>
Oranges	<ul style="list-style-type: none"> <li>• Oils</li> <li>• Manufacturing of plastics</li> <li>• Orange juice (fresh and frozen concentrate)</li> <li>• Jams and other foods</li> <li>• Cleaning agents</li> <li>• Teas</li> <li>• Animal feed</li> </ul>

Source: the authors.



and technology have had increasing success in agro-processing industries. The advanced processing of palm oil in Malaysia and the growth through innovation in the Brazilian ethanol industry provide two examples of this success. New Zealand heavily invested in science, engineering, and technology to successfully grow its food-processing sector into its largest export sector. It exports wines, meat and other value-added products infused with better

flavours and characteristics valued by consumers and produced with efficient, technologically advanced production and processing techniques.<sup>22</sup>

The Government of Ghana and its policy makers have recognized the potential of science, engineering, and technology as an essential part of an effective knowledge-based economy, but to date have not been able to capture its full benefits, at least in the

#### Box 4.3. Stakeholders Input on Agribusiness Innovation Centers

A group of participants at the July 2008 Stakeholders Meeting (see box 4.2 above) focused and deliberated on the desirability and feasibility of setting up Agribusiness Innovation Centers (AICs) and Incubators.

After a deliberation on the existing R&D capabilities in Ghana, the group observed that the capabilities and skills exist to initiate AICs in Ghana immediately. Some of the reasons cited were that the Food Research Institute (FRI) already operates as an innovation center that, despite a need for substantial strengthening, offers a model and lessons learned for AICs. FRI has already pioneered a number of food products, for example the fufu convenience flour. Furthermore, the Kwame Nkrumah University of Science and Technology (KNUST) and the University of Ghana (UOG) at Legon have been working on similar initiatives. It was stated that these institutions have qualified personnel to man the AIC initiative. The University of Development Studies (UDS) in Tamale would possibly need some support in attracting more doctorate level candidates and experienced food processing specialists to partake in food and agro-processing research and development of relevance to the region. Nevertheless, nationwide there are a variety of tertiary institutions which could supply sufficient number of well-trained personnel to initiate and man the proposed innovation centers.

#### Recommended Locations and Focus Commodities for Agribusiness Innovation Centers

The group suggested the feasibility of first starting the initiative by instituting and/or further strengthening the existing innovation centers. It was recommended to kick-start the innovation centers initiative with three AICs distributed among the three major regional zones in the country – South, Central, and North – and located at the premises of the existing institutions as follows:

- South: Food Research Institute (FRI) & University of Ghana (UOG) focused on fish, fruits and vegetables, horticulture, cereals (maize), roots and tubers products and processes.
- Central: Kwame Nkrumah University of Science and Technology (KNUST) & Crop Research Institute (CRI) with major emphasis on roots and tubers, fats and oils (oil palm), cereals (soy), peanuts, cocoa, poultry
- North: University of Development Studies (UDS) & Savannah Agricultural Research Institute (SARI) with expertise in cereals (sorghum and millet), shea butter, legumes, livestock.

The principal objective was to prioritize commodities that have the propensity to be processed into as many innovative products as possible for optimal value-added and competitive access to local, regional and international markets. The suggestions were based on a review of recent commodity prioritizations in Ghana's main agricultural policy documents that took into consideration current production levels, consumption levels, availability of consistent supply, and most importantly, the existing potential for value addition.

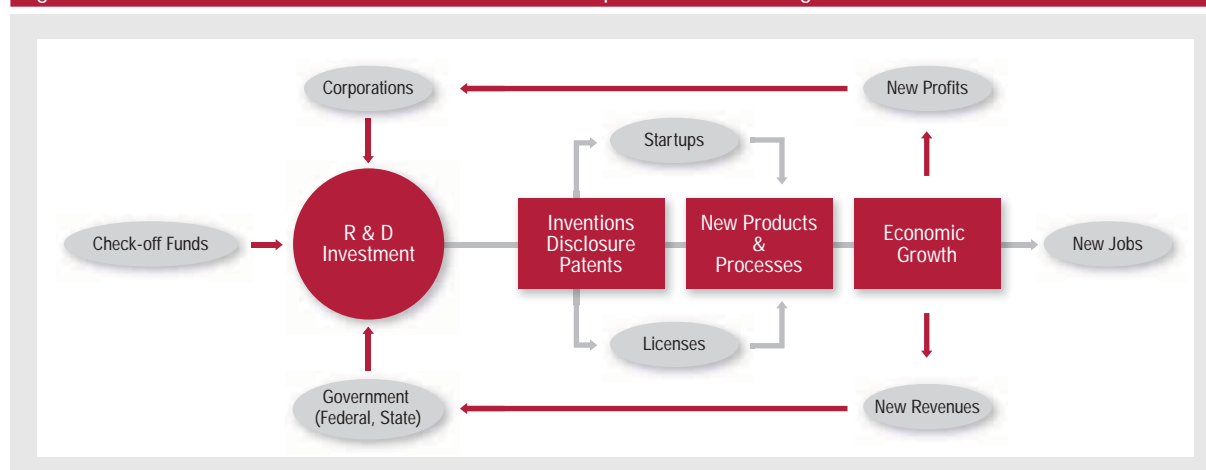
#### Mandate of Agribusiness Innovation Centers

The group discussed the mandate of those innovation centers with regard to their functions and the services they would provide. It was generally agreed that the AICs should first and foremost focus on research and development efforts demanded by the private sector as well as on capacity building by providing "hands-on" experience to students and opportunities for faculty and researchers to conduct product and process oriented work. Each of these centers must also include a venture center for assisting new businesses and entrepreneurs by providing them technical and marketing assistance. The AICs will need to be equipped with generic equipment for teaching and research of food processing as well as specialized equipment required for experimentation with processing and value-addition of the commodities commonly produced in their respective region.

For the AICs to be fully integrated in the existing food and agro-processing landscape in Ghana and to spearhead innovation and technology transfer they must be mandated to cooperate and collaborate with all existing and potential interested stakeholders and ongoing projects that seek to capitalize on the opportunities for further commercialization of food processing in Ghana.<sup>23</sup>



Figure 4.10. Schematic of contribution of SET-based enterprises to economic growth



Source: Essegbey (2008).

food and agro-processing domain. This is partially explained by the very serious lack of modern facilities and infrastructures dedicated to the production of knowledge-intensive, value-added products and processes from agricultural commodities and the very limited science and technical expertise within the country to carry on cutting-edge innovations that are globally competitive. However, Ghana has also lacked a clear strategy and package of programmes designed to comprehensively develop the sector.<sup>24</sup>

#### 4.6. Recommendations

These recommendations are designed to raise technological capacity and the overall level of innovation in the national food and agro-industry. The main recommendation is the establishment of agricultural innovation centres fitted with equipment, machines and instruments needed to improve products and process technology and adapt these technologies to the requirements of locally available raw materials. These innovation centres have been found to be an effective way of fostering sustainable growth and stimulating entrepreneurship. There are numerous examples from other countries where these centres have helped launch new products and processes from concept to commercialization.<sup>25</sup> The science and technology innovation centres are generally associated with universities and are often established alongside business incubators for use by individual entrepreneurs and cooperatives, start-up businesses, existing small- and mid-sized food companies, and retail and wholesale establishments. A single firm or entrepreneur acting alone can rarely

produce successful technological innovation and adaptation. Solving complex problems is often beyond the capability of a single player and the need for partnerships cannot be overemphasized. However, effective partnerships are enabled by institutionalized set-ups that help forge innovation and entrepreneurship. The innovation centres embody this institutional set-up that provides the facilities, network, expertise, and manpower necessary to push forward food and agro-processing innovation.

The recommendations in this report are based on the study's analysis as well as input from a meeting of various Ghanaian food and agro-processing stakeholders in July 2008. Boxes 4.2 (page 85) and 4.3 (page 87) describe the inputs from this group of stakeholders.

##### 1) Establish a network of two or three AICs

The creation of AICs is a promising route for the translation of concepts to commercialization in a systematic and expeditious manner. These centres have proven to be effective in fostering sustainable business growth and stimulating entrepreneurship, while also providing a wide array of resources and technologies for existing manufacturing groups and food businesses. The centres offer start-ups and more established enterprises a unique avenue for developing an array of novel products for the value-added market that provide socio-economic benefits. While an innovation centre is a hub of R&D generally associated with a university, it is sometimes coupled with a business incubator that provides physical space and business assistance from conceptualization to commercialization of a product or process.

An AIC is used by individuals and cooperatives, start-up food companies, existing small and mid-sized food companies, and retail and food-service establishments. It is essentially a physical entity whose objective is to provide R&D facilities and high-quality science, technology and business advisory services in order to facilitate and accelerate new business creation. The innovation centres also provide training space for students and translational research opportunities for faculty. An ideal innovation centre is generally managed by and located in the vicinity of an educational institution with strong programmes in the science, technology and engineering aspects of food and agriculture. Innovation centres are dedicated to assisting agribusiness in the scale-up and commercialization of new products and technologies. Early stage business entrepreneurs and the more established food organizations would find the innovation centre and its campus of services a unique avenue for developing and processing an array of food products for the value-added market.

By creating AICs, Ghana could align efforts among government, industry and academia; leverage its unique strengths; create new, globally focused advantages; and above all, help maintain a sustainable value-addition food chain. The new facilities needed to achieve these objectives and their interactions are embodied in the following schematic illustration (figure 4.11).

These centres could be established in regions of Ghana active in agriculture production and processing (see figures 4.3 and 4.4) with an appropriate institutional partner such as a university. This would allow each AIC to focus on the most promising set of commodities produced in its geographic region. Each AIC would house specialized equipment for research, testing, packaging and processing regional commodities. A network of two or three AICs would allow for wider geographical coverage and provide the benefits from both competition and cooperation among them.

The objective of AICs would be to catalyse and support new innovative business activity by offering firms an environment to experiment, test and pilot product innovations and business ideas. The translational research done at an AIC is highly applied and focused on improving products or services or piloting new ones. For example, a small food-processing company with an existing business in pineapple juice could come to the innovation centre to develop sweeter or

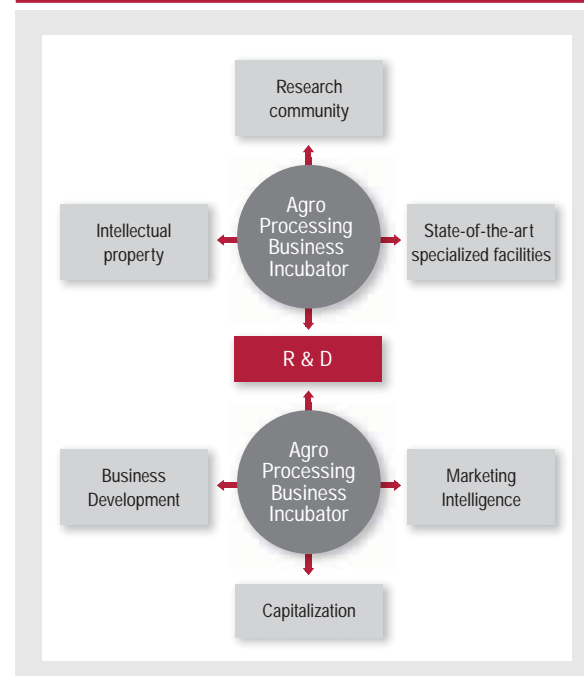
more diluted varieties of juice and package a small run of the new product for test marketing. The AIC staff could provide assistance with designing the test marketing process and connections to investors and customer pools. The same processing company could work further with AIC engineers on a product concept utilizing the pineapple cores.

Each AIC would provide training space for students and translational research opportunities for faculty and research staff. An innovation centre is therefore generally located in the vicinity of an educational institution with strong programmes in the science, technology and engineering aspects of the AIC focus sector. The staff would provide a range of business support services and sector-specific knowledge. Business services could include connecting businesses with international investors, providing sector-specific marketing information, undertaking technology demonstration projects and networking entrepreneurs with collaborators at firms, universities and research institutes.

## 2) Establish funding mechanisms for innovation and market-oriented R&D

Currently, most agro-processing enterprises in Ghana – apart from large multinationals – perform little research and experimentation to improve their

Figure 4.11. Conceptual Framework for Agribusiness Innovation Center and Business Incubator



Source: Essegbey (2008).

products and processes and fill new market niches.<sup>26</sup> This is not surprising, as the facilities and funding mechanisms that support enterprise-led R&D in Ghana are generally weak. As a result, there is little innovation in firms, limited product differentiation and firms with a competitive advantage lack the capacity to keep their advantage when market conditions change.<sup>27</sup> The multinational agro-processors that operate in Ghana, in contrast, do perform R&D to improve their products and processes. However, the vast majority of this R&D is carried out in the home countries of transnational corporations. They operate in isolation from the local Ghanaian agribusinesses and have little interaction with local universities or research centres. This limits the learning opportunities for local firms, students, and workers. In other words, the presence of agribusiness transnational corporations has produced few spillovers and little impetus for the development of a vibrant community of local, Ghanaian SME agro-processors.

To overcome this weakness, it is necessary to encourage viable funding sources for innovation and market-oriented R&D. The sources of innovation financing should be varied – for example, the firms themselves, foreign and domestic investors, and public R&D financing instruments.<sup>28</sup> These funding sources should be open to agribusinesses, including SMEs, and entrepreneurs creating new agribusinesses. Several possibilities are discussed below.

The notion of what constitutes an innovation should be adapted to the realities and needs of Ghanaian agribusinesses and might include (a) technological innovations, such as installing capital equipment, acquiring technology, conducting R&D to develop new products and processes, and monitoring technological developments in the sector; (b) organizational innovations, such as introducing new management models, implementing technical norms and standards, and building managerial capabilities to acquire and use new technologies; and (c) market development activities, such as market intelligence research, strategic planning or participation in international trade fairs.

#### Agribusiness research and development and innovation fund

The Science and Technology Research Endowment Fund, or STREFund, is a source of funding for R&D that potentially supports a wide range of research priorities. While this fund is a useful first step towards

obtaining support for R&D, it is insufficient (distributing only the annual investment proceeds from a \$500,000 endowment). It also targets its funding at the public research system rather than the R&D needs of the private sector. A better alternative would be to set up a fund for agribusiness innovation targeting SMEs, which are critical to building a competitive sector and linking farmers with regional and international markets. The SME agribusiness innovation fund could provide matching grants to SMEs working jointly with technological service providers – local universities, laboratories and AICs – to finance various innovation-related activities.

The matching grants would be designed as an incentive for SMEs and collaborating institutions, including AICs. The grants would encourage SMEs to invest in various forms of innovation. Further, the grants would encourage research and educational institutions to provide SMEs with technology transfer services, such as staff training, laboratory testing capacity, applied R&D and market studies. To improve the university-to-industry linkages, universities could be encouraged to establish special technological service centres with technological facilitators as part of their staff. These technological facilitators would visit interested SMEs, provide them with a brief technological diagnosis and help formulate proposals for new innovations. These facilitators, in effect, would be the linkage mechanism between SME agribusinesses and education and research institutions.

#### Innovation investment credit

The Government should consider fiscal incentives for investment in R&D and innovation by firms.<sup>29</sup> An innovation investment credit would allow firms to recover some portion of spending on innovation.<sup>30</sup> In a developing country such as Ghana, where private sector spending on R&D and innovation is especially low, the credit should support investment in innovation using a broad definition as described above. The credit should seek to attract foreign and large investors to partner with local SMEs by providing these firms with credit for innovation pursued in collaboration with local SMEs.

#### Check-off fees and other industry-managed R&D funding

Ghanaian industry should consider setting up collective mechanisms for self-financing R&D and business development. Producer check-off fees that collect a small tax for each commodity sold at market offer a

**Box 4.4. Ghana's Experience with Marketing Agencies**

In some countries, commodity marketing agencies have served as the mechanism to fund a large share of market-oriented agricultural research and development (e.g. Malaysia, United States, New Zealand). Outside of the well-established Ghana Cocoa Board (known as COCOBOD),<sup>31</sup> Ghana has had limited experience or success in establishing marketing agencies for its leading commodities.<sup>32</sup> Marketing agencies, when organized as an instrument for state control of a sub-sector, can lead to well-known market distortions. The World Bank has in many instances recommended the elimination of such agencies or boards in many countries, arguing that a liberalized agriculture sector offers farmers and other operators in the value chain fairer compensation for their goods and services. However, marketing agencies properly organized to limit market distortions, have served an important role in agro processing in some countries by supporting new business development, the marketing of products, organization and extension services for producers, and, as mentioned above, funding of research, development, and piloting of new products derived from the commodity.

Good international practice can be looked to for models on which to base new or reformed marketing agencies in Ghana.<sup>33</sup> In general, these successful marketing agencies are industry owned and managed, are sustainably funded through producer fees, have some limited legislative power to ensure producer conformity to quality and standards, and offer a full range of marketing, product development, and promotion services rather than only one or two services. These agencies are governed by the stakeholders (especially producers and processors) that would benefit from further development of the commodity into various processed bio-products. These agencies are not involved in the ownership of processing companies. While government might have provided some initial funding for the agencies, they are rapidly transitioned to a sustainable private model of financing.

Various organizations in Ghana (including private businesses in some cases) now perform a limited range of the functions normally ascribed to commodity marketing agencies. Box table 4.4.1 provides a non-exhaustive list of these organizations. In addition, a number of failed attempts at establishing marketing agencies have been recorded. Among others, the failures include the meat marketing board (known as the Food Distribution Company), the poultry board, and agencies for yam, rice, and pineapple. These failures can be attributed to various causes often including excessive government interference in the activities of the agencies leading to management inefficiencies and a failed business model. In other cases, the marketing agencies functioned as owners of processing businesses that became unsuccessful.

**Box table 4.4.1. Existing Marketing Organizations in Ghana**

Commodity	Marketing Organization	Ownership Structure	Activities
Wheat and flour	West Africa Mills, market traders	Wholly private	Organization of producers
Maize (grain and flour)	Market Women	Wholly private	Organization of producers
Rice	Ghana Rice Interprofessional Body, CCTC, Market Women	Wholly private	Organization of producers
Chicken	Kwabena Darko, Sydal Farms, others	Wholly private	Organization of producers
Pineapple	Milani, Bomart, Jei Rivers	Wholly private	Organization of producers
Mango	Producer Associations	Wholly private	Organization of producers
Vegetables	Market Traders	Wholly private	Organization of producers
Yam	Producer Associations	Wholly private	Organization of producers
Banana	VREL, Golden Exotics	Wholly private	Organization of producers
Cashew	Olam, Cashew Nut Producer Association	Wholly private	Organization of producers
Cocoa	Cocobod, Licensed Buying Companies (LBCs)	Public-Private: Private LBCs carry out internal purchasing, publicly-owned Cocobod carries out external marketing activities	R&D, quality control, extension, purchasing, market research, promote and regulate sales, export price stabilization
Shea nut	Cocobod, Olam, Kasadjan	Public-Private	Quality control, purchasing, market research, promote sales

**Box 4.4. Ghana's Experience with Marketing Agencies (Cont.)**

However, few of these organizations support the full range of marketing activities generally performed by commodity marketing agencies. Many of the organizations only provide basic organization of producers (producer associations). Particularly few of the established agencies support research and development to ensure the current and future competitiveness of processing activities. The main exception is COCOBOD that oversees cocoa and, until recently, shea nut.

COCOBOD has successes to its credit, particularly in providing extension services, ensuring quality, and ensuring consistent market access. However, the Cocoa Board model of price setting has periodically led to difficulties in ensuring stable and fair purchase prices. This should serve as a warning to the usefulness of simply replicating the cocoa board across other commodities.

Sources: Participants in July 2008 Agro Processing Stakeholders Meeting at STEPRI-CSIR, Accra.

means to collect industry funding. In many countries, these collective funding mechanisms are managed by marketing agencies for particular commodities that serve to provide a sustainable source of funding for agribusiness research and product development.<sup>34</sup> These agencies ideally work for the benefit of producers by promoting innovative uses of the commodity they represent.

As described in box 4.4, Ghana has had both positive and negative experiences with marketing agencies or boards; therefore, it should cautiously consider marketing agencies among other possibilities to collectively fund market-oriented R&D. The agencies would complement the development of AICs by supporting entrepreneurs, investors, engineers and students in undertaking new product development and test marketing of products based on each marketing agency's commodity. Marketing agency support to R&D should be market driven and aimed at attracting co-funding by local and foreign businesses interested in developing new bio-products. Research and development would generally take two forms. Firstly, targeted R&D projects carried out at research institutes or universities could aim to develop technologies that are beneficial to the industry as a whole, for example, novel technologies funded by the fish marketing agency for recovering omega-3 fatty acids from fish oil. Secondly, a competitive grants scheme could be managed by each agency to fund promising R&D projects initiated by firms. The scheme should fund only those pro-

jects that offer the highest probability of success in the market based on a quality business or marketing plan, the availability of co-financing, proven market access, or the innovativeness of the technologies or products pursued. The objective would be to fund those projects that could provide the greatest short- and long-term benefit to the stakeholders of the marketing agency, that is, the farmers and agribusinesses supporting the marketing agency.

**3) Set up an industry advisory group, composed of government, university, research institute and industry representatives, to guide the development of the food and agro-processing industry.**

The coordination of food and agro-processing in Ghana will require an organizational framework that brings the Government, the national research system, and the private sector together to work towards the success of the industry. Participants in the food and agro-processing stakeholders meeting of July 2008, which was organized in preparation of the Review, recommended the establishment of the Industry Advisory Group, which would seek to provide coordination, direction and practical and systemic solutions for developing the food and agro-processing industry in the country. The Group would help create a climate hospitable to the kinds of private enterprises that can stimulate change from a subsistence-farming economy to an integrated, market-oriented, agricultural-based economy.

The mandate of the Industry Advisory Group would be to (a) define a strategy for building national capacity for agro-processing in Ghana and enhancing the growth and performance of industries in the sector; (b) define the roles of the Government, universities and research institutes, and industry to enable the achievement of the sector's goals and objectives; and (c) work with the hosting institutions to establish the AICs and create plans to ensure the sustainability of the innovation centres and incubators.

The Stakeholders Group recommended that the Industry Advisory Group should (a) be located in the Office of the President in order to endow the Industry Advisory Group with cross-ministerial clout; (b) provide guidance on the establishment of AICs in broad terms, including establishing the management boards and the geographical distribution; and (c) have representation from organizations of the key stakeholder categories: universities and research institutions, government and industry.<sup>35</sup>



## NOTES

<sup>1</sup> Ministry of Food and Agriculture (2007).

<sup>2</sup> Association of Ghana Industries (2007).

<sup>3</sup> As one example, the Ministry of Agriculture reports that Ghana produces 8.17 million tons of cassava annually but only consumes 3.4 million tons domestically. See <http://blogs.myjoyonline.com/sms/2008/04/16/are-we-safe-from-the-world-food-crises/>.

<sup>4</sup> In advanced economies, over 80 per cent of the value in agriculture is captured by post-harvest activities (Rizvi 2008).

<sup>5</sup> Ministry of Food and Agriculture (2007).

<sup>6</sup> Ministry of Trade, Industry, and Private Sector Development (2008).

<sup>7</sup> Ibid.

<sup>8</sup> Ibid.

<sup>9</sup> Essegbey (2008).

<sup>10</sup> Ministry of Food and Agriculture.

<sup>11</sup> See World Bank (2008a) for a complete picture of recent trends in the horticulture sector.

<sup>12</sup> Essegbey (2008).

<sup>13</sup> See [www.doingbusiness.org](http://www.doingbusiness.org).

<sup>14</sup> <https://www.fdipromotion.com/ipaperf09/pdf/AppendixA.pdf>.

<sup>15</sup> Ghana's experience with marketing boards is discussed later in this chapter in box 4.4.

<sup>16</sup> The success rate and optimal design of R&D tax incentives is controversial. However, many governments continue to support these incentives, despite limited success in measuring the results of these efforts.

<sup>17</sup> See chapter 2, 2.4.2, for a more detailed discussion of Ghana's intellectual property regime.

<sup>18</sup> See table 3.3.

<sup>19</sup> See chapter 3, Ghana's Research and Development System

<sup>20</sup> <http://venturecapitalghana.com.gh/>.

<sup>21</sup> Based on discussions with the Managing Director of the Fund.

<sup>22</sup> For an overview of New Zealand's science- and technology-based progress in food and agro-processing, see Development Outreach, <http://www.devoutreach.com/SpecialReportScaling/tabid/75/Default.aspx>.

<sup>23</sup> A list of projects related to agro-processing would include the Millennium Development Authority, the Federation of Associations of Ghanaian Exporters, the Root and Tuber Improvement and Marketing Programme, the West Africa Agriculture Productivity Programme, the Inland Valley Rice Project, Cassava: Adding Value for Africa, the Rural Enterprise Project, Africa Knowledge and Transfer Partnerships, the Energy Centre at Kwame Nkrumah University of Science and Technology and private-sector entities involved in outgrower schemes and contract farming.

<sup>24</sup> The National Development Planning Commission's medium-term strategy attempts to rectify this shortcoming, by planning agricultural development along the entire value chain.

<sup>25</sup> Examples of innovation centres for food processing include the Rutgers Food Innovation Center (<http://www.foodinnovation.rutgers.edu/incubatoroverview.html#shared>) and the University of Nebraska Food Processing Center: <http://fpc.unl.edu/>. The Rutgers facility "is designed for use by farmers and cooperatives, startup food companies, existing small and mid-sized food companies, and retail and foodservice establishments who are assisted from concept to commercialization, and enabled to have new product prototypes tested and evaluated, and to literally have their products produced in a state-of-the-art food-processing facility that meets the regulatory standards of local, state and federal (both FDA and USDA) agencies." (Rutgers Food Innovation Center website).

