AFRICA'S SCIENCE AND TECHNOLOGY CONSOLIDATED PLAN OF ACTION

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ACRONYMS

ADB	African Development Bank
AEC	African Economic Commission
AISI	African Information Society Initiative
AMCOST	African Ministerial Council for Science and Technology
APRM	African Peer Review Mechanism
ASIF	African Science and Innovation Facility
AU	Africa Union
AVOIR	African Virtual Open Initiative and Resources
AVU	African Virtual University
CBD	Convention on Biological Diversity
COMESA	Common Market for Eastern and Southern Africa
CSSDA	Conference on Security, Stability, Development and Cooperation in Africa
DST	Department of Science and Technology
EAC	East African Community
ECOWAS	Economic Commission of West African States
GDP	Gross Domestic Product
GEANT	Pan-European Data Communications Network
GMOs	Genetically Modified Organisms
HDR	Human Development Report
HRD	Human Resources Development
HRST	Human Resources, Science and Technology
HSGIC	Heads of State & Government Implementation Committee
ICT	Information & Communications Technology
IDRC	International Development Research Center
IK	Indigenous Knowledge
LPA	Lagos Plan of Action
MDGs	Millennium Development Goals
NEPAD	New Partnership for Africa's Development
NIS	National Innovation System
OAU	Organization of African Unity
OECD	Organization for Economic Co-operation and Development
PRC	Permanent Representative Committee
PPP	Public-Private Partnership
RECs	Regional Economic Communities
SADC	Southern Africa Development Community
S&T	Science and Technology
SMEs	Small & Medium Enterprises
UNECA	United Nations Economic Commission for Africa
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization

INTRODUCTION

This plan of action consolidates science and technology programmes of the African Union (AU) Commission and the New Partnership for Africa's Development (NEPAD). It is the instrument for the implementation of the decisions of the first African Ministerial Conference on Science and Technology held in Johannesburg, South Africa in November 2003. It gives practical meaning to the decision of Second Ordinary Session of the Assembly of the AU held in July 2003 in Maputo, Mozambique to integrate the NEPAD Programme into the AU structures and processes. [Assembly/AU/Decl. 8(II)].

The plan of action has evolved from a series of continental and regional workshops. In February 2003 the Secretariat of NEPAD and the Department of Science and Technology (DST) of the Republic of South Africa organized a regional workshop on "Developing a Shared Platform for Science and Technology Development." This workshop identified specific programmatic issues and areas that would form the focus of further dialogue. It recommended that a high-level African ministerial conference be convened and a forum—the NEPAD Science and Technology Forum—be established to promote further dialogue and build strong constituencies for science and technology. The NEPAD Science and Technology Forum was then created and focused on mobilizing experts, civic groups and policy-makers to prepare for the ministerial conference.

The November 2003 African Ministerial Conference on Science and Technology, organized by the NEPAD Secretariat with the support of DST and the United Nations Education, Scientific and Cultural Organization (UNESCO), adopted an 'Outline of a Plan of Action' containing twelve flagship programme areas and specific policy issues. It also established the African Ministerial Council on Science and Technology (AMCOST) and its Steering Committee for Science and Technology as the overall governance structure for setting continental priorities and policies pertaining to the development and application of science and technology for Africa's socio-economic transformation. The Conference stressed the urgency of building the continent's capacities to harness, apply and develop science and technology in order to eradicate poverty, fight diseases, stem environmental degradation, and improve economic competitiveness.

The 'Outline of a Plan of Action' has been elaborated to focus on specific projects and concrete actions. This has been done through workshops held in each of the five regions between November 2004 and March 2005. In addition experts' consultations and studies on key issues have been conducted to provide a rich technical base for the programmes and projects. These efforts generated by NEPAD and the AU Commission's 2004-2007 Strategic Plan for Human Resources, Science and Technology form Africa's Consolidated Science and Technology Plan of Action.

This 'Consolidated Science and Technology Plan of Action' articulates Africa's common objectives and commitment to collective actions to develop and use science and technology for the socio-economic transformation of the continent and its integration into the world economy. It is erected on three interrelated conceptual pillars. These are: (a) capacity building (b) knowledge production, and (c) technological innovation. Capacity building in this context refers to the creation, improvement and mobilization of human skills, physical infrastructures, financial resources and the necessary policies for science and technology to be produced and used to solve specific African problems. Knowledge production is really about the conduct of science—the generation of scientific and technical knowledge about Africa's problems and identification of specific ways to solve the problems. This is what is often referred to as R&D. Technological innovation entails the generation of specific products, processes and services.

The Plan of Action puts emphasis on developing an African system of research and technological innovation by establishing networks of centers of excellence dedicated to specific R&D and capacity building programmes. It complements a series of other AU and NEPAD programmes for such areas as

agriculture, environment, infrastructure, industrialization and education. It is organized as follows. The first two sections provide the overall socio-economic context, common goals and criteria for identifying and developing the programmes and their projects. The third section is about flagship R&D programmes while the fourth describes programmes dedicated to improving policies and institutions. The last section deals with the nature of institutional arrangements and financial mechanisms for implementing the Consolidated Plan of Action.

SECTION 1: BACKGROUND

1.1 Africa's Development Challenges and Opportunities

African countries made a bold attempt to turn around their development fortunes by adopting in July 1979, the Monrovia Strategy and in April 1980, the Lagos Plan of Action (LPA) for the Economic Development of Africa 1980–2000 and the Final Act of Lagos. The LPA was a visionary, far-reaching and unprecedented blueprint on how to foster collective self-reliance and sustainable development of the continent. Subsequent attempts at charting Africa's development have drawn inspiration from that visionary framework. Despite these efforts, Africa remains the poorest and economically marginalized continent in the world.

A key challenge to the realization of the vision and goals articulated in the LPA and subsequent socio-economic development frameworks has been that of implementation of specific policies and programmes. The continent has continued to rely on external financial support often targeting short-term activities and solutions. It has taken a short-term view of human development and failed to accord adequate attention to the sources of economic change and sustainable development. In this respect, science, technology and innovation have not been given serious attention as engines of long-term development. This is demonstrated by, for example, low and declining public expenditure on research and development (R&D) in most countries as well as weak or a lack of links between industry on one hand and science and technology institutions on the other. Research results of public R&D activities do not often get accessed and used by local industries, particularly small and medium-scale enterprises (SMEs). In many cases there is mismatch between R&D activities and national industrial development goals and strategies.

A number of African countries formulated their science and technology policies in the 1970s and 1980s when development imperatives and technological opportunities were different. Many of the policies are focused on organizational aspects and not on programmatic issues. A viable science and technology policy has to be "underpinned by well-designed measures for addressing issues such as learning, technology, technology diffusion, transfer, research and development (R&D)" (Report of the Millennium Project 2004, page 19). A wave of legislative action also resulted in a considerable rise in the number of research institutions conducting, in most cases, exclusively basic research. A 1974 UNESCO survey reported that the number of research institutes in African countries grew from a few hundred in 1963/64 to over 2,000 in 1969/70 with a research work force of about 11,000 which came out to be an average of 5.5 workers per institute and most of the research institutes were concentrated in 19 of the 34 countries covered. Throughout the 1980s and 1990s, science and technology received low priority despite considerable empirical evidence from South-East Asia and other regions showing that investment in science and technology yields direct and indirect benefits to national economies.

Africa's low investment in science and technology is also manifested in declining quality of science and engineering education at all levels of educational systems. Student enrolment in science and engineering subjects at primary, secondary and tertiary levels is also falling. The continent is also loosing some of its best scientific and technical expertise to other regions of the world. In many countries infrastructure for R&D has been neglected and is decaying. Institutions of higher education, particularly universities and technical colleges, are in urgent need of renewal after many years of neglect and disorientation from local and national priorities.

1.2 New Sources of Optimism and Action

In September 2000 African countries and the international community adopted the Millennium Development Goals (MDGs) at the United Nations Millennium Summit. They committed themselves to seek and take practical solutions to major challenges of global poverty and insecurity facing majority of the world's population, especially those in Africa. The MDGs are:

Goal 1: Eradicate extreme poverty and hunger;
Goal 2: Achieve universal primary education;
Goal 3: Promote gender equity and empower women
Goal 4: Reduce child mortality;
Goal 5: Improve maternal health;
Goal 6: Combat HIV/AIDS, malaria and other diseases;
Goal 7: Ensure environmental sustainability;
Goal 8: Develop a global partnership for development.

The MDGs are international standards for tracking human development. Their attainment will require reorientation of development policies and programmes to focus on long-term sources of economic change and growth. This will need to explicitly take into account the role of science and technology in socio-economic transformation. Countries will need to design and implement policies as well as create institutional arrangements that promote the development and application of science and technology to solve specific problems around each of the goals. The role that science and technology play in the attainment of the MDGs is implicit in the Millennium Declaration adopted by the Heads of States. In the Declaration, the international community committed itself to "take special measures to address the challenges of poverty eradication and sustainable development in Africa, including debt cancellation, improved market access, enhanced Official Development Assistance and increased flows of Foreign Direct Investment, as well as transfers of technology."

Science and technology issues have acquired increasing attention of the international community. For example, the Johannesburg Plan of Implementation adopted by governments at the World Summit on Sustainable Development (WSSD) is largely about the role of science and technology in meeting sustainable development goals. Many of its recommendations are about mobilizing and directing science and technology to solve problems associated with energy deficiency, food insecurity, environmental degradation, diseases, water insecurity and many other sustainable development challenges. The Plan calls on the international community to [p]romote technology development, transfer and diffusion to Africa and further develop technology and knowledge available in African centres of excellence; and [s]upport African countries to develop effective science and technology institutions and research activities capable of developing and adapting to world class technologies."

In its report, *Our Common Interest*, the Commission for Africa devotes attention to the importance of building Africa's scientific and technological capacities. It makes recommendations on building and/or strengthening centers of excellence in science and technology as well as higher education institutions in Africa. The Commission specifically recommends that AU and NEPAD in collaboration with UNESCO should set up a high-level working group to complete a detailed programme on centers of excellence for implementation by December 2005, building on the NEPAD mapping of science and technology capacity. International donors, partners from southern nations such as India and Brazil, the World Bank, and other national and regional stakeholders should be involved. Improved co-ordination in Africa should be matched by co-ordination amongst international donors. The programme needs to be rolled out to capitalise on existing strengths, to address gaps and ensure that investments in physical and human capital are sequenced.

The G8 group of industrialized countries has also put science and technology high on its development agenda for Africa. Its last Summit in Gleneagles, Scotland issued a communiqué containing statements on the group's commitment to support the development of "centres of excellence" in science and technology in Africa. Such centres would be network within the continent as well as promoted to establish links to those outside.

At continental, regional and national levels, African countries and their leaders have begun to accord priority to science and technology as important factors in efforts to attain MDGs and transform

Africa's economies. They recognize that without investments in science and technology the continent will stay at the periphery of the global knowledge economy. This recognition is manifested in the kinds of new institutional arrangements and programmes that African countries are establishing.

1.3 A New Institutional Framework

The adoption of the Abuja Treaty in 1994 on the establishment of an African Economic Community (AEC) for the economic integration of Africa, constituted an important and forward looking act by the African Heads of State and Government. The 14 major regional economic groupings in the continent were to constitute the building blocks of the Community. The abolition of the Organization of African Unity (OAU) and the creation of the African Union (AU) in Lusaka, Zambia in July 2001, with the objective of accelerating the implementation of the Abuja Treaty, also constituted a renewed commitment of African political leaders to the socio-economic advancement of the Continent. The vision of the AU is to "build an integrated, prosperous and peaceful Africa, an Africa driven and managed by its own citizens and representing a dynamic force in the international arena". The Constitutive Act of the AU made provisions for the following organs and Continental Institutions in accordance with the stipulations in the Abuja Treaty and the Sirte Declaration on the creation of the AU: The Assembly of the Union; The Executive Council; The Pan-African Parliament; The Court of Justice; The Permanent Representatives Committee (PRC); The Specialized Technical Committees (STCs); The Economic, Social and Cultural Council; two financial institutions, namely the Central Bank and the African Monetary Union and The Commission of the AU.

