CENTERS OF EXCELLENCE IN SCIENCE AND TECHNOLOGY FOR AFRICA'S SUSTAINABLE DEVELOPMENT
Towards New Forms of Regional and Sub-Regional Networks

INTRODUCTION[1]

One of the preconditions for national and regional economic competitiveness as well as sustainable development is the emergence and growth of institutions dedicated to scientific research and technological innovation. Institutions devoted to research and technological innovation are the bedrock of a modern knowledge economy. They are indeed vital parts of the cognitive structure of any economy that gets well integrated into the rapidly globalizing system. Thus, for African countries to effectively respond to the forces of globalization and achieve sustainable development goals articulated in the New Partnership for Africa's Development (NEPAD), the Plan of Implementation of the World Summit on Sustainable Development (WSSD) and the Millennium Development Goals (MDGs), they need to build and/or strengthen institutions for Research and Development (R&D).

NEPAD explicitly recognizes this: that Africa's economic renewal and sustainable development will not be achieved without effective and efficient R&D institutions. Through NEPAD African countries wish to establish networks of "centres of excellence, especially through the Internet, for cross-border staff exchange and training programmes, … and researchers." Building such networks is one of the most significant ways of pulling Africa's scientific and technical resources together to address shared or common regional R&D challenges and related priorities.

This paper provides a conceptual framework and general policy guidance for translating into concrete actions NEPAD's aspiration to build networks of centers of excellence. It draws on a number of recent studies on issues pertaining to institutional change and development, with emphasis on ways and means to build scientific and technological research institutions in developing countries. The paper outlines some of the generic characteristics of an institution that may be conceived of as a centre of excellence in scientific research and technological innovation. A set of process and policy issues as well as specific activities are suggested to constitute NEPAD's programme on networks of centres of excellence.

1. INSTITUTIONS FOR R&D IN AFRICA: OVERVIEW OF CAPACITY BUILDING CHALLENGES

1.1 Traditional approach of institutional building

For many years African countries have been preoccupied with the search for measures to build and strengthen their R&D institutions. Based on their national aspirations to grow and sustain institutions of world-class category in the pursuit for scientific and

[1] This paper was prepared by Dr. John Mugabe of NEPAD for the African Ministerial Conference on Science and Technology for Development

technological development, many of the countries have experimented with different approaches of institutional building. A significant amount of national and international resources have gone into establishing national R&D institutions in the region.

In many cases these efforts have focused on structural and 'hardware' aspects of institutional building. Technical and financial resources have been expended on physical infrastructure such as buildings (brick and mortar) and some equipment. This supply-oriented approach has taken the form of installing modern equipment and training some scientists and technicians by using 'international' consultants. The expectation of many governments and the scientific community has been that with modern buildings, some core group of scientists and with equipment, these institutions would naturally grow into centres of excellence. Possibly, with some luck, this approach may have generated institutions of international standing in some African countries. In many cases, however, it left behind organizational entities that are not capable of responding to domestic and international demands. Establishing physical infrastructure and training of scientists have not generated effective and efficient institutions: those that adequately respond to scientific and technological developments in such ways as to address national and international goals and challenges.

These efforts of building R&D institutions were informed by the view that what African countries lack are modern laboratories, scientists and equipment. Once these are supplied to them by donors, they would naturally get centres of excellence. This supply-oriented approach has continued to influence public policy and political discourse on building R&D institutions in Africa. It has also had it mark on academic studies and evaluation of R&D institutions. In this respect, emphasis by scholars and evaluators has tended to be on inputs—how many scientists? how big and modern the laboratories are? What are the annual budgets? etc. It is not uncommon to hear some policy-makers' statements or to read evaluations that give certain national R&D institutions 'centre of excellence' status simply because they have more scientists, more money and more modern equipment.

There are at least two weaknesses of this supply-oriented approach to institutional building. The first is it reduces R&D institutions into their physical pieces or components. The approach largely ignores *intra and inter-organic links*, biological and social, that influence any agency's evolution and growth into a stable and productive organization. It treats the R&D institution as asocial inorganic enterprise. Each R&D institution is treated as if it is an isolated entity: not part and parcel of a national (or even an international) system of innovation.

Secondly, the supply approach takes do not give attention to whether an R&D institution has and properly articulates a sustainable development *purpose*. Number of persons and possibly size of programmes in the institution matter irrespective their relevance to the national and/or international purpose. It does not focus on utilization of and outputs from scientific resources. This approach tends to restrain policy-makers and the general public from questioning whether R&D institutions are responsive to and responsible for sustainable development goals.