<sup>26</sup> See World Bank (2007a, 2008d).

<sup>27</sup> Ibid.

<sup>28</sup> Some R&D should be expected to be financed by firms themselves. However, as demonstrated in countries with successful food-processing sectors, additional sources of applied R&D financing are critical to product and business development.



Pre-commercial R&D as well as start-up capital is critical for businesses working at the pilot stage of new ideas. R&D funding sources to support the industry might include public R&D funds, commodity check-off fees, and private investors.

<sup>29</sup> Fiscal incentives consist of a favorable tax treatment to R&D expenditure and may take the form of accelerated depreciation, tax credits, tax holidays or import tariff exemptions. Financial incentives refer to the direct funding of enterprise R&D projects by the Government through grants or subsidies, preferential loans (including interest allowances) or equity stakes (Mudambi, 1999).

<sup>30</sup> R&D tax credits are widely used in member countries of the Organisation for Co-operation and Development (OECD) to overcome a well-established market failure leading to underinvestment by firms in pre-commercial R&D. See, for example, OECD (2003). The credit could be adapted for the realities and needs of Ghana's private sector.

<sup>31</sup> For example, Malaysia's palm oil industry finances nearly \$200 million of R&D annually from a production tariff.

<sup>32</sup> More information on the Ghana Cocoa Board can be found at: <http://www.cocobod.gh>.

<sup>33</sup> Many of the judgments and recommendations in this section are based on the marketing agencies group formed for the Ghana Food and Agro-processing Stakeholders meeting held on 14 July 2008 at the Council for Scientific and Industrial Research's Science and Technology Policy Research Institute (STEPRI-CSIR) in Accra.

<sup>34</sup> Examples of well-functioning marketing agencies might include the soybean and corn boards in the United States, various agencies in New Zealand and Australia that promote dairy, apple, pear, kiwi fruit, horticulture, meat and wool products, and agencies in the United Kingdom that promote milk, potatoes and bacon.

<sup>35</sup> The stakeholders recommended a nine-person board, with members serving a four-year term and representing the following bodies: industry (chairman); the Government of Ghana (rotating between the Office of the President, the Ministry of Trade and Industry, and the Ministry of Education, Science, and Sports), the Ministry of Food and Agriculture, Association of Ghana Industries, research institutions, universities (e.g. Kwame Nkrumah University of Science and Technology), innovation centres, international experts and the financial sector (e.g. Bank of Ghana).

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Promoting innovation  
in the traditional and herbal  
medicines sector



## PROMOTING INNOVATION IN THE TRADITIONAL AND HERBAL MEDICINES SECTOR

### 5.1 Introduction

Ghana has a long tradition of valuing and supporting the development of traditional medicine. Traditional medicine (TM), for the purposes of this report, is defined as “the sum total of the knowledge, skills and practices based on theories, beliefs and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illnesses” (MOH-GNDP, 2002). Traditional herbal medicine (THM) is one aspect of traditional medicine, and relates specifically to the use of plants, plant parts and plant products as medicinal remedies. The terms “complementary medicine” and “alternative medicine” (as opposed to Ghanaian traditional medicine) are used to denote traditional medicine practices and products imported from outside Ghana, such as Chinese traditional medicine and Ayurvedic medicine. In this report, however, the term “traditional herbal medicines” – that is to say, the products, as opposed to the practice of traditional medicine – will also be used occasionally to include imported medicines.

Traditional medicine practitioners and traditional herbal medicines remain key elements in the provision of healthcare to around 60 per cent of the population,<sup>1</sup> but these still operate outside the public sector health system, despite long-held expectations that the two could be integrated. The domestic market is therefore viewed as potentially large, and represents an important source of income for deprived communities which depend on indigenous knowledge systems and plant resources for their livelihood. At the same time, Ghana is trying to diversify its export base and promote the development of non-traditional export products. In this area, traditional herbal medicine is perceived to have significant growth potential with the development of plant-based medicines for export.

Government efforts at the policy level to promote and mainstream traditional herbal medicine in Ghana have intensified in recent years. Science, technology and innovation are seen as key factors in the development of THM, and have been given prominence in current

policy objectives. This review provides an opportunity to assess the progress to date, and to reflect on what policy objectives and measures might warrant review and adjustment in the face of prevailing bottlenecks and barriers to future progress. This chapter concentrates on packaged traditional herbal medicines. It is particularly concerned with innovations in THM, and with the application of science and technology to support innovation in this area.

### 5.2 The potential role of traditional herbal medicine

Traditional medicine offers a range of healthcare treatment, including psychiatric care, which is similar to that offered by allopathic (i.e. orthodox) medicine. Practitioners of traditional medicine tend to be specialists, either in particular areas of disease management, or in other types of healthcare. The latter group includes psychic and spiritual healers, bonesetters (who specialize in treating bone fractures), and traditional birth attendants.<sup>2</sup> A Green Paper on health issued in 2001 refers to a “large but unknown number” of traditional healers in Ghana (MOH, 2001). Estimates range from 45,000 to 100,000.<sup>3</sup> A census carried out in 2001 found some 20,000 indigenous traditional healers resident in local communities, and approximately 40,000 to 50,000 people claiming involvement in the practice of traditional medicine.<sup>4</sup> Based on a population estimate of 22.1 million, the ratio of traditional medicine practitioners to general population in Ghana can be estimated to be between 1:491 and 1:221. Using the 2001 census data and taking 45,000 as an estimate, the ratio is closer to 1:400 or 1:500. The latest available figures indicate that there are 1,400 registered pharmacists in Ghana,<sup>5</sup> and around 7,000 chemical/drug sellers,<sup>6</sup> the latter being restricted to sales of over-the-counter medicines, including herbal remedies. In comparison, recent data presented in UNDP’s global Human Development Report estimate that the number of physicians per 100,000 people is approximately 15,<sup>7</sup> giving a ratio of physicians to population of 1:6667 (which compares favourably with most other countries in sub-Saharan Africa) and an approximate total number of physicians in the country of 3,300. Simply in terms of access, these figures demonstrate the importance of traditional medicine to healthcare provision in Ghana.

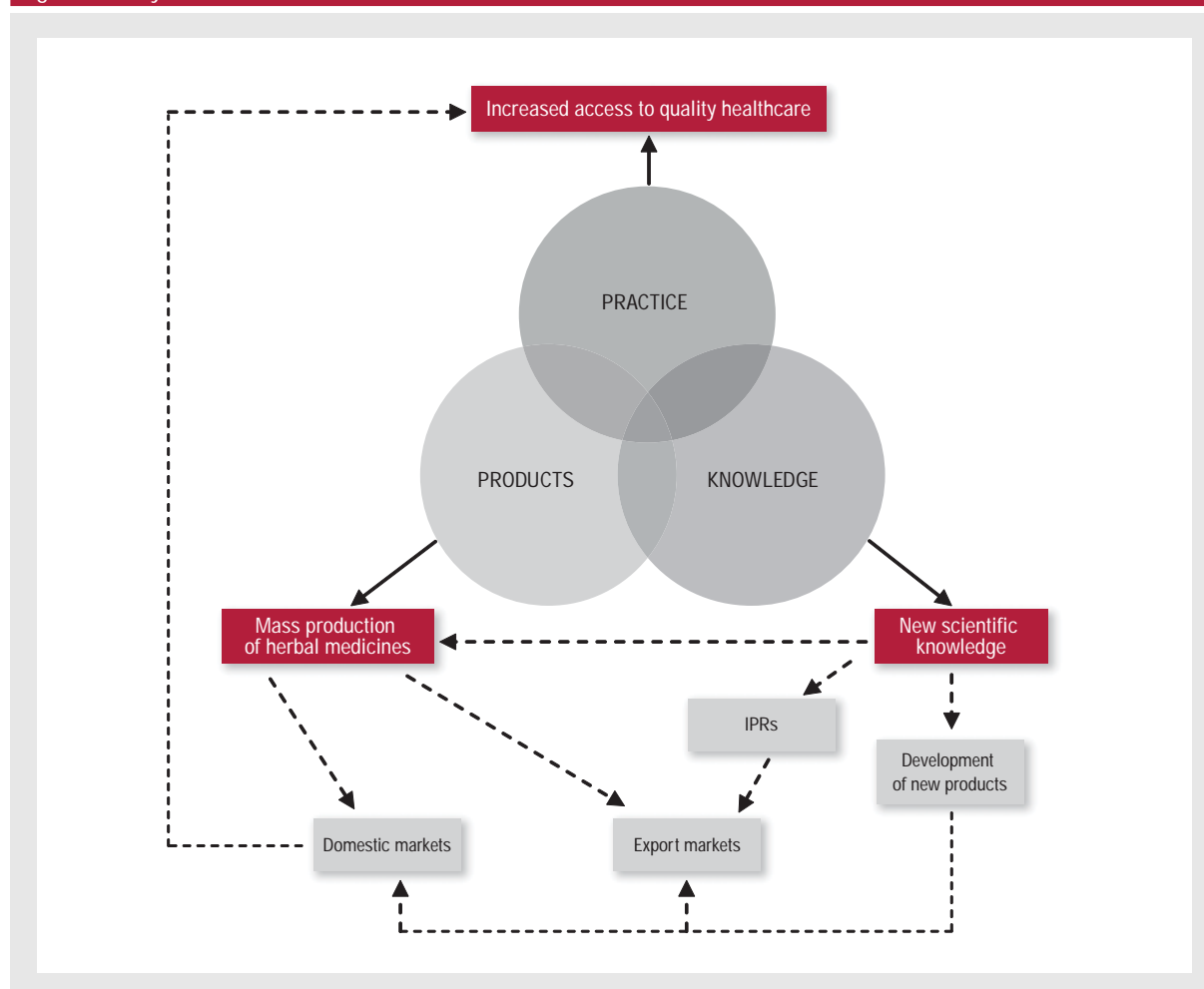
The Ministry of Health estimates that about 60 per cent of Ghanaians use traditional and alternative

medicine,<sup>8</sup> and that those living in rural areas are especially likely to use traditional and alternative medicine (MOH, 2007). However, the proportion that uses herbal medicines – including people that self-diagnose and buy directly from retailers, including pharmacies and drug sellers – may be much higher. In the national strategic plan for traditional and alternative medicine development in Ghana, it was estimated that around 80 per cent of rural and peri-urban people sought traditional remedies or practitioners for their health needs (MOH-TAMD, 2005). At the policy level, the Government of Ghana has long been active in promoting and supporting maintenance of the cultural traditions represented by traditional medicine, and in developing the potential to incorporate it into public-sector health service provision.

### 5.3 Traditional herbal medicine: practice, products and knowledge

In terms of integrating traditional herbal medicine into orthodox (i.e. allopathic) medicine, there are three distinct (though overlapping) elements to be considered: (a) the practice of traditional medicine; (b) the medicinal products themselves; and (c) the traditional indigenous knowledge which is embodied in both the practices and the products of traditional medicine, and which can be used as the basis for generating new knowledge and products commensurate with the scientific standards and norms of allopathic medicine. Each of these three aspects involves different – although, again, overlapping – sets of stakeholders, policy issues and objectives, technical problems, and potential contributions to healthcare provision and the economy (see figure 5.1).

Figure 5.1 Key elements of traditional herbal medicine



Source: the author's elaboration.

As figure 5.2 shows, there are two ways in which new products may emerge. The first – and quickest – route is through the adaption, improvement and commercialization of existing traditional herbal medicines for mass markets. This is particularly important in that there is already a domestic market for these products. Furthermore, the health service delivery system anticipates that these products could increase access to affordable medicines in Ghana. The second route, which uses knowledge about traditional herbal medicines as the basis for new allopathic drugs, is less direct, more science-intensive, has a longer time-lag for the development of a new product, and has potentially higher risk in terms of the benefits it would bring to healthcare provision in Ghana.<sup>9</sup>

The potential for the large-scale manufacture of packaged products will be dependent upon, and perhaps constrained by, operations both upstream and downstream along the value chain. Therefore, the following sections will review STI activities, related policies and regulations, the actors involved in the supply of raw materials, and the commercial diffusion of packaged products. Figure 5.2 shows a simple schematic of this approach, with the arrows representing influences on and linkages between the various elements in the “innovation system” that will be considered.

## 5.4 Institutional and policy framework

There are two broad areas of mandate under the Ministry of Health. The first is health policy, which is directly under the Ministry’s remit. The other is health service delivery, which is under the auspices of the

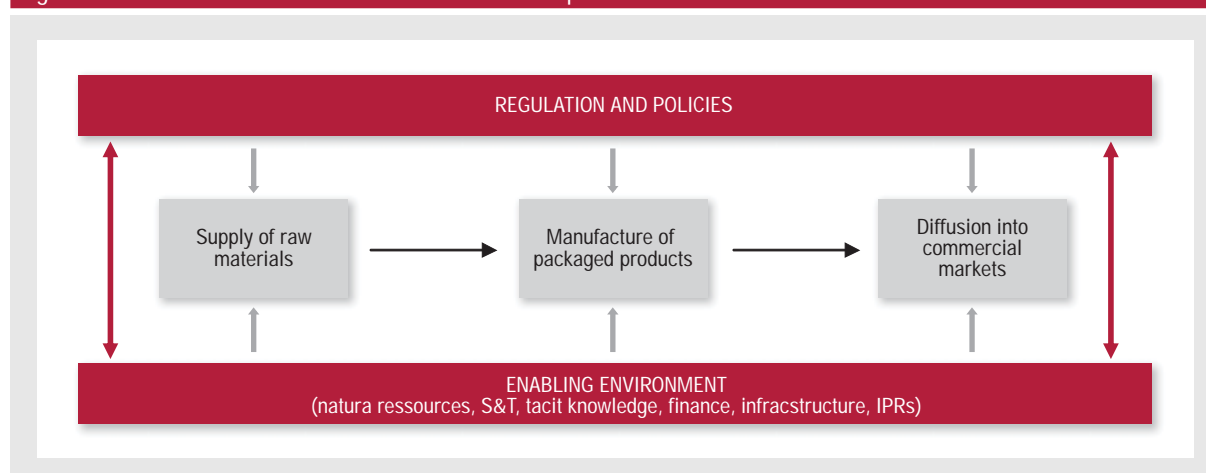
Ghana Health Service (GHS). Other key functions that are directly relevant to TM development are regulation, R&D, and education. The key elements and entities that make up the institutional and policy framework for TM in Ghana are shown in figure 5.3.

### 5.4.1 Overall policy for traditional medicine

While there has been a directorate for traditional medicine within the Ministry of Health since 1991, the Ministry of Health acknowledges that, for many years, the health sector has placed emphasis on the provision of allopathic medicine, and that traditional and alternative medicine have been relatively neglected.<sup>10</sup> The Ministry has now begun to intensify its efforts to support the development of TM in Ghana and to incorporate both practices and products into health service delivery. The key recent initiatives are:

- The establishment of a full Traditional and Alternative Medicine Directorate (TAMD) within the Ministry, whose role is to coordinate policies for TM development;
- The setting up of the Traditional Medicine Practice Council Secretariat, to register TM practitioners, monitor their practices, and act as a key collaborator in the regulation of practices in herbal medicine and the sale of products;
- Supporting capacity-building at the Centre for Scientific Research into Plant Medicine to carry out assessment and testing of traditional herbal medicines, including clinical trials;
- Encouraging the introduction of a programme on herbal medicine within the School of Pharmacy at the Kwame Nkrumah University of Science and Technology.

Figure 5.2. Manufacture of traditional herbal medicine products in Ghana



Source: the author’s elaboration.

#### 5.4.2 Traditional and Alternative Medicine Directorate

Originally, the activities of the Traditional and Alternative Medicine Directorate (TAMD) concentrated on capacity-building related to education and training for traditional healers, and improving the quality of practices by traditional healers.<sup>11</sup> Its mission is to nurture the development of TM products and services to the level of quality where they can be safely integrated into national healthcare programmes. Its functions are, essentially:

- Policy initiation and the development of implementation guidelines for legal and administrative frameworks;
- Coordinating information and strategic planning related to TM development; and
- Fostering collaboration with stakeholders, including allopathic practice, through education and information-sharing.

Its policy thrust is continuous R&D of products and services, sustainable conservation of medicinal plant resources, and technology transfer for large-scale production of herbal medicines. An overall objective for the development of TM, as stated in the TAMD strategic development plan for 2005–2009, is – by means of “rigorous research” – “improving [traditional health care] to acceptable standards and making it marketable to a wider group of people, including export markets.”

The plan highlights two broad goals:

- The health goal is to increase access to acceptable standards of traditional healthcare so as to improve the health status of all Ghanaians; and
- The economic goal is to develop Ghanaian traditional and alternative medicine practices and products to international standards.

The objectives laid out in the strategic plan, taken collectively, reflect a systemic approach to planning for the integration of TM. As a broad framework for the development of TM in Ghana, the strategic action plan is a useful steering document. Nevertheless, its implementation is likely to require the building of complementary policies, programmes and activities in a wide variety of ministries and public sector organizations.

#### 5.4.3 Health service delivery

Health service delivery in Ghana comprises the government health service, private-sector and NGO/mission health facilities, traditional medicine practitioners, and pharmacies and drug sellers. The public-sector health system is administered by the Ghana Health Service (GHS). The GHS is responsible for healthcare facilities, the engagement of healthcare professionals, and the procurement of drugs and medicines for public-sector use. Therefore, the GHS has the main operational role to play in the incorporation of traditional medicine – both practices and products. Constraints on access to healthcare services in Ghana are twofold, i.e. both geographic and financial. There are two key policy objectives to be met: (a) to increase access to healthcare services; and (b) to increase access to affordable medicines.

In recent years, the main focus of the efforts to meet these objectives has been the expansion of allopathic health facilities within the public health system, together with a major change in the way that healthcare is financed, and the restructuring of the procurement and supply system for drugs and other medical supplies. To date, progress towards the integration of traditional medicine practice in the GHS system, at a formal national level, has been slow, although in some areas TM practitioners and physicians cooperate informally at the local level. The GHS does not yet have a clearly defined plan for the integration of traditional medicine practice into its service provision at the present time, although policymakers are reported to currently be considering four options for promoting integration, based upon ideas from a survey of stakeholders.<sup>12</sup> The inclusion of traditional herbal medicine products into GHS service delivery is, at present, subject to the provisions of the National Drugs Policy, which is under the auspices of the Ghana National Drugs Programme.

#### 5.4.4 Ghana National Drugs Programme

The Ghana National Drugs Programme (GNDP) was introduced in 1997 as part of the first five-year medium-term strategic framework (1997–2001), with the intention of improving access to essential medicines. The programme initially included the development of a national drug policy, and subsequently also the following: legislation, procurement and distribution of drugs, financial management of revolving funds for drugs, and issues related to the quality and rational use of drugs (MOH-GNDP, 2002).



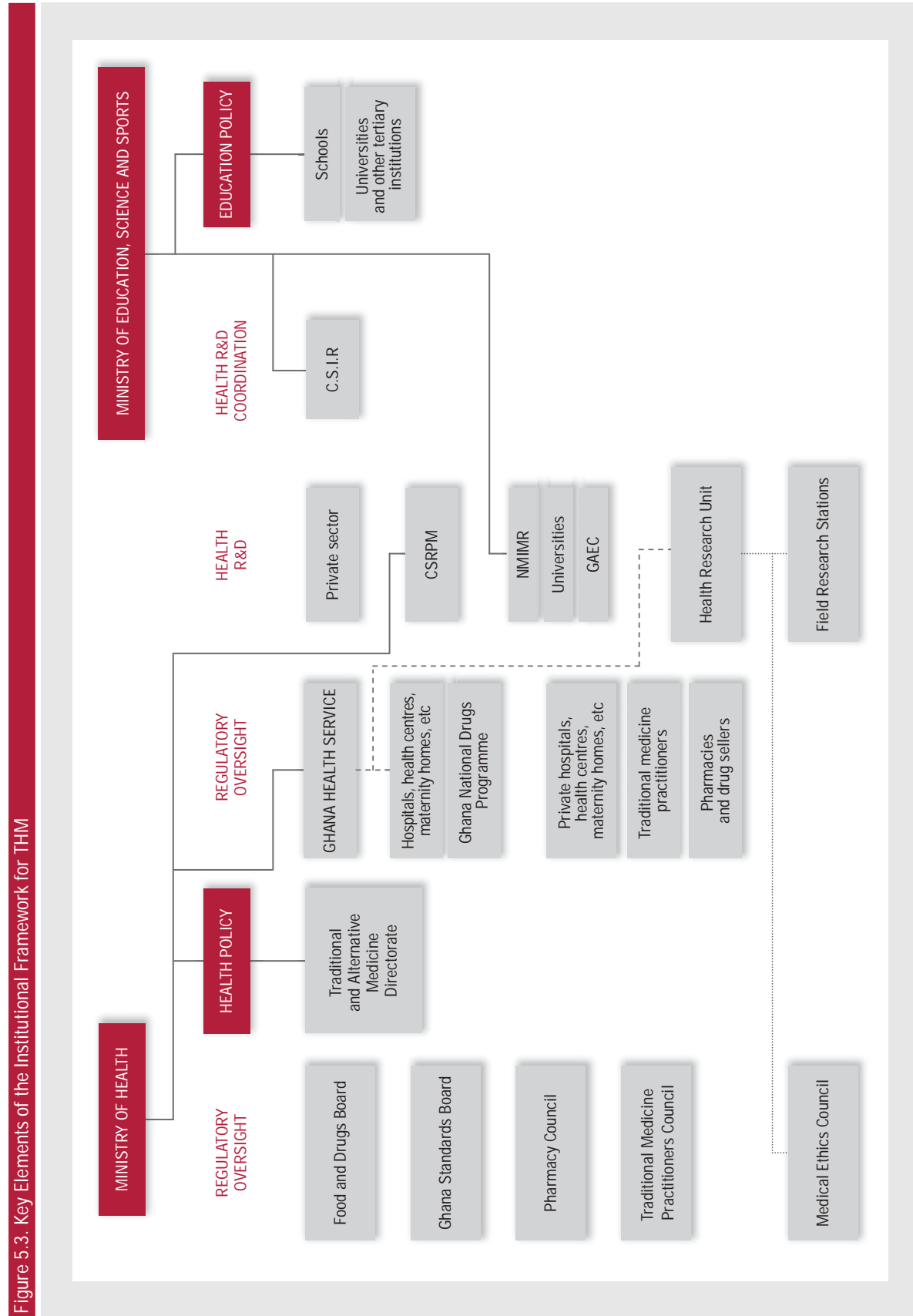


Figure 5.3. Key Elements of the Institutional Framework for THM

Source: the author's elaboration.

There are significant barriers to introducing traditional herbal medicines into the public health system. Administration of drugs and medicines within the public sector health system conforms to nationally published standard treatment guidelines, which, in turn, form the basis for publication of the national Essential Medicines List (EML) – this is sometimes also referred to in documents as the Essential Drugs List (EDL). Ghana has implemented the “essential medicines” concept since 1988, and produced its first EML in 1993. There are currently no traditional or alternative herbal medicines on the EML. Prescription of drugs within the public healthcare system is restricted to those medicines identified in the EML. One proposal made has been to introduce a separate EML in Ghana for THM.

Like the strategic plan for the development of traditional and alternative medicine in Ghana, the GNDP identifies a wide range of interrelated, cross-sectoral activities, covering scientific research, cultivation of medicinal plants, and the development of manufacturing. However, the main thrust of the current activities – which is in line with the national strategic plan for traditional and alternative medicine – is the regulation of traditional medicine practice and THM.

#### 5.4.5 Regulation

The three key regulatory aspects of traditional medicine relate to quality, safety and efficacy. Other important regulatory aspects include drug advertisements, standards of practice for drug outlets, post-marketing surveillance, and pharmacovigilance.<sup>13</sup> The main bodies responsible for regulatory oversight in relation to traditional medicine are:

- the Traditional Medicine Practice Council;
- the Food and Drugs Board; and
- the Ghana Standards Board.

In addition, the Pharmacy Council is responsible for licensing drug outlets, including pharmacies and drug sellers, and the Medical Ethics Council is responsible for approving the conduct of clinical trials into all medicinal products. For this review, the key pieces of legislation that establish regulatory mechanisms for traditional medicine were identified as the Traditional Medicine Practice Act and the Food and Drugs Law.

#### 5.4.6 Traditional Medicine Practice Act

Under the terms of the Traditional Medicine Practice Act 2000,<sup>14</sup> all traditional medicine practitioners must be registered and all traditional medicine practices

must be licensed. This is the key role of the Traditional Medicine Practitioners Council (TMPC). The TMPC determines whether an applicant for registration has “adequate proficiency” in the practice before awarding registration. The application must first be endorsed by two representatives from three specified authorities in the district and/or community where the practitioner is based (Government of Ghana, 2000). The TMPC is also mandated to monitor the activities of practitioners to “ensure that they conform to safety standards and the aims of the National Drugs Programme” (MOH-TAMD 2005). Registration must be renewed on an annual basis. Also under this Act, herbalists who produce herbal medicines for sale must be registered with the Food and Drugs Board (FDB).

#### 5.4.7 Food and Drugs Law

Under the Food and Drugs Law 1992, all herbal medicines and homeopathic drugs that are manufactured, prepared, sold, supplied, exported, or imported into Ghana must be registered with the FDB. The FDB was established in Ghana as a result of the introduction of the Food and Drugs Law 1992, and became operational in 1997. The FDB is responsible for the approval and registration of food products, drugs, medical devices, household chemicals and cosmetics, whether intended for sale or distribution in Ghana, for export or import. Before 1997, herbal medicines were not regulated in Ghana. Depending on their characteristics and intended use, some traditional herbal products are suitable for registration as food supplements rather than as drugs, as is the case in many other countries. Where this is not appropriate, herbal medicines are subject to the FDB’s “Guidelines for the registration of herbal/homeopathic drugs in Ghana”. However, full implementation of the regulatory procedures is being phased in for herbal medicines.