The AU Commission has a portfolio of Human Resources, Science and Technology (HRST) with a 2004-2007 Plan of Action to: "Promote Human Resource Development, Capacity Building and Science and Technology as tools and Youth as partners for socio-economic development". The Plan of Action is to be implemented through programmes that, *inter alia*, focus on policy harmonization, cooperation and coordination in the areas of education, training, capacity building and science and technology; Strengthening higher education and research through promotion and establishment of regional centers for excellence based on NEPAD areas; and promoting the implementation of science and technology provisions of the various continental treaties with a view to strengthening the scientific base of the continent

The creation of AU was also associated with the adoption of the New Partnership for Africa's Development (NEPAD) July 2001 Summit in Lusaka. NEPAD is an expression of the commitment by African political leaders to address Africa's multifaceted development challenges and take a practical approach towards the realization of the goals of the Abuja Treaty. In the framework of NEPAD African leaders recognize that science and technology will play a major in the economic transformation and sustainable development of the continent. One of NEPAD's overall objectives is to bridge the technological divide between Africa and the rest of the world. It recognizes that such technologies as information and communication technologies are critical in remote sensing, environmental policy-making and planning, and agricultural development. These technologies will also enable African countries to establish efficient early warning and monitoring systems for conflict management and natural disaster prevention.

NEPAD has also the objective of doubling "teledensity to two lines per 100 people by 2005, with an adequate level of access for households." It promotes ICTs to on develop local content software based on Africa's cultural systems. NEPAD also focuses on the formulation and implementation of programmes to:

(a) "promote cross-border co-operation and connectivity by utilizing knowledge currently available in existing centres of excellence in the continent";

(b) "develop and adapt information collection and analysis capacity to support productive activities as well as for exports outside Africa"; and
(c) "generate a critical mass of technology expertise in targeted areas that offer high growth potential, especially in biotechnology and geo-science."

SECTION 2: COMMON VISION, OBJECTIVES AND PRINCIPLES

2.1 Vision and Objectives

The vision of this 'Science and Technology Consolidated Plan of Action' is that of Africa that is free of poverty and well integrated into the global knowledge economy. It is this vision that underpins programmes and projects outlined herein. The overall goals of this consolidated plan are:

a. to enable Africa to harness and apply science, technology and related innovations to eradicate poverty and achieve sustainable development; and
b. to ensure that Africa contributes to the global pool of scientific knowledge and technological innovations

Programmes and projects outlined in this Plan will be implemented through regional, continental and international cooperation in science and technology. They focus on the following:

(a) Improving infrastructure or facilities for R&D and promote sharing of such facilities;
(b) Creating institutional and policy arrangements that enable African countries to mobilize and share their scarce resources to conduct science and generate technological innovations;
(c) Strengthening the continent's human skills base by increasing the number of scientists, technicians and engineers.
(d) Improving the quality and intensity of regional cooperation
(e) Building a strong political and civil society constituency for science and technology in Africa.
(f) Improving the quality of science, technology and innovation policies of African countries through processes that promote sharing of experiences and policy learning.
(g) Strengthening the capacity of regional economic bodies to mainstream science and technology into their sectoral programmes and projects.
(h) Promoting the application of science and technology to achieve specific MDGs; and
(i) Promoting innovative ways and means of financing science and technology in Africa.

2.2 Principles and Criteria[1]

The proposed programmatic initiatives will be further developed and implemented guided by the following principles:

- *Adding new value*—emphasis will be placed on those activities and processes that will add new and significant value to existing national, sub-regional and regional programmes.
- *Building on prior progress/achievements*—the plan as a whole and its projects will aim at maximizing collective learning from previous efforts and promoting synergy among existing sub-regional and regional science and technology initiatives.
- *Sharing progress, outputs and impacts*—the plan and its implementation are not aimed at meeting interests or needs of a particular country or group of countries but all participating AU Member States.

[1] A detailed set of criteria and guidelines for project design were adopted by the Steering Committee. See annex 1.

- *Collective ownership and broad based participation*—the programmes will be further developed and implemented through participatory processes and activities with all groups of stakeholders (governments, industry, youth, civil society and international partners).
- *High-level political ownership and support*—the programmes will be owned and supported at the highest levels of governance in African countries and the international community.
- *Maintaining flexibility to change the programmes as regional needs and conditions change*—the programmes and their implementation mechanisms will evolve in a flexible and anticipatory manner. They are not cast in stone but will be adjusted to respond to changing needs and conditions to maximize learning by Africa and its institutions.
- *Collective action with differentiated capabilities*—clear recognition that while the continent has shared goals and needs, its countries have different levels and ranges of capabilities—financial, human, scientific and technological. Genuine regional and continental cooperation will thus be required to mobilize, share and utilize existing national capabilities for common scientific and technological development. Emphasis should be on building partnerships that utilize the diverse range of existing sub-regional and regional institutions and expertise while collectively leveraging international support.

SECTION 3: FLAGSHIP RESEARCH AND DEVELOPMENT PROGRAMMES

This section outlines specific flagship R&D programmes and projects that will be developed and implemented over the next five years. The programmes are organized in clusters based on their relationships and potential of establishing inter-related networks of implementing institutions. Projects outlined in each of the programme areas are just indicative. They constitute the first generation of continental and regional activities that were defined and agreed upon at regional workshops. Additional projects will be designed in the life of this Science and Technology Consolidated Plan of Action. The initial time-frame for implementing the projects is 2006-2010.

PROGRAMME CLUSTER 1:
BIODIVERSITY, BIOTECHNOLOGY AND INDIGENOUS KNOWLEDGE

PROGRAMME 1.1: CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY

1.1.1 Overview

Africa's biodiversity is a major source of its economic and social transformation. Biodiversity holds enormous potential of transforming the continent's agricultural and industrial systems to contribute to economic change and poverty reduction. The unique species of plants and animals as well as ecosystems constitute the continent's natural wealth. However, this diversity is underutilized and is being lost at alarming rates. Conserving and promoting sustainable use of biodiversity is one of the challenges that African countries have committed themselves to addressing. This is manifested by the number of countries that have ratified the United Nations Convention on Biological Diversity (CBD) and its Cartagena Protocol on Biosafety as well as such regional treaties as the African Convention on the Conservation of Nature (commonly referred to as the Algiers Convention).

To conserve and sustainably use biodiversity African countries will need to harness and apply science and technology. This is because conservation and sustainable use are knowledge-intensive activities and cannot be attained without investments in the generation and application of scientific knowledge and technological innovations. The NEPAD framework document and the CBD explicitly recognize this. For example, the CBD contains specific provisions on the need to strengthen scientific and technological capacities for conservation. It calls on Contracting Parties to invest in research and innovation to generate technologies for conservation and sustainable use of biodiversity. Article 9 of the CBD focuses on strengthening *ex situ* conservation while Article 12 is on research and training (with emphasis on the need to establish programmes for scientific and technical training). The NEPAD framework commits African countries to establish regional networks of centers of excellence in science for conservation and sustainable use of the continent's biodiversity.

1.1.2 Programme Objectives

This programme aims at strengthening Africa's scientific and technological capacities for biodiversity conservation and sustainable use. It focuses on measures that will build a strong conservation science foundation and generate sustainable use technologies. Its specific objectives are to:

1.1.2.1 Build a new cadre or generation of conservation scientists and technicians;
1.1.2.2 Improve the quality of gene-banks and promote the sharing of scientific facilities to conserve germplasm
1.1.2.3 Add value to Africa biodiversity and generate natural products through bio-prospecting; and
1.1.2.4 Promote the development and diffusion of a range of sustainable use technologies.

1.1.3 Indicative Projects and Activities

The above goals will be achieved through the development and implementation of specific projects. The first cluster of projects to be further elaborated and implemented will include the following:

Project 1: Mobilization and Training of Conservation Scientists

National and regional capacity assessments have shown that Africa has inadequate supply of conservation scientists e.g. taxonomists to effectively engage in research and related technological innovation. The continent as a whole requires increased numbers of conservation biologists and technicians to be able to ensure that its biodiversity is well conserved and sustainably utilized. Meeting this challenge will require institutions and programmes that are dedicated to training in conservation science.

This project will be developed to provide financial and technical resources for training in conservation science. It will be organized as an African Conservation Science Training Scheme for fellowship grants that will be made available to a consortium of African universities for MSc and PhD students. Emphasis will be placed on injecting resources into well designed continental training programmes. The following activities will be undertaken to establish the proposed Scheme:

1. A comprehensive review of conservation science training programmes and institutions will be conducted to identify needs and leading universities and related research agencies that would form a network of centres of excellence in conservation science
2. Identified universities and research agencies will develop a specific 5 years modular postgraduate training programme and budget that will be considered and approved by NEPAD and AU by July 2006
3. A conservation science capacity trust fund will be set up by December 2006. The trust will be the main source of grants for student fellowships.

Project 2: Strengthening and Networking African Gene Banks

Gene banks play a crucial role in the conservation and use of biodiversity. They are important institutions not just for the preservation of germplasm but for its sustainable use. Gene banks are also expected to be generators and sources of new scientific knowledge and information on ecosystems, species and genes. However, few African countries have national gene banks, and the few national gene banks that exist are not adequately equipped and organized to achieve the continent's goals. Many of the countries may not be able to establish national banks, and in many cases the creation of stand-alone gene banks may not be cost effective given the common challenges of conservation and shared biodiversity base of the continent.

This project will focus on establishing an African network of regional gene banks—five regional hubs with state-of-the art conservation and research facilities will be developed on the continent. These will be networked to constitute a hierarchy of scientific and technical competences. A regime of guidelines or a conservation protocol will be developed and adopted by governments to facilitate African scientists and technicians to access and use the hubs. The following actions will be taken to develop the project:

1. A comprehensive scientific and technical capacity assessment of existing national and regional gene-banks. The assessment will identify specific needs and ways of establishing a continental network of gene-banks.
2. An experts' task team shall be established to develop a detailed project proposal for strengthening and networking African gene banks. The team shall be expected to put emphasis on improving the scientific research base of gene-banks.
3. An investment workshop will be organized to build a special trust for the project.

Project 3: Adding Value to Africa's Biodiversity

Africa's biodiversity is a potential source of medicinal, food and chemical products. It holds great potential for poverty reduction and the continent's economic development. However, this potential is not adequately tapped and used. Plants, species and genes as well as the rich indigenous knowledge held by the African people are to a large extent still outside the formal economic production structures of many African countries. Their contributions to the continent's economic recovery and sustainable development are not well known.

Biodiversity prospecting—the search for wild species, genes and their products—can contribute to poverty reduction and sustainable development in Africa. A few African countries have invested in biodiversity prospecting. Many do not possess scientific programmes and technical facilities to engage in prospecting. This proposed project will focus on building a continental network for diversity prospecting. Specific actions will include:

1. Identifying and networking competent R&D institutions for biodiversity prospecting
2. Supporting taxonomic and inventory processes by the network of institutions
3. Organizing germplasm collection missions, based on agreed upon guidelines
4. Screening samples for chemicals, microrganisms and genes
5. Establishing an African bio-innovation hub or park to develop specific products in partnership with industry
6. Facilitating contractual relations between members of the proposed network of institutions, and between African countries
7. Conducting or offering training in biodiversity prospecting

PROGRAMME 1.2: SAFE DEVELOPMENT AND APPLICATION OF BIOTECHNOLOGY

1.2.1 Overview

Life sciences and related advances in biotechnology are opening up new opportunities to increase food production, stem environmental degradation, fight such diseases as malaria, HIV/AIDS and tuberculosis, and add value to natural resources as well as promote industrialization in Africa. They can contribute to the reduction of poverty and improvement of the continent's economic competitiveness.