The supply approach has given many African countries R&D institutions that have limited, if any, impacts on national economic change and sustainable development. Institutional arrangements that have emerged in these countries have poor linked and relevant to national development. They tend to characterized organizational inefficiencies and policy coordination problems, poor choice of research projects and short-term and insufficient funding.[2]

Many African R&D institutions are now facing major challenges arising with globalization and liberalization of economies, rapid technological change, and increasing private sector investment in R&D. To meet these challenges they will need to acquire new forms of capabilities. They will need capabilities to understand changing policy contexts and to align their research programmes with sustainable development agends. Such capabilities are multidisciplinary in nature. However, in many countries the R&D institutions lack multidisciplinary orientation and tend to narrowly focus around scientific areas.

There are now renewed efforts to rethink approaches of organizing and building of R&D institutions in Africa. These are stimulated by a growing realization that many of these agencies are not configured in such ways as to focus on and contribute to the attainment of sustainable development. In South Africa for example, the Council for Scientific and Industrial Research (CSIR) established at least 50 years ago to conduct basic and applied research has not adequately focused on national economic growth and poverty reduction goals. In the past years the CSIR's mission did not require it to conduct research that explicitly supports development and transfer of technologies to rural economies. Its agenda has largely been around research and innovation for private industry. There are now efforts to reform the CSIR to focus its research and innovation programme more explicitly on sustainable development goals. The Department of Science and Technology (DST) is spearheading this reform agenda through the new National R&D Strategy. It is providing financial resources and policy guidance to the CSIR to develop and implement poverty reduction orientated research and innovation activities.

A similar case is the Kenya Industrial Research and Development Institute (KIRDI). KIRDI was established to conduct research for industrial change and development. During the 1970s and 1980s it was endowed with scientific infrastructure and human resources. It attracted financial resources from the government, international donors and the United Nations Industrial Development Organization (UNIDO). KIRDI has joint projects with the University of Nairobi and other research bodies. However, it does not have strong links to local and foreign industrial firms. Over the past decade or so it has lost a good number of high cadre scientists to private companies and research institutes abroad. Today there is discussion, at least within the Ministry of Trade and Industry, of

[2] UNCTAD, 1990. *R&D Institutes in Developing Countries and their Contribution to Technological Innovation: A Synthesis Report*. UNCTAD/ITP/TEC/11, Geneva, 1990

how to reform and re-orientate the Institute to focus on Kenya's industrialization challenges.

The above cases should not be read as those of institutional failure. They are provided to point out that there are efforts to reform R&D institutions in some African countries to ensure that these institutions become more and more relevant to national and international sustainable development agendas. But on the whole, most of the efforts to build R&D institutions in many African countries have failed to generate 'centres of excellence'. This is manifested in the low and declining levels of scientific and technological development, relocation of high cadre scientists ('brain drain') to other regions of the world, limited and declining scientific publications output, low and declining patent intensity, weak links between industrial production and research, and loss or erosion of public confidence in R&D institutions.

This situation—the low and deterioration of scientific and technological status—in many African countries led some international agencies and donors to establish programes to build 'new centres of excellence'. For example, since the late 1980s the United Nations Educational, Scientific and Cultural Organization (UNESCO) has organized a series of workshop and studies on 'centers of excellence'. A number of donors, for example the Swedish International Development Cooperation Agency (Sida), have also been rethinking their approach to institutional building. Sida has recently started to focus more on an output-oriented approach where funding does not target isolated projects and training activities, but long-term institutional reform and management. An example of a Sida funded institutional building experiment is the Biotechnology for Eastern African Programme (BIOEARN) which is building a network of research activities in universities in Ethiopia, Kenya, Tanzania and Uganda. Its overall goal is to create both *policy conditions* and scientific infrastructure for cutting edge biotechnology R&D in these countries. It promotes sharing of experts and facilities among institutions participating in the network and training of scientists in these institutions.

1.2 New African Initiatives on Centers of Excellence: Some Examples

In addition to the institutional reforms being proposed and undertaken in a number of African countries, there are also new initiatives to build large centers dedicated to specific scientific research and technological innovation goals. These initiatives include the African Institute of Space Science (AISS), African Laser Centre (ALC), African Virtual University (AVU), the Bioscience Facility for Eastern and Central Africa, and Square Kilometre Array (SKA).