Registration requires that herbal products successfully undergo acute toxicity testing and that the proposed product labels be submitted for the FDB’s approval. From the year 2000, FDB approval has also depended on passing an FDB inspection of the manufacturing facilities used in the production of the herbal product. Advertisements for the herbal products in the mass media must also be approved by the FDB. Since 2003, it has also been a requirement that the product labels include the name of the active ingredient – or, at least, the name of the plant(s) used. The botanical name of the plant is required, rather than local names (which may differ between regions and indigenous

languages). Following registration, the FDB carries out regular quality and safety monitoring of samples of registered products that are on sale at pharmacies and other retail outlets. According to the FDB, labelling and other advertising activities have proved to be the key challenges in the registration process.

#### 5.4.8 Health R&D

Ghana does not have an S&T policy or innovation policy for the health sector. For the most part, STI policy is expressed in terms of R&D needs that are related to the implementation of broader policies, such as the National Drugs Policy. Scientific research into medicinal plants and herbal medicines is carried out mainly in public-sector research institutions and universities. The main centres of R&D into plant medicine products in Ghana are the:

- Centre for Scientific Research into Plant Medicine;
- Noguchi Memorial Institute for Medical Research; and
- School of Pharmacy, Kwame Nkrumah University of Science and Technology.

In addition, several other university departments carry out research related to medicinal plants, including the botany, chemistry and biochemistry departments at the University of Ghana Legon, and the chemistry department at the University of Cape Coast.

R&D in most pharmaceutical firms in Ghana relates to quality-control issues rather than to the development of new products, and most of these firms are not manufacturing traditional herbal medicines. One notable exception is Phyto-Riker Pharmaceuticals, which has two herbal medicines in their product range. The R&D activities of individual herbalists are not documented, well known, or even explicitly acknowledged at the policy level.

#### 5.4.9 Centre for Scientific Research into Plant Medicine

The Centre for Scientific Research into Plant Medicine (CSRPM) was established in 1975, under the Ministry of Health, and is based at Mampong-Akuapem in the Eastern Region of Ghana. Its original mandate covers:

- Scientific research into plant medicine, specifically relating to its improvement;
- The establishment and maintenance of botanical gardens for medicinal plants;
- Cooperation with, and liaison between, traditional medicine practitioners, other research institutions,

and commercial organizations, in the area of plant medicine; and

- Collation and dissemination of information.

The Centre is now also involved in the production and sale of its own range of herbal medicines, and carries out toxicological testing to support registration of herbal medicines with the FDB. CSRPM is a World Health Organization (WHO) "collaborating centre" in the area of plant medicine.

#### 5.4.10 Noguchi Memorial Institute of Medical Research

The Noguchi Memorial Institute of Medical Research (NMIMR) was set up as a semi-autonomous research institute in 1979, under the overall auspices of, and on the campus of, the University of Ghana, Legon, Accra. Plant medicine is not a major area of research at the NMIMR. The plant medicine programme at the institute is in its early stages, though some of the current staff had carried out research on herbal products earlier. The Institute's recent increase in activity in this area is important, as it arguably has the best facilities for advanced scientific research in Ghana.

#### 5.4.11 KNUST Faculty of Pharmacy

Research in a range of issues related to herbal medicines is carried out at the Faculty of Pharmacy, Kwame Nkrumah University of Science and Technology, in Kumasi. The key departments are Pharmacognosy, Pharmacology and Pharmaceutics. Most of the research carried out is done with internal university resources, and very few projects receive significant research funding from external sources. Perhaps as a result, the laboratory facilities are not well equipped by academic standards. The screening and chemical analysis of medicinal plants is the single largest research area, with less work being undertaken on existing herbal products. Individual researchers are also working on projects in microbiology (relating to potential anti-microbials derived from plant sources) and tissue culture for medicinal plants.

#### 5.4.12 The coordination of R&D in health

Responsibility for the coordination of health research in Ghana had been under the Deputy Director-General of the Council for Scientific and Industrial Research (CSIR). The CSIR itself is responsible for 13 public-sector research institutes (none of which are directly concerned with research either into medicines or health issues, as these are under the mandate of the Ministry of Health).<sup>15</sup> The CSIR operates under the

Ministry of Environment, Science and Technology. However, coordination under the Deputy Director-General has ceased, and therefore the CSIR's role in the coordination of research is not entirely clear. It has no policy development remit, nor does it administer any research funding for health. The Deputy Director-General in charge of this remit is on the Governing Council of the CSRPM.

#### 5.4.13 Education and training

Education and training related to THM can be seen from two perspectives. The first relates to the training of TM practitioners, which has traditionally been carried out under apprenticeship systems. The second is concerned with provisions under the mandate of government ministries, which includes:

- Education and training within the formal education system; and
- Training offered to TM practitioners and herbal product manufacturers by public organizations.

Current policy deals only with the second type of education and training; the linkages with traditional training appear to be absent. The aim of the existing training for practitioners of traditional medicine is to enhance their services/treatment through introduction to modern medical knowledge and methods.

Policy in the formal education system is under the Ministry of Education, although the universities tend to have autonomy in designing their curricula. Tertiary education in areas related to plant medicine is carried out in the university departments that were listed in section 5.4.8. The only specific programme in herbal medicine is a BSc at the School of Pharmacy, KNUST, which started in 2001. The integration of herbal medicine into the curricula of Ghana's Medical Schools has not yet taken place.

### 5.5 STI activities and challenges

The main activities and challenges in THM in Ghana relate to R&D, the manufacture of THM products, the supply of raw materials, and regulation. These are considered here within the context of the potential development of a herbal medicines industry.

#### 5.5.1 Research and development

There are no accurate and comprehensive national data on the number of plants used in traditional herbal medicine, but there is mounting evidence that some species with known medicinal properties are

becoming increasingly difficult to find, suggesting that they may be under threat of disappearing altogether in some areas of Ghana. R&D to support the stock of data on plants of medicinal importance, together with their sustainable use in herbal medicines, is identified as a policy priority in Ghana.

The scientific community in Ghana has been working for many decades to build up documented knowledge about the national stock of plant genetic resources, including those known or believed to be of medicinal relevance. The main institutions undertaking scientific research to build the stock of knowledge on plant genetic resources, and/or maintaining germplasm collections, are the:

- Centre for Scientific Research into Plant Medicine (CSRPM), particularly the Plant Development Department, and to a lesser extent, the Phytochemistry and Production Departments;
- University of Ghana, Legon (Departments of Chemistry, Botany and Biochemistry);
- Kwame Nkrumah University of Science and Technology (KNUST), Kumasi (Departments of Pharmacology, Pharmacognosy and Pharmaceutics in the School of Pharmacy);
- University of Cape Coast (Department of Chemistry);
- Noguchi Memorial Institute for Medical Research (NMIMR);
- Botanical gardens, including those at Aburi in the Eastern Region (located close to the CSRPM);
- Plant Genetic Resource Centre (PGRC), an institute of the CSIR;
- Science and Technology Policy Research Institute (STEPRI) of CSIR – publishers of the Ghana Herbal Pharmacopeia.

All the academic/research institutions have sufficiently equipped laboratories to carry out work in phytochemistry and/or microbiology, though only NMIMR has well-equipped molecular biology laboratories.

The goals can be divided into three types:

- a) Adding to the national knowledge base on local medicinal plants in order to identify potential and priorities for:
  - i) the development of products; and/or

- ii) conservation initiatives to protect plants of medicinal value;
- b) The development of new allopathic drugs;
- c) The development or improvement of herbal medicines.

To date, in Ghana, no new allopathic drugs have been developed as a result of research into plant medicine. This situation is common across Africa. In the field of drug development, researchers – and SMEs – face formidable barriers to doing so. These barriers relate to the investment needed for prolonged, science-intensive developmental work, but more especially to the costs of controlled clinical trials.<sup>16</sup>

One option to overcome these barriers to the development of new allopathic drugs based on medicinal plants is to undertake R&D only to the stage where the product under development can be patented, with the objective of gaining the benefits from licensing fees and royalties. This is, at present, a key objective of the plant medicine research programme under way at the NMIMR.<sup>17</sup> There may also be some potential to forming partnerships with foreign organizations or consortiums to develop plant medicines from local plants, although this has not yet been done in Ghana. Both of these options raise issues about the local capacity to undertake patenting activities, not just in Ghana, but also in potential export-market countries.

The only new commercial products that have emerged from public-sector scientific research in plant medicine in Ghana have been the herbal medicines produced at the CSRPM. A private sector firm, Phyto-Riker, has developed and now manufactures two herbal medicinal products. Some herbalists are themselves scientists – in the sense of being formally trained in, for example, pharmacology – and carry out some “formal” R&D on their own products. With regard to the testing, evaluation and improvement of herbal products, relationships do exist between the public and private sectors. For example, CSRPM, NMIMR and the Faculty of Pharmacy at KNUST have carried out testing on traditional herbal medicines to treat malaria and HIV/AIDS – two diseases that have been particularly highlighted by current policies as priorities for the development of herbal medicines. However, these relationships bring the question of intellectual property protection for traditional knowledge to the fore. In terms of intellectual property rights protection, Ghana has a Patents Act, and an intellectual property

rights guideline document has reportedly been developed between the agriculture, forestry and health ministries for the protection and sustainable development of plant genetic resources and the related indigenous knowledge for health, agriculture and industry. Ghana has been represented in WHO forums related to the production of a strategy on IPR, indigenous knowledge, and public health innovations. Nevertheless, while a certain level of trust has been built between the research institutions (particularly CSRPM) and some Ghanaian herbalists, THM is still shrouded in secrecy to a large extent.

### 5.5.2 The production of herbal medicines

Traditional herbal medicines come in various forms, depending on the degree to which they have been processed by a herbalist. The prevalence of manufactured decoctions and tinctures, together with packaged dried herbs for home preparations, on the domestic market in Ghana may be seen as an indication of the dominance of small-scale low-tech production systems in THM manufacturing. The introduction of automated production and a trend towards THMs in solid dosage forms, where possible and appropriate, has advantages for the development of improved products in respect of quality. Uniformity (particularly in respect of dosage), longer shelf life, and easier transport and storage are key potential benefits from the supply side. In turn, these benefits could make it easier to meet the quality requirements of the regulatory system. The introduction of new technologies can also help address standards related to Good Manufacturing Practice. However, most herbalists in Ghana lack the capacity to make this transition in production methods without significant investment in the acquisition and absorption of new technologies.

There is a need to move towards production methods that are more suited to large-scale production, although this means a need for technological upgrading by small-scale herbalists.

### 5.5.3 Supply and cultivation of medicinal plants

A crucial issue that is raised by the potential expansion of THM production in Ghana is the supply of raw plant materials. At present, there is relatively little cultivation of medicinal plants for use in herbal products. Most plants are gathered from the wild, and there is evidence that some medicinal plants that are already used by herbalists are becoming more difficult to find in some localities. The strategic plan for the develop-



ment of THM covering the period 2005–2009 proposed that a national survey be carried out to identify medicinal plants that are endangered and/or of commercial interest in Ghana.

The dominance of trees as raw material for traditional herbal medicines has significant implications for sustainability of supply, given their relatively slow growth and high land requirements. The prevalence of forest tree species in the mix of medicinal plants used by herbalists, if indicative of the overall use of plants in THM, presents significant problems for the introduction of mass cultivation. These problems include the land requirements, the time lag between planting and harvesting, and the potential loss of potency or other undesirable alteration of a plant's characteristics when grown outside the natural habitat.

A potential limitation on the long-term commercial viability of medicinal plant farming is the lack of easily deployed techniques for the propagation of mass uniform planting material. Collection of seed or material for vegetative propagation from the wild is unlikely to be viable in this respect. Work to develop tissue culture<sup>18</sup> for the mass propagation of medicinal plants was identified as a priority at the national level some years ago,<sup>19</sup> but little has been accomplished to date.

#### 5.5.4 Regulatory science

By the end of 2007, a total of 1,068 herbal medicines had been registered at the FDB since compulsory registration began in 1998. The FDB reports that, up to and including 2004, around 40 per cent of registered products were produced by Ghanaian manufacturers (see fig. 5.4).<sup>20</sup> The total number of registered products has grown substantially since then. However, the current total represents a relatively small proportion of the traditional herbal medicines used throughout Ghana. Moreover, according to the FDB, the majority of the registered herbal medicines to date come from the Greater Accra or Asante regions.<sup>21</sup> The registration process itself is proving to be a difficult barrier for herbalists to overcome, despite the relatively relaxed scientific testing and evaluation regulations.

The three criteria by which medicines are evaluated are safety, quality and efficacy. Under the present FDB requirements, acute toxicity testing is the only prerequisite for applying for registration of a herbal medicine. Capacity to undertake the testing already exists, though additional capacity would be needed should a regulated herbal medicines industry be developed on a large scale. An unknown number of

herbal products that are unregistered and untested (by “scientific methods”) are being used throughout Ghana, although they are now illegal. Current policy favours increased regulation and more comprehensive testing of THMs, with the expectation that this would drive unsafe and/or ineffective herbal products off the market. However, it does seem that the realities of the regulatory situation – i.e. the small number of testing centres located only in the southern half of the country, the costs to herbalists of testing and registration, the mandatory disclosure of their trade secrets, and the lack of enforcement of the law – serve to obscure the possible range of impacts of this policy.

#### 5.5.5 Development of a traditional herbal medicine industry

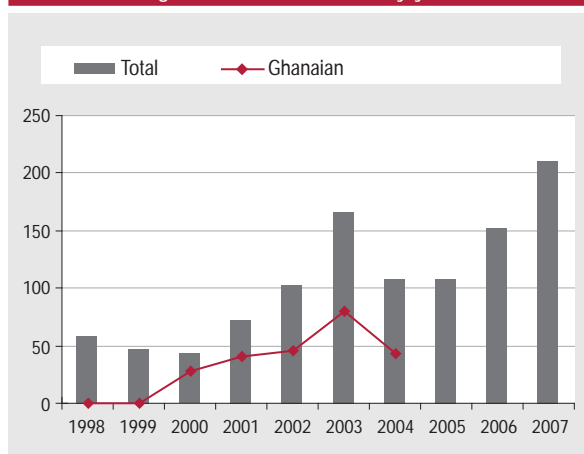
There are a number of pharmaceutical manufacturing companies in Ghana, but only one of these – Phyto-Riker Pharmaceuticals – produces herbal medicines. The exact number of herbalists that are producing traditional medicines for sale in Ghana is not known. Grupper et al. (2005) report only 36 local herbalists and a further 22 foreign herbal medicine manufacturers, however the current figure is higher according to TAMD, with 140 small-scale manufacturers listed at the middle of 2008. According to the TAMD, recent growth in the “formal” herbal medicine industry in Ghana is being driven largely by business people, and to some extent by plant growers, rather than by the traditional medicine practitioners and herbalists themselves.<sup>22</sup>

The domestic over-the-counter (OTC) medicines market is the industry's main target market; and indeed, for most firms, it is the only target market. The FDB reports that it has received a small number of requests for certification of registered herbal products for export: all of these were for exports to other countries in the West Africa subregion.<sup>23</sup> Together with the two main unresolved issues of raw materials supply and regulatory requirements, the characteristics of these three existing and potential markets will determine the future of the herbal medicine industry. Individual firms within the industry face the challenges of developing capacities to upgrade their production methods, meet changing regulatory standards, and package and market their products, according to the demands of the different markets.

The size of the potential markets for THMs is unknown, and this makes it very difficult to prioritize interventions.<sup>24</sup> However, data from the pharmaceuticals markets in



**Figure 5.4. Traditional and Alternative Medicines Registered with the FDB, by year**



Source: FDB, December 2007

Ghana indicate that the public sector accounts for a relatively small proportion of the retail sales value of imported and locally produced pharmaceuticals (table 5.1).

#### 5.5.6 THM for the public sector health system

The conventional view on the potential of locally manufactured medicines, including traditional herbal medicines, from the health system's perspective, has been that access to quality medicines could be expanded while at the same time making foreign exchange savings through import substitution. This expectation has not been met by the pharmaceutical sector in Ghana. Current procurement procedures in the GHS are based on annual international competitive bids, and local manufacturers have generally found themselves unable to compete with imports on ex-factory prices. In the Ghanaian pharmaceutical industry's case, this appears to be due primarily to economies of scale. It is noted that pharmaceutical firms in Ghana do not produce any "innovator" allopathic medicines – i.e. medicines that have been developed in-house.<sup>25</sup> Therefore, all products manufactured locally are competing with often very large-scale foreign manufacturers. Moreover, the annual bidding process has deterred some local manufacturers from producing for the public sector market altogether, as margins are low and there is no long-term contractual security under the present system. Rather, their production is geared towards the domestic OTC market (Grupper et al., 2005).

Given the relatively small size of the market, the uncertainties of annual competitive bidding, and the regulatory hurdles involved, the GHS may not be the most

attractive market for the commercial manufacture of traditional herbal products.

#### 5.5.7 Ghana's domestic over-the-counter market for THM

The domestic market for OTC herbal products is still not well understood. The size of the market is not clear, and the factors driving consumer behaviour in respect of OTC herbal medicines have not been precisely identified. The two factors that are most closely identified with consumer purchases of herbal medicines are greater accessibility and lower cost relative to health service facilities and prescription medicines. In Ghana, as in many other countries, TM has always been seen as critical for the provision of low-cost and accessible healthcare, predominantly for the poorest segment of the population, who not only have low incomes but also very often live far from modern medical facilities. Should the cost of OTC remedies increase significantly due to the cost to manufacturers of stricter regulation, the segment of the market for whom cost is the main factor determining consumer choice may diminish greatly.

Perhaps most significantly, it may be that the impacts of current improvements in state healthcare provision, involving the establishment of new hospitals and clinics, and the implementation of the National Health Insurance Scheme, will be of overriding importance for the future of the domestic OTC market. The ongoing improvement in accessibility of modern clinics and hospitals in rural areas of Ghana, and the provisions of the National Health Insurance Scheme that enable modern medicines to be prescribed at little or no cost to poor consumers – while, of course, extremely desirable – are likely to significantly reduce the existing and potential market for OTC herbal products.

#### 5.5.8 Export markets

Anecdotal evidence suggests that THMs are sometimes exported in small batches through

**Table 5.1 Public and private sector markets for pharmaceuticals in Ghana, 2004**

	Retail sales value US\$ millions	% of total consumer market
Public sector imports	17	7
Private sector imports	106	42
Private sector local manufacture	127	51
Totals	250	100

Ghanaian expatriates, and, occasionally, by foreigners who have used THMs while temporarily visiting the country. The FDB reports that few requests from herbal manufacturers for export approval certificates have been received.<sup>26</sup> Those that did request formal approval were exporting to other countries in the West Africa region. Little has been done to assess the location and size of potential export markets for Ghanaian THMs. Access to foreign markets where local traditional medicines are already entrenched, such as China and India, is likely to be extremely difficult. This may also be the case within sub-Saharan Africa, especially where the competitiveness of Ghanaian products in markets outside the Economic Community of West African States (ECOWAS) is reduced as a result of other regional free trade arrangements (particularly the Southern African Development Community (SADC)). With regard to Ghana's main potential markets outside Africa – Europe and the United States – there are regulatory barriers that will limit the potential for exports, and different consumer preferences that may require innovative approaches to packaging and marketing.

Until the introduction of a new European Union directive on traditional herbal products in 2004, Ghanaian herbal products may have been able to enter the market in some European countries. The regulatory regimes varied in strictness between different countries. In the United Kingdom, for example, some herbal medicines could be exempted from registration altogether.<sup>27</sup> In France, the registration procedure for traditionally used products (as evidenced by a simple statement of their traditional use) was very straightforward. A list of plants and indications was required on the label, but most products did not require any safety or efficacy studies to be undertaken. The laws in Germany were a little stricter; efficacy was considered to be proven by long-term use (as in France), but product safety tests were required (Steinhoff, 2002). The new directive, which was designed to harmonize regulation of herbal products across the European Union, affords significant advantages to products used traditionally in the region. Now, proof of efficacy can be based on evidence of their use for a minimum of 30 years, as per WHO recommendations, but with the additional caveat that at least 15 of these years must relate to use within the European Union. New products from outside the region must now undergo more comprehensive efficacy assessment. In addition, the new requirements for quality testing

under the directive are stricter than was the case in most European countries prior to 2004. The directive, which is being phased in over several years, is causing concern even for well-established exporters of Chinese, Ayurvedic and other herbal medicines,<sup>28</sup> as many of their products do not meet the requirement for 15 years existing use in the EU, and this would, of course, also apply to potential exports from Ghana.

Under the existing regulatory system in the United States, herbal products can either be registered as food supplements or as drugs; there is no specific regime for herbal medicines.<sup>29</sup> The regulatory process for drugs is, of course, prohibitively costly. Therefore, only those Ghanaian herbal products that can meet the regulatory standards for allopathic medicines, or those that can be registered as food supplements,<sup>30</sup> have potential for being exported to the United States. While the labelling requirements are stricter than those in force in Ghana at present (e.g. all ingredients must be listed on the label), the dietary supplements market is relatively lightly regulated and monitored. Approval from the Food and Drug Administration (FDA) for a new product on the market is required only if it contains a "new dietary ingredient",<sup>31</sup> and while the FDA is responsible for oversight, and investigates complaints, very little routine monitoring is undertaken. The FDA largely puts the onus on manufacturers to self-regulate in the dietary supplements market (FDA, 2001).

In fact, in both the United States and Europe, traditional herbal products are most commonly registered as food supplements. Anecdotal evidence from the United Kingdom indicates that around 80 per cent of the herbal products sold through the country's leading chain of alternative/complementary healthcare stores are sold as food supplements, with only about 20 per cent being registered as herbal medicines. On this basis, the labelling regulations prohibit any mention of indications or any other description of the products' usages, other than the recommended dosage. For consumers, matching their needs to specific products relies on the advice of the herbalists or store staff, or on general consumer awareness about the most common use(s) of particular herbs. Therefore, herbal manufacturers in Ghana who aim to develop products for export to the United States or Europe (as food supplements) may also need to engage in extensive awareness-raising and promotional activities in order to attract customers to unfamiliar herbal products.

## 5.6 Recommendations

Ghana is a leading example in sub-Saharan Africa of policy and institutional development in traditional herbal medicine. The Ministry of Health's recognition of – and efforts to develop and apply – the concepts of a “health industry” and “health innovation” are extremely progressive, and it is hoped that this STIP Review will be a useful contribution to the policy planning now being carried out. The MOH and the Ministry of Trade and Industry are well poised to overcome the conventional (but often only notional) hierarchical barriers that have separated development initiatives in “science” from those to support “innovation”. Ghana now has a clear advantage over many other countries in relation to development of African traditional herbal medicine. If efforts to bring about the commercialization of safe and effective packaged herbal products – either as medicines or food supplements – can be intensified, the country could set the standards for the integration of THM into both healthcare and the wider economy. A “big push” along these lines might give Ghana a competitive edge in foreign markets, as well as fulfilling the long-standing goals of the healthcare system.

However, accessing and successfully penetrating overseas markets will require intensive and persistent learning on the part of exporters and potential exporters, policymakers, and regulatory bodies. In this, learning experiences from the development of policy and activities to support other non-traditional exports might be explored, and applied appropriately in the area of THM development. Within Ghana, the value of the domestic market has not been accurately assessed. Nevertheless, it appears that there is a high level of demand for traditional herbal medicine.

The STIP Review finds that, broadly speaking, activities related to THM that could be carried out within the boundaries of the MOH mandate, and also those involving the scientific research institutions, have been progressing more successfully than those that cross the boundaries between health, trade and industry, agriculture, and the environment. In its 2007 Programme of Work, the MOH admitted that, while intersectoral collaboration had been highlighted as a key factor in the achievement of “optimal health outcomes within the sector”, relatively little had actually been achieved so far. On that basis, the MOH indicated an intention to “adopt a multi-sectoral and multi-stakeholder approach for policy dialogue, coordination, planning, resource mobilization and allocation” (MOH, 2007).

Efforts at the MOH, and elsewhere, that support the development of joint resource mobilization and allocation are very much to the Ministry's credit, and it is hoped that international partners and other government ministries will also be active in bringing about new funding mechanisms for cross-sectoral programmes.

The following have been identified as gaps, barriers and bottlenecks that are major factors in limiting effective implementation of the strategic action plan:

- A lack of guaranteed funding from identified sources for the proposed activities;
- Limited or no progress in cross-sectoral activities;
- Insufficiently detailed specification of priority measures/actions/projects within and between activities proposed in the plan;
- The concentration of activities in Greater Accra, Kumasi, and to a lesser extent, the Eastern Region;
- Imbalances between the rates of progress in key areas of development, particularly, cultivation of medicinal plants, private-sector development, and regulatory oversight; and
- A lack of relevant information on which to base, and prioritize, proposed activities.

Of these, the lack of data to inform policy is perhaps the most pressing issue for THM. Popular assumptions exist – in Ghana, and elsewhere – that local production of both pharmaceuticals and herbal medicines would increase access to affordable medicines. Grupper et al. (2005) indicate that this would not necessarily be so for pharmaceutical drugs in Ghana, which are often unable to compete on price with imports. It is also assumed that herbal medicines are generally less expensive than their allopathic alternatives, yet evidence from South Africa proves this also to be an incorrect assumption (Mander et al., 2007). Discussion has been ongoing on priority areas for action, and some progress has been made in identifying several specific work programmes for THM. However, there is still a pressing need for clearer information about existing and future potential markets for THM, in order to identify, justify and prioritize specific strategic directions, goals and activities.