The development of a new generation of safer and more affordable vaccines for human diseases such as meningitis, and for animal diseases such as rabies is set to enlarge prospects of human development in very profound ways. Already the application of biotechnology in agriculture has resulted new crop varieties with improved tolerance to pests and diseases, and higher nutritional value. Genomics is making it possible for scientists and companies to identify genes that are linked to particular diseases. They are able to develop genetic tests that can facilitate prevention of certain human illnesses, and crop and diseases. This science has also advanced drug development in very profound ways. Combined with advances in imaging technology and sensors, medical practitioners will be able to use genomic approaches to diagnose many diseases and offer early treatment. The completion of the mapping of the malaria parasite genome and the genomes of bacteria and many other parasitic organisms will pave the way for the development of vaccines and other control measures for many of diseases in Africa.

African countries have identified specific priorities for biotechnology development and application. These are based on an analysis of current constraints, possible availability of new technologies, and/or potential for new R&D approaches to address previously intractable problems. These constraints can be grouped into two: (a) scientific and technical and (b) limited capacity—human, infrastructure, policy, public awareness and funding. The constraints include:

1. Inadequate protocols for regeneration and rapid multiplication of disease-free planting materials including diagnostic systems
2. Lack of access to isolated genes and biotechnologies
3. Lack of new genes/markers and transformation protocols to address production constraints
4. A limited range of techniques and knowledge for application for sustainable mining and environmental restoration
5. Inadequate characterization, evaluation, and conservation of existing crop, animal, and soil-organism germplasm.
6. Inadequate capacity to develop and safely apply biotechnology (human, infrastructure, bioinformatics, and funding).
7. Inadequate policies and legal frameworks (biosafety, IPR, strategies).
8. Lack of indigenous commercial enterprises to promote biotechnology product development; and
9. Inadequate awareness and appreciation of the role of biotechnology in R&D.

1.2.2 Programme Objectives

This programme shall be dedicated to removing the above and other related constraints. Its overall objective is to build Africa's capacities to develop and safely apply biotechnology in agriculture, health, mining, industry and other areas. Its specific objectives are to:

(a) create a critical mass of African scientists and technicians with skills to engage in frontier life sciences;
(b) Increase access to and sharing of affordable state-of-art class research facilities for genomics, bioinformatics, gene technology, immunology, etc to be conducted in Africa by African scientists;
(c) Increase mobility of scientists across the continent to conduct research on common priority problems
(d) Mobilize existing scientific expertise and direct it to address specific common research and innovation challenges
(e) Stimulate the emergence and growth of African biotechnology innovation hubs and related companies

The programme and its projects will focus on mobilizing and integrating at the continental level critical mass of physical and financial resources and expertise needed to enable Africa effectively harness and apply biotechnology. Institutions and expertise will be networked around joint project activities targeting specific developmental problems as well as enabling the continent to contribute to advancing knowledge.

1.2.3 Indicative Projects and Activities

The flagship programme will be implemented through clusters of interrelated projects. Specific thematic areas of coverage will include:

1. Research and Training into gene expression and proteomics

This cluster of activities will largely focus on building knowledge base and training on gene expression and proteomics. The aim is to enable African scientists to decipher the functions of genes and their protein products, and to build information on the complex functioning of biological systems and processes. African researchers will be able to target genomics and proteomics to specific indigenous crops, livestock and human health aspects.

For example, in Eastern and Central Africa emphasis will be placed on accessing and using information from successful mapping of the genomes of other cereals and using the data to develop more drought tolerant and disease resistant lines of sorghum and pearl millet, through more efficient and targeted breeding with new molecular tools and technologies. This knowledge and techniques will be diffused throughout the continent through the networks of centres of excellence. The African network of centres of excellence in biosciences will provide overall institutional leadership on cereal related genomics and proteomics research.

Research and innovation in health related genomics and proteomics will be led by the Southern Africa and North Africa regional hubs. Emphasis will be put on identifying processes and developing products to cure opportunistic infections of people living with HIV/AIDS. Examples of such infections are oral thrush (*Herpes simplex*), shingles (*Herpes zoster*) and fungal diseases. The project shall integrate the use of existing traditional medicine into modern vaccine development.

2. Building and using capacity for bioinformatics

Bioinformatics—the development and use of computational and mathematical methods—is generating a spectacular increase in biological data. It has emerged as a multidisciplinary discipline bringing together life sciences, informatics, mathematics and information technology. Bioinformatics is making it possible for scientists and industry to create and maintain databases of gene sequences. It is expanding the frontiers of biological sciences, shifting emphasis from individual biomolecules to the analysis of the interactions of complex networks that control biological systems. This multidisciplinary field offers enormous and growing opportunities to improve agricultural research and production, improve healthcare, and to conserve and sustainably use biological resources in developing countries.

Bioinformatics cannot be disregarded by any African country that intends to engage effectively with biosciences and such new technologies as biotechnology. In addition to this, African countries may also want to manage their own specific data on indigenous biological species, on local epidemiology and biodiversity programmes. These tasks clearly require that statisticians and informatics experts become advanced users of bioinformatics software and develop a capability to solve problems locally.

This project aims at establishing a continental platform for bioinformatics. The platform will be a network of leading centres that will be dedicated to the generation and provision of information on genomics to academic and research institutions in Africa. Activities on the platform will include training courses, exchange of information and expertise within Africa and between Africa and the international community, and joint genomics data generation and management.

3. Development of biopesticides and biofertilizers for sustainable agriculture

Expanding and intensifying African agriculture are currently based on increasing application of agrochemicals including, pesticides and fertilizers. Many of the agrochemicals are a major source of environmental degradation and pollution. They also have irreversible negative impacts on human and animal health. Research will be conducted and used to develop environmentally sound biopesticides and biofertilizers. A detailed project proposal with specific research themes and innovation pathways will be prepared by a team of experts.

1.2.4 Institutional Arrangements for Implementation

This programme will be implemented as the core of the African Biosciences Initiative that is being established under the auspices of NEPAD. The Initiative is largely a network of leading centres and consists of hubs and nodes. Four hubs have been identified and established as follows: Biosciences East and Central Africa (BecA) at the International Livestock Research Institute (ILRI) in Kenya; the Southern African Network for Biosciences (SANBio) at the Council for Scientific and Industrial Research (CSIR), Pretoria, South Africa; the West African Biosciences (WAB) at Institute Senegalais de Recherches Agricoles (ISRA) in Dakar, Senegal, and the Northern Africa Biosciences (NAB) at National Research Centre (NRC) of Cairo, Egypt. These hubs posses the necessary physical infrastructure to develop and implement regional and continental biosciences projects

PROGRAMME 1.3: SECURING AND USING AFRICA'S INDIGENOUS KNOWLEDGE BASE

1.3.1 Overview

Africa has a relatively rich body of indigenous knowledge and related technologies. This is embodied in the continent's cultural and ecological diversities and has been used by the African people for thousands of years to solve specific developmental and environmental problems. Indigenous knowledge and technologies play major roles in biodiversity conservation, sustainable use and prospecting. In addition, their contributions to increasing food production, fighting HIV/AIDS and other diseases, and stemming environmental degradation are considerable.

Despite their contributions, indigenous knowledge and technologies are not adequately promoted and protected in most African countries. Institutions to safeguard the rights of indigenous knowledge holders are weak in most countries. In addition, there are weak links between the formal R&D institutions and local communities that hold and use the knowledge. This has denied Africa the opportunity to better understand and use its indigenous knowledge base.

African leaders have recognized and stressed the importance of protecting and promoting indigenous knowledge and technologies to solve specific problems and improve the continent's economies. Paragraphs 140 and 141 of the NEPAD framework document are devoted to the protection and promotion of indigenous knowledge and related technological innovations. Paragraph 140 states: "Culture is an integral part of development efforts of the continent. Consequently, it is essential to protect and effectively utilize indigenous knowledge…and share this knowledge for the benefit of humankind….special attention [will be given to] the protection and nurturing of indigenous knowledge…..inventions, … and all other tradition-based innovations and creations."

1.3.2 Programme Overview

This programme aims at implementing paragraph 140 of the framework document. Its overall objective is to strengthen Africa's capacity to harness and apply as well as protect indigenous knowledge and technologies. Specific objectives of the programme are:

(a) build or enhance public understanding of the nature and contributions of indigenous knowledge and technologies;
(b) promote linkages between formal R&D institutions and holders of indigenous knowledge and technologies;
(c) increase intra-African sharing and application of indigenous knowledge and technologies to solve specific problems; and
(d) improve the continent's capacity to protect indigenous knowledge and technologies from piracy and related misappropriation.

1.3.3 Indicative Projects and Activities

The above objectives will be realized through the implementation of specific projects. In the short to medium term the following projects will be further developed and implemented.

Project 1: Development of an African Databank on Indigenous Knowledge and Technologies

Auditing, documenting and supporting research are some the ways of protecting and promoting the use of indigenous knowledge and technologies. Once the knowledge and technologies are in the public domain, it is relatively difficult for corporate actors and individuals to misappropriate them and unfairly or illegally acquire intellectual property rights. This proposed project will focus on establishing an African Indigenous Knowledge and Technologies Bank. This will be a source of information on various forms of knowledge and technologies held and used by traditional and/or local African communities. Specific actions of the project will include:

1. Preparation of comprehensive guidelines and methodologies for auditing and documenting indigenous knowledge and technologies. The guidelines and methodologies will be based on good practices from around the world.
2. Development of a common protocol for provision to, and access and use of knowledge and technologies in the proposed bank. This will be mechanism to ensure that countries and institutions participating in the project share benefits in a fair and equitable manner.
3. Training courses on auditing, collection and documentation of indigenous knowledge and technologies will be offered by identified institutions and experts
4. Establishment of a virtual e-bank of indigenous knowledge and technologies will be explored. Consideration will be given to establishing a network of national indigenous knowledge documentation centres.

Project 2: Promoting the Integration of Indigenous Knowledge and Practices in Education Curriculum

The erosion of African indigenous knowledge base is largely associated with the absence of mechanisms to ensure that the knowledge and related practices are passed on from one generation to generation. Often old generations are dying without endowing new ones with the wealth of information and skills on the use and management of African ecological and agricultural systems. This threatens the future cultural well being of African communities.

This proposed project aims at promoting education on African indigenous knowledge systems in schools and institutions of higher learning. It will facilitate the integration of indigenous knowledge

issues into curriculum and related teaching methodologies. Specific actions to further develop and implement this project will include:

1. Reviewing the indigenous knowledge content of current curricula of African education systems, and identification of international good practices of integration indigenous knowledge issues into formal education
2. African workshops for educational systems to consider proposals on how best to integrate indigenous knowledge into the curricula and teaching practices. The workshops will focus on and be guided by international good practices; and
3. Development and promotion of an African body of methodology and guidelines for integrating indigenous knowledge systems into formal education and training.

PROGRAMME CLUSTER 2:
ENERGY, WATER AND DESERTIFICATION

PROGRAMME 2.1: BUILDING A SUSTAINABLE ENERGY BASE

2.1.1 Overview

Energy is fundamental to poverty reduction and economic transformation of Africa. Its production and use affect the social, economic and environmental dimensions of the continent's development. The availability and use of energy will to large extent determine how and whether African countries increase agricultural productivity, provide safe water, achieve higher levels of industrialization, and efficiently use information and communications technologies to get integrated into the global economy. The nature and range of energy sources that the continent develops and uses will determine how well its natural environment is sustained. However, most African countries face various forms of energy insecurity. They rely on a narrow range of energy sources that are not environmentally sound.