The African Institute of Space Science

The AISS is initiative is aimed at networking existing space science activities and facilities into a coherent network that focuses on frontier science for Africa's development. The idea of AISS emerged from at a workshop of astronomers and space

scientists to discuss the future of astronomy and space science in South Africa.[3] One of the emerging themes of the workshop was that greater collaboration within Africa and other South-South collaboration would strengthen not just South Africa's but the continent's scientific and technological capacity in space science. A regional initiative could harness space science for the development of Africa without crippling investments for any individual country.

The AISS would exploit a wide range of potential applications of space science in addition to the usual satellite applications such as meteorology and remote sensing. High-bandwidth communication by satellites would generate such benefits as like radical improvements in the delivery of health services and education, and quality education at remote locations. Satellite navigation systems would benefit economic development and tourism in many African countries. To take advantage of and maximize of comparative advantages of various African countries, the AISS will be organized a networked distributed operational centres based on existing facilities with nodes across the continent.

The Bioscience Facility for Eastern and Central Africa

The Bioscience Facility for Eastern and Central Africa is a new initiative endorsed by NEPAD's Steering Committee is to support Eastern and Central African countries to develop and apply bioscience research expertise to produce technologies that help poor farmers to secure their assets, improve their productivity and income and increase their market opportunities. It will aim at providing a focal point for the African scientific community to support the activities of national, regional and international agencies as they address agriculturally related problems of the highest priority for alleviating poverty and promoting development on the continent.

The research conducted by this Facility will focus on problems that can be addressed by biological research, that are especially important to the poor in the region, and that are not being investigated by research institutions or the private sector in the developed world. Examples of regional priorities include production of stress-tolerant, disease-resistant or nutritionally enhanced cultivars of crops that are the mainstay of poor farmers but of little or no importance to Western farmers or multinational agribusinesses. Many diseases killing the crops and livestock of the poor are neglected by the R&D community. Control of livestock diseases requires development of vaccines and diagnostic tests and better use of indigenous breeds possessing genetic resistance to disease. No vaccines or diagnostic tests currently exist for some of the most nutritionally and economically devastating diseases of livestock in the region; other diseases are being inadequately controlled by crude technologies, some with undesirable effects, such as environmental pollution.

State-of-the-art research laboratories for the biosciences, including genomics and proteomics and containment facilities for safe genetic manipulation of plants (e.g.,

[3] See www.nrf.ac.za

development of improved varieties) and micro-organisms (e.g., for vaccine development), and safe handling of pathogens used in the research programmes. A key institutional challenge is to find ways that permit effective sharing of the Biosciences Facility among countries and partners in the region. Sharing expensive facilities make great sense for the poorest continent on earth but there are few existing models to signpost how to achieve this. This Facility may foster innovations generating greater collaboration among Africa's research systems, advanced biosciences institutions worldwide and the private sector.

The Biosciences Facility will be hosted by existing research institutions, with refurbished laboratories of the International Livestock Research Institute's (ILRI), in Nairobi, Kenya, at the centre of the hub, greatly reducing the need to invest in new buildings and infrastructure. Transaction costs will be kept to a minimum by obtaining support services from the host institution rather than establishing a new administrative structure. Building on an existing institute will also help in the immediate provision of the diverse research management, technical expertise and support services required to do strategic biosciences research.

The Facility will be open to all qualified institutions and individuals. It will focus initially on a handful of projects helping to resolve high-priority problems identified by national and regional organizations. Projects may originate from individual scientists within universities or national research organizations, and regional organizations. International consortia and the private sector will be encouraged to use the facilities and work together with African scientists and their institutions to address the agreed research priority issues.

Establishment of the Biosciences Facility has been made possible by an investment of more than US$21 million by the Canada Fund for Africa through the Canadian International Development Agency (CIDA). The Rockefeller Foundation, the Gatsby Charitable Foundation and the Syngenta Foundation have expressed interest in funding regional consultations and the design of the Facility. The Doyle Foundation funded the concept development phase.

The Square Kilometer Array (SKA)[4]

The SKA is an initiative to develop a telescope to provide two orders of magnitude increase in sensitivity over existing facilities at metre to centimetre wavelengths. To achieve this goal will require a telescope with one square kilometre of collecting area - one hundred times more collecting area than the Very Large Array. The Square Kilometre Array (SKA) would probe the gaseous component of the early Universe, thereby addressing fundamental questions in research on the origin and evolution of the Universe. The SKA would complement planned facilities at other wavelengths.