Following from this, building effective “learning” relationships between regulation, regulatory science, scientific research, indigenous knowledge, manufacturing, and markets is crucial in order to

ensure that cohesion between goals (both short- and long-term) and activities is sustained as part of policy implementation. The key imbalance at the moment appears to be between the development of regulation and regulatory science on the one hand, and private-sector development (including individual herbalists and their traditional knowledge) on the other. The planned development of THM in Ghana is, arguably, a major paradigm shift – as such, more intervention is warranted than current policy affords. This relates not only to capacity-building in manufacturing, but also to incentives for the establishment of plantations and private-sector R&D, and for the provision of relevant information (e.g. on the best available technologies, and access to foreign markets).

As a result of the STIP Review's findings, priority policy recommendations for the future development of THM in Ghana are divided into three categories: (a) information-based policy development for the THM industry; (b) regulation; and (c) R&D coordination to support these.

#### Information-based policy development for the THM industry

1) A set of studies/meetings to evaluate – both qualitatively and quantitatively – the potential markets for THM should be given the highest priority in plans to develop the THM industry.

It is suggested that these activities include:

- An assessment of potential THM export markets. This might best take the form of a broad study of THM regulations, import barriers, market value, and most popular products (including their characteristics and marketing) in selected countries within and outside sub-Saharan Africa;
- A more detailed survey of the OTC market for herbal products in Ghana, along the lines of the 2004 MOH-DFID survey undertaken on local production of medicines in Ghana (Grupper et al., 2005), but with a particular focus on factors guiding consumer behaviour in respect of seeking advice and purchasing medicinal products;
- A review of goals and priorities for the integration of THM into the public-sector health service delivery system. This review should take place at a stakeholder meeting designed to:
  - (i) identify and evaluate key areas of progress, as well as bottlenecks and barriers that have constrained progress to date;

(ii) reaffirm or adjust goals for future progress;

(iii) set realistic priorities and schedules for the achievement of specific goals; and

- A study of the net contribution of TM to the Ghanaian economy.

Following on from these initial activities, strategic options to support the future development of the THM industry need to be debated and a firm strategic direction established.

In the absence of accurate data on market potential, the ministries might concentrate initially on evaluations of existing capacity, the design of incentive mechanisms, and piloting a small number of initiatives to test potential models for future development. Here, it is recommended that two key areas be investigated, and supported, as appropriate. The first is the potential to exploit the spare production capacity and tacit knowledge of the existing pharmaceutical firms. The second is to consider – and perhaps pilot – a strategy of developing “clusters” around THM production activities.

2) Develop a clearly articulated strategy to support micro and small-scale THM enterprises.

Initial activities to support the development of appropriate incentive mechanisms would involve:

- Assessing the potential for one or more herbalists to partner with existing pharmaceutical firms with a view to utilizing the spare production capacity (as reported in Grupper et al. (2005) and reiterated in MOH (2007)) and the associated tacit knowledge in these firms. Different types of partnership are possible, including mergers, joint ventures, and production contracts;
- Evaluating the existing initiative to share dedicated production facilities in Kumasi, and developing this as a model for supporting the establishment of THM production clusters – including the cultivation of plant materials, as well as manufacturing activities – in other areas. The model could be extended to include joint purchasing contracts (e.g. of raw materials and packaging materials) and joint marketing activities.

#### Inclusive regulation

Regulation of traditional herbal medicines is an area in which very visible progress is now being made. However, given the dynamic and systemic nature of



technical change, this raises some concerns about whether the development of the regulatory system is moving at a pace that will drive THM development in the desired direction, or constrain its development potential. On the other hand, while the flexible phase-in for the implementation of regulations is designed to ameliorate potential problems in this regard, it also creates uncertainty for THM enterprises.

Taking into account the very varied capacities among producers of traditional herbal medicines, it is suggested that the “all or nothing” (i.e. registered drugs are legal, all others are illegal) registration process be adjusted so that: (a) leaders in the THM industry can progress to internationally acceptable and recognized standards within the Ghanaian regulatory system; but also that (b) micro-enterprises involved in the production of herbal medicines can enter and progress through the registration process according to their existing capacities, and their ability to invest in a gradual build-up of new capacities. However, maximum time limits should be applied for each phase of the system to discourage complacency – that is to say, where producers might be tempted to achieve legality for their products but not go beyond this.

**3) Consideration should be given to the introduction of a more gradual and inclusive process of herbal medicine registration, but with fixed phase-in schedules.**

A suggested outline for this system (to be debated and/or “fleshed out”) might include:

- An initial notification procedure, as suggested by WHO,<sup>32</sup> which could be done at the district level, perhaps through the TM desks that are proposed to be set up in the district assemblies. Each notified product would be given a unique identifier and its details would be included in a confidential compendium (the compendium has been proposed already). Notification would be the official start of a regulatory process with a schedule of fixed (maximum) deadlines, and would also give herbalists a basis for later claims for IPR protection, once the IPR regime for indigenous traditional knowledge is in place.
- The further stages of the regulatory and registration process could be associated with:
  - (i) progressive deadlines for acute toxicity testing, and a series of future assessments (including efficacy assessments, quality tests, and chronic

toxicity tests), each of which confers an enhanced approval rating for the product. This might be, for example, a “star” system (with the scale running from 1 to 3, or from 1 to 5), with acute toxicity leading to a 1-star rating, and so on. The original notification identifier would be used in place of the existing FDB registration number for all products until they reached the required stage for full registration; and

(ii) the establishment of different regulatory pathways for different types of products from the early stages of testing – for example, some products could be recommended for registration as food supplements rather than herbal medicines, as is now done at the FDB; others might be eligible for a government-supported “fast tracking” system (such as medicinal products used to treat malaria), depending on the MOH’s urgent priorities.

It must be noted that, if the registration of herbal products is to become an enforceable legal requirement, associated with a fixed schedule, the capacity of the FDB and testing institutions to handle a large (but so far unmeasured) increase in the number of applications for regulatory approval needs to be enhanced – irrespective of whether a more complex system, such as this, is implemented. The time needed should not be underestimated. In the European Union, for example, the phase-in period for implementation of the new regulations is 7 years – and this is for countries that already have substantial regulatory and scientific capacity for implementation.

The GNDRP has funded activities in both the FDB and the Pharmacy Council to improve on regulatory implementation, including the establishment of a National Pharmacovigilance Centre (MOH-GNDRP, 2004). However, the role of the Pharmacy Council in education, training and information dissemination to support THM could be extended. This would require that the capacity of the Pharmacy Council should be strengthened to include more training and information to pharmacists and – particularly – chemical sellers, with a view their effective participation in enforcement of the Food and Drugs Law (in respect of unregistered herbal products).

**4) Strengthen the role of the Pharmacy Council to support regulatory compliance through pharmacists and chemical sellers, the capacity of the FDB to handle a large increase in applications for THMs (both as food**

supplements and herbal medicines) and the capacity of the Traditional Medicine Practice Council to act as a key collaborator in the regulation of herbal medicine practice and sales.

Weak capacity to enforce registration and the absence of a legal regime for the protection of indigenous knowledge act as disincentives for producers of traditional herbal products to submit their products for testing and disclose their trade secrets. On a personal or local level, trust has been built up between some herbalists and some scientific researchers and research institutions. However, where an expansion of registration applications is anticipated from herbalists that do not already have good relationships with approved testing centres, testing of products on trust is less likely. While the present situation persists – and, realistically, this may be for some years to come – some form of low-cost interim solution would be appropriate.

5) Alleviate the potential distrust of regulatory science on the part of THM producers through standard letters of contract produced and signed by scientific institutions that carry out regulatory testing.

A standard letter of contract between herbalists and scientific institutions carrying out safety, quality and efficacy testing should be designed, and distributed to the testing centres. Such a letter should give legal assurance to herbalists that the testing centres will not use disclosed information for potentially commercial purposes (including R&D that goes beyond what is necessary for regulatory testing) without the further agreement and consent of the herbalists.

#### R&D support and coordination

The National Drug Policy emphasizes the need for a “well-coordinated research programme”. Current policy for THM is clear about some of the key needs, and the potential stakeholders in the scientific and policy communities. However, specific mechanisms to ensure coordinated research are lacking at the moment, and the potential roles of private sector stakeholders are not always fully articulated. As was mentioned in section 3, it is the case in Ghana, as elsewhere, that R&D is more focused on the properties of medicinal plants and products than on their cultivation, harvesting and processing. However, institutional responsibilities in these last areas are not as clear-cut as for medicinal plants and/or herbal products. Medicinal plants are an area of interest to several ministries, but not a priority issue for any

one ministry.<sup>33</sup> Few policies exist that are designed to promote the cultivation and sustainable use of medicinal plants for either social or commercial benefits, and there appear to be weak links between the different ministerial mandates and activities in this field. The Ministry of Health has the clearest and strongest links between existing policy and the activities of the scientific community.

The first issue is to build a coordination mechanism for government-sponsored research related to plant medicines and herbal products (where funding comes directly from government resources, but also including donor funding that is channelled through ministries). Knowledge flows and collaborative learning within the scientific community are generally good. The number of institutions working in the area of plant medicine is relatively small, meaning that the epistemic community is quite small, and its members often know each other through long-established informal as well as formal links. Therefore, despite the disparate ministerial mandates under which the various institutions operate, and their wide geographic dispersal, the informal links have historically provided channels through which learning can take place. Formal collaborations are now more common in research projects, and the CSRPM is well set up as the hub of information flows within the community. Furthermore, the CSRPM has constituted a permanent Research Committee for the Centre, whose members include representatives from the three oldest universities (University of Ghana, KNUST, and University of Cape Coast), and from the Ministry of Health, the CSIR, and the NMIMR. This is one potential mechanism for facilitating the coordination of research activities in plant medicine. Achieving an adequate degree of inter-agency and cross-sectoral participation is nevertheless desirable. The proposed National STI Implementation Agency might also represent a potential coordinating mechanism.

6) Strengthen the capacity of the Research Committee at the Centre for Scientific Research into Plant Medicine to coordinate, with inter-agency participation, government-sponsored multi-disciplinary research programmes into traditional herbal medicine.

Next, it has been noted by the MOH that the health system, in general, has in the past been “supply driven”, and that the time has come for a more “demand driven” approach. Given the wide range of potential research needs, the limited research resources available, and funding constraints, there is a need to be very



precise in identifying key priorities. This cannot and should not be left to scientific researchers to decide, either individually or as a group. In respect of R&D in herbal medicine products, demand comes from two very different sets of actors. The first is, of course, the Ministry of Health and the Ghana Health Service, in relation to health service delivery. The second set is the producers of both commercially grown medicinal plants and manufactured herbal products.

In order for R&D to meet health-sector needs, the MOH – with the GNDRP, GHS, TAMD and the regulatory bodies – should identify priorities. These priorities could be in terms of, for example, key diseases or other health problems that might be treated with herbal products, or individual products that have already been identified as having substantial promise to meet key needs. All the R&D needs in the areas of developing identified products or ranges of products (including sustainable cultivation, the harvesting and processing of plants, and meeting FDB registration requirements)<sup>34</sup> would collectively form a research programme. The programme could be coordinated by the CSRPM Research Committee. Pre-assured funding to cover at least one programme should be made available by the MOH, or through a joint fund with other ministries, or through foreign development partners.

7) The MOH should establish a mechanism, on an ongoing basis, for identifying and prioritizing public sector R&D efforts to support the development of herbal products of interest to the MOH, and elaborate specific R&D programmes around key priorities. Funding should be allocated to whole programmes only, on the basis that any single programme that is dependent on non-assured funding resources may not be carried out effectively, if at all. It is suggested that this mechanism should involve relevant ministries (assuring inter-

agency participation), the private sector, and other key stakeholders, and be administered by an independent body, such as the proposed National STI Implementation Agency.

All other government-funded or government-supported R&D for THM should be commissioned or carried out by the private sector, which includes growers, manufacturers of herbal products, co-operatives of each of these, and representative associations. This funding should be separate from the funding allocated to the public sector. A variety of mechanisms could be used to invest government R&D funds in this way, according to the specific circumstances of the enterprises and associations involved. These mechanisms include (a) tax relief on R&D investment; (b) customs duty reductions or waivers for hardware and consumable materials dedicated to R&D activities; and (c) grant funding for R&D commissioned from public-sector research institutions (on the basis that results will be shared among stakeholders with common interests). It should be noted that R&D relevant to the development of herbal products will inevitably cover areas that are outside the strict remit of the MOH. These areas might include, for example, cultivation techniques for medicinal plants, whether tablets/capsules/liquids etc. are used, and manufacturing methods. Therefore, a special fund is needed for allocation to private sector R&D.

8) Consideration should be given to establishing a THM development fund with the cooperation and participation of the MOTI, MOH and MOFA. A proportion of the fund should be ring-fenced for demand-driven R&D activities that are carried out, or commissioned by, the private sector. Management of this fund should be carried out by the proposed National STI Implementation Agency or by an appropriate ministry department.

## NOTES

- <sup>1</sup> According to a recent Ministry of Health estimate (MOH, 2007).
- <sup>2</sup> It should be noted that some traditional medicine practitioners in Ghana are simply herbalists, who do not claim any spiritual influence in their practices (Tsey, 1997).
- <sup>3</sup> See, for example, Romero-Daza (2003) and Nyarko (2007).
- <sup>4</sup> Communication from the Director of the Traditional and Alternative Medicine Directorate, May 2009. An estimated 100,000 people are employed in the industry, including retailers, itinerant vendors, manufacturers and canvassers.
- <sup>5</sup> MOH-GNDP (2002).
- <sup>6</sup> Grupper et al. (2005).
- <sup>7</sup> UNDP (2007).
- <sup>8</sup> The terms “complementary medicine” and “alternative medicine” are used to distinguish between Ghanaian TM and imported traditional medicine practices and products from outside the country such as Chinese TM and Ayurvedic medicine. In this report, however, the term “traditional herbal medicines” – that is, the products, as opposed to the practice of traditional herbal medicine – will also be used occasionally to include imported medicines.
- <sup>9</sup> However, there could be substantial benefits from the research process itself, including substantial additions to the stock of national knowledge about the country’s plant genetic resources.
- <sup>10</sup> MOH (2007).
- <sup>11</sup> Interview with the Director of TAMD, December 2007.
- <sup>12</sup> Based upon communication from TAMD, May 2009.
- <sup>13</sup> Pharmacovigilance involves quality checks and testing of medicinal products at (or taken from, under authority) points of sale.
- <sup>14</sup> Complementary and Alternative Medicine is governed by a separate Act – the Alternative Medicine Act.
- <sup>15</sup> The distinction being made here is between health R&D as related directly to those areas under the MOH’s remit such as diseases and medicines; health-related R&D into (for example) food safety, which is carried out at the CSIR’s Food Research Institute; and the conservation of medicinal plants, which is part of the work done at the CSIR’s Plant Genetic Resources Research Institute. The CSIR’s Forestry Research Institute of Ghana is another research institute that has direct relevance to work on medicinal plants.
- <sup>16</sup> At a World Intellectual Property Organization (WIPO) workshop on IPRs for pharmaceuticals, held in Geneva in November 2006, a representative of the pharmaceutical industry estimated that, worldwide, around 50 per cent of drugs developed failed at stage 3 clinical trials. It was found that it was now common among medium-sized European pharmaceutical manufacturers that have drug-development functions to patent promising drugs after stage 1 or – at the latest – stage 2 trials, rather than risk losing the investment costs of carrying out stage 3 trials (WIPO, 2006).
- <sup>17</sup> Interview with the Director and Deputy-Director of NMIMR, December 2007.
- <sup>18</sup> Plant-tissue culture techniques allow for the production of hundreds of identical plants to be grown from a small piece of disease-free plant tissue under sterile laboratory conditions, and in a suitable growth medium. Further propagation can take place without having to wait for the plants to mature and bear fruit and seeds. Protocols for tissue-culturing differ between plant species, and no appropriate protocols have yet been developed for many medicinal plants.
- <sup>19</sup> This was highlighted at the National Stakeholders’ Priority-setting Conference for Sustainable Biotechnology in Agriculture and Health in Ghana, held in December 1999 (Essegbey et al., 1999).
- <sup>20</sup> Interview and personal communication with FDB regulatory officer.
- <sup>21</sup> Interview with FDB regulatory officer, December 2007.
- <sup>22</sup> Interview with the Director of TAMD, December 2007.
- <sup>23</sup> Correspondence with FDB, January 2008.
- <sup>24</sup> There is extensive literature on the development of THM in other countries in Africa and across the world. Many publications make reference to the CBD estimate of global trade of \$60 billion in the year 2000. But few systematic attempts at assessing market potential appear to have been carried out. Of those found (e.g. Cho (2000) and Mander et al. (2007)), the methodologies used did not disaggregate OTC herbal medicines from overall expenditure on traditional medicine
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(including the services of traditional healers). Even these overall figures must be treated with caution, as they may not incorporate payments “in kind” (WHO, 2002).

<sup>25</sup> In fact, it is implicitly assumed in the guidelines for the registration of allopathic medicines that this is, and will remain, the situation. One provision for registration is that a new (or “innovator”) drug must normally be on the international market for a minimum period of two years before registration in Ghana (FDB, 1996b).

<sup>26</sup> Communication with FDB, January 2008.

<sup>27</sup> Two types of exemption existed: products sold to an individual person by a herbalist following a consultation, and “dried, crushed or communitated plants without any written recommendation for use”.

<sup>28</sup> Including, for example, those from Switzerland (which is not a country of the European Union).

<sup>29</sup> Confirmed in a personal communication with the United States Food and Drug Administration, December 2008.

<sup>30</sup> The distinction is very clear in the United States. “Products sold as dietary supplements that bear a claim to treat, mitigate or cure a disease are drugs and are subject to regulation as such” (FDA 2004).

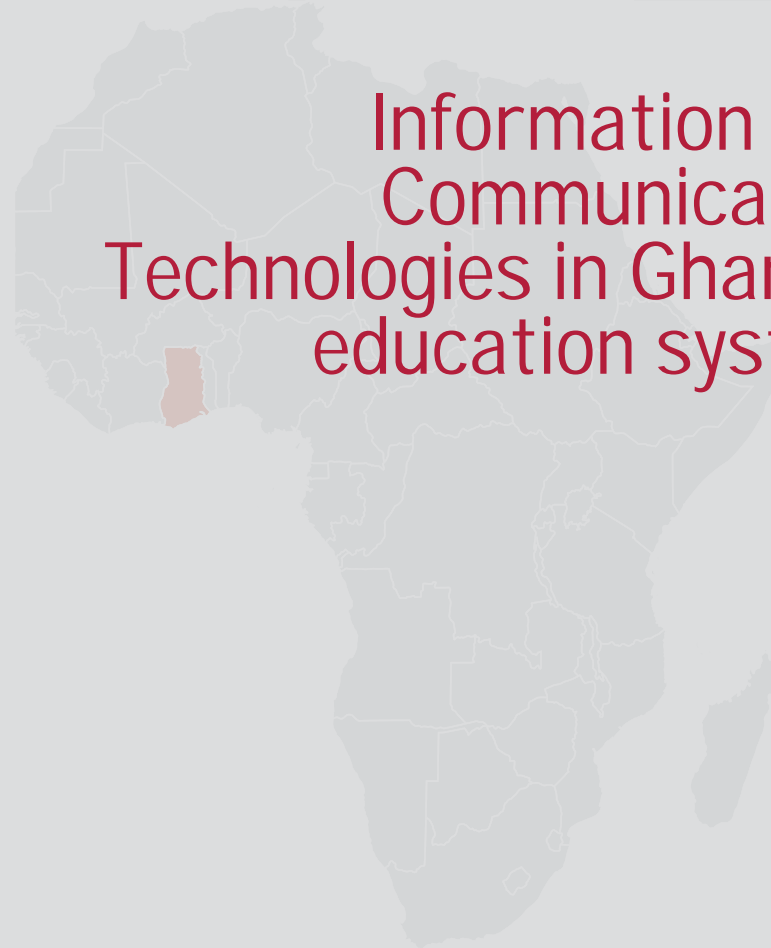
<sup>31</sup> Defined as one that was not sold in the United States in a dietary supplement before 15 October 1994.

<sup>32</sup> Noting the special characteristics and context of herbal medicines, WHO suggested in 1998 that a notification procedure might be a minimum requirement of the regulatory system, with the subsequent implementation of registration and assurance of Good Manufacturing Practice. To supplement very basic regulations, WHO suggested that governments might compile a list of controlled toxic plant materials whose use would not be permitted where regulation was minimal (WHO, 1998).

<sup>33</sup> This is reflected in Ghana’s current biodiversity policy. In the country’s most recent status report submitted to the secretariat of the Convention on Biological Diversity (CBD), meeting the Convention’s objectives in relation to sustainable use, incentives to conserve, research and training, public education and awareness, technology transfer, exchange of information, and scientific and technical cooperation, were all flagged as “low priority” areas in Ghana’s efforts to implement the CBD (MES, 2005).

<sup>34</sup> This is one aspect of the “fast-tracking” of herbal products through the regulatory process.

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Information and  
Communication  
Technologies in Ghana's  
education system

## ICTs IN GHANA'S EDUCATION SYSTEM

### 6.1 Introduction

The importance of information and communication technologies (ICTs) to the proper functioning of a modern economy, and their potential to improve people's lives, is now well recognized. Even before the World Summit on the Information Society (in its two phases in 2003 and 2005) called on developing countries to develop ICT policies in order not to be excluded from the digital revolution, Ghana was engaged in the development of an ambitious ICT policy.

As part of its overall ICT policy, Ghana plans to use ICTs to improve the quality and availability of the education system and of outcomes from education at all levels. The objective and scope of this study was to analyse and evaluate opportunities and constraints with regard to meeting the goals of the national policy on ICT for education, with a particular focus on distance education at the secondary and tertiary levels. The study begins with a brief overview of the state of ICT in Ghana, outlines the ICT for Accelerated Development (ICT4AD) policy, and then reviews the ICT in Education policy and the use of distance education in the formal education system – namely in high schools, in technical and vocational education and training (TVET) institutes, and in universities.

### 6.2 ICT in Ghana: an overview

This section provides a brief overview of the state of ICT in Ghana in terms of the key ICT policy, institutional and legal framework, progress in increasing access to ICT, and private-sector development.

#### 6.2.1 ICT policy and strategy (e-strategy)

Since the early 1990s, Ghana has considered the use of ICT as a means to leverage the country's development process. To this effect, a first five-year plan for accelerated development was launched in 1994. More recently, Ghana has developed its ICT for Accelerated Development (ICT4AD) policy statement, which was officially adopted in 2004. The ICT4AD took into consideration Ghana's Vision 2020 Socio-Economic Development Framework, the Ghana Poverty Reduction Strategy (2002–2004) and the

Coordinated Programme for Economic and Social Development of Ghana (2003–2012). The ICT4AD is a product of the National ICT Policy and Plan Development Committee set up by the Government to develop an ICT-led socio-economic development policy for the country.

Its vision is to “improve the quality of life of the people of Ghana by significantly enriching their social, economic and cultural well-being through the rapid development and modernization of the economy and society using information and communication technologies as the main engine for accelerated and sustainable economic and social development.”<sup>1</sup> The main mission is to transform Ghana into an information-rich, knowledge-based and technology-driven high-income economy and society. The ICT4AD policy statement identified 14 priority areas (pillars) to be targeted. It recognized the need to develop a number of sector-specific implementation strategies on which to base ICT4AD action plans to implement the provisions of the policy. A number of sector-specific ICT implementation strategies have been developed – one being the National ICTs in Education strategy.

#### 6.2.2 ICT institutional framework

ICT4AD was developed through an inclusive process with multi-stakeholder representation. Relevant public sector institutions include the National ICT Policy and Plan Development Committee, all government ministries, the National Communications Authority, the National Information Technology Agency, and the Ghana Investment Fund for Telecommunications. The Ministry of Communications plays a major role as an actor for developing the ICT infrastructure and services, most importantly as the government body in charge of coordination and implementation of the overall ICT4AD policy. The Ghana Information and Communications Technology Directorate is the operational arm of the Ministry of Communications for ICT policy implementation and coordination of governmental ICT initiatives. The National Communications Authority is primarily responsible for regulating the telecommunications sector. The Ghana Investment Fund for Telecommunications is in charge of promoting universal access and universal service. A bill to establish the National Information Technology Agency, whose mission will be to regulate the provision of ICT services, is under examination.

All ministries must develop an ICT policy statement in line with ICT4AD, including the broad strategies and specific ICT goals to be pursued towards the realization of their specific ICT policies. Furthermore, each ministry is in charge of the deployment and exploitation of ICTs within the relevant sector of the ministry to support activities and improve the delivery of services within the sector.

### 6.2.3 ICT legal framework in Ghana

The National Communication Act (1996; Act 524) governs the ICT sector, and makes provision for the establishment of an independent regulatory authority – the National Communications Authority (NCA) – to manage the sector. A strong liberal orientation is provided under the Act. As regards the ICT industry, two acts have been promulgated, including the Layout-Designs (Topographies) of Integrated Circuits Act (2004; Act 667) and the Copyright Act (2005; Act 690). The 1996 National Communications Authority Act is being reviewed to provide a comprehensive legal framework for the whole ICT sector. Three bills are under consideration: the Telecommunications Bill, the National Information Technology Agency Bill and the Electronic Transactions Bill.