The Human Development Report 2001 published by the United Nations Development Programme (UNDP) shows that a majority of African countries rely on traditional fuel, mainly fuel-wood. A large part of the continent's population lacks access to reliable, affordable and socially acceptable energy services. Energy consumption is uneven between rural and urban areas within many countries. In addition, most African countries do not have efficient energy systems. The available scarce energy is often not efficiently harnessed and utilized.

African countries have committed themselves to search and increase affordable energy, to reserve environmental degradation that is associated with the use of traditional fuels in rural areas, and exploit and develop the hydropower potential of the river basins of Africa. This commitment is explicitly written in paragraph 109 of the NEPAD framework.

At the World Summit on Sustainable Development (WSSD) the international community committed itself to supporting Africa to effectively address the energy challenges. Chapter 8 paragraph j of the Plan of Implementation from WSSD is dedicated to energy issues. It specifically focuses on: (a) the need to "[e]stablish and promote programmes, partnerships and initiatives to support Africa's efforts to implement NEPAD objectives on energy, which seek to secure access for at least 35 per cent of the African population within 20 years, especially in rural areas" and (b) "support to implement other initiatives on energy, including the promotion of cleaner and more efficient use of natural gas and increased use of renewable energy, and to improve energy efficiency and access to advanced energy technologies, including cleaner fossil fuel technologies, particularly in rural and peri-urban areas"

Meeting the NEPAD energy goals will require investments in scientific research and technological innovation. The first NEPAD Ministerial Conference on Science and Technology articulated this point and identified thrusts for a comprehensive African programme for energy research and technology development. These thrusts are (a) information on and knowledge of existing appropriate energy technologies; (b) R&D to develop new alternative energy technologies; and (c) commercialization and/or access of energy technologies.

2.1.2 Programme Objectives

The overall objective of this programme is to enlarge Africa's energy security through the generation and application of scientific knowledge and related technological innovations. Its specific goals are to:

(a) increase rural and urban access to environmentally-sound energy sources and technologies;
(b) improve energy efficiency; and
(c) increase or enlarge the range of energy sources and technologies for household and commercial uses.

2.1.3 Indicative Projects and Actions

These goals will be achieved through specific projects. During the next three to five years, the following projects will form the core activities of the flagship programme.

Project 1: African Databank of Energy Research and Technologies

To improve Africa's access to and use of environmentally sound energy sources and technologies, a continental databank or information base will be created. This will be done through a comprehensive energy technology assessment and foresight exercise. The exercise will cover such aspects as status of energy research and innovation, specific national and common African energy needs, global trends in energy research and technologies, impacts of different energy technologies, and the nature of market/costs of various types of technologies.
It will be conducted by relevant competent national authorities in African countries supported by African experts and international partners. Specific activities and actions to be taken will include the following:

1. Preparation of relevant materials for training national teams to conduct energy technology assessment and foresights
2. Training workshops on energy technology assessments and foresights
3. Launch and conduct of national energy technology assessments and foresights
4. Based on national assessments and foresights, develop a comprehensive continental databank of energy technologies
5. Support countries to develop and/or improve energy technology procurement policies and strategies.

Project 2: Research on and development of bio-energy technologies and other renewable energy sources

The production of energy in Africa and other parts of the world is increasingly being determined by environmental, in addition to social, economic and technical, factors. International and local concerns over global warming and climate change have given more impetus to research on renewable sources of energy. A large share of the continent's energy needs will need to be met from renewable sources.

This project area will aim at enlarging the range of renewable energy technologies. Its emphasis will be on sustainable use of the continent's bio-resources (such as wood and solid wood residues). The project will build capacity for combined heat and electricity production (CHP) based on local resources. In collaboration with international partners, designated African centres will conduct R&D on the following:

- fluidised bed gasification of biomass or recovered fuel;
- integrated harvesting techniques for forest fuels; and
- pyrolysis to generate liquid biofuels.

Other R&D areas and themes will be identified based on technical workshops to be conducted by designated centres. Such energy sources as hydrogen and fuel cells will be explored with the aim of building the capacity of the continent to participate in related international R&D programmes.

2.1.4 Institutional Arrangements for Implementation

The above and related projects will be further developed and implemented by a proposed African Energy Research and Innovation (AERI) Network. The AERI will be configured as a network of designated centres of excellence in scientific research and technological innovation in energy. Specific actions to establish AERI will include the following:

1. Designing and adoption of specific criteria and guidelines for identifying centres of excellence
2. Identification and designation of regional hubs using the criteria and guidelines
3. Formulation and completion of network agreement and business plans by the designated hubs.

PROGRAMME 2.2: SECURING AND SUSTAINING WATER

2.2.1 Overview

African leaders have identified water scarcity and related insecurity as one of the sources of the continent's underdevelopment and increasing economic decline. Thus they have placed issues associated with the development, supply and management of water high on the agenda of the NEPAD. In the framework of NEPAD, the leaders have committed themselves to "ensure sustainable access to safe and adequate clean water supply and sanitation, especially for the poor" and "[to] plan and manage water resources to become a basis for national and regional cooperation and development."

Achieving the goals on water will require investments in science and technology. Science and technology play important roles in water development, supply and management. They are crucial for assessing, monitoring and ensuring water quality. The WSSD Plan of Implementation recognizes the role of science and technology in meeting water goals. In paragraph 27 it commits governments to "[i]mprove water resource management and scientific understanding of the water cycle through cooperation in joint observation and research, and for this purpose encourage and promote knowledge-sharing and provide capacity-building and the transfer of technology, as mutually agreed, including remote-sensing and satellite technologies, particularly to developing countries and countries with economies in transition." In addition, to ensure that adequate clean water is available to majority of Africans, affordable rural water technologies will be required.

The first NEPAD Ministerial Conference on Science and Technology decided on water sciences and technologies to constitute one of main flagship programmes. The programme will be designed to strengthen the continent's capabilities to harness and apply science and technologies to address challenges of securing adequate clean water as well as managing the continent's water resources.

2.2.2 Programme Objectives

This flagship programme focuses on water quality, sanitation and water resources management. Emphasis is on promoting increased use and production of scientific knowledge and technological innovations. Its specific goals are to:

(a) Improve the conservation and utilization of the continent's water resources
(b) Improve the quality and quantity of water available to rural and urban households
(c) Strengthen national and regional capacities for water resource management and reduce impacts of water-related disasters
(d) Enlarge the range of technologies for water supply and improve access to affordable quality water.

2.2.3 Indicative Projects and Actions

The following project areas will constitute the core of this programme, at least in the short and medium-term.

Project 1: Scientific Assessment of Africa's Water Resources and Systems

There is a relatively poor knowledge base of and scanty information on Africa's water resources and related ecosystems. Building scientific information on the continent's water resources is crucial for improving their development and sustainable management. Scientific research and assessment are also important to inform the formulation and implementation of policies and development of technologies for integrated water management. This proposed project will focus on:

1. Developing common scientific methodologies and tools for conducting systematic assessment of the continent's water resources and ecosystems. Emphasis will be river basins and underground water systems.
2. Training African scientists and technicians on the methodologies and tools to conduct water assessments
3. Launching and conducting water assessments at sub-regional and regional levels
4. Developing a databank of Africa water resources and ecosystems; and
5. Disseminating scientific information on the nature of water resources and ecosystems.

Project 2: Research and Technologies to Assess and Monitor Water-related Disasters (Emphasis on floods)

Many African countries suffer from frequent floods along their rivers and other water bodies. The impacts of floods on the continent's economies are considerable and increasing. Every year thousands of people die and infrastructure estimated at millions of US$ is destroyed as a result of floods. While in the short-term floods cannot be prevented, their impacts can be reduced if appropriate technologies are used to conduct forecasts. Forecasts that provide relatively long lead time can be used to evacuate people from high-risk areas or even to create retention basins to reduce flood peaks and volumes.

This project will explore the possibility of developing and applying a continent-wide flood forecast system. It will focus on:

1. Identifying and assessing existing technologies for flood control to determine their applicability in Africa. Emphasis will be on the kinds of resources required to acquire, modify and apply the technologies in Africa
2. Developing a databank and disseminating information on the technologies

3. Conducting research to modify, improve and develop flood control technologies

Project 3: Knowledge and Technologies to Improve Water Quality and Quantity

A fundamental prerequisite to the development and application of technologies for improving water quality and sanitation in Africa is a systematic and extensive set of water quality data on both sources of impairments and existing technical responses. Data is required to assess the different sources of contamination and their impacts. Many African countries do not have scientifically strong systems for assessing water quality and quantity as well as the relative seriousness of the related environmental and human health problems.

In addition to the generation of data, deliberate efforts need to be made to develop technologies for improving quality as well as increase the supply of water to African households.

This project will focus on:

1. Reviewing existing international water quality assessment methodologies and techniques and promoting use of appropriate ones through training workshops and postgraduate studies on water quality
2. Research on and development of desalination technologies, with emphasis on small modular units that use low and renewable energy
3. Research on and related technology development for treating and supplying drinking water from aquifers. This is crucial to ensure that poor populations in peri-urban areas have access to clean water
4. Research and application of knowledge on eutrophication. A key aspect of improving and managing water in Africa is the prevention of eutrophication of dams, rivers and lakes, and biological control of weeds. It is recommended that research be conducted to develop new technologies to address eutrophication related problems.

2.2.4 Institutional Arrangements for Implementation

The above proposed projects will be further elaborated and implemented by a continental network of centres of excellence. The network will comprise of regional hubs and nodes. To identify and designate such hubs and nodes as well as create the network as a whole, the following actions will be undertaken:

(a) a multi-disciplinary task team of experts and policy-makers has been established to prepare specific criteria and guidelines for identifying and designating centers or institutes. Such criteria and guidelines shall spell out mechanisms for promoting the sharing of centers' facilities and expertise across the continent as well as means of ensuring the sustainability of the network.
(b) An inter-ministerial committee of water and science and technology departments and ministries will be created to ensure proper governance of the proposed network
(c) A water science and technology trust fund will be established in the African Water Facility at the African Development Bank to support the implementation of the programme.

PROGRAMME 2.3: COMBATING DROUGHT AND DESERTIFICATION

2.3.1 Overview

Drought and desertification are major environmental and socio-economic problems with negative effects on the livelihood of populations in many African countries. Two thirds of the continent is desert or drylands, and almost three quarters of agricultural land is degraded to some degree. It is estimated

that more than 500 million hectares of the continent's land is affected by soil erosion and degradation. Drought and desertification greatly affect Africa's agricultural productivity and environmental sustainability.

In many African countries, combating desertification and promoting economic development are interdependent. Many poor African people have limited choice but to over-exploit the land. The degradation of land through use of unsustainable practices and technologies threatens their livelihoods. It is a source of social and political tensions and conflicts in some communities and countries of the continent. Desertification has other adverse impacts on non-drylands as well. In addition to dust storms, biophysical impacts include downstream flooding, impairment of global carbon sequestration capacity, and global climate change.

A majority of African countries are contracting parties to the United Nations Convention to Combat Desertification (UNCCD). By being parties to the UNCCD, the countries have committed themselves to mobilize and secure action to arrest expansion of deserts and arrest land degradation. The need to invest in measures to combat drought and desertification is also emphasised in the NEPAD framework document. Paragraph 138 of the framework identifies such measures as rehabilitation of degraded lands as crucial. Several NEPAD programmes have projects dedicated to issues of land rehabilitation, soil erosion, water management and biodiversity conservation. In addition to these, scientific research and technological innovation will be required to address challenges of drought and desertification.