[4] Source: www.nrf.ac.za and www.dst.gov.za

It will be an interferometric array of individual antenna stations, synthesizing an aperture with diameter of up to several 1000 km. A number of configurations are under consideration to distribute the 10^6 square meters of collecting area. These will include 30 stations each with the collecting area equivalent to a 200 metre diameter telescope, and 150 stations each with the collecting area of a 90 m telescope. Approximately 50% of the array is to be contained within a centrally-condensed inner array to provide ultrahigh brightness sensitivity at arc-second scale resolution for studies of the faint spectral line signatures of structures in the early Universe. The outrigger stations will provide a ten to one hundred-fold increase in angular resolution to allow high resolution imaging of faint emission from the interstellar media of distant galaxies, as well as the surface of stars, and the active nuclei of galaxies

1.3 New International Initiatives: The Canadian and Nordic Cases

Canada has a number of national efforts to establish national and international networks of centres of excellence. These include the Canadian Networks of Centres of Excellence (NCE) programme that has been operating since the 1990s. NCE is unique range of relatively mature and organic partnerships among universities, industry, government and non-governmental organizations that focus on conducting and training scientific research and entrepreneurial capacity into tangible economic and social benefits for all Canadians and the country's economic competitiveness. NCE is integrated into Canada's Innovation Strategy and funded to the tune of $77.4 million per year.

By end of 2002, at least 700 companies, 200 provincial and federal government departments and agencies, 60 hospitals and 150 universities from Canada and abroad were involved in the NCE programme. The active involvement of Canadian industry provides stimulate employment opportunities for university students and ensures that universities conduct research that is relevant to economic production goals. In fact, about 84 percent of network graduates are successful at finding jobs. In 2001-2001 industry contributed about $44 million to NCE activities.

NCE mobilizes and networks distinguished scientists with peer reviewed scientific outputs. It creates centres for these scientists to work together on common national research projects. These centres are networked, often virtually, to assemble a critical mass of scientific capacity to address strategic research questions that vital to Canada's sustainable development. Together, the centres are capable of achieving more than the sum of their individual efforts.

Another initiative is the Canadian International Network for Development and Development (CINDI) that is being established by a group of eminent Canadian scientists. It is proposed to be a strategic alliance of Canadian and international partners to generate scientific and technological solutions for sustainable development needs. CINDI is intended to mobilize and strengthen Canada's scientific and technological innovation capacity to address global problems and to position Canada as an international leader in research for global development. A key goal of the initiative is to mobilize and enable young Canadian scientists to engage in science and technological research for the benefit of developing countries. It will concrete on three convergent technological areas:

nanotechnology, biotechnology and information technology. Emphasis of research and innovation will be on water, energy, health, agriculture and biodiversity (WEHAB).

In addition to the Canadian, other efforts at establishing networks of centres excellence are the Nordic networks being established across the Scandinavian countries. These involve Denmark, Norway, Finland and Sweden.

> Many …Scandinavian researchers find themselves in …situation(s), being driven together by varying degrees of serendipity, proximity and necessity. Of these, necessity is perhaps the dominant force. Norway, Denmark, Sweden and Finland are physically large, but have small populations and limited resources. Over the past decade, each has built up research networks within its own borders in an effort to maximize what they have. More recently, the countries have turned their attention to their neighbours, seeking to create formal and informal connections with each other, and with nations beyond Scandinavia—particularly in the Baltic region. …Scandinavian researchers are finding success by building networks from the bottom up—relying on informal collaborations as the basis for bigger endeavours. …Without good communication and coordination, duplicated efforts can trump any benefit of interacting and waste any gains that might have resulted from sharing resources or infrastructure.[5]

The three above cases demonstrate how countries are increasingly reorganizing and building new forms of institutional arrangements to maximize benefits of scientific research and technological innovation at both national and international levels. They talk to the need for collaborative arrangements or networking to ensure that scarce intellectual and physical resources are shared and efficiently used in R&D. Such arrangements evolve as a result of clear and deliberate policies of governments, informal and formal networking among scientists, commitment of adequate financial resources on predictable basis, and determination by countries to make their research facilities available to their neighbours' scientists. Often they require guidance and involve learning on the part of countries, institutions and researchers involved.