### 6.2.4 Evolution of ICT access and socio-economic impact

Ghana has experienced rapid growth in mobile telephony access since 2003, as opposed to fixed-line telephony which has witnessed very little growth. Ghana continues to face major challenges in terms of slow growth in both internet and PC penetration. There is slow growth in the number of PCs per 100 inhabitants and in the number of internet users. As in much of Africa, broadband internet is still at an early stage of deployment. The main access to internet services is through the school system, the workplace, and internet cafés. The Government plans to establish Community Information Centres in all the 230 constituencies in the country, which would provide basic ICT services such as telephones, internet connectivity, word processing, photocopying and general literacy training. The Community Information Centres project took off in 2005, and as at November 2006, 15 centres were operational, while the construction of ICT infrastructure for 40 centres is at an advanced stage. These centres are important tools for increasing access to the internet in communities where access is otherwise not generally available, and they act as important means for communication and providing access to knowledge. Internet tariffs

remain high, due mainly to the high cost of using the ICT infrastructure (the Ghana Telecom backbone and SAT-3 International Connection). Cost of access is therefore an important issue – one faced by many countries in Africa. In terms of improving economic performance, the access to and efficient use of ICT by enterprises is an important issue, although not one directly addressed in this study. It should be noted that facilitating access to and successful absorption of ICT by enterprises is as important as doing so in the area of education. There are several good examples of ICT being used as a basis for local innovation (see section 6.2.6), but not enough is known about the impact of ICT in enabling enterprise innovation more broadly.

It is difficult to evaluate the actual impact of ICT on socio-economic development in the country. The measures of access to ICT available do not provide direct evidence on actual impact, although access itself is in many respects still limited, with the exception of mobile telephony. The rapid spread of mobile telephony has been successful in increasing access by the general population to communications services, which is necessary in a modern economy, given the more marginal expansion in fixed-line telephony. The real impact of ICT is very likely to be heavily constrained by limited public access to e-mail and internet services, due in large part to low PC penetration. Internet access is important for improved access to knowledge, both inside the school system and in society more broadly, and access is deficient both in the school system and more widely. As in most African countries, access in rural areas is particularly problematic. Indeed, ICT could also be used much more extensively to provide benefits to Ghana from the large reserve of Ghanaian skilled human capital abroad – for example in medicine, to link with foreign medical expertise in order to help provide solutions to Ghana's health challenges. Such ideas offer a potential means to greatly increase the impact of ICT development in the country. To achieve this, spreading adequate access to the internet and e-mail much more widely is particularly important, as is reducing the cost. As mobile telephone technologies improve – offering increasingly more functional and low-cost e-mail and internet services – their diffusion may offer the potential to make faster progress in expanding access to these services.

### 6.2.5 Education in ICT disciplines

The training of ICT specialists at the university level is one of the most important factors in building up the



Table 6.1. Tertiary Education in ICT in Ghana

Institution	Faculty/ School	Department	Diploma (degree)
University of Ghana, Legon (UG)	Faculty of Science	Department Computer Science	BSc
Kwame Nkrumah University of Science Technology (KNUST)	Faculty of Electrical and Computer Engineering	Electronic and computer engineering department	BSc
University of Mines and Technology (UMT)	Faculty of Engineering	Information Technology Department	
University of Cape Coast (UCC)	School of Physical Sciences	Department of Computer Science and Information Technology	- BSc Computer Science - BSc information technology
Ghana Institute of Management and Public Administration (GIMPA)	Greenhill College		- Bachelor of Information & Communication Technology
Ghana Telecom University College			- BSc in Computer Eng. - BSc in Telecom. Eng. - Masters in Telecom. Management - MS in Telecom. Eng.

Source: websites of universities; interviews in December 2007.

ICT base of a country. Table 6.1 shows the various public universities that offer university degree courses in areas related to ICT, such as computer science, computer engineering, and telecommunication engineering. While most public universities train ICT specialists at bachelor's level, only one university offers a master's degree in ICT. Some private universities, such as the Accra Institute of Technology, offer university degrees in ICT too.

As far as scientific research is concerned, there are no statistics on R&D in the ICT field in Ghana. However, there is a commitment by policymakers and the private sector to the promotion of innovative ICT firms through the improvement of ICT physical infrastructure, planning for ICT parks and incubators, and various ICT projects. The Ministry of Communications is planning a park dedicated to ICT, and laboratories at the Ghana Multimedia Centre are acting as an incubator and currently maturing 10 start-up firms. There is certainly also development work being carried out by some private Ghanaian software firms, even though there are currently no statistics available to measure its scale.

#### 6.2.6 Private ICT firms and the local ICT industry

One assessment of ICT use in Ghana<sup>2</sup> found that the Ghanaian ICT sector is dominated by computer vendors and distributors of computer products and services. The hardware sector is dominated by small enterprises mainly involved in the sale of computers and peripheral units, while the software

sector mainly consists of companies selling standard and off-the-shelf packages and software. The report also mentioned that computer assembly was at a very early stage of development, and that software development was fairly limited. Since then, at least a few Ghanaian ICT firms have emerged as important innovators, providing services not previously available in the country.

Some local IT firms have developed strong capabilities and software development experience, although their growth may have been constrained by a very narrow market, especially when big software projects are awarded to foreign firms. Busy Internet, an internet service provider, has expanded to become an important local innovator, diversifying into the hosting of young start-ups and providing communication and logistics services. Softribe, a local software firm, has launched an innovative e-trade project that provides an IT-based system for exporting local handicraft products to the United States through online purchasing. This project could prove instrumental in providing access for small-scale artisanal producers to international markets. Ventures such as these can leverage the relatively strong skills base in Ghana, and help to build a more dynamic domestic ICT sector that can help to reduce the significant flow of skilled labour out of the country (brain drain).

These enterprises show that there is potential to expand ICT-enabled innovation in Ghana. Naturally the question arises of how to support it and build it. It would be a good idea for policymakers to establish

linkages for communication and dialogue with Ghana's private-sector ICT enterprises, in order to discuss measures that could effectively promote local ICT enterprise development in the country.

As part of the government policy to promote business process outsourcing activities, several call centres and data management operators have been launched. The second component of the World Bank-financed eGhana project entitled "Business Outsourcing and Local ICT Business" is providing technical assistance to the Government, which aims at (a) attracting IT and IT-enabled services investment; and (b) promoting the development of local ICT businesses. Research conducted by Hewitt Associates on behalf of the Government of Ghana has highlighted the business process outsourcing sector's potential to create some 37,000 direct jobs and nearly 150,000 indirect jobs, and to generate revenues of approximately \$750 million within a five-year period. Ghana has been recognized as an attractive destination for business process outsourcing, and was ranked the number one destination in sub-Saharan Africa (ahead of South Africa) and number 22 globally out of 40 countries by AT Kearney Global Services Location Index, in November 2005. To meet this challenge, Ghana should continue to develop its human resources specializing in ICT. There appears to be considerable room for growth in software development as an industry in Ghana, as well as for further innovation in using ICT for ventures that are commercially feasible and provide important services with high rates of social return.

### 6.2.7 Conclusion

Ghana has aimed, from an early date, to use ICT as a tool to accelerate the country's development process, officially adopting the Ghana ICT for Accelerated Development policy (ICT4AD) in 2004. The country has the ambitious objective of transforming itself into an information-rich, knowledge-based and technology-driven high-income economy and society. The commitment of key players at the national level and the support of international bodies in the implementation of the ICT4AD policy have resulted in tangible progress through various ICT projects undertaken as partnerships with international organizations and others. However, Ghana must still address a set of challenges if it wants to more fully leverage the potential of ICT to contribute to socio-economic progress. There remain major challenges in overcoming low rates of PC penetration and internet access in the country. Public efforts have aimed at spreading PCs

through the school system and promoting community information centres and internet cafés. These are all useful avenues for diffusing internet access. Improving facilities at schools, in particular, is likely to have high rates of social return. The rapid diffusion of mobile telephony with increasingly functional and low-cost e-mail and internet access presents an emerging opportunity that might also be pursued to increase the diffusion of internet access. This is a development that policymakers may wish to keep in mind as internet mobile telephony progresses.

It is therefore recommended that policymakers, in particular the Ministry of Communications, should consider designing and implementing an internet development policy to accelerate its deployment in order to reach a critical threshold permitting the country to take advantage of the full potential offered by the network. Special emphasis could be devoted to high-speed connections. Consideration could also be given to creating innovative measures to promote the wider use of mobile telephones featuring e-mail and internet access, which are becoming increasingly functional.

## 6.3 ICT in education

This section deals with ICT in education, in particular secondary education. A brief review of the structure of the Ghanaian education system is followed by an evaluation of the ICT in Education (ICTE) policy, its major objectives, achievements and challenges.

### 6.3.1 The education system in Ghana

In 2007, Ghana undertook an important reform of its education system to meet the challenges of the new millennium. The reform places great emphasis on ICT and science and technology, and in particular on the teaching of ICT at all levels of the education system, with special attention to be given to the training of teachers, particularly in ICT. After the reform, universal basic education became an 11-year-long educational process, made up of two years of kindergarten, six years of primary (elementary) school and three years of junior high school (middle school). After junior high school, students may choose to go into different streams at senior high school. A new four-year senior high school cycle will offer a general education with general, business, technical, vocational and agriculture options, to enter either a tertiary institution or the job market. Tertiary education possibilities are, however, in practice restricted, due to the capacity

Table 6.2. Structure of the Ghanaian education system

Cycle	Level	Institutions	Starting age	Years
Tertiary	Tertiary	Universities, Polytechnics, Professional Institutes, Colleges of Education	19+	4
Second Cycle Education	Senior High School	Grammar/Vocational/ Technical/Agricultural/ Apprenticeship Program	15	4
First Cycle Education	Basic Education (Free Education)	Junior High School	12	3
		Primary School	6	6
		Kindergarten	4	2

Source: Ministry of Education, Science and Sports, ICT in Education Programmes Unit.

constraints of the formal school system. Technical, vocational and agricultural institutions will offer four-year courses too, including the core senior high school subjects. As a result, the Ghanaian education system is now structured as shown in table 6.2.

The Ministry of Education has overall responsibility for education-sector policy, planning and monitoring. Education delivery and implementation is devolved to institutions, districts and regions through various agencies of that ministry. The Ghana Education Service is the agency that implements the basic cycle components as well as the second cycle (senior secondary, technical and vocational institute) components. The other agencies cover the rest of the education system, with the major subsector responsibilities assigned to the National Council for Tertiary Education and the Non-Formal Education Division.

### 6.3.2 ICT in Education (ICTE) policy

The Government of Ghana has recognized the importance of ICT in the education system. In response, it has developed an ICT in Education (ICTE) policy and has launched various initiatives aimed at deploying ICT in schools (and in communities), in partnership with the private sector and international organizations. The policy (of which a first draft was issued in 2006 and a second draft was prepared during 2007) remains in draft form, awaiting final approval. Implementation has nevertheless begun. The ICT4AD policy statement recognizes the need to develop a number of sector-specific implementation strategies on which to base ICT4AD action plans to implement the provisions of the policy. The ICTE policy is an important sector-specific ICT policy. The ICTE policy went through an extensive consultation process with various stakeholders (public, private, civil society, development partners). The ICTE policy is strongly linked to the country's ICT4AD policy, and is both coherent

and articulate. The current policy of introducing ICT in education is based on the lessons learnt from a set of initiatives undertaken on an experimental basis. However, implementation has faced major challenges, particularly in terms of meeting the large funding requirements, equipment maintenance, and cost of internet access.

The ICT in Education (ICTE) policy was developed through a multi-stakeholder process based on the work of a special technical committee on ICT in education and a team from the (former) Ministry of Education, Science and Sports. The Ministry of Education has overall responsibility for the ICTE policy and its implementation, but it may assign the implementation of specific strategies to any of its agencies.

The overall policy goal is to "enable every Ghanaian to be able to use the ICT tools and resources confidently and creatively to develop the skills and knowledge needed to achieve personal goals and be full participants in the global knowledge economy by 2015."<sup>3</sup> The specific policy goals include:

- To facilitate the deployment, use and exploitation of ICT within the educational system to improve on educational access and delivery, to support teaching and learning from the elementary level upwards;
- To modernize the educational system to improve the quality of education and training at all levels of the educational system and to expand access to education, training and research resources and facilities;
- To orient all levels of the country's educational system to the teaching and learning of science and technology in order to accelerate the acculturation of science and technology in society and produce a critical mass of required human resources and a well informed citizenry;

Table 6.3. ICTE Policy Thematic Areas and Objectives

Thematic Area	Objectives
1. Education Management Ministry, Agencies And Educational Institutions	1.1 Acquire and implement various easily integrated Information Management Systems 1.2 Develop institutional capacity in the use of computer-based management tools to enhance administration and management 1.3 Formulate acceptable use policies based on security, privacy, intellectual property laws, cultural and moral values in Education Management
2. Capacity Building	2.1 Development of ICT Faculty & Enhancement of Practical Training in Tertiary Institutions 2.2 Provide appropriate ICT Training to all Teachers 2.3 Use Distance learning to offer training to teachers in basic (first cycle) schools who have applied for further studies.
3. Infrastructure, E-Readiness And Equitable Access	3.1 Facilitate the establishment maintenance and support of the necessary infrastructure and related ICT resources within the education system. 3.2 Facilitate equitable access to ICTs for all students and communities
4. Incorporating ICT Into The Curriculum	4.1 Integrate ICTs into the curriculum
5. Content Development	5.1 Develop Appropriate Content for Open, Distance and e-Learning
6. Technical Support, Maintenance & Sustainability	6.1 Ensure effective support and maintenance of ICT infrastructure
7. Monitoring And Evaluation	7.1 Institute programmes and procedures to monitor and evaluate the implementation of the various components of the ICT in Education Policy

Source: the author, based on Ghana ICTE policy.

- To achieve universal basic education and improve the level of basic and computer literacy in the country;
- To ensure a population in which all citizens are at least functionally literate and productive;
- To expand and increase access to secondary and tertiary education; and
- To strengthen science education at all levels and in all aspects of the educational system, especially at the basic and secondary levels.

These policy goals have been adapted and expanded to develop a number of concrete guidelines, objectives and strategies which are grouped into seven thematic areas. Table 6.3 presents the seven areas and the objectives assigned to them. Each objective has a number of associated strategic actions.

The objectives and strategic actions are to be translated into concrete plans of action respecting the three implementation phases retained by the Ministry of Education to meet the overall ICTE goals by 2015. The three phases are as follows:

Phase I: Enhance a system-wide and institutional readiness to use ICT for teaching, learning and administration;

Phase II: Ensure system-wide integration of ICT into teaching and learning and encourage communities to

support ICT facilities in educational institutions; and  
Phase III: ICT integrated at all levels of the education system – management, teaching, learning and administration.

Several factors are considered to be critical for the success of the action plans, namely: leadership, political and governmental commitment and support at the highest levels, funding, active participation by stakeholders, teamwork and project-based principles of operational management, continuous coordination and feedback at all stages of implementation, change management, and monitoring and evaluation. Once the plans are developed and adopted, they should provide substantial support to the implementation of the ICTE policy, which is considered as a basic component of the newly adopted educational reform started in the 2007–2008 school year.

For the purposes of coordination, the ICT in Education Unit (ICTE Unit) in charge of the Ministry's Ghana e-Schools and Communities Initiative will serve as an umbrella initiative, a single-window unit, to drive all ICTE initiatives at the pre-tertiary level. The ICTE Unit must ensure that ICTE implementation is conducted with fairness and equity throughout all regions of Ghana. The former MEST established the National ICT in Education Coordinating Committee to oversee the development of an integration plan to support the objectives and strategies of the ICT in Education policy. This

national body will essentially provide guidance during the entire implementation process and will serve as an advisory body.

The Coordinating Committee is a multi-stakeholder group that includes sector partners and representatives drawn from different organizations, including public sector bodies (other ministries, departments and agencies), the private sector, civil society, development partners, the Ministry of Education, departments and agencies of the GES, educational institutions (public and private), parents and students.

The United Nations' Global e-Schools and Communities Initiative (GeSCI) has already committed to provide assistance to the MEST's ICTE Unit to drive the ICTE programmes. Moreover, all ongoing ICT in Schools initiatives will come under the umbrella of the ICTE Unit.

Implementation of the ICTE policy and action plans will also require the full involvement of national partners (private organizations, development partners, NGOs, parent-teacher associations, and former students' associations). Equally important is the involvement of international partners such as the World Links for Development Programme, the GLOBE Programme, the United Kingdom's Department for International Development (DFID), the World Bank Institute, GeSCI, the United Nations Development Programme (UNDP), the United States Agency for International Development (USAID), SchoolNet, Computer Aid International, the New Partnership for Africa's Development (NEPAD), ICT firms' partners etc. The partners' major role consists of fund-raising or providing direct funding. They are also expected to provide support, technical assistance and direction to the ICTE programmes and projects.

### 6.3.3 Implementation to date of ICT in Education projects in Ghana

In a study carried out to review and assess the ICT in Education initiatives in Ghana in 2005, sponsored by GeSCI, twenty initiatives were selected and their impact assessed to see what lessons could be learned. Several positive achievements were noted:

- The initiatives had contributed to a wider number of students and teachers acquiring ICT skills and developing a strong interest in ICT and science;
- The schools involved in the initiatives were motivated to expand the project and/or acquire more ICT equipment; a number of private-public

partners, including parent-teacher associations and civil society organizations, had collaborated in the efforts; and

- The lessons learned from the initiatives provided good examples for other schools to introduce their own ICT programmes.

However, the projects themselves faced a number of challenges. At least half of the initiatives had been launched as pilot projects, none of which had later expanded into national initiatives.

The main implementation challenges included:

- Poor selection of schools without the involvement of GES or the former Ministry of Education, Science and Sports (MOESS), resulting in duplication and hence some schools having several parallel initiatives and others (especially in the remote rural towns) having none;
- Lack of policy direction at all levels (schools, districts, national) for the integration of ICT in education;
- Heavy dependency on external funds, with most initiatives stopped after depletion of initial funding;
- Obsolete and inappropriate equipment as support for the initiatives;
- Lack of trained ICT personnel (including teachers) – far below the numbers needed to support the initiatives, with most capacity-building activities being one-off efforts with no ongoing trainings planned.

The initiatives succeeded in motivating the development of a policy and related strategies for ICTE taking into account the lessons of these past experiences and embracing the ICT4AD vision for Ghana. Field interviews and various documents serve to highlight a number of developments within the ICTE framework, which may be classified according to the seven thematic areas of ICTE policy.

In terms of achievements, tangible progress has been made in several areas. With respect to capacity-building, the training of teachers in ICT is ongoing under the sponsorship of the Government and the United Nations-initiated main E-Schools Initiative. Furthermore, 100 tutors from the teacher training colleges were given training in ICTs so that they could train teachers with the skills they had acquired. Young graduates have been selected to fulfil their national service as ICT technicians. Several initiatives are being



pursued related to the thematic area of “infrastructure, e-readiness and equitable access”. These include, for example, a Ministry of Education cost-sharing initiative, and a PC project (the GAP Initiative) in collaboration with Intel Corporation to assemble computers in Ghana for \$350 each, as well as initiatives to supply schools with computer equipment. The government project to build a national fibre optic backbone to improve connectivity throughout the country and increase bandwidth will be instrumental in providing adequate connectivity throughout the country.

In terms of the fourth thematic area of “incorporating ICTs into the curriculum”, ICT was introduced as a mandatory core subject in all senior high schools during the 2007–2008 school year. The ICT course consists of six periods of 40 minutes per semester. A textbook for the ICT course is under development, and will emphasize real problem resolution. Under the fifth thematic area of “content development”, an educational portal (<http://www.edughana.net>) is under construction. In addition, the ICTE Unit is proceeding with the selection of appropriate content from the internet to make it available on the portal. The ICTE Unit reached agreement with a content development company, and the Government launched the Innovative Best Teacher Award, which rewards innovative teaching and encourages teachers to develop their own content. With regard to “technical support, maintenance and sustainability”, training courses have been set up in technical institutes to enable beneficiaries to handle troubleshooting, refurbish computers, and solve related problems. The ICTE Unit is offering training on monitoring and evaluation for inspectors and regional coordinators, to help schools in sharing experiences and to help inspectors in the evaluation task. The launching in September 2007 of ICT as a mandatory core subject in all senior high schools was an important step.

Several important challenges present major obstacles to achieving the goals of the ICTE policy. The deployment of computer labs in all 500 senior high schools, their connection to the internet, and the training of trainers imply a huge effort and expenditure that may prove beyond the budget available. Some schools, especially in rural areas, either lack adequate electric power, or have no electricity. There are also problems with the lack of availability and high cost of ICT maintenance services in some areas, and difficulties with reliable access to the internet and, especially, with the high cost of internet access.

Furthermore, implementation of the ICTE policy should ideally have been preceded by a translation of the ICTE policy into action programmes to ensure the best chances of success.

It is therefore recommended that the Ministry of Education should consider designing plans of action that would ensure a clear linkage between the implementation phases and the ICTE policy thematic objectives, specify clearly the role of the different actors and budget each of the actions. The teaching of an ICT course as a mandatory core subject in all senior high schools might be given the highest priority and be made the major focus for the next three to five years. An action plan dedicated to this goal should be developed. The plan should address the provision of ICT equipment, the training of trainers, internet connections, maintenance, and electricity provision, and should estimate the financial resources required.

There are two major phases. Phase 1 deals with the actions required to equip all public senior secondary schools, train ICT trainers and all the senior secondary school's teachers. Phase 2 extends this approach to all public junior secondary schools. It will be necessary to consider what it may be possible to achieve in terms of available resources.

## 6.4 Distance education

### 6.4.1 The motivations and objectives of distance education

There is increased interest worldwide in distance education (DE), because of the potential to use ICTs to improve DE delivery. This is true in Ghana, where it is hoped that DE can help provide solutions to challenges faced by the education system, particularly in terms of capacity constraints and educating students in rural areas. There is also the perceived potential to reduce the cost of education services. Many new concepts have emerged, such as distance learning, virtual universities, virtual schools, open universities, e-learning, blended learning, and web-based learning. ICTs are changing the possibilities for delivering educational content, accessing informational and pedagogical resources, communicating, tutoring etc. Most importantly, the use of internet communication facilities is fostering the emergence for students of special interest networks, discussion forums, and more student–professor interaction. Networking is breaking the sense of isolation that prevailed in traditional forms of paper-



based distance education, and is decreasing the dropout rate of distance learners.

Distance education in Ghana deals with all levels of education – secondary, vocational and tertiary. The ICT4AD and ICTE policies both refer to DE and the role it can play as an alternative model of education to complement the efforts of the Government to ensure that Ghana attains the target of “Education for All”, and, in particular, to provide solutions to urgent challenges that Ghana faces in:

- Improving the qualification level of teachers in basic and secondary education; and
- Increasing the limited enrolment capabilities both of the vocational schools and the universities.

Ghana’s ICT4AD and ICTE policies highlight several goals to be achieved through DE:

- Promote and encourage distance education, including electronic distance education and virtual learning, focusing on tertiary-level education and training in all fields and disciplines to broaden access to educational and training resources and services to a larger section of society;
- Develop programmes and initiatives aimed at professional skill development in work places in public- and private-sector institutions, through in-service training, distance education and training, and lifelong learning; and

- Provide multiple avenues for the professional development of both pre-service and in-service teachers, especially through distance education, reducing the number of teachers leaving the classroom for study leave, as well as the cost.

More precisely, the ICTE policy refers to DE as means to accomplish a certain number of objectives and strategic actions, as outlined in table 6.4.

The President’s Special Initiative on Distance Learning is a major undertaking launched in 2002. It was to operate in three phases:

- A junior secondary school and senior secondary school unit offering English, mathematics, the sciences, and other subjects to young people both within and outside the school system;
- An open college/school system offering courses in information technology, business management, accounting, entrepreneurship skills, and technical and vocational skills within both the formal and informal sectors at post-junior secondary school level; and
- A teacher-training unit offering courses on teaching English and mathematics, to complement the distance learning teacher education being provided by the University of Education at Winneba and the University of Cape Coast.

**Table 6.4. Strategic Actions to be supported by DE**

Thematic Areas	Objectives	Strategic Actions
Thematic Area 2: Capacity Building	2.1. Development of ICT Faculty & Enhancement of Practical Training in Tertiary Institutions 2.2. Provide appropriate ICT Training to all Teachers 2.3. Use Distance learning to offer training to teachers in basic (first cycle) schools who have applied for further studies.	2.1.7. Put in place special Distance Learning postgraduate Programs for ICT faculty. 2.2.2. Promote the use of electronic and distance education and virtual learning systems to complement and supplement face-to-face campus based education and training systems. 2.3.1. Set up appropriate infrastructure at selected centres to facilitate distance learning for all teachers pursuing further courses. 2.3.3. Set up digital e-Libraries to support Distance Education.
Thematic Area 3: Infrastructure, E-readiness and Equitable Access	3.1 Facilitate the establishment maintenance and support of the necessary infrastructure and related ICT resources within the education system.	3.2.3. Develop infrastructure to support Distance Education and e-Learning.
Thematic Area 5: Content Development	5.1 Develop Appropriate Content for Open, Distance and e-Learning	5.1.1. Institute and organize cost effective distance education programs to cover all levels of education in the formal and informal sectors.

Source: the author, based on Ghana ICTE policy.

#### 6.4.2 Distance education for high schools

Phase 1 of the President's Special Initiative on Distance Learning (PSI-DL) aims at effectively bridging the educational gap between well-endowed and poorly endowed schools in rural areas, and at providing young people needing remedial classes with the opportunity to improve on their grades. A major concern is the teaching of English and mathematics. Phase 1 began in July 2003, with the broadcasting of lessons on the national television station. Handbooks, videocassettes and CDs were produced from the English and mathematics lessons that were broadcast, and are being sold to schools and the general public at subsidized prices as learner support materials. Since 2006, content has been delivered on CDs only.