2.3.2 Programme Objectives

The overall objective of this programme is to strengthen the scientific and technical capacities of African countries to combat drought and desertification. Its specific goals are to:

(a) improve scientific understanding of and sharing of information on the causes and extent of drought and desertification in Africa;
(b) mobilize, build and promote sharing of scientific expertise and technical skills in drought and desertification related research; and
(c) grow regional and continental centres of excellence in drought and desertification research.

2.3.3 Indicative Projects and Activities

The above objectives will be achieved by further developing and implementing specific projects, including the ones outlined below.

Project 1: Promoting Exchange of Scientific Information on Drought and Desertification

There is a growing body of scientific studies on drought and desertification in Africa. Without any doubt, there is a tremendous amount of scientific knowledge on land degradation, soil erosion and other aspects. However, it seems that access to these valuable data is hampered, as national surveys and results of projects and programmes related to drought and desertification are not adequately disseminated. This makes it difficult to promote best practices and implement an integrated approach encompassing land degradation, vulnerability, and rehabilitation. In addition, it makes it difficult to invest in developing new technologies. There is a clear and urgent need for reviewing the current scientific research activities on drought and desertification in order to design ways to promote dissemination of the relevant data. Access to and use of such data is crucial for determining new research priorities.

This proposed project will focus on:

1. Developing a standardized or common framework for profiling and disseminating information on the nature and outputs of scientific research being conducted by African and international institutions. The framework will also form the basis of establishing a continental information hub or pivot on drought and desertification research;

2. Development of a continental databank on scientific research and technologies aimed at combating drought and desertification; and

3. Preparing and disseminating a comprehensive profile of African scientists and technicians in areas related to drought and desertification, with emphasis on soil science and water management.

Project 2: Building and Sharing Scientific and Technical Capacities

Most African countries have relatively weak scientific and technical capacities—skills/expertise, institutions, funding and physical infrastructure—to launch and sustain national programmes for drought and desertification research. It is crucial that they design and adopt measures to collectively strengthen training and research capacity in various aspects of desertification and drought. This project aims at establishing a network of African universities and related R&D agencies to increase the range and quality of scientific skills. Its specific actions will include:

1. A comprehensive assessment of capacity (with emphasis on the kinds of skills and equipment) needs of the continent as a whole. This will be done largely through questionnaire and review of national reports or submissions. It will also focus on the nature and impact of African universities' programmes;
2. Based on the assessment and clear criteria as well as guidelines, universities and R&D centres will be identified and designated as hubs and nodes of an African Drought and Desertification Research and Innovation Network.
3. Establishment of an MSc and PhD fellowships scheme will be an important basis for increasing scientific capacity. Based on specific criteria and guidelines students will be supported to undertake postgraduate studies and research at the hubs and nodes. Research focused on increasing scientific understanding of the causes of and trends in drought and desertification will be encouraged.

PROGRAMME CLUSTER 3:
MATERIAL SCIENCES, MANUFACTURING, LASER AND POST-HARVEST TECHNOLOGIES

PROGRAMME 3.1: BUILDING AFRICA'S CAPACITY FOR MATERIAL SCIENCES

3.1.1 Overview

The poor state of Africa's infrastructure (e.g. roads, energy, telecommunications, rails and houses) is a major impediment to economic and social development. It undermines the continent's efforts to stimulate the emergence and growth of industries, including small and medium scale enterprises. The lack of good infrastructure is also one of the sources of low foreign direct investment in and technology transfer to many African countries.

The development of new and improvement of existing infrastructure is dependent on economic, structural and ecological factors. Most of the continent's economies are not capable of developing and sustaining large infrastructures that are developed using foreign materials. The costs of constructing and maintaining roads, rails and houses are relatively high in many African countries mainly because of over-reliance on foreign materials. In addition some, if not most, of the imported materials are not suited to Africa's tropical and semi-tropical conditions. The use of unsuitable imported materials to develop infrastructure in Africa not only increases the burden on national budgets but may also cause irreversible environmental damage.

There is relatively weak scientific and technical capacity for materials research in most African countries. Few institutions on the continent have the physical and human capacities to conduct research and develop new materials. To address this challenge, African leaders have agreed on activities that build endogenous scientific and technical capacities to conduct research and innovation in materials. The first NEPAD Ministerial Conference on Science and Technology adopted a flagship programme for materials research.

3.1.2 Programme Objectives

This proposed programme aims at building Africa's capacity to engage in materials research and related technology development. Its overall objective is to strengthen the existing African network on materials research. The programme's specific objectives are to:

(a) Build new skills or expertise in materials sciences
(b) Promote sharing of physical infrastructure for research and exchange of scientific information; and
(c) Promote public-private sector partnerships on materials research and innovation.

3.1.3 Indicative Projects and Activities

To achieve the above goals the following projects will be further developed and implemented.

Project 1: Strengthening postgraduate training and research on materials

This project will be developed and organized as postgraduate fellowship scheme for MSc, PhD and Post-doctoral research. In collaboration with the African Materials Research Society (Africa-MRS), the following actions will be taken to develop this project:

1. Identification and assessment of existing materials science training programmes in/of African universities. The assessment will focus on such aspects as quality and relevance of the programmes, quality of research infrastructure, ability to expand enrolment, and university-industry links
2. Design of a common/African postgraduate training curriculum on materials sciences
3. Identification and designation of a core group of African universities to offer the training; and
4. Establishment of a trust fund and specific criteria for providing fellowships.

Project 2: Strengthening the African Materials Research Society

The African Materials Research Society (Africa-MRS) was formed in December 2002 in Dakar, Senegal. Its main objectives are:

- To promote excellence in all aspects of materials research in Africa
- To act as a networking centre to stimulate multi-disciplinary collaboration between researchers on the continent.
- To strengthen national and cross-border linkages between governmental science desks, research organisations, manufacturing industry and higher education for appropriate policy development.
- To encourage high-level human resource development in materials science.
- To identify and stimulate international linkages that will act to both broaden and deepen the skills and competence base for materials research in Africa.

The African-MRS is the only continental network dedicated to materials science and technology development. It is relatively young and needs strengthening. This proposed project will focus on supporting it to:

(a) design a comprehensive African programme for research and innovation. The programme will focus on aspects such as processing, testing and characterization of materials, development of infrastructure materials, polymers and materials recycling, and computational aspects of materials.
(b) identify regional hubs and nodes of laboratories to be shared across the regions and continent of Africa
(c) organize annual conferences and workshops aimed at promoting scientific exchange and review
(d) develop and sustain an African Journal of Materials Sciences
(e) establish explicit links to industry and international research programmes.

PROGRAMME 3.2: BUILDING ENGINEERING CAPACITY FOR MANUFACTURING

3.2.1 Overview

Rapid global economic changes and the exclusion of the continent from the industrial revolution stimulated by advances in manufacturing clearly demonstrate the need for African countries to build strong engineering capacity. Globalization is largely influenced by the capacity of nations and their firms to produce new and novel industrial goods and services. This capacity is to a large extent of an engineering nature. Indeed revolutionary technological, economic and related industrial opportunities will be tapped by those countries with strong engineering base.

Africa's low and declining levels of industrialization are manifestation of its limited and in many cases qualitatively poor engineering base. The continent relies on a narrow range of economic activities

mainly because it is not able to add value to its abundant natural resources through manufacturing and thus most of its countries export raw materials. Its economic change and industrial transformation will depend on the strengthening of manufacturing capacity. To achieve this, the quality of engineering education and training needs to be improved and more engineers generated.

High education institutions—universities and technical colleges—have crucial roles to play to enable Africa to build engineering capacity. They have to be at the forefront of continental engineering programmes. Ensuring that these institutions are able to recruit and retain quality staff is therefore vital to Africa's future supply of highly skilled scientists and engineers. However, many African institutions of higher education experience problems recruiting and retaining postdoctoral researchers and lectures in engineering courses. In addition to this constraint, these institutions have weak links to industry.

African leaders and the international community have recognized and begun to put emphasis on the urgency of strengthening the continent's engineering capacity through the revitalization of higher education institutions. The NEPAD framework document puts emphasis on the need to establish networks that are aimed at improving the quality of engineering training and increasing numbers of African engineers. The Commission for Africa calls for "specific action for strengthening science, engineering and technology capacity …. Scientific skills and knowledge enable countries to find their own solutions to their own problems, and bring about step-changes in areas from health, water supply, sanitation and energy to the new challenges of urbanization and climate change. And, critically, they unlock the potential of innovation and technology to accelerate economic growth, and enter the global economy."

3.2.2 Programme Objectives

This programme will focus on revitalizing engineering training in African higher education institutions in order to increase the number and quality of engineers. Its specific goals will include:

(a) improving the state/quality of infrastructure and curriculum for engineering training
(b) promoting the sharing of equipment among higher education institutions to maximum impact on improving engineering capacity
(c) strengthening inter-university networking to share training staff and research experiences; and
(d) strengthening university-industry partnerships to ensure that engineering training is relevant to economic production and industrialization priorities.

3.2.3 Indicative Projects and Activities

This programme will be implemented through clustered projects and activities including the ones proposed below.

Project 1: Assessment of Engineering Infrastructure and Curriculum of Higher Education Institutions

In order to determine specific interventions that are needed to improve the capacity of higher education institutions for good and relevant engineering training, it is crucial that adequate and reliable data and information on the nature and quality of existing capabilities and content of training is generated and provided to decision-makers and potential investors. This project will be designed as a capacity assessment exercise. Specific actions will include:

1. Development of a comprehensive framework and questionnaire for data gathering.
2. Commissioning a competent agency or network to use the framework and questionnaire to gather data and provide a comprehensive assessment of capacities and needs to improve and increase training in specific areas of engineering
3. A workshop will be organized for deans of engineering faculties or institutes to review the capacity assessment and design a set of interventions that are required to select a number of higher education institutions that should be considered to be designated as regional hubs and nodes. The workshop will also propose a African common curriculum for engineering training
4. A comprehensive plan and budget for infrastructure improvement in the designated hubs and nodes will be developed and submitted to African governments and international partners for consideration. A proposal to establish an African engineering trust fund will be considered. Such a fund may be a mechanism for ensuring that infrastructure is provided to and sustained at the hubs.

Project 2: Promoting University-Industry Partnerships for Engineering Training

Industry, including small and medium scale enterprises, has a major role to play in the building of Africa's engineering capacity. It is a source of ideas as well as financial and technical resources for improving infrastructure, curriculum and research at higher education institutions of engineering. Industry can also be a major client of the institutions' engineering training programmes. However, in Africa the links between industry and engineering training institutions are relatively weak and absent in many cases. Improving university-industry interactions is one of the main ways of ensuring that African countries make the transition from the mere conduct of scientific research to technological innovation: the generation of specific products and processes.

This project will aim at improving the quality and intensity of university-industry partnerships for engineering. Its specific actions or activities will include:

1. Documenting international good practices or cases of university-industry links or partnerships that have promoted the strengthening of national engineering capacity and stimulated specific technological innovations. Emphasis will be placed on the kinds of policies and laws that governments (e.g. in Asia, Americas and Europe) have used to encourage university-industry links/partnerships.
2. Establishing and holding an annual roundtable or conference of deans of engineering faculties, industrialists, policy-makers and business representatives. The roundtable or conference will provide a platform for exchange of views and design of concrete projects. Emphasis will be on how industry can influence the quality of engineering training programmes in order to produce graduates able to needs of industry.
3. Identifying and promoting adoption of innovation policies that lead to strong university-industry partnerships

PROGRAMME 3.3: STRENGTHENING THE AFRICAN LASER CENTER (ALC)

3.3.1 Overview

One of the most potent scientific tools over the ages for elucidating the laws of nature and applying those laws for the betterment of mankind is light. With the rise of quantum mechanics, man came to understand that light is composed of individual particles called photons. By shining these photons onto various materials, scientists and engineers have been able to probe the innermost structure of matter.