2. Features of Centres of Excellence and Related Networks

2.1 Conceptual Issues

The above exploration has shown that designing R&D institutions to achieve excellence in scientific and technological activities is a knowledge based and intensive process. Building R&D institutions is a gradual process of experimentation with different approaches. However, countries need to have clear indicators or benchmarks to determine whether their R&D institutions are moving to or have acquired excellence status.

[5] Smaglik, P. 2002. 'Building Nordic Networks'. Nature, Vol. 420, 12 December 2002. www.nature.co./nature

A number of indicators have been proposed by various studies. In this paper we propose the list developed in a recent paper by Araoz, A. (2003). These are listed below:

Indicators of performance for a Center of Excellence

(1) Indicators for scientific outputs

- Number of publications, weighted by the 'impact factor' of the review
- Number of patents, national and international; % international
- % of projects devoted to themes of sustainable development such as environmental protection, material and energy saving, occupational hazards, etc.
- Level of scientific excellence, as determined by an external evaluator on the basis of peer judgment (qualitative, A to E)
- Relevance to the building of capability in the institute, as determined by an external evaluator (qualitative, A to E)
- Level of support given to production of services, as determined by an external evaluator (qualitative, A to E)

(2) Indicators for output of services

- Number of clients and % annual growth in the 'users' and 'Government' categories
- Volume of revenues and % annual growth in the 'users' and 'Government' categories
- Volume of revenues and % annual growth in R&D and non-R&D services
- Volume of revenues and % annual growth from international clients
- % of value of services related to sustainable development in total volume of revenues
- % of value of services related to employment creation in total volume of revenues
- Satisfaction of clients in the Users and Government categories, established through a survey (qualitative, A to E)
- Satisfaction of societal beneficiaries, established through a survey (qualitative, A to E)

(3) Indicators for capability building

(a) Human resource development

- % of scientists with 1 week or more of training in advanced areas
- % of scientists undergoing training for a higher degree
- Satisfaction of scientists regarding opportunities for personal development, established through a survey (qualitative, A to E)

(b) Networking

- Number of quality institutions actively interacting with the institute (exchange of personnel, exchange of information, joint activities, etc.) at home and abroad
- Number of scientific events attended, at home and abroad
- % of institute's budget devoted to interactions, at home and abroad

(c) Relationships with Government and funding agencies

- Appraisal of relationships, as determined by an external evaluator (qualitative, A to E)

(4) Indicators for delivery system/business development

- % of income from clients in total budget

- % of selling costs (cost of delivery system/business development) in total budget
- % of selling costs in total income from clients
- % of costs of developing awareness (market research, advertisement, brochures, exhibitions, personal contacts, presentations, Internet, etc.) in total income from clients
- % of repeat clients in total clients
- Number of new service areas inaugurated

(5) Indicators for management

(a) Personnel management

- Remuneration of scientists (base salary plus incentives) at entry level and senior level. Comparison with remuneration in non-R&D sectors
- % turnover of scientists (should not be too high or too low)
- Staff satisfaction with working conditions, established through a survey (qualitative, A to E)

(b) Financial management

- Appraisal of quality of financial management, as determined by an external evaluator (qualitative, A to E)

(c) Project management

- % of projects delivered on time
- % of projects delivered within project budget
- Appraisal of methods used to manage projects, as determined by an external evaluator (qualitative, A to E)
- Degree of autonomy at project leader level (forming the team, deployment of personnel, financial commitments, relations with client, etc.), as determined by an external evaluator (qualitative, A to E)

(6) General indicators of performance for the institute

- % growth of budget
- % growth of staff
- % growth of client income in budget
- Number of national missions/assignments in which the institute is involved
- Number of scientists that have received national and international awards
- Number of scientists in international committees, boards of journals, etc.
- Satisfaction of government and its agencies with institute's excellence and performance, established through a survey (qualitative, A to E)
- Satisfaction of industry with institute's excellence and performance, established through a survey (qualitative, A to E)

This paper suggests that African countries should consider and use such indicators in their national and regional efforts to develop centres of excellence. The indicators show that a centre of excellence is an institution that is making impact—effectively and efficiently solving or contributing to the solution of specific problems. To qualify as a center of excellence an institution should have achieved demonstrable high levels of

scientific productivity and innovation on the basis of agreed upon standards. It should have developed structures and activities oriented to build capacity. "This may be understood as the ability to (i) improve the quality of human resources through training and the work involved in producing excellent scientific outputs, (ii) enlarge the access to knowledge through networking with the international scientific community and other means, and (iii) relate to funding sources that may support expansion and upgrading. The possession of a satisfactory competence in capability building is a necessary characteristic if the institute is to keep up its level of excellence and improve on it."[6]