The offer of content was extended in 2007 to include other science courses based on the syllabus of the West African Senior School Certificate Examination). Future courses will be chosen according to educational needs and in close cooperation with GES. Out-of-school members of the public needing remedial classes can access PSI-DL lessons through CDs, as well as through community initiatives supported by PSI-DL. Eight learning centres have been created in partnership with churches, mainly in Accra. With regard to content production, the TV programmes are produced by four private production companies, each in charge of courses of a given level. The best teachers from the best schools are selected to present the lessons. Selection and quality control committees were set up for this task.

The objectives of the programme are clear and are very important to improve the quality of education in high schools and colleges. The initiative is well targeted and well structured. Numerous letters have been received from parents with positive feedback on the programmes. Many teachers have also found that the initiative has helped them to improve their teaching methods. Some teachers use the CDs on a private basis. The programme appears to be having a positive impact on the targeted beneficiaries. However, several challenges have been noted, including inadequate budgets devoted to the PSI-DL, the relatively high cost of content production, the lack of television sets and/or electric power in a number of schools (particularly rural ones), schools requesting CDs to be distributed free of charge, and a lack of incentives in place to get teachers and schools interested in engaging with the programme. In addition, there does not appear to be adequate cooperation with the ICTE programme

implemented by the Ministry of Education, and the programme does not have an evaluation system able to provide precise feedback for monitoring and evaluation purposes. There is, however, a plan to undertake a thorough evaluation with the assistance of the Commonwealth of Learning. This evaluation should be studied carefully before proceeding to further implementation stages.

Taking into account the importance of this component of the PSI-DL initiative for the support it provides to the educational system and to the teachers and students in junior high schools and senior high schools, it is recommended that the Government of Ghana should consider consolidating and increasing the support provided to the PSI-DL. The support could be translated by equipping all schools (junior high schools and senior high schools) that do not yet have the appropriate equipment so that they can take full advantage of the programme, and by supporting content development and diffusion. It might be opportune to develop and broadcast a course on ICT for senior secondary schools, as required by the new educational reform. This might be a priority action to be coordinated with the ICTE Unit.

#### 6.4.3 Distance education for technical vocational education and training

Phase 2 of the PSI-DL planned an Open Schooling in Technical and Vocational Education and Training (TVET) with the support of the Commonwealth of Learning, to ensure that unemployed youth will have an opportunity to acquire skills to earn a livelihood and enhance their chances on the job market. In 2004, PSI-DL formed an eight-member steering committee, which started planning Open Schooling in TVET targeted at post-junior secondary school youth (15 years and above). Based on a field assessment of the 127 technical and vocational institutions, the committee selected 12 institutions nationwide to be part of an Open Schooling in TVET pilot project. Phase 2 started in 2007 in the 12 institutions selected nationwide to take part in the Open Schooling in TVET pilot project. A DL pilot experiment has also been conducted in a prison.

Pilot courses are offered for the first-year modules in block-laying and concreting, catering, basic mathematics and basic English. In order to develop the course content, PSI-DL organized several workshops for material development and writing for writers for the TVET programme. The writers have written

the content for the four above-mentioned modules. The courses are available in print form, and electronically on CDs. A dual system is adopted for content delivery. One group of students follows the regular face-to-face courses, and another group of students are distance learners. The distance learners also benefit from face-to-face lessons once every two weeks at weekends, designed to accommodate working people. The courses are distributed in paper form and on CDs. The courses are broadcast on television in the evening, too. Courses must be paid for, but financial support is provided to poor and vulnerable students.

The programme is at an early stage, and little feedback was available to make a proper evaluation. As is the case for the high schools programme, an evaluation of the pilot experiment is planned with the assistance of the Commonwealth of Learning. Distance education in technical fields requires a delicate balance, and it is recommended that careful consideration be taken of the outcome from the evaluation of the PSI-DL Open Schooling in Technical and Vocational Education and Training (TVET) component before considering its extension.

#### 6.4.4 Distance education at university level

The major objective of distance education at university level is to ensure access to higher education for the many qualified people who cannot pursue on-campus university education, due to the constraints on space at the universities. Other major objectives are to reduce the cost of higher education, and to enable a larger number of people living in remote areas to access

higher education services. Ghana has a long history with DE at the tertiary level. The idea first appeared during the 1980s. Several programmes targeting the training of professionals, and especially teachers, were launched during that period. However, due to certain difficulties, some programmes have been abandoned. Despite the difficulties, and convinced that DE could offer new opportunities for students, the Government of Ghana sponsored, between 1991 and 1994, a number of surveys to assess DE needs in Ghana.

Based upon the recommendations from these surveys, four universities (the University of Ghana, the University of Cape Coast, the Kwame Nkrumah University of Science and Technology and the University of Education Winneba) agreed to start DE programmes. The distance education courses offered by public universities in 2008 are presented in table 6.5.

The Centre for Distance Education of the University of Ghana is part of the Institute of Adult Education. It started in November 2007 with the recruitment of 700 students at first-year level. The entry requirements for the distance education programme are the same as those for the University of Ghana's bachelor's programmes. The instructional materials (textbooks) have been prepared by professors from the departments in charge of the curriculum, and under the control of those departments. Plans are under way to use ICT to drive the DE programme, with a five-year plan under preparation.

**Table 6.5. Public Universities offering Distance Education**

Institution	Distance Education Unit	Programs, degrees
University of Ghana, Legon (UG)	DE Unit, Institute of Adult Education (created in 2007)	- BA and BSc. in Administration
Kwame Nkrumah University of Science Technology (KNUST)	Faculty of Distance Learning	- Undergraduate Programs in Computer Engineering, Computer Science, Mathematics, Building Technology, Business Administration - Masters Programs in Mathematics, and Business Administration
University of Cape Coast (UCC)	DE Unit	- Diploma in Basic Education
University of Education Winneba (UEW)	Center for Distance Education (created in 1996)	- Diploma in Basic Education - two year Post-Diploma Basic Education programs
Ghana Institute of Management and Public administration , (GIMPA)	Distance Learning Center	- Short Training Sessions for Professionals - Undergraduate programs in Business Communication, Computer Science - Certificate in Journalism

Sources: websites of universities and interviews.

Note: These programmes may have changed since this research was conducted.

The distance education programme is currently at a preliminary stage where content is being issued as printed matter. Students get their textbooks from the Centre for Distance Education. Face-to-face meetings with students are organized every month in the regions (12 hours of face-to-face meetings and a three-hour session per module for 4 modules). Meetings are run by graduate students and young persons in fulfilment of their national service. The meetings are held in the 10 regional premises of the Institute of Adult Education. Before the exams, students spend two weeks on campus to review their courses with the professors. They also take their exams on campus.

The Ghana Institute of Management and Public Administration (GIMPA) is a university dedicated to training, consultancy and research in leadership, business management and public administration. GIMPA targets students, middle- and top-level executives in the public and private sectors, and non-governmental organizations (NGOs) as clients. The GIMPA Distance Learning Centre is one of 14 pilot centres that are members of the Global Development Learning Network (GDLN). The GIMPA Distance Learning Centre became operational in June 2000 with the support of the World Bank and the Government of Ghana. The Centre has internet access and a videoconferencing system using a satellite connection. A multimedia laboratory with 60 PCs is open to students and for the production of multimedia content. Both short training sessions and long training sessions are available. The short training sessions are available on a range of different subjects, and the long training sessions offer undergraduate programmes in business communication and in computer science, as well as a certificate in journalism, in conjunction with the African Virtual University. Long-term training is provided using various means, including online distance learning systems with universities abroad (Australia and Sweden), as well as CDs/DVDs. For its short training courses, the Centre calls on international experts present in Ghana and on experts from abroad linked by video connection.

The University of Education, Winneba (UEW) Institute for Educational Development and Extension (IEDE) is a pioneer in DE in Ghana. IEDE's facilities comprise study centres located in the ten regions of the country. IEDE runs a dual-mode programme. DE, as a second mode of delivery of university courses, has been a prominent part of UEW programmes. It focuses on teacher education, with the same academic

and professional components as the on-campus programmes. The main objective is to upgrade the many teachers who need to obtain a diploma while keeping them at school. This is in order to fulfil the Ministry of Education directive that the minimum qualification for teaching in Ghanaian basic schools by the year 2005 should be a diploma instead of a certificate. In addition to the three-year diploma in basic education, UEW offers two-year post-diploma basic education programmes in vocational and technical education, mathematics, science, English, and life skills. The annual enrolment in DE (2007–2008) is about 2,000. It is expected that this will increase to 10,000 in several years' time.

The University of Cape Coast (UCC) offers a three-year diploma in basic education. Its DE programme also aims at upgrading the academic and professional competence of teachers at basic schools. It is therefore targeting the same population as UEW.

The Kwame Nkrumah University of Science and Technology (KNUST) Faculty of Distance Learning was launched in 2006 with the objective of delivering programmes of study (both ongoing and new) from all the colleges of the University in the distance learning mode, through the use of a wide range of technologies such as print, multimedia and videoconferencing. The Faculty of Distance Learning plans to offer its programmes by alternating between distance learning and face-to-face modes. It also plans to establish off-campus distance learning centres in some regions of the country to serve as coordination points – for students' learning, for their interaction with facilitators, and for student support.

DE programmes are also being developed by private universities such as the Accra Institute of Technology (AIT) – a private school of engineering that offers degrees in engineering, technology and industrial systems, computer science and information technology, business and management. Its delivery modes include campus-based delivery (face-to-face classes and lectures), online courses (via the internet), online courses and learning materials (available on CDs and in printed format) and/or courses at an AIT E-Learning Centre.

Most of the DE programmes at the universities are relatively recent. However, several challenges have been identified, particularly in the area of ICT infrastructure constraints. Some of the programmes experience difficulties at the level of internet

connection reliability, and in mobilizing professors for the development of content. Large investments are required in ICT infrastructure and in the teams of professionals needed to create the online content (such as instructional designers, graphic designers, animators, tutors and video professionals). Another challenge relates to the adequacy of the vision, strategy, and plans of action for developing effective DE programmes. Achieving fully-ICT-enabled and highly functional DE requires ICT infrastructure upgrading and considerable upfront investments that may be difficult to achieve for individual institutions on their own, especially without strong international support of the kind that the GIMPA Distance Learning Centre enjoys.

Many Ghanaian institutions involved with DE intend to evolve towards fully-ICT-enabled DE programmes. This raises the important issue of reaching a critical mass. They may underestimate the challenges that they will be faced with. It is therefore recommended that the universities involved with DE, with the support of the Ministry of Education, should aim to combine their efforts and establish a joint DE programme. The joint programme could eventually lead to the creation of an Open University. A major objective of this virtual university would be to match the growing need for university education to the large surplus of qualified applicants for places on-campus. The creation of an Open University could benefit greatly from the experiences of other countries, in particular the United Kingdom's Open University.

## 6.5 Recommendations

The four recommendations emerging from this analysis are the following:

- 1) The Ministry of Communications should design and implement an internet development policy to accelerate internet deployment

The objective would be to reach a critical threshold permitting the country to take advantage of the full

potential offered by the network. Special emphasis should be devoted to high-speed connections. Consideration could also be given to creating innovative measures to promote the wider use of mobile telephones featuring e-mail and internet access, which are becoming increasingly functional.

- 2) The Ministry of Education should design plans of action that would ensure a clear linkage between the ICTE policy's thematic objectives and its implementation phases and specify clearly the role of the different actors and budget each of the actions

Furthermore, the teaching of an ICT course as a mandatory core subject in all senior high schools might be given high priority for the next three to five years. An action plan dedicated to this goal should be prepared. The plan should look at ICT equipment, training of trainers, internet connections, maintenance, and electricity provision, and should estimate the financial resources required.

- 3) Evaluation of distance learning programmes should be carried out and evaluation outcomes considered carefully

The outcome of the evaluations of the President's Special Initiative on Distance Learning (PSI-DL) programme for high schools and the Open Schooling in Technical and Vocational Education and Training (TVET) component should be studied carefully before considering their extension.

- 4) The universities involved with distance education with the support of MOE should consider combining their efforts and establishing a joint distance education programme

The joint programme could aim to lead to the eventual creation of an Open University. A major objective of this university would be to answer the unfulfilled need for university training, since only 42 per cent of qualified applicants (16,628 out of a total of 40,062 qualified applicants) were accepted at public universities to continue their studies in 2006, and the number of applicants will grow further in the future.

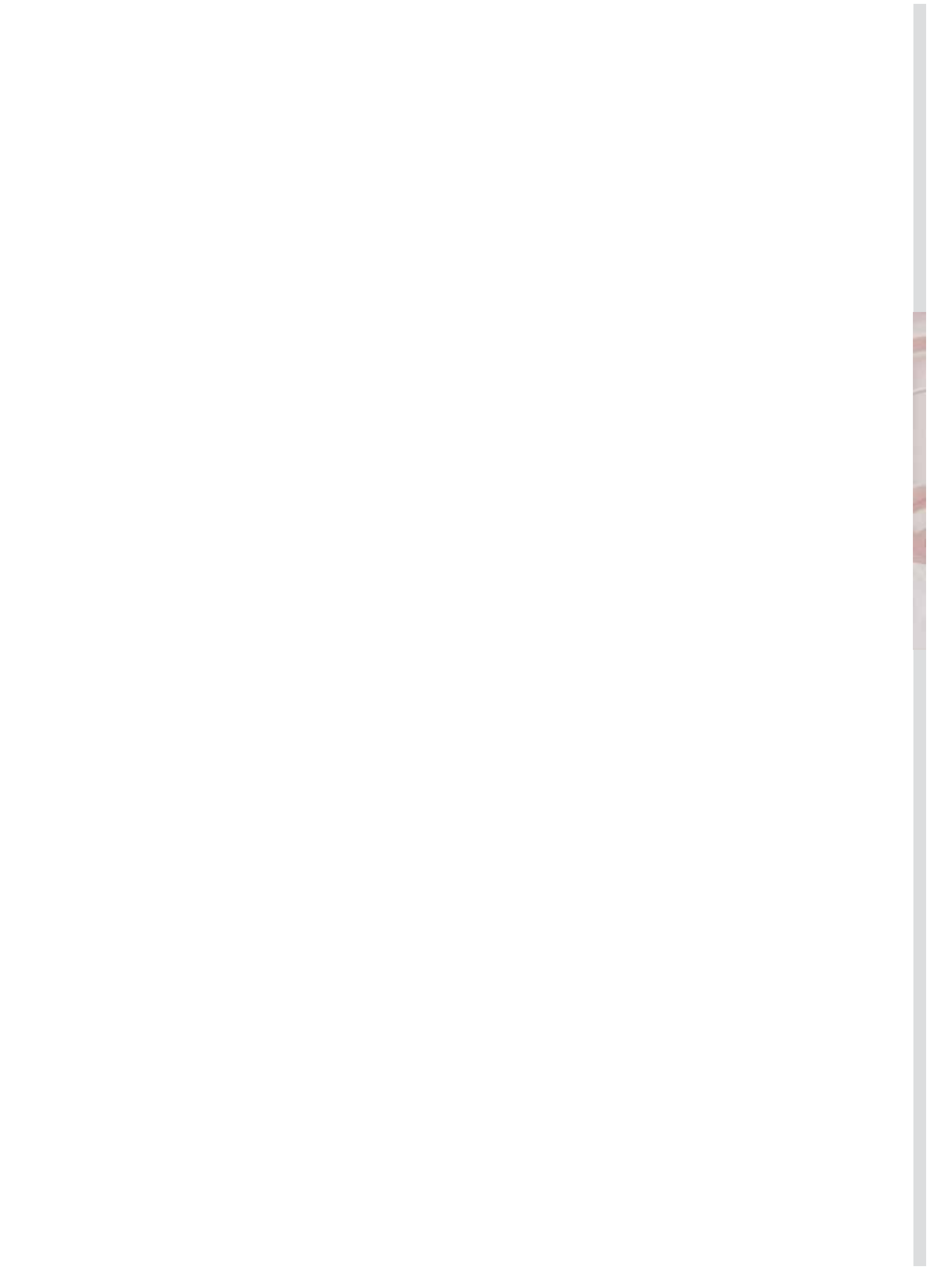
## NOTES

<sup>1</sup> Republic of Ghana (2003: 21).

<sup>2</sup> Dzidonu C (2002).

<sup>3</sup> Republic of Ghana (2006: 17).







## Bibliography

## BIBLIOGRAPHY

### National innovation system

- AfDB (2005). Ghana: Country Strategy Paper 2005–2009. African Development Bank.
- AfDB and OECD (2007). African Economic Outlook. African Development Bank and the Organization for Economic Cooperation and Development.
- AfDB and OECD (2008). African Economic Outlook. African Development Bank and the Organization for Economic Cooperation and Development.
- Adarkwa K (2008). Keynote address delivered at the official launching of the Science and Technology Research Endowment Fund. Kwame Nkrumah University of Science and Technology. Kumasi.
- Ayogu M (1999). Case studies: Private-sector participation in infrastructure in Uganda, Ghana and Nigeria. African Development Bank. Economic research paper no. 44.
- Biggs T, Shah M and Srivastava P (1995). Technological capabilities and learning in African enterprises. World Bank technical paper no. 285.
- Boateng K and Ofori-Sarpong E (2002). An analytical study of the labour market for tertiary graduates in Ghana. Report prepared for the World Bank and the National Accreditation Board of Ghana.
- Bogeti Z et al. (2008). Achieving Accelerated and Shared Growth in Ghana: A MAMS-Based Analysis of Costs and Opportunities. The World Bank Africa Poverty Reduction and Economic Management and Development Economics Prospects Group. Washington D.C.
- Dzobo NK (1974). The Report of the Education Review Committee – The New Structure and Content of Education for Ghana. Accra.
- Government of Ghana (1996). Council for Scientific and Industrial Research Act, 1996. Act 521. Accra.
- Hausmann R and Rodrik D (2003). Economic development as self-discovery. *Journal of Development Economics*. 72 (2003) 603–633.
- Hu M and Mathews J (2005). National innovative capacity in East Asia. *Research Policy*. 34: 1322–1349.
- Juma C and Yee-Cheong L (2005). *Innovation: Applying Knowledge in Development*. Earthscan. United Kingdom.
- Kwame Nkrumah University of Science and Technology (2005). *Technocrat*. 3. (2 and 3): 22.
- Lundvall B-A (1992). Introduction: 2–13. In: Lundvall BA, ed. *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*. Pinter Publishers. London.
- Lundvall B-A et al. (2002). National systems of production, innovation and competence-building. *Research Policy*: 31 (2002) 213–231. Elsevier.
- Ministry of Education, Science and Technology (2000). National science and technology policy document. Accra.
- OECD (1997). *National Innovation Systems*. OECD. Paris: 9.
- OECD (2007). *OECD Reviews of Innovation Policy: South Africa*. OECD. Paris.
- President's Committee on Review of Education Reforms in Ghana (2002). Meeting the Challenges of Education in the Twenty-first Century. Report of the President's Committee on Review of Education Reforms in Ghana.
- Republic of Ghana (1996). Council for Scientific and Industrial Research Act, 1996. Act 521. Accra.
- Republic of Ghana (2000). National science and technology policy document. MEST. Accra.
-

- Republic of Ghana (2008). Report on the Development of Education in Ghana. Ministry of Education, Science and Sports. Accra
- Republic of South Africa (2007). Technology Innovation Agency Bill. Government Gazette. No. 30164. 17 August.
- UNCTAD (2003a). Africa's Technology Gap. United Nations publication. UNCTAD/ITE/IPC/Misc.13. Geneva and New York.
- UNCTAD (2003b). Investment Policy Review: Ghana. United Nations publication. Sales no. E.02.II.D.20. Geneva and New York.
- UNDP (2001). Human Development Report 2001: Making New Technologies Work for Human Development. United Nations Development Programme. New York.
- UNESCO (2007). Science and technology profile of the Republic of Ghana. United Nations Educational, Scientific and Cultural Organization. Paris.
- UNIDO and Government of Ghana (2006). Technology Innovation Centre for Capital Goods in Ghana. Status report. September.
- University of Ghana. University of Ghana Basic Statistics, 1999–2006.
- WIPO (2007). WIPO Patent Report: Statistics on Worldwide Patent Activities. World Intellectual Property Organization. Geneva.
- WTO (2008). Trade policy review: Ghana. Report by the secretariat of the World Trade Organization. ET/TPR/S/194.
- World Bank (2005). Corporate Governance: Ghana Country Assessment. World Bank. Washington, D.C.
- World Bank (2006a). Benchmarking FDI Competitiveness in Sub-Saharan African Countries. World Bank. Washington, D.C.
- World Bank (2006b). Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems. World Bank. Washington, D.C.
- World Bank (2008). Doing Business 2009. World Bank. Washington, D.C.
- World Bank (2009). Accelerating Catch-Up: Tertiary Education for Growth in Sub-Saharan Africa. World Bank. Washington, D.C.
- Zachary PG (2003). Black Star: Ghana, Information Technology and Development in Africa: 7–8. Centre for Science, Policy and Outcomes. Columbia University.

### Research and development system

- Abrol D. Changing connections of the publicly funded R&D laboratories with industry and academia in India: lessons from the CSIR system. NISTADS. New Delhi (mimeo).
- AfDB (African Development Bank) (2007a). Strategic orientation in support to higher education, science and technology (HEST). Stakeholders' consultations. 12–13 April. Accra. <http://www.afdb.org/en/>
- AfDB (African Development Bank) (2007b). Strategy for higher education, science and technology. July. <http://www.afdb.org/en>
- AMCOST III (African Ministerial Conference on Science and Technology: third ordinary session) (2007). Science, technology and innovation for industrialization: Articulating an African Union vision. AU/EXP/ST/15(III). 12–16 November. Mombasa.
- Amoah JY and Aggey M (2006). Development and transfer of a mechanized palm kernel-shell separator. IIR. Accra.

- Augusto G (2002). Context, co-presence and “compossibilities”: Bioprospecting between endogenous knowledge and science in South Africa. *International Journal of Biotechnology*: 4 (2 and 3): 239–265.
- Bernardes AT and Da Motta e Albuquerque E (2003). Crossover, thresholds, and interactions between science and technology: Lessons for less developed countries. *Research Policy*. 32 (5): 865–885.
- Bogetic Ž, Bussolo M, Ye X, Medvedev D, Wodon Q and Boakye D (2007). *Ghana’s Growth and Poverty Reduction Story: How to Accelerate Growth and Achieve the MDGs?* World Bank. Washington, D.C.
- Bound K (2007). *India: The Uneven Innovator*. Demos. London.
- Chandra N (2008). Putting research results into use: Interrogating knowledge transfer policies at the Indian institutes of technology. Paper presented at the VI Globalics Conference. 22–24 September. Mexico City.
- Chaves CV and Moro S (2007). Investigating the interaction and mutual dependence between science and technology. *Research Policy*. 36: 1204–1220.
- Comin and Hobijn (2004). Cross-country technology adoption: Making the theories face the facts. *Journal of Monetary Economics*. 51 (1): 39–83.
- Council of the University of Ghana (2008). Statement on the report of the Visitation Panel. University of Ghana. Legon.
- CRI (n.d.) Strategic Plan 2008–2013. Crop Research Institute. Kumasi.
- CRIG (2002). Research staff publications 1938–2000. Cocoa Research Institute of Ghana. Tafo.
- CSIR (2006). Annual Report. Council for Scientific and Industrial Research. Accra.
- CSIR (Council for Scientific and Industrial Research) (1996a). Conditions of service for senior members of staff. Accra.
- CSIR (1996b). Conditions of service for senior staff. Accra.
- CSIR (1996c). CSIR Vision and Strategy 2001. New Delhi.
- CSIR (n.d.). Strategic considerations 2005–2009. Accra.
- CSIR Act, 1996. Act 521.
- CSRPM (Centre for Scientific Research into Plant Medicine) (2007). 2006 Annual Performance Report. Mampong-Akuapem.
- CSRPM (n.d.a). List of publications (2000–2007).
- CSRPM (n.d.b). List of research officers.
- CSRPM (n.d.c). 2008–2015 strategic plan. Mampong-Akuapem.
- CSRPM (2006). Annual performance report. Mampong-Akuapem.
- CSRPM Decree, 1975. N.R.C.D. 344.
- Dahlman C, Goel VK and Dutz MA (2007). Creating and commercializing knowledge. In: Dutz MA, ed. *Unleashing India’s Innovation: Toward Sustainable and Inclusive Growth*. World Bank. Washington, D.C.
- Fagerberg J and Srholec M (2008). Technology and development: Unpacking the relationship(s). Paper presented at the sixth Globalics Conference. 22–24 September. Mexico City. [www.globalics.org](http://www.globalics.org)
- Ghana Cocoa Research Institute Decree, 1979. S.M.C.D. 234.
- Ghana/EU Cocoa Sector Support Programme (2003). Technical Assistance for the Reorganization and Commercialization of the Cocoa Research Institute of Ghana. CRIG strategic plan. Masdar. Hook, Hampshire.
-