Nowadays, researchers have been able to expand tremendously the role played by light in a myriad of new scientific and technological applications. Notable among those applications is the use of light for advancements in telecommunications, the application of focused beams of light for medical surgery, and the generation of intense beams of light for elucidating the structure of proteins – the workhorses of our bodies' many biological functions.

If African nations are to play a major role in utilizing light to advance science and technology, thereby contributing to the strengthening of their economies, it is essential to wait no longer in making the kinds of investments that will lead to substantial economic payoffs. Recognizing the need to invest in light sources, most of which fall under the scientific term laser, the African laser community came together to establish the African Laser Centre (ALC). The mission is to enable "African nations to collaborate with each other and internationally to play a major role in utilising light to advance science and technology, thereby contributing to the strengthening of their economies, their global competitiveness, education and welfare of their people."

The ALC was launched at the first NEPAD Ministerial Conference on Science and Technology. It is emerging as a virtual network of centers of excellence dedicated to research and the development of laser technologies for the African continent. The ALC will promote shared use of laser facilities to conduct research and training programmes.

3.3.2 Programme Objectives

This proposed programme aims at building Africa's capacity to engage in laser research and technology development as well as related applications. Its overall objective is to strengthen the ALC. The programme's specific objectives are to:

(a) Build and/or increase African skills or expertise in laser research and technologies
(b) Ensure development, sustainability and sharing of facilities for laser research and technology development; and
(c) Promote expansion of the ALC network of facilities

3.3.3 Indicative Projects and Activities

Project 1: Strengthening the African Laser Centre

The ALC is the only continental network dedicated to laser research and technology development. It is relatively young and needs strengthening. This proposed project will support the ALC to:

(a) design a comprehensive African programme for laser research and innovation.
(b) increase regional hubs and nodes of laboratories to be shared across the regions and continent of Africa
(c) organize annual conferences and workshops aimed at promoting research and exchange of information laser technologies and their applicability in Africa
(d) develop and sustain an African journal of laser research and technologies; and
(e) establish links with industry and the international laser research and innovation community.

Project 2: Strengthening postgraduate training and research on lasers

This project will be developed and organized as postgraduate fellowship scheme for MSc, PhD and Post-doctoral research. In collaboration with the ALC, the following actions will be taken to develop this project:

1. Identification and assessment of existing laser research and training programmes in/of African universities. The assessment will focus on such aspects as quality and relevance of the programmes, quality of research infrastructure, ability to expand enrolment, and university-industry links
2. Design of a common/African postgraduate training curriculum for laser research and technology development
3. Identification and designation of a core group of African universities to be linked to the ALC to offer the training; and
4. Establishment of a trust fund and specific criteria for providing fellowship grants.

PROGRAMME 3.4: TECHNOLOGIES TO REDUCE POST HARVEST FOOD LOSS

1.4.1 Overview

One of the sources of food insecurity in Africa is post harvest crop loss. In African countries pre- and post-harvest crop losses are higher than the global average and impact more severely on already endangered livelihoods. It has been estimated that at least 10 percent of the continent's crop productivity is lost on and off farm. This is mainly because most subsistence farming communities to do not have access to appropriate technologies. A wide range of existing food processing technologies is not accessible to and adapted by African countries and their communities. Climatic conditions also contribute to crop losses. Floods, heavy rains, droughts and other related factors cause considerable post harvest crop loss.

Tropical root and tuber crops (cassava, sweet potato, yam and cocoyam) are both important household food security and income generating crops in many African countries. Well over five million people in Africa depend on these crops for food, feed and income and many of these people are the poorest of the poor. Take cassava as an example. Cassava can considerably transform local economies. It can be used more in processed forms for food, feed and starch derived products. Cassava represents an important part of the economies of most regions of Africa. However, due to the perishability of the crop, processing is necessary to increase shelf -life.

Overcoming the perishability of the crops, enhancing nutritional value and adding economic value through processing are the main ways of enlarging food security in Africa. Available technologies for processing roots and tubers limit these crops from reaching their full potential as sources of both food and income. The development and introduction of new processing technologies offer potential to improve food security and local industrialization.

3.4.2 Programme Objective

This programme aims at promoting research to identify, develop and promote diffusion of relevant or appropriate technologies to reduce post harvest food loss, with initial emphasis on crops. It will specifically focus on:

(a) Conducting an inventory of current technologies and practices for reducing post-harvest food loss;
(b) Promoting exchange of information on appropriate technologies;
(c) Stimulating new research and technological innovation; and
(d) Encouraging multidisciplinary networks of research and technicians to work on specific food technology development initiatives.

3.4.3 Indicative Projects and Activities

The following projects will be developed and implemented in the short to medium term.

Project 1: Promoting the Development and Diffusion of Appropriate Food Processing

The food industry is a major employer whether operating at the level of the small scale entrepreneur or commercial producers. Research in food processing helps enterprises with limited access to capital meet international food standards of processing and quality management. Food processing research should be directed at adding value to raw materials. This can be done by separation processes which extract or refine the raw material into a desired primary fraction and lower grade secondary fraction(s), by preventing raw material biodeterioration to increase shelf life and stabilise quality and by optimising nutritional value.

This proposed project will be developed around the following key areas/domains:

1. processing and utilisation of small grains, sorghum and millets;
2. utilisation of by products in animal feeding systems, development of polyaromatic hydrocarbons in oilcakes, mycotoxins in oilcakes
3. Fermentation and the quality management of tea and coffee; water control in the wet coffee processing industry; and
4. improving the efficiency of fish processing

The following concrete steps will be taken to generate specific detailed project components. Leading experts in food processing will be commissioned to prepare project proposals. These will be reviewed at an African conference on food processing. The conference will identify and establish a continental network of centres of excellence in food processing to implement agreed on projects in the four priority areas.

Project 2: Promoting Industrial Use of Cassava

Research has shown that conversion of cassava into products for the starch, food, plywood, paperboard, textile and pharmaceutical industries can contribute significantly to the transformation of rural African economies and improve livelihoods. In many African communities cassava is consumed in two forms; a dried product made from heap-fermented roots; and dried whole roots. These are processed into flour and consumed as a stiff porridge in both rural and urban areas. These traditional products have the advantage that they can be produced relatively cheaply using little equipment. However, two main limitations associated with them are: (i) the flour is not of a high enough quality for use in other food products (e.g., bakery products) and (ii) the methods used are labour intensive.

Current uses of cassava are narrow and limited to subsistence. The crop is consumed domestically within the areas in which it is produced. The continent as a whole is not exploiting the full potential of this crop because of a variety of social, economic and technical factors. The high perishability of harvested cassava and the presence of cyanogenic glucosides require immediate processing of the

storage roots into more stable and safer products. Storage and packaging technologies to extend shelf life can contribute to increasing cassava root availability and reliability, and facilitating industrial processing for export. In addition to tap the full industrial potential of cassava, innovative public-private sector partnerships are required to establish a market chain from producer to end-user.

This project will focus on promoting the development, diffusion and application of technologies for industrial use of cassava. Initial emphasis will be placed on such actions:

1. Conducting baseline research on socio-economic and technological aspects of cassava processing. This will include identifying existing technologies and measures to promote the technology diffusion across the continent.
2. Identifying and promoting diffusion of improved drying techniques; and
3. Piloting of a hand-driven chipping machines to improve quality and reduce the labour input involved in conventional processing
4. Documenting and disseminating technical knowledge to support the development of new technologies
5. Developing technologies to process cassava waste for improved biomass utilization, with emphasis on energy.
6. In partnership with industry, promoting the establishment of cassava starch extraction mini plants in order to meet starch demands for textile, pharmaceutical and paper industries.

To achieve the above actions, a consortium of research, technology development and industry will be established out of a workshop. The consortium will develop a comprehensive programme of work and mobilize investment.

PROGRAMME CLUSTER 4: INFORMATION AND COMMUNICATION TECHNOLOGIES, AND SPACE SCIENCE AND TECHNOLOGIES

PROGRAMME 4.1: INFORMATION AND COMMUNICATIONS TECHNOLOGIES

4.1.1 Overview

While there is increasing acquisition and use of Information and Communications Technologies (ICTs) in Africa, the rate of technical change is still low compared to other regions of the world. Africa is to a large extent a net importer and consumer of ICT. Its contribution to global software research is limited. Furthermore, the continent has not really adapted the content of ICT to suit its social and economic systems, with emphasis on poverty reduction and economic growth.

Despite the potential development benefits from software innovation, there is a shortage of capacity in African higher education institutions. Instead of being concentrated in individual institutions, expertise in computer science, information systems and related disciplines is scattered among institutions with small pockets here and there, with little or no collaboration among them. Through alliance building and creative use of technology, it is possible to create virtual concentrations of experts who are engaged in computer science, information systems as well as informatics.

Higher education institutions in Africa which should be in the forefront of ensuring Africa's participation in the ICT revolution are severely under-resourced in comparison to their counterparts in the developed world. Furthermore, the information technology infrastructure of African higher education is poorly developed and unevenly distributed. Despite these difficulties, a number of higher

education institutions in Africa have made significant progress in building ICT infrastructure, and developing computer science and other ICT disciplines. One area with potential for African higher education is the innovation in the development, maintenance and support of free and open source software (FOSS).

An important area of investment for Africa is software innovation. This is because:

- The cost of software projects are low in comparison to other areas that have requirements for expensive equipment;
- Software has the potential to have a high development impact with relatively low cost
- Free software and open source lowers the barriers to entry and to innovation, and promotes collaboration and optimal use of resources; and
- The cross cutting nature of software & potential relationship with other development programmes

4.1.2 Programme Objectives

This programme will aim at establishing a continental research network on ICTs. It will bring together leading universities and research centres to design and implement projects that generate software with African content. Its specific goals will be to:

(a) stimulate technical change and innovation in ICTs
(b) build skills in local software research and development; and
(c) build knowledge of Open Source Software and promote its application in education, health and conduct of science.

4.1.3 Indicative Project and Activities

The following project ideas will be further developed and implemented. The institutional mechanism for designing and implementing the projects will be African Virtual Open Initiatives and Resources (AVOIR) initiative that currently comprises of software innovation nodes in African universities in Kenya, Mozambique, Senegal, South Africa, Tanzania, and Uganda with project leadership and management based at the University of the Western Cape (UWC).

Project 1: Harnessing and developing software for e-learning

E-learning is the core of the current AVOIR initiative, and it is based on research conducted at UWC during the past 10 years, including the development of a first-generation e-learning system. That system, known as KEWL (Knowledge Environment for Web-based Learning), has been used extensively in international and national collaborative projects and its features serve as the basis for the creation of the next generation (KEWL.NextGen). Research conducted on projects implemented using KEWL has informed e-learning best-practices, in particular best practices in relation to collaborative learning in the African context. These best-practices and the recommendations of many first-generation users are informing the development of the next generation system.

This proposed project will focus on:

1. Developing new generations of e-learning systems
2. Training in the use of new e-learning systems
3. Improving infrastructure for ICT software research and development

Project 2: Developing Capacity for e-health

Health issues present major challenges to the African continent, especially with the advent of the HIV/AIDS pandemic, as well as the numerous environment-related diseases that are endemic to tropical regions. Information and communications technology has potential to be used in the health sector in many ways. The AVOIR team has also been working with the pharmacy department of a local hospital in Cape Town to develop software to facilitate the management of hospital pharmacy practice. The primary focus of this work, which is a small pilot project, has been on the management of anti-retroviral (ARV) therapy. The system will be used to dispense ARV drugs and will later be expanded to a hospital administration system.

This proposed project will:

1. promote the testing and application of the e-health software
2. design and provide training on e-health and
3. promote the diffusion of the e-health software across the continent.