3. TOWARDS A NEPAD PROGRAMME ON CENTRES OF EXCELLENCE

For decades now, many African countries have been building and/or investing in R&D institutions. In such areas as agriculture, medicine, fisheries and meteorology, national institutions and programmes have been established. Some of these institutions and programmes have attracted national and international support, and may have made pronounced contributions to Africa's sustainable development. However, in many cases they have operated as isolated initiatives with limited relevance to national and regional needs. They have continued to articulate interests of small groups of scientists often with peripheral linkages to economic production and policy-making in the region.

In a variety of new fields African countries have tended to create and/or invest their limited human, organizational and financial resources in short-term programmes often on ad hoc basis. Resources are spread so thinly to that no meaningful contributions are to national and regional development. For example, in the area of biotechnology the tendency in the region is for each country to have its own agency and programmes even where such efforts address similar problems and where resources could be pulled together to focus on shared R&D opportunities. The spreading of resources around narrowly defined national interests has denied Africa from growing centres of excellence. In such areas as ICT many of the countries may not have resources to develop and sustain centres for world-class science and technology.

It has now become clear that in new areas of science and technology, African countries can achieve significant levels of development and innovate for sustainable development if and when they mobilize and direct their differentiated capabilities to common R&D challenges. Essentially, it is meaningful for countries to build their individual scientific and technological capabilities through agencies and programmes that consolidate and sharply focus their resources on common well-defined problems or agendas.

NEPAD and the Plan of Implementation Agenda 21 adopted at the WSSD recognize the establishment of networks of centres of excellence as one of the best ways and means of strengthening the continent's scientific and technological development. Such networks

[6] Araoz, A. 2003. 'R&D Centers of Excellence as Instruments for Development'. Draft Paper for the Centre for International Development (CID), Harvard University.

would offer the loci for mobilizing regional resources to confront and solve common sustainable development problems. It is also through such networks that countries can maximize technological learning.

The networks of centres of excellence should have clear objectives in line with regional sustainable development goals and needs. They will be able to attract stable, adequate and predictable funding from variety of sources including sales of their services to public and private sectors. In addition, they should be endowed with up-to-date equipment, information facilities, management systems, and strong and dynamic links to international science bodies and private sector clientele. They should be designated as African/NEPAD millennium science and innovation centres.

NEPAD's Programme on Networks of Centres of Excellence would aim aimed at providing intellectual guidance and political support to sub-regional and regional efforts to establish networks of centres of excellence within the framework of NEPAD. It will be a source of policy guidance to NEPAD's and other regional initiatives on centres of excellence. Through research and consultative processes, NEPAD will:

(a) Develop features or characteristics of centres of excellence and then assess the extent to which existing selected networks and centres in Africa fit the descriptions.
(b) Draw lessons from Canada's and European Union's experiences in developing knowledge networks or centres of excellence.
(c) Design and Implement measures to effectively engage existing centres of excellence in the implementation of NEPAD's programmes.

To achieve the above objectives, NEPAD in collaboration with competent regional and international institutions will:

(a) Undertake a study to provide conceptual understanding of what constitutes a centre of excellence and the specific areas/fields of sustainable development in which such centres should be considered for strengthening and/or creation. The paper will draw lessons from experiences of OECD, EU, Canada and other groups that have establishing world-class shared science facilities for groups of countries or federal regions. It will suggest specific ways of creating sub-regional and regional networks in Africa.
(b) Develop draft guidelines for identifying, developing, reviewing and evaluating large regional S&T facilities and networks of centres of excellence in Africa.
(c) Submit the background study and proposed guidelines to the ministerial conference and seek adoption of guidelines and key decisions on how best to engage in the creation of networks of centres of excellence.
(d) Prepare a data bank and profiles of large science facilities in Africa—an extensive exercise will be conducted to identify existing science laboratories that offer opportunities for regional cooperation in specific areas. A team of experts will be selected to visit countries and conduct the exploration/profiling of science

facilities on the basis of terms of reference generated by the first study and adopted at the first ministerial conference on science and technology.