- Ghana Joint Assistance Strategy (G-JAS) (2007). Commitment by partners to work toward GPRS II goals and harmonization principles.
- Graffham A and Dziedzoave N (n.d.). Crop post-harvest programme: Sustainable uptake of cassava as an industrial commodity. Final report of project. 1 January 2003–31 December 2004. FRI. Accra.
- Hussain A (1986). Report of the CSIR Review Committee: Towards a new perspective. CSIR. New Delhi.
- Institute of Industrial Research (n.d.). Strategy document 2008 to 2012. Institute of Industrial Research. Accra.
- Industrial Designs Act, 2003. ACT 660.
- Juma C and Serageldin I (lead authors) (2007). Freedom to Innovate: Biotechnology in Africa's Development. A report of the High-Level African Panel on Modern Biotechnology. AU and NEPAD. Addis Ababa and Pretoria. [www.nepadst.org](http://www.nepadst.org)
- Kim YK, Lee K and Park WG (2008). Appropriate intellectual property protection and economic growth in countries at different levels of development. Paper presented at the VI Globelics Conference, Mexico City. 22–24 September.
- Knell M (2008). Technology, growth and poverty alleviation in sub-Saharan Africa. Unpublished manuscript.
- Kwame Nkrumah University of Science and Technology (2005a). Corporate Strategic Plan. Abridged version, 2005–2014 (PLAN2k14). Kumasi.
- Kwame Nkrumah University of Science and Technology (2005b). College of Engineering Strategic Plan 2007–2016. June. Kumasi.
- Kwame Nkrumah University of Science and Technology (2008a). Basic Statistics. 42nd Congregation. Planning Unit. June. Kumasi.
- Kwame Nkrumah University of Science and Technology (2008b). Quality Assurance Bulletin No. 5. Publications for the period 2006–2008. June. Kumasi.
- Kwame Nkrumah University of Science and Technology (2008c). Vice-Chancellor's Report. June. Kumasi.
- Kwame Nkrumah University of Science and Technology (n.d.). Strategic Plan. COS Plan 2K14. College of Science. Kumasi.
- Krauskopf M, Krauskopf E and Méndez B (2007). Low awareness of the link between science and innovation affects public policies in developing countries: the Chilean case. *Scientometric*. 72 (1): 93–103.
- Lall S and Pietrobelli C (2002). *Failing to Compete: Technology Development and Technology Systems in Africa*. Cheltenham. Elgar.
- Lockett A, Wright M, and Franklin S (2003). Technology transfer and universities' spinout strategies. *Small Business Economics*. 20: 185–200.
- Mouton J and Waast R (2008). Study on national research systems: a meta-review. Draft Global Synthesis Report. UNESCO. Paris.
- National Resources International (n.d.). Government of Ghana: NIRP. Partial commercialization of CSIR secretariat, WRI and INSTI. Vols. 1 and 2.
- National Development Planning Commission (2005). Growth and Poverty Reduction Strategy (GPRS II).
- New Partnership for Africa's Development (2003). Developing a science and technology strategic framework: A synthesis report of the first workshop. April. [www.nepadst.org](http://www.nepadst.org)
- New Partnership for Africa's Development (n.d.). Governing science, technology and innovation in Africa: Building national and regional capacities to develop and implement strategies and policies. [www.nepadst.org](http://www.nepadst.org)
-



- Oil Palm Research Institute (2002). Draft strategic plan 2003–2007. Kade. Patent Regulations, 1996. L.I. 1616.
- Pietrobelli C (2001). National industrial systems in Africa: The nature and deficiencies of technological effort in African industry. Background paper for UNIDO WIDR 2001. Second draft.
- Republic of Ghana (2008). The Medium-Term Expenditure Framework for 2008–2010 and the Annual Estimates for 2008. 23. Ministry of Education, Science and Sports (Science).
- Ribeiro LC, Ruiz RM, Bernardes AT and Albuquerque E (2006). Science in the developing world: Running twice as fast? Computing in Science and Engineering. July/August: 86–92.
- Southern African Regional Universities Association (2008). A Baseline Study on Science and Technology and Higher Education in the SADC Region. Studies Series 2007. www.sarua.org
- Siegel DS, Waldman D and Link A (2003). Assessing the impact of organizational practices on the relative productivity of university technology transfer offices: an exploratory study. Research Policy. 32: 27–48.
- Trademarks Act, 2004. Act 664.
- UNCTAD (2003). Africa's Technology Gap. United Nations publication. UNCTAD/ITE/IPC/Misc.13. Geneva and New York.
- UNCTAD (2007). The Least Developed Countries Report 2007: Knowledge, Technological Learning and Innovation for Development. United Nations publication. Sales no. E.07.II.D.8. New York and Geneva.
- University of Cape Coast (2003a). Corporate Strategy. UCC, Cape Coast.
- University of Cape Coast (2003b.) Statutes, 2003. UCC, Cape Coast.
- University of Cape Coast (2007a). Basic Statistics. Data Processing Unit, University of Cape Coast. Cape Coast.
- University of Cape Coast (2007b). Vice-Chancellor's Annual Report. University of Cape Coast. Cape Coast.
- University of Cape Coast Law, 1992. P.N.D.C.L. 278.
- University of Ghana (1994). Vision 2000 Plus: Strategic Plan. University of Ghana, Legon.
- University of Ghana (2007a). Annual Report. University of Ghana, Legon.
- University of Ghana (2007b). Basic Statistics. University of Ghana, Legon.
- Watkins A and Ehst M, eds. (2008). Science, Technology and Innovation: Capacity-Building for Sustainable Growth and Poverty Reduction. World Bank. Washington, D.C.
- Wessner CW and Shivakumar SJ (2007). India's changing innovation system: Achievements, challenges, and opportunities for cooperation. In: Dutz M, ed. Unleashing India's Innovation: Toward Sustainable and Inclusive Growth. World Bank. Washington, D.C.
- World Bank (2007). Building Knowledge Economies: Advanced Strategies for Development. World Bank. Washington, D.C.

### Food and agroprocessing

- Association of Ghana Industries (2007). AGI Business Climate Survey 2007. Accra. [http://www.agighana.org/business\\_environment/useful\\_docs/index.php](http://www.agighana.org/business_environment/useful_docs/index.php)
- Essegbey G and Aggey M (2007). Technological change in small and medium-scale enterprises during financial sector liberalization in Ghana. Journal of Applied Science and Technology. 12 (1 and 2): 133–139.
- Essegbey G (2008). Ghana: Cassava, cocoa and poultry. In: Larsen K, Kim R and Theus F, eds. Agribusiness and Innovation Systems in Africa. World Bank. Washington D.C.
- Federation of Associations of Ghanaian Exporters (2007). Ready for take-off: Ghana horticulture. Accra.

- Ghana Ports and Harbours Authority (2007). Ghana Ports Handbook 2007–2008. Colchester. Land and Marine Publications Ltd.
- Ghana Investment Promotion Centre. Ghana Investment Profile: Food Production and Processing. [http://www.gipc.org.gh/Userfiles/file/sector\\_profiles/Food.pdf](http://www.gipc.org.gh/Userfiles/file/sector_profiles/Food.pdf) accessed on 12 April 2011.
- Ghana Investment Promotion Centre website. <http://www.gipc.org.gh/>
- Government of Ghana (2005). The Millennium Challenge Compact between the United States of America acting through the Millennium Challenge Corporation and the Government of the Republic of Ghana. October.
- Government of Ghana (2006). The Millennium Challenge Compact with Ghana Executive Summary. August.
- Government of Ghana (2007). The Millennium Development Authority/Agricultural Credit Programme policies and procedures manual. September.
- Institute of Statistical, Social and Economic Research. The State of the Ghanaian Economy in 2007. Legon.
- Karikari IB (2006). Ghana's Land Administration Project (LAP) and Land Information Systems (LIS) Implementation: The Issues. Accessed on 12 April 2011. [http://www.fig.net/pub/monthly\\_articles/february\\_2006/karikari\\_february\\_2006.pdf](http://www.fig.net/pub/monthly_articles/february_2006/karikari_february_2006.pdf)
- Land Administration Project. <http://www.ghanalap.gov.gh/> accessed on 12 April 2011.
- Mudambi R (1999). Multinational investment attraction: Principal–Agent considerations. *International Journal of the Economics of Business*. 6 (1): 65–79.
- Ministry of Food and Agriculture (2007). Food and Agriculture Sector Development Policy (FASDEP II). Ministry of Food and Agriculture. Accra.
- National Development Planning Commission (2005). Growth and Poverty Reduction Strategy (GPRS II) 2006–2009. Accra.
- Spielman DJ and Birner R (2008). How innovative is your agriculture? Using innovation indicators and benchmarks to strengthen national agricultural innovation systems. ARD discussion paper no. 41. World Bank. Washington, D.C.
- World Bank (2006a). Doing Business 2007. World Bank and International Finance Corporation. Washington D.C.
- World Bank (2006b). Project appraisal document on two proposed credits to the Republic of India for the National Agricultural Innovation Project.
- World Bank (2007a). Meeting the Challenge of Accelerated and Shared Growth: Options for Export Diversification and Faster Export Growth in Ghana. Country economic memorandum: Ghana.
- World Bank (2007b). Enhancing Agricultural Innovation: How To Go Beyond the Strengthening of Research Systems.
- World Bank (2008a). The Revised Food Safety Action Plan. MoFA/WB-AFTAR Food Safety Task Force. Draft report.
- World Bank (2008b). Ghana Export Horticulture Cluster Strategic Profile Study. Part I: Scoping Review.
- World Bank (2008c). World Development Report 2008: Agriculture for Development.
- World Bank (2008d). Ghana Investment Climate Assessment 2007. World Bank. <http://www.enterprisesurveys.org/Portal/>.

### Traditional and herbal medicine

- African Union (2007). The status of traditional medicine in Africa, and review of progress made on the implementation of the Plan of Action on the African Union Decade of Traditional Medicine (2001–2010). Paper presented at the third session of the African Union Conference of Ministers of Health. Johannesburg. 9–13 April 2007.

- Biotechnology Development Programme (Ghana) Database (2001). Compiled from data collected as part of a University of Strathclyde/STEPRI project entitled "Building capacity for sustainable biotechnology development in agriculture and health in Ghana".
- Bogetic Ž, Bussolo M, Xiao Y, Medvedev D, Wodon Q and Boakye D (2007). Ghana's growth story: How to accelerate growth and achieve the Millennium Development Goals? World Bank paper (draft) prepared for discussion at the Ghana Country Economic Memorandum Technical Review Workshop, Accra. May.
- Brinckmann J and McIntyre M (2006). Proposed quality control guidelines for the EU directive on traditional herbal medicinal products: implications for small to medium-sized enterprises. In: *Journal of the American Botanical Council*. Issue 70: 62–66.
- Cho B-H (2000). The politics of herbal drugs in Korea. In: *Social Science and Medicine*. 51: 505–509.
- Centre for Scientific Research into Plant Medicine (2000). Silver Jubilee (1975–2000) publication.
- Dennis F, ed. (2002). *Conservation and Sustainable Use of Medicinal Plants in Ghana: Ethnobotanical survey*.
- Essegbey G, Frempong G and Stokes K (1999). Proceedings of the National Stakeholders' Conference on Priority-Setting for Sustainable Biotechnology in Agriculture and Health. Elmina. December.
- Evans-Anfom E (1986). *Traditional Medicine in Ghana: Practice, Problems and Prospects*. J.B. Danquah Memorial Lectures. Seventeenth series. February 1984. Accra. Academy of Arts and Sciences.
- FDA (2001). Overview of dietary supplements.
- FDA (2004). Factsheet on FDA's strategy for dietary supplements.
- Food and Drugs Board (1996a). Guidelines for the registration of herbal/homeopathic drugs in Ghana. Accra.
- Food and Drugs Board (1996b). Guidelines for the registration of allopathic drugs. Accra.
- Grupper M, Boateng F, Amporful E and Binka J (2005). Improving Access to Medicines: The Case of Local Production and Greater Access to Medicines for Ghana.
- Government of Ghana (2000). *Traditional Medicine Practice Act (Act 575)*. Accra.
- Harmsworth K and Lewith GT (2001). Attitudes to traditional Chinese medicine amongst Western-trained doctors in the People's Republic of China. In: *Social Science and Medicine*. 52: 149–153.
- Janes C (1999). The health transition, global modernity and the crisis of traditional medicine: the Tibetan case. In: *Social Science and Medicine*. 48: 1803–1820.
- Mander M, Ntuli L, Diederichs N and Mavundla K (2007). *Economics of the Traditional Medicine Trade in South Africa*.
- Matowe L, Duwiejua M and Norris P (2004). Is there a solution to the pharmacist brain drain from poor to rich countries? In: *The Pharmaceutical Journal*. 272: 98–99.
- Ministry of Environment and Science (2002). *National Biodiversity Strategy for Ghana*. Ghana.
- Ministry of Environment and Science (2005). *Republic of Ghana: Third National Report to the CBD*. Ghana.
- Ministry of Finance (2007). *Ghana Budget Statement for 2008*. Accra.
- Ministry of Health (MOH) (2001). *Partnerships for health: bridging the inequalities gap. The second health-sector five-year programme of work, 2002–2006*. MOH green paper. Accra.
- MOH (2007). *The Ghana Health Sector Annual Programme of Work 2007*. Accra.
- Ministry of Health–Ghana National Drugs Programme (MOH–GNDP) (2002). *An Assessment of the Pharmaceutical Sector in Ghana*. Accra.
- MOH–GNDP (2004a). *National Drug Policy*. Accra.
-

- MOH-GNDP (2004b). Ghana Essential Medicines List. Accra.
- MOH-GNDP (2004c). Standard Treatment Guidelines. Accra.
- Ministry of Health–Traditional and Alternative Medicine Directorate (2005). A National Strategic Plan for Traditional and Alternative Medicine Development in Ghana 2005–2009. Accra.
- Ministry of Trade and Industry (2005). National Trade Policy. Accra.
- National Development Planning Commission (2005). Growth and Poverty Reduction Strategy (GPRS II) 2006–2009. Accra.
- Nyarko A (2007). Plant medicine in the twenty-first century: Confronting the challenges in Ghana. Inaugural lecture by the Director of the Noguchi Memorial Institute for Medical Research. University of Legon. November.
- Nyarko A, Asiedu-Gyekye IJ and Sittie AA (2005). A Manual of Harmonized Procedures for Assessing the Safety, Efficacy and Quality of Plant Medicines in Ghana. Accra. Ministry of Health.
- Richter M (2003). Traditional medicines and traditional healers in South Africa. Discussion paper prepared for the Treatment Action Campaign and AIDS Law Project, South Africa.
- Romero-Daza, N. (2002) Traditional Medicine in Africa. In *Annals of the American Academy*, 583: 173-176.
- Shankar D and Venkatasubramanian P (2005). The evolution of global standards for traditional medicine. Science and Development Network (SciDevNet) policy brief. March.
- Smith F (2002) Reflections on healthcare in Ghana. In: *The Pharmaceutical Journal*. 268: 768.
- Son AHK (1998). Modernization of the system of traditional Korean medicine (1876–1990). In: *Health Policy*. 44: 261–281.
- Steinhoff B (2002). The legal framework for herbal medicinal products in Europe. Presentation given at the GA Congress. 2 September.
- Science and Technology Policy Research Institute (2007). The Ghana Herbal Pharmacopoeia. Council for Scientific and Industrial Research. Accra.
- Strangeland T, Dhillon SS and Reksten H (2008). Recognition and development of traditional medicine in Tanzania. In: *Journal of Ethnopharmacology*. 117: 290–299.
- Tsey K (1997). Traditional medicine in contemporary Ghana: a public policy analysis. In: *Social Science and Medicine*. 45 (7): 1065–1074.
- UNCTAD (2007). The Least Developed Countries Report 2007: Knowledge, Technological Learning and Innovation for Development. United Nations publication. Sales no. E.07.II.D.8. New York and Geneva.
- UNDAF (2005). United Nations Development Assistance Framework (UNDAF) for Ghana, 2006–2010.
- UNDP (2003). Human Development Report 2003.
- UNDP (2004a). Human Development Report 2004.
- UNDP (2004b). Breaking the HIV/AIDS chain: A human development challenge. Ghana Human Development Report 2004. Accra.
- UNDP (2005). Human Development Report 2005.
- UNDP (2006). Human Development Report 2006.
- UNDP (2007). Human Development Report 2007/2008.
- UNESCO (2007). Science in Africa. Paris. UNESCO.
- World Health Organization (1998). Guidelines for the Appropriate Use of Herbal Medicines. Geneva. WHO.
-

- World Health Organization (2002). Traditional Medicine Strategy 2002–2005. Geneva. WHO.
- World Trade Organization (2007). Trade Policy Review: Ghana. WT/TPR/S/194. Geneva. WTO.
- Yee S-K, Chu S-S, Xu Y-M and Choo P-L (2005). Regulatory control of Chinese proprietary medicines in Singapore. In: Health Policy. 71: 133–149.

### ICTs in education

- Agyakoma KA (2007). Brief. PSI Distance Learning.
- Akumfi CA (2002). L'éducation pour apprendre à vivre ensemble. Apprendre à vivre ensemble au Ghana et en Afrique de l'Ouest: Problèmes et solutions. Dans: Perspectives. 32 (1). [www.ibe.unesco.org/publications/Prospects/ProspectsPdf/121f/121fakum.pdf](http://www.ibe.unesco.org/publications/Prospects/ProspectsPdf/121f/121fakum.pdf)
- Dzidonu C (2002). An empirical study of the development, deployment and the exploitation of ICTs in Ghana. International Institute for Information Technology and the Economic Commission for Africa.
- Dzidonu CK (2003). An integrated ICT-led socio-economic development policy and plan. Development Framework for Ghana.
- Frempong GK (2007). Towards an African e-index: Telecommunications sector performance in Ghana.
- Ghana Patent Act, 1992.
- The Ghana ICT4AD process: Sector-specific implementation strategies. <http://www.ict.gov.gh>
- Global E-Schools and Communities' Initiative. (GeSCI). Transforming education, empowering communities, promoting development.
- Government of Ghana (2003). The Ghana ICT For Accelerated Development (ICT4AD) policy.
- Government of Ghana. Ministry of Education and Sports (2006). The Ghana ICTs in Education policy (draft).
- Government of Ghana. Ministry of Education, Science and Sports (2007). ICT in education. Newsletter. 1 (1). April.
- InfoDev (2007a). Survey of ICT and education in Africa. Draft. <http://www.infodev.org/en/Publication.353.html>.
- InfoDev (2007b). Survey of ICT and education in Africa. 2: 53 Country Reports. <http://www.infodev.org/en/Publication.354.html>.
- Ismail M (2002). Readiness for the Networked World: Ghana Assessment. <http://www.ict.gov.gh/pdf/Ghana%20Readiness%20Assessment1.pdf>.
- Koomson G. Turning Ghana's youthful population into skilled human resource.
- Mallet JC. Ghana distance education programme. In: Hope A and Guiton P, eds. Strategies for Sustainable Open and Distance Learning. 6.
- Mangesi K (2007). Survey of ICT and education in Africa. Ghana Country Report. <http://www.infodev.org/en/Publication.406.html>.
- Ministry of Communications. Promoting the information society in Ghana. <http://www.ict.gov.gh>.
- Ministry of Communications. eGhana Project (IDA CR 4226-GH).
- Ministry of Education, Science and Sports. ICT in Education Programmes Unit. Draft copy of ICT policy.
- Nyarko Emily (2007). Developing ICT-enabled education – The future for Ghana.
- Kwapong OATF (2005). Socio-economic predictors of acquisition and utilization of information and communication technology (ICT) for the empowerment of rural women in Ghana. Doctoral thesis. University of Ghana, Legon.

- Republic of Ghana. National ICT Policy and Plan Development Committee. Survey of ongoing ICT projects and initiatives in government ministries and public sector organizations. <http://www.ict.gov.gh/html/Survey%20of%20On-going%20ICT%20Projects%20and%20initiatives%20.htm>.
- Republic of Ghana. Ministry of Communications. National ICT Policy and Plan Development Committee. Deployment and exploitation of ICTs in government ministries and public sector organizations. <http://www.ict.gov.gh/html/ict%27s%20in%20gov%27t%20ministries%20&%20public%20sector%20organizations.htm>.
- researchICTAfrica.net. Le fonctionnement du secteur des Technologies de l'information et de la communication (TICs) en Afrique: Etat des lieux dans sept pays africains.
- Tadayoni R and Skouby KE (2003). Research and Education Network in Ghana. Promoting ICT In developing countries through research cooperation. In: Proceedings of the International Conference on Information Technology in Regional Areas. [http://users.dec.uwi.edu/smarshall/itira/proceedings\\_online/2003/non-ref\\_papers/tadayoni\\_skouby.pdf](http://users.dec.uwi.edu/smarshall/itira/proceedings_online/2003/non-ref_papers/tadayoni_skouby.pdf).
- UNESCO (2005). UIS statistics in brief. Education in Ghana. General information. [http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=289&IF\\_Language=eng&BR\\_Country=2880&BR\\_Region=40540](http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=289&IF_Language=eng&BR_Country=2880&BR_Region=40540).
- University of Cape Coast. The University of Cape Coast ICT policy. [www.ict.gov.gh/pdf/ICT%20Policy%20-%20U.C.C.pdf](http://www.ict.gov.gh/pdf/ICT%20Policy%20-%20U.C.C.pdf).
- University of Ghana. Basic statistics.
- University of Ghana (2006). ICT strategic plan (2005–2010). Version 3.0.
- University of Ghana (2007a). ICT policy.
- University of Ghana (2007b). UG distance education programme to take off from November 2007.
- World Bank (2005). ICT-at-a-Glance. Ghana. [http://devdata.worldbank.org/ict/gha\\_ict.pdf](http://devdata.worldbank.org/ict/gha_ict.pdf).
- World Bank (2007). Status of projects in execution – FY07 Ghana. 10 October. <http://www1.worldbank.org/operations/disclosure/SOPE/FY07/AFR/Ghana.pdf>.
- World Economic Forum. The Global Information Technology Report 2005–2006. [http://www.weforum.org/pdf/Global\\_Competitiveness\\_Reports/Reports/gitr\\_2006/rankings.pdf](http://www.weforum.org/pdf/Global_Competitiveness_Reports/Reports/gitr_2006/rankings.pdf).

## Annex 2

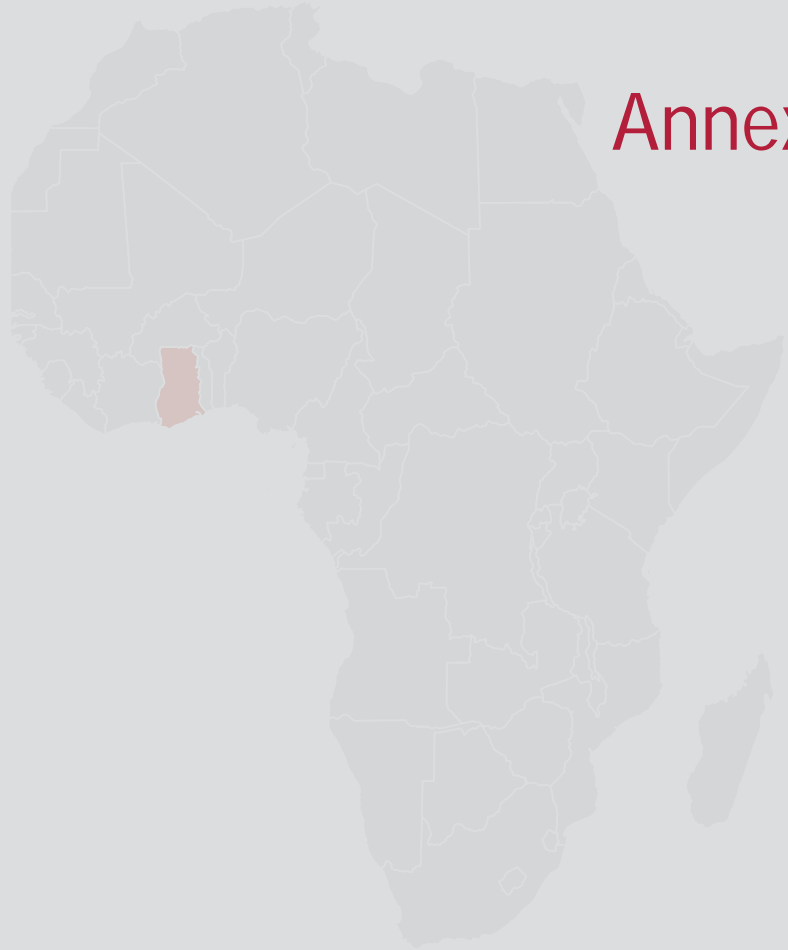
- Chaves CV and Moro S (2007). Investigating the interaction and mutual dependence between science and technology. *Research Policy*. 36: 1204–1220.
- Fagerberg J and Srholec M (2008). Technology and development: Unpacking the relationship(s). Paper presented at the sixth Globelics Conference. 22–24 September. Mexico City. [www.globelics.org](http://www.globelics.org)
- Juma C and Serageldin I (lead authors) (2007). Freedom to Innovate: Biotechnology in Africa's Development. A report of the High-Level African Panel on Modern Biotechnology. AU and NEPAD. Addis Ababa and Pretoria. [www.nepadst.org](http://www.nepadst.org)
- Mouton J and Waast R (2008). Study on national research systems: a meta-review. Draft Global Synthesis Report. UNESCO. Paris.
- New Partnership for Africa's Development (2003). Developing a science and technology strategic framework: A synthesis report of the first workshop. April. [www.nepadst.org](http://www.nepadst.org)
- New Partnership for Africa's Development (n.d.). Governing science, technology and innovation in Africa: Building national and regional capacities to develop and implement strategies and policies. [www.nepadst.org](http://www.nepadst.org)



Ribeiro LC, Ruiz RM, Bernardes AT and Albuquerque E (2006). Science in the developing world: Running twice as fast? Computing in Science and Engineering. July/August: 86–92.

Watkins A and Ehst M, eds. (2008). Science, Technology and Innovation: Capacity-Building for Sustainable Growth and Poverty Reduction. World Bank. Washington, D.C.

World Bank (2007). Building Knowledge Economies: Advanced Strategies for Development. World Bank. Washington, D.C.