PROGRAMME 4.2: ESTABLISHING THE AFRICAN INSTITUTE OF SPACE SCIENCE

4.2.1 Overview

As a whole, Africa is very poorly represented in the space science. Space technology is advancing at an increasing pace, yet most African countries lack the human, technical and financial resources to utilise existing space-based infrastructure for even the most basic applications in meteorology, communications and natural resource management. Space science provides a unique vantage-point from which to study the natural environment on the grandest possible scale and from which to deliver communications. By its very nature space provides a platform to address problems from a regional perspective. This will foster multi-lateral cooperation and largely eliminate the needs for any single country to shoulder the full burden of developing capability to utilise space applications.

Space science and technology form as much a part of the social, cultural and political landscape today as oceanic exploration did 300 years ago. The use of space science for development in Africa presents opportunities that cannot be ignored, and there is need to establish institutional arrangements to enable Africa to tap the benefits. The current and emerging space science capacities in Southern Africa, and its growing scientific linkages with other countries in the region, has highlighted the need for improved coordination of current and future activities in order to maximise the scientific and societal benefits of space science.

The concept of an African Institute of Space Science is currently under discussion by a variety of stakeholders on the continent. The proposed Institute would promote and coordinate cross-cutting multi-disciplinary research and applications in space science and technology to address the development needs of the region.

4.2.2 Programme Objectives

This programme will focus on determining the feasibility of establishing AISS and related programmes. It will specifically aim at:

(a) building public and policy-makers' awareness of the benefits of space science to Africa's economic transformation and sustainable development;
(b) mapping global trends and identifying specific technological opportunities; and

(c) identifying specific institutional arrangements for space science in Africa

4.2.3 Indicative Activities

To realize the above goals, the following activities and/or actions will be taken:

1. *Establishment of an inter-governmental experts' committee*—a committee of experts will be created to conduct a feasibility study for the establishment of the AISS. The committee will focus on such issues as what should be the mission and programmes of the AISS; the organizational configuration; specific funding needs and sources; and human resources endowment. The committee shall present its report to the Bureau of AMCOST by end of 2006
2. *Establishment of a website and media outreach on space science and their benefits*—to build public and policy-makers' understanding of the benefits of space science and create a constituency for the proposed AISS, a web-based outreach project will be established. This will be facilitated by experts in public understanding of science. In addition, such media as radio, newspapers and TV will be used to promote public understanding. Special media programmes on space science will be developed and promoted.
3. *Organize an African electronic conference on space science*—to solicit views and technical input from the international community, an e-conference on space science and related opportunities will be organized. The conference agenda and deliberations will be guided by a background paper to be commissioned.

SECTION 4: IMPROVING POLICY CONDITIONS AND BUILDING INNOVATION MECHANISMS

This section describes programmes for improving policy conditions and related capacities as well as the necessary mechanisms to promote technological innovation. It focuses on specific research and capacity building initiatives that will be taken to improve the quality of science, technology and innovation policies at national, regional and continental levels[2].

PROGRAMME 5.1: AFRICAN SCIENCE, TECHNOLOGY AND INNOVATION INDICATORS INITIATIVE (ASTII)

1.1 Overview

Science, technology and innovation (STI) indicators are crucial for monitoring Africa's scientific and technological development. They are useful for formulating, adjusting and implementing STI policies. Indicators can be used to monitor global technological trends, conduct foresight exercises, and determine specific areas of investment. An example is the target of a ratio of R&D spending to GDP of 1% for African countries.

It becomes immediately evident that indicators of the number of people engaged in research at the present time are needed, to suggest how many will be required if the target is to be achieved. That raises questions about the production of researchers by universities, and their mobility within the system and across its boundaries through immigration and emigration. Again more indicators are needed if the picture is to be understood. As part of gathering the data to construct the indicators, best practices may be found in the organizations being surveyed which can be shared across the system. At the end of the day, the target may not be achieved, but the functioning of the system may have been improved. This is an important outcome of a benchmarking exercise.

For indicators to be used effectively, they must be embedded in the policy process, and that requires interaction between policy makers and statisticians. Policy makers must be able to formulate objectives, such as the need to feed more people with domestically grown food, and programmes to move the economy and the society towards the objectives. These could include genetic research leading to more robust breeds of plants and animals, or new breeds, the development of vaccines and of better diagnostic tests for food safety.

Statisticians can then formulate survey questions which provide information on the state of these programmes (funding, number of researchers involved), of their outcomes (number of new plant breeds), and their impacts (increase in quantity of food delivered to market). For the process to work there has to be discussion of the policy questions to be illuminated, leading to the formulation of survey questions, which, if answered well, will provide the information needed. The process of interaction and co-operation allows each group to do what it does best, policy analysis and development on one hand, and survey question and questionnaire development on the other. These are quite different skills, but they must be brought together if the resources available for indicator production are to be used effectively and efficiently.

In both cases, there may be need for capacity building which can be addressed by the African Observatory for Science, Technology and Innovation (AOSTI) through the provision of training, sample

[2] Annex 3 provides a set of selected AU Commission Policy related projects.

survey instruments, and case study templates, as well as practical advice on the development of country profiles, indicator reports, and the use of indicators in evidence-based policy.

The importance of indicators has been recognised by African leaders and policy-makers. At the first African Ministerial Conference on Science and Technology, countries committed themselves to develop and adopt common sets of indicators. The system of indicators will track the development and functioning of the African national systems of innovation and it will constitute the mainstay for the production of the African Innovation Outlook. The Outlook will report on the developments in science, technology and innovation in Africa at national, regional and continental level.

1.2 Programme Objectives

The overall objective of this programme is to build Africa's capacity to develop and use STI indicators. Its specific objectives are to:

(a) develop and cause the adoption of internationally compatible STI indicators;
(b) build human and institutional capacities for STI indicators and related surveys;
(c) enable African countries to participate in international programmes for STI indicators; and
(d) inform African countries on the state of STI in Africa.

1.3 Indicative Projects and Activities

Project 1: Development and Adoption of African Common Science, Technology and Innovation Indicators

A set of indicators can be developed to describe the science, technology and innovation system of a country, and to support the policy processes and public debate. However, those indicators become even more valuable if they support comparisons with other countries in Africa. For this to happen, there have to be agreement by among African countries on definitions, on statistics, indicators, and methods of collection and of interpretation of data.

NEPAD has established an experts' working group that is preparing the necessary document with proposed indicators and guidelines for conducting surveys. This should form the basis for initiating an intergovernmental process to enable African countries to agree upon definitions and methods, and where none exist, to develop definitions and methods appropriate to the relevant government authorities. Building on the work done by the experts' working group, this project will:

1. Establish an inter-governmental committee of national experts on STI indicators. The committee will consider and agree upon common definitions, indicators and methods for conducting STI surveys. It will also determine modalities for integration of STI indicators into the African Peer Review Mechanism (APRM).
2. Establish formal relations or links with OECD and other regional STI indicators platforms and programmes. This will enable African countries to participate in and learn from other STI indicators programmes.
3. Identify and cause the designation of competent national authorities for STI indicators
4. Publish and widely disseminate an African STI Indicators Manual based on the work of the proposed inter-governmental committee

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Project 2: Establishing an African STI Observatory

To ensure that the STI indicators and information gathering as well as collation, compilation and validation are standardized, it is proposed that an African Observatory of Science, Technology and Innovation (AOSTI) be created. This body would also provide the locus of networking all designated

competent national authorities. The proposed Observatory will be the African equivalent to coordinating bodies such as the OECD Directorate for Science, Technology and Industry, managing expert committees from African countries and producing manuals, the AIO, and providing capacity building, all as part of improving the understanding of the dynamics of African innovation systems.

An important role for the Observatory would be to manage the collection of statistics on science, technology and innovation from African countries. It will build capacity through the provision of training, sample survey instruments, and case study templates, as well as practical advice on the development of country profiles, indicator reports, and the use of indicators in evidence-based policy. It will assure uniformity in the methodologies and definitions utilized for the collection of data in the participating countries, will coordinate the timely collection of data and it will organize relevant short courses as necessary. It will identify and acquire the existing primary data internationally and develop the relevant indicators (i.e. bibliometrics, patents, trade and educational statistics et cetera). The observatory will further be responsible for the production and dissemination of the "African Innovation Outlook".

AOSTI will also work with international peers such as the multilateral organizations OECD, Eurostat and the UNESCO Institute for Statistics, various CNAs and donor agencies having special interest in STI indicators. For there to be a dialogue about indicator development with UN organizations, Eurostat, the OECD, and national organizations outside of Africa, there must be a single African voice for the development and application of indicators of science, technology and innovation activities. AOSTI will provide this voice.

The process leading to the establishment of AOSTI will include:

(a) The proposed intergovernmental committee on STI indicators shall consider and approve modalities for establishing the AOSTI.
(b) An experts' team or identified institutions will be commissioned to develop a comprehensive programme of work as well as governance structure and funding mechanisms for AOSTI. The programme of work and related elements will be considered and approved by the committee.

PROGRAMME 5.2: IMPROVING REGIONAL COOPERATION IN SCIENCE AND TECHNOLOGY

2.1 Overview

Scientific and technological development is a learning process that is largely achieved by countries through cooperative or collaborative efforts of sharing experiences, information, infrastructure and such other resources as human and financial. Today no country can secure higher levels of scientific advances and technological progress without interacting with its peers and neighbours. The ability of countries and firms to innovate, both in technical and managerial ways, is largely determined by strategic alliances they forge both within their industrial landscape and across sectors. Furthermore, for industrial firms to become successful in generating new innovations they often have to create partnership with public R&D institutions. This is clearly manifest in such fields as biotechnology: relatively strong and strategic partnerships between university R&D activities and operations of companies.

Regional cooperation in S&T can take various forms, including joint science projects, sharing of information, conferences, building joint or common laboratories, setting common standards for R&D, and exchange of expertise. A common problem or challenge, such as the development of a HIV/AIDS vaccine, can be one of the primary factors stimulating cooperation. The United States of America and many EU countries invest considerably in science and technology cooperation. This is manifested in the

growing number of joint laboratories, EU common projects, growing numbers of co-authored scientific publications, transatlantic movement of scientists, and intensity of science and technology policy activities in the OECD. The USA spends about US$ 600 million per year on S&T collaboration with developing countries. The emergence of the European Research Area is a clear demonstration of the importance of S&T cooperation among EU countries.

There is recognition by African policy-makers and scientists of the importance of regional cooperation in science and technology. This is explicit from provisions in regional and sub-regional treaties, in decisions of regional meetings and from various statements. Most of the regional treaties have provisions on science and technology cooperation.

However, not much has been done to translate the provisions of the treaties into concrete processes and activities on S&T cooperation. Many African countries continue to work with isolated R&D systems often with limited scientific and technical expertise and financial resources. The continent, as a whole, has spread its limited resources too thinly across science and technology fields. In many cases existing science infrastructure of the relatively well-to-do countries of the region is not accessible to others that desperately require it.

2.2 Programme Objectives

The overall goal of this programme area is to support African countries to intensify and improve the quality of their cooperation in science and technology. Its specific goals are to:

(a) Build capacity for regional and international cooperation in science and technology
(b) Promote exchange of good practices of cooperation in science and technology; and
(c) Generate a common African framework for cooperation in science and technology.