## Annexes

## ANNEX 1. SUMMARY OF STIP REVIEW RECOMMENDATIONS

Study	Recommended actions
National innovation system	<p>Recommendation 1: Establish a specialized agency – a National STI Implementation Agency (NIA) – to coordinate and implement STI policies and programmes.</p> <p>Recommendation 2: Design a realistic multi-year implementation strategy to accompany the 2010 national STI policy and the establishment of an NIA.</p> <p>Recommendation 3: Strengthen the legislature in innovation policymaking, for example by establishing a specific parliamentary committee for science and innovation (to replace the current Parliamentary Committee on Environment and Science).</p> <p>Recommendation 4: Build skills and promote an entrepreneurial culture.</p> <p>Recommendation 5: Sharpen economic targets and the country's technology focus, for example through technology assessment exercises and technology foresight exercises.</p> <p>Recommendation 6: Implement measures to develop the private sector and promote innovation in enterprises.</p> <p>Recommendation 7: Continue to increase investments in improving physical infrastructure.</p> <p>Recommendation 8: Find ways to ensure greater executive and political leadership on STI development.</p>
Research and development system	<p>Recommendation 1: The Government should increase its budgetary allocation to S&amp;T in order to give meaning to its commitment to S&amp;T. In order for Ghana to become a knowledge economy, the path will be neither cheap nor short. Knowledge workers need to be well paid. They also need quality equipment and facilities. The discrepancy in salaries between scientists at the institutes and academics at the universities is not justified. All this means that substantial monies must be released for science and technology, and that such investment only make sense in the context of long-term commitments that transcend electoral cycles. An increase in spending for a few years followed by cutbacks is counter-productive.</p> <p>Recommendation 2: The Government should consider bringing the entire S&amp;T system under one ministerial roof. This assessment has not seen any evidence that having three ministries rather than one to which the research institutes and universities report benefits the system. Instead, it makes coordination even more difficult in a system which, at present, is not particularly adept at ensuring relevance, efficiency and effectiveness. It should be emphasized that if the knowledge economy is as important for Ghana as has been highlighted in some key policy documents, such a ministry must enjoy considerable clout.</p> <p>Recommendation 3: The research system must increase its efficiency. This concerns staffing levels at the research institutes, in particular. This study has shown that core/support staff ratios in Ghana bear little comparison to those in similar organizations elsewhere. Across the system, the management of research, technology, people, and their ideas must become more professional.</p> <p>Recommendation 4: The research system must substantially increase its external income. This requires, first and foremost, a motivated scientific and academic workforce. Hence, powerful incentives must be put in place to encourage people to win – especially – international research tenders, and to commercialize technological innovation. Secondly, it requires a supportive and professionally managed environment in which researchers can rely on upstream (e.g. tender opportunity scanning) and downstream (e.g. marketing, network-building, commercialization, IP management) services whose delivery is essential for the success of core activities.</p>

Study	Recommended actions
Research and development system	<p>Recommendation 5: In reality, directing all these measures at the entire system contemporaneously is impossible. What is possible is to open up space for experimenting with institutional and organizational alternatives in selected areas of the research system. Existing areas of excellence in the research system should therefore be identified and nurtured. This must be guided by the need to focus on those activities where certain prerequisites exist and where interventions have a better than even chance of succeeding. To make this possible, the Government should not take an approach whereby successful income generation on the open market is penalized by a reduction in the government subvention. Good performance should be rewarded at all levels, which means that for budget purposes, the idea of co-funding should be introduced. In these centres of excellence, it is important that rules and incentives facilitate a market for ideas, seed funding, and project execution, so that the most vibrant and relevant parts of the research infrastructure can grow while those that do not produce what is expected of them are allowed to close down.</p> <p>Recommendation 6: Promote more professional management across the R&amp;D system.</p> <p>Recommendation 7: The entire system should increase its self-reflexivity. Annual reports should be taken more seriously. Strategic plans that are not updated on a regular basis have little use. Reviews should be undertaken at regular intervals, including through external panels, in order to monitor whether the system is on track.</p>
Food and agro-processing	<p>Recommendation 1: Establish a network of 2–3 agribusiness innovation centres (AICs), distributed among the three major regional zones in the country and located at the premises of existing institutions of higher learning. The AICs would act as hubs for the economic clusters of the food and agro-processing industry. The major activity of the AICs is to spur home-grown innovations and developments in food and agro-processing technologies to convert raw commodities into products that are facing barriers to commercialization. The AICs should be modelled on similar centres that have worked successfully to stimulate entrepreneurship and agribusiness innovation in a diverse set of countries. A derivative undertaking would entail adding business incubators, which offer tenant space to start-ups for short-term entrepreneurial and commercial use, to process, distribute and sell value-added farm products that address market needs. The AICs would offer opportunities to provide workers with practical skills and would produce students and entrepreneurs who are job creators and not job seekers. The AICs and related regional infrastructure would target a set of commodities that offer high potential for exploitation in each region.</p> <p>Recommendation 2: Improve funding mechanisms for market-oriented research, development, and innovation performed by Ghana's agribusinesses. In order to develop the agro-processing sector, Ghana must provide ways to support research and development (R&amp;D) and low-tech and high-tech innovation by existing agribusinesses and entrepreneurs. Investments in facilities and equipment made by businesses, research institutes and innovation centres will be wasted if businesses lack the financial resources to undertake innovation. Funding mechanisms could include commodity "check-off" fees to be collected and invested by the industry, national competitive matching grants, tax credits for innovation-related activities, or the scaling-up of existing sources of funding including the national venture capital fund and the research endowment fund.</p>

Study	Recommended actions
Food and agro-processing	<p>Recommendation 3: Establish an industry advisory group to guide the food and agro-processing industry's development, composed of government, university, research institute, and industry representatives. The advisory group – modelled on similar bodies in other countries – would seek to provide coordination, direction, and practical and systemic solutions for developing the food and agro-processing industry in Ghana. This group would seek to create a climate hospitable to the kinds of private enterprises that can stimulate change from a subsistence farming economy to an integrated, market-oriented, agricultural-based economy.</p>
Traditional and herbal medicines	<p>Recommendation 1: A set of studies/meetings to evaluate, both qualitatively and quantitatively, the potential markets for THM should be given the highest priority in plans to develop the THM industry. It is suggested that these activities include an assessment of potential THM export markets, a more detailed survey of the OTC market for herbal products in Ghana (along the lines of the 2004 Ministry of Health–DFID survey undertaken on local production of medicines in Ghana but with a particular focus on factors guiding consumer behaviour in respect of seeking advice and purchasing medicinal products), and a review of goals and priorities for the integration of THM into the public-sector health-service delivery system, at a stakeholder meeting.</p> <p>Recommendation 2: Develop a clearly articulated strategy to support micro and small-scale THM enterprises.</p> <p>Recommendation 3: Consider the introduction of a more gradual and inclusive process of herbal medicine registration, but with fixed phase-in schedules.</p> <p>Recommendation 4: Strengthen the role of the Pharmacy Council to support regulatory compliance through pharmacists and chemical sellers, and the capacity of the FDB to handle a large increase in throughput of applications for THMs (both as food supplements and herbal medicines).</p> <p>Recommendation 5: Alleviate the potential distrust of regulatory science on the part of THM producers, through standard letters of contract produced and signed by scientific institutions that carry out regulatory testing.</p> <p>Recommendation 6: Strengthen the capacity of the Research Committee at the Centre for Scientific Research into Plant Medicine (CSRPM) to coordinate government-sponsored multi-disciplinary research programmes into traditional herbal medicine.</p> <p>Recommendation 7: The Ministry of Health should establish a permanent mechanism for identifying, prioritizing and funding public-sector R&amp;D programmes that support the development of THM products of interest to the country. Funding should be allocated to whole programmes only, on the basis that any single programme that is dependent on non-assured funding resources may not be carried out effectively, if at all. This R&amp;D mechanism should prioritize programmes based on input from relevant ministries, the private sector, and other key stakeholders, and should be administered by an independent body, such as the proposed NIA.</p> <p>Recommendation 8: Consider establishing a THM development fund with the cooperation and participation of the MOTI, MOH and MOFA. A proportion of the fund should be ring-fenced for demand-driven R&amp;D activities carried out by the private sector. Management of this fund could be carried out by the proposed NIA or by an appropriate ministerial department.</p>

Study	Recommended actions
ICTs in education	<p>Recommendation 1: The Ministry of Communications should design and implement an internet development policy to accelerate internet deployment in order to reach a critical threshold permitting the country to take advantage of the full potential offered by the network. Special emphasis should be devoted to high-speed connections. Consideration could also be given to creating innovative measures to promote the wider use of mobile telephones featuring e-mail and internet access, which are becoming increasingly functional.</p> <p>Recommendation 2: The Ministry of Education should design plans of action that would ensure a clear linkage between the ICTE policy's thematic objectives and its implementation phases and specify clearly the role of the different actors and budget each of the actions. Furthermore, the teaching of an ICT course as a mandatory core subject in all senior high schools might be given high priority for the next three to five years. An action plan dedicated to this goal should be prepared. The plan should look at ICT equipment, training of trainers, internet connections, maintenance, and electricity provision, and should estimate the financial resources required.</p> <p>Recommendation 3: Evaluation of distance learning programmes should be carried out and evaluation outcomes considered carefully. The outcome of the evaluations of the President's Special Initiative on Distance Learning (PSI-DL) programme for high schools and the Open Schooling in Technical and Vocational Education and Training (TVET) component should be studied carefully before considering their extension.</p> <p>Recommendation 4: The universities involved with distance education with the support of MOE should consider combining their efforts and establishing a joint distance education programme. The joint programme could aim to lead to the eventual creation of an Open University. A major objective of this university would be to answer the unfulfilled need for university training, since only 42 per cent of qualified applicants (16,628 out of a total of 40,062 qualified applicants) were accepted at public universities to continue their studies in 2006, and the number of applicants will grow further in the future.</p>



## ANNEX 2. THE AFRICAN POLICY ENVIRONMENT FOR STI-BASED DEVELOPMENT

Throughout Africa, a policy environment is emerging that seems very much conducive to fostering the knowledge economy, in the context of the global economy's changes towards more knowledge-intensive activities. This assessment is right on time. African leaders committed in 2006 to investing one per cent of GDP in research and development by 2010 (ADB, 2007b). The African Union's Science and Technology Consolidated Plan of Action aims at the "assertion of Africa's position in the global knowledge society, through the development and application of S&T in eradication of poverty, fighting diseases, stemming environmental degradation and improving the global economic competitiveness of the continent" (AMCOST, 2007: 2). This is to be done on the basis of "capacity-building, knowledge production and technological innovation to trigger an avalanche of Africa's industrialization" (AMCOST, 2007: 4). Already in 2003, the secretariat of the New Partnership for Africa's Development (NEPAD) recommended that, because of the limited national S&T capacities, regional technology platforms be built so as to pool resources.<sup>1</sup> Its Office of Science and Technology subsequently began to establish a network of centres of excellence in the biosciences, water sciences, and technology development.<sup>2</sup> Hence, at the level of policy intentions, things are happening.

The question is how much difference this will make in the future. For the time being, no matter what innovation, education or training indicators one consults, Africa still scores way below the world average in everything that matters: it has fewer researchers, publishes fewer articles, has more trouble accessing venture capital, does not register many patents, is less present in global value chains, and in 2003 had a GERD/GDP ratio of 0.025 per cent (excluding South Africa). In 2003, fewer than half a million people studied science, engineering, and agriculture in sub-Saharan Africa, excluding South Africa. As a percentage of 20–24 year olds, that is roughly three times less than in other developing countries.

Also, although according to the World Bank's Investment Climate surveys, machinery imports are the single most important source of technological innovation in Africa, the share of machinery in total imports into

sub-Saharan Africa actually declined between 1980 and 2004. Since sub-Saharan Africa (excluding South Africa) attracted only one per cent of global inward FDI flows in 2000–2006, the much-vaunted advantages of globalization through licensing and foreign ownership are not exactly forthcoming, either. All these statistics combine to ensure that sub-Saharan Africa's per capita GDP is – along with South Asia's – the lowest in the world and some 10 times lower than the world average, and that life expectancy, in contrast to the rest of the developing world, has actually been going down since 1990 (Knell, 2008).

Recent assessments of African STI policies in the global knowledge economy have been rather critical. In a baseline study on science, technology, and higher education in the SADC region for the Southern African Regional Universities Association (SARUA), the authors highlight serious weaknesses in science policies, particularly related to inadequate funding and political support (SARUA, 2008: 7).<sup>3</sup> They are also cautious on the strategic role that universities are supposed to play in the modern knowledge economy, arguing that this idea may not be appropriate for countries with less developed STI systems.

In the face of such assessments, exhortations to build at least one "world-class university in every African country to attract, train and retain scientific talent, invigorate quality education and ensure a culture of scientific excellence in Africa", as proposed at a stakeholder consultation of the ADB's Strategic Orientation in Support to Higher Education, Science and Technology in 2007, seem but wishful thinking (ADB, 2007a: 3).<sup>4</sup>

In an analogous example, in a review of the strategic orientation guiding the Poverty Reduction Strategy Papers for 11 LDCs, UNCTAD (2007) concluded that the new emphasis on growth was not matched by attention to technological change as an important source of that growth. This was attributed in part to the fragmentation of S&T infrastructure in the 1990s as a result of structural adjustment policies undertaken during that period.

A background paper for UNIDO's World Industrial Development Report 2001, based in part on examples from Ghana, described sub-Saharan Africa's science and technology infrastructure as follows:

The infrastructure is small, passive, and largely ineffective. It is often poorly funded and motivated, and has weak or no links with industry. Its ability to de-

velop, adapt and disseminate industrial technologies is weak. It seems to have little awareness of the competitive needs of local industry, even less of how new technologies can be introduced to potential users. [...] An additional dimension of the negligible institutional linkages in sub-Saharan Africa is the relationship with educational institutions. Very few firms collaborate with technical departments in universities or polytechnics. [...] Most technology institutions tend to lack credibility with private firms, and cannot reach out to them effectively. [...] Thus, this infrastructure is clearly unable to help weak industrial sectors that are themselves endowed with poor technological capabilities" (Pietrobelli, 2001: 33–34 (emphasis in original)).

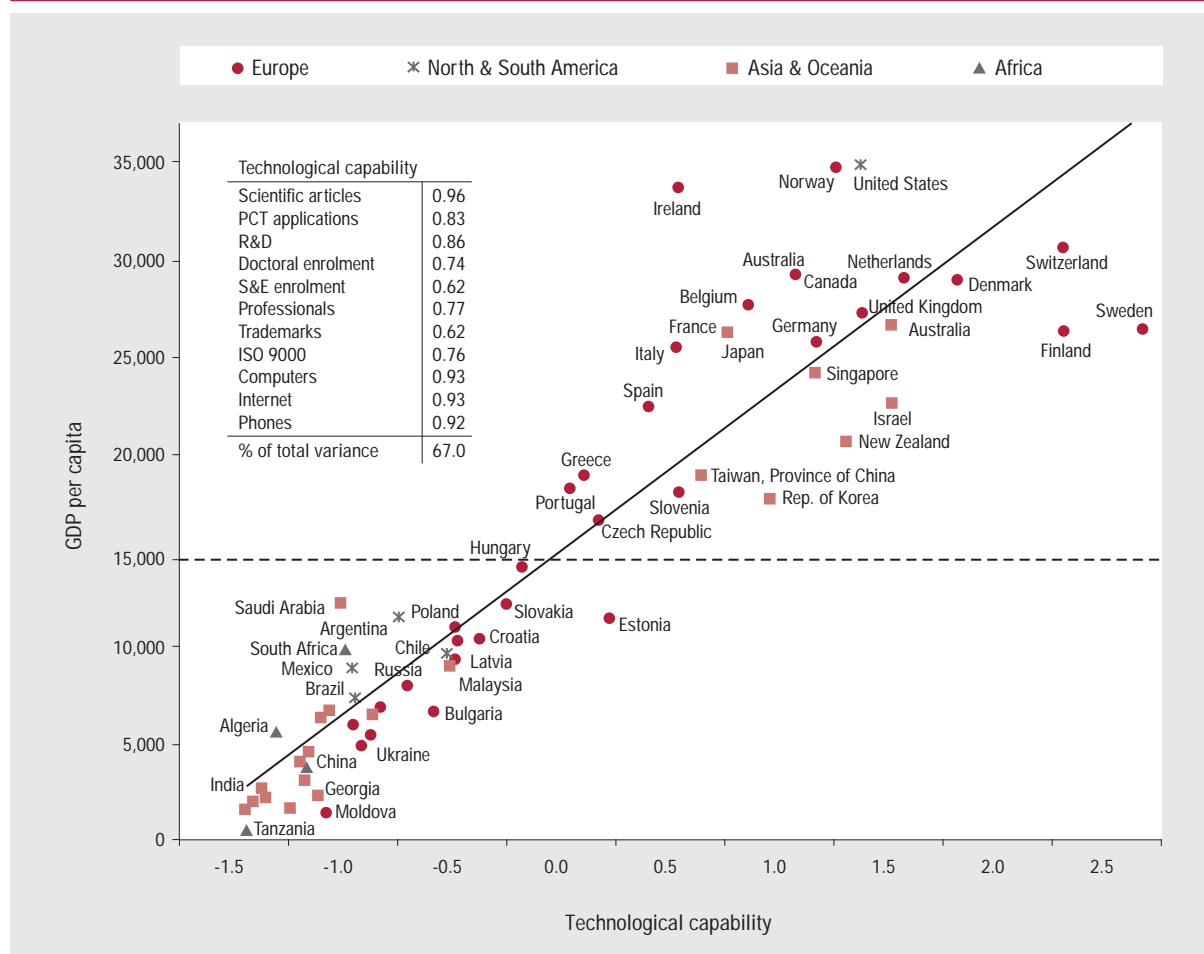
Discussing Ghana in particular, Lall and Pietrobelli (2002) and UNCTAD (2003) have argued that Ghana's success in developing its science and technology capabilities has been disappointing, and represents an important constraint on the country's development

and ability to compete in export industries, much as in other African countries.

But unsatisfactory past performance does of course not detract from the powerful insight that economic development depends on the application of science and technology and innovation, including for low-income countries, and thus on the need to improve future performance.<sup>5</sup> Figure A.2.1 relates a composite measure of technological capability to GDP per capita. It illustrates the strong correlation between the two – higher levels of technological capability are evidently linked to higher levels of per capita income, which is a proxy for development.<sup>6</sup>

Similarly, research on the evolution of national innovation systems suggests that (a) the number of and channels for interaction among scientific infrastructure; (b) technological production; and (c) economic growth change in relation to the level of economic

Figure A.2.1 GDP per capita and technological capability over 2000–2004

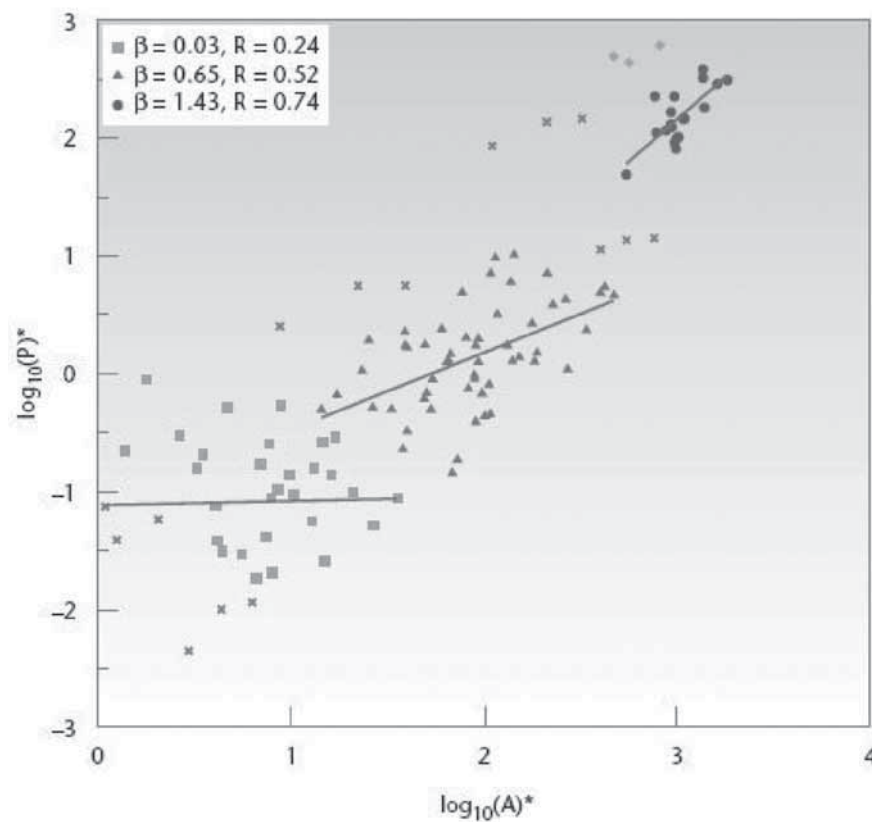


Source: Fagerberg and Srholec (2008).

development (Bernardes and Albuquerque, 2003).<sup>7</sup> Thus, at low levels, countries have such low levels of scientific output that no technological production results. This is not to say that investments in science by poor countries are a waste of money. Almost by definition, poor countries start at low levels. The issue is that such low levels must be seen merely as a stepping stone to successively higher levels of investment, simply because “a little bit of science” is unlikely to generate even “a little bit of technology”. At medium levels, interactions and feedbacks between the two start to materialize. At high levels, all connections are operative. An important conclusion of this work is that there are thresholds between these various levels

which move over time. This means that countries with ambitious STI agendas effectively shoot at moving targets, in the sense that the technological achievements of the world constantly progress and thus become harder to catch up to, unless national efforts are dynamic as well. Figure A.2.2 illustrates the three levels of interaction by drawing on data for 150 countries for USPTO-registered patents and papers in the hard and applied sciences recorded in the Thomson Reuters ISI database. The first group shows no correlation between scientific and technological output. Interactions are stronger in the second group, and highest in the third group.

Figure A.2.2 The three phases of catch-up

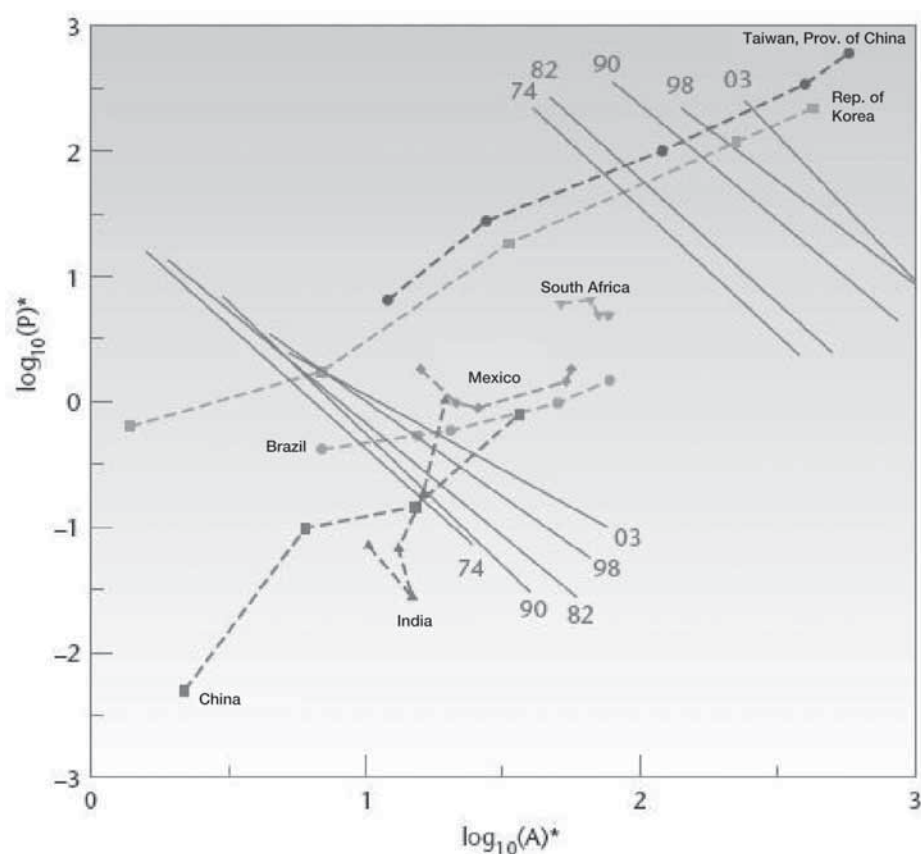


Source: Ribeiro et al. (2006).

Figure A.2.3 illustrates the idea of moving thresholds between levels 1 and 2, and 2 and 3, respectively, for a number of prominent latecomer economies. Only the Republic of Korea and Taiwan Province of China

advanced faster than the thresholds themselves, while all others progressed, but not fast enough to graduate out of level 2 and into level 3.<sup>8</sup>

Figure A.2.3 Scientific and technological production



Source: Ribeiro et al. (2006).

## NOTES

<sup>1</sup> NEPAD (n.d.). See also NEPAD (2003).

<sup>2</sup> For example, Juma and Serageldin (2007).

<sup>3</sup> See also Mouton and Waast (2008).

<sup>4</sup> New views on this may be forthcoming as a result of a global research project on the developmental role of universities in the South (funded by Canada's International Development Research Centre under its Research on Knowledge Systems (RoKS) programme), which includes Nigeria, South Africa and Uganda.

<sup>5</sup> Cf. Watkins and Ehst (2008), World Bank (2007).

<sup>6</sup> For the full exposition, see Fagerberg and Srholec (2008).

<sup>7</sup> See also Chaves and Moro (2007).

<sup>8</sup> See Ribeiro et al. (2006) for a full exposition.



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