2.3 Indicative Projects and Activities

The following project ideas will be further developed and implemented to achieve the above goals:

(a) Providing a synthesis review of how international and regional processes have addressed the importance of cooperation in science and technology. Emphasis shall be placed on such international instruments as Agenda 21, WTO agreements, declarations of the United Nations, environmental treaties from the UNCED and WSSD processes as well as regional economic and trade treaties. One of the aims of the review is to provide a succinct illustration of commitments made by countries and the different institutional arrangements they have established to implement science and technology provisions of the agreements.
(b) Identifying bilateral science and technology agreements and studying, through case approaches, how these have been translated into concrete actions in terms of joint projects and programmes. Emphasis will be on the nature and intensity of learning by each of the countries involved. The study will be organized in such a way as to cover arrangements signed among African countries and those between African countries and their counterparts from other regions of the world. A methodological framework for studying the implementation of bilateral and multilateral science and technology agreements will be developed.
(c) Identifying and promoting best practices in science and technology cooperation. This activity will largely focus on drawing lesions from science and technology cooperation arrangements in the European Union, Asian and the OECD groups.
(d) Formulating and promoting the adoption of a body of guidelines and/or a protocol on science and technology cooperation. On the basis of the results of the above activities a-c, a body of guidelines on negotiating and implementing bilateral science and technology cooperation agreements will be developed. Emphasis of the guidelines will focus on the nature of the process

of agreement negotiation, priority setting, institutional actors, implementation modalities and financial mechanisms.

(e) Regional workshops on S&T cooperation in Africa will be organized to discuss and disseminate findings of the studies and the framework guidelines/protocol. Through consultations in NEPAD and AU forums, the feasibility of negotiating and adopting an African protocol for science and technology cooperation will be explored.

PROGRAMME 5.3: BUILDING PUBLIC UNDERSTANDING OF SCIENCE AND TECHNOLOGY

3.1 Overview

Scientific and technological development cannot be achieved without the participation and support of the populace and their political institutions. It requires active engagement of policy-makers, politicians, youth, women, private industry and other groups of stakeholders. These groups are not passive recipients of science and technologies developed by scientific and technical communities but important players in processes that shape the focus and patterns of technological change and development. They determine the nature and levels of resources that go into public scientific enterprise and the overall governance of science and innovation.

In Africa the bond between science and society is still weak; and there are gaps between activities of the scientific communities and overall development aspirations of communities. Often the general public does not have ownership of and direct influence on scientific and technological developments. There are also weak links between scientific enterprises and policy development. The net result is the absence of a strong science culture and constituencies that demand and promote scientific and technological development.

3.2 Programme Objectives

The overall objective of this programme is to build public and political constituencies for science and technology. Its specific goals are:

(a) to increase awareness of the contributions that science and technology can make to Africa's economic recovery and sustainable development; and
(b) To increase public participation in science and technology policy-making.

3.3 Indicative Activities

This programme will establish an electronic forum for policy-makers, scientists, corporate sector and civil society to debate specific science, technology and innovation issues; and to determine priorities in R&D. It will not necessarily be a forum for promoting consensus on any specific policy issues but an avenue for identifying ways and means to respond specific demands and policy imperatives. The forum will serve as platform for popularising science and engaging politicians as well as corporate sector in dialogue on science and technology policy issues. The forum will also explore ways and means to organize the following workshops and/or conferences:

(a) Annual youth conferences on science and innovation—African youth will be brought together through conferences to debate the role of science and innovation in the continent's sustainable development, and to establish networks of youth science clubs that are aimed at enriching youth appreciation of the role of science in sustainable development. The conferences will be organized on specific themes and areas of scientific and technological development.

(b) Parliamentarians' conferences on science and innovation—this will be a annual event to provide members of the AU Pan-African Parliament opportunities to reflect on the roles and implications of scientific and technological development, and devise ways of improving the quality of legislation in support of science, technology and innovation activities.

In addition to the above activities, media sessions, training workshops and a variety of other outreach processes will be developed.

PROGRAMME 5.4: BUILDING A COMMON AFRICAN STRATEGY FOR BIOTECHNOLOGY

4.1 Overview

The role of modern biotechnology in the economic transformation and sustainable development of Africa is the subject of increasing debate and controversy. The debate can be traced to the late 1980s but has acquired new dimensions as a result of a variety of factors including rapid scientific and technological advances, increasing commercialization of genetically modified foods, increasing food insecurity in Africa, and growth in the activities and influence of environmental activists. Recent famines and hunger in parts of Sub-Saharan Africa and the decision by some African governments to reject genetically modified food provided to their countries as aid have moved the debate from the confines of scientific and environmental groups to the centre of public policy and politics in the region. There are two extreme positions that characterize the debate: pro- and anti-biotechnology camps.

The extreme pro-biotechnology groups catalogue potential benefits of the technology and often dismiss any concerns about potential risks. They tend to portray biotechnology as the panacea to food insecurity in Africa. On the other extreme are the anti-biotechnology activists that associate the technology with nothing but danger and risks. They will like the development, commercialization and application of the technology stopped. The two extreme views have tended to confuse many African policy-makers and sections of the public because of the lack of reliable information and guidance available to these groups. There is increasing uncertainty and confusion in many of the African governments' responses to a wide range of social, ethical, environmental, trade and economic issues associated with the development and application of modern biotechnology. This is likely to deny African countries opportunities to derive benefits while at the same time minimizing risks from the technology. These countries need to establish informed policies and strategies to respond to developments associated with biotechnology. They should not continue to react to agendas set by other regions of the world.

NEPAD framework document commits Africa to the creation of an African platform on biotechnology. It articulates two interrelated goals of the platform. This first is to "generate a critical mass of technological expertise in targeted areas that offer high growth potential" from biotechnology and the second is to "harness biotechnology in order to develop Africa's rich biodiversity and … improving agricultural productivity and developing pharmaceutical products." To realize these goals African countries will need to first and foremost build common consensus and strategies on how best to ensure that they maximize benefits from the technology while at the same time addressing potential environmental, health, ethical and economic risks or concerns emerging with rapid advances of the technology.

NEPAD's first African Ministerial Conference on Science and Technology recognized the urgency of African countries developing and adopting a common position and strategic approach to biotechnology issues. It was recognized that the absence of African consensus and strategic approaches to address emerging biotechnology issues allows different interest groups to exploit uncertainty in policy-making, regardless of what may be the objective situation for Africa.

NEPAD and the African Union (AU) Commission have established a high-level African Panel on Biotechnology (APB) to facilitate open and informed regional multi-stakeholder dialogues on, inter alia, scientific, technical, economic, health, social, ethical, environmental, trade and intellectual property protection issues associated with or raised by rapid developments in modern biotechnology.

4.2 Programme Objectives

The overall goals of the programme are to*:*

- Ensure that Africa adopts a proactive strategy to capture economic, health care, environmental, and industrial benefits from biotechnology and manage potential challenges, risks and tradeoffs associated with the development, commercialization and application of the technology;
- Support African countries to implement provisions of the Cartagena Protocol on Biosafety and related provisions of the Convention on Biological Diversity (in particular Article 19 on handling of biotechnology and distribution of its benefits);
- Strengthen Africa's capacity to respond to issues associated with modern biotechnology as they emerge in international negotiations at the World Trade Organization (WTO) and other international forums.
- Develop strategic ways and means of contributing to the fulfilment of NEPAD's core goals of sustainable development; and
- Facilitate the harmonization of biosafety regulations as well as build a regional network of centres of excellence in biotechnology management, including risk assessment and regulation.

The APB will use succinct analyses to propose a strategy for biotechnology. Such a strategy should reflect Africa's common values, articulate shared needs and should focus on common opportunities. It will aim at identifying specific common areas of technology development, risk assessment, capacity building, and appropriate institutional arrangements to enable African countries, through AU, to effectively respond to developments in/with modern biotechnology. The African strategy on biotechnology will be presented to and adopted at a high level Africa inter-ministerial symposium on biotechnology and subsequently by NEPAD Heads of State and Governments Implementation Committee (HSGIC) and the AU Summit.

PROGRAMME 5.5: BUILDING SCIENCE AND TECHNOLOGY POLICY CAPACITY

5.1 Overview

The extent to which Africa is going to harness, develop and apply science, technology and innovation to achieve economic change and sustainable development will depend on the nature of policies and institutions that its countries will put in place at national, regional and continental levels. Science, technology and innovation policies are instruments for determining how, where and why financial, physical and human resources are committed to R&D. They are also used to stimulate specific actions for ensuring that scientific knowledge generated by R&D programmes is applied to create social and economic products.

Many African countries do not have explicit national science, technology and innovation policies. A few countries designed science and technology policies in the 1970s and 1980s. These policies do not reflect realities of the globalizing world and national economic imperatives of this new millennium. In addition, these policies have not been implemented because of a wide range of factors, including the absence of national capacity for policy monitoring and adjustment.

Today African policy-makers and political leaders are confronted with a growing range of complex social, economic, ethical and political issues associated with rapid scientific and technological developments. Take developments in genomics and other areas of modern biotechnology for example. The application of these technologies in agriculture and industry raise a variety of complex policy issues. These range from measures to ensure that economic benefits are shared among all stakeholders in a fair manner to ethical and risk considerations associated with the manipulation of genes. African policy-makers and leaders require an understanding of relevant social, economic and legal aspects so that they can formulate and implement appropriate policies and legislation.

Second, the private sector is becoming a major investor in R&D. This is partly due to globalisation, the opening up and integration of national economic systems as well as liberalization of trade, which is changing the locus of R&D. Globalization raises a number of new questions about institutional configurations and change to ensure that commercial interests and goals do not overshadow the need to address public needs. There is an increasing debate about how to enlarge and sustain public research on priorities for poor people. Scientists and research managers in agricultural research systems are under increasing pressure to identify strategic ways of partnering with private industry without losing sight of their responsibility to address problems of the poor and generate public goods. However, there are also pressures towards privatisation within developing countries simply due to national macroeconomic reform and new entrepreneurial opportunities that have begun to present themselves. This is forcing national R&D systems to seek alternative financial sources for their work.

Third, public science institutions or research organizations are faced with fundamental questions about their relevance, performance and accountability. There is increasing evidence and consensus that current configurations of public R&D are not responsive to growing demand for new knowledge and innovations, and that they are not changing fast enough to respond to technological and geo-economic developments. Science, technology and innovation policies are required to deal largely with institutional, socio-economic and political factors that either enhance or inhibit innovation in the broad sense of both the generation and application of knowledge in economic production.

Majority of African countries do not have an adequate supply of and/or access to officials with specialized skills and experience in science, technology and innovation policy analysis. Yet the successful implementation of this action plan requires government officials and experts with skills in policy analysis. Building capacity for science, technology and innovation policy analysis, formulation, monitoring and implementation will be a core aspect of making the transition to sustainable development.

5.2 Programme Objectives

The overall objective of this programme is to create a cadre of African civil servants and academics with skills in science, technology and innovation policy analysis. Its specific goals are to:

(a) stimulate the establishment of science, technology and innovation policy courses at post-graduate level in African universities and other higher education institutions;
(b) build a critical mass of science policy advisors to African governments and private sector; and
(c) build and disseminate information and experiences on science, technology and innovation policy analysis, advice and development.

5.3 Indicative Projects and Activities

The following interrelated projects will be further developed and implemented to achieve the above goals.

Project 1: Design and Provision of an African Science, Technology and Innovation Post-Graduate Course

To build specialized skills in science, technology and innovation policy research and analysis, Africa as a whole requires a comprehensive project to train at masters and doctoral levels. Such training needs to be well designed and focused on imparting skills for research and problem solving. So far, there is no university in Africa that have a comprehensive postgraduate programme for science, technology and innovation policy. A few programmes in African universities tend to cover various aspects of policy research and analysis but in isolated or non-systematic manner.

This project aims at promoting the design and implementation of a continental postgraduate course. Specific actions to develop the course will include:

(a) Organization of a workshop to develop conceptual framework, modules and teaching as well as research guidelines for the course. The workshop will bring together a number of carefully selected African and international universities
(b) Establishment of a consortium or network of universities dedicated to science, technology and innovation policy training and related research supervision; and
(c) Piloting of the course and introducing the necessary adjustments between 2007 and 2010.

Project 2: Short-term Executive Workshops for Senior Government Officials

This project will be developed as clustered workshops to introduce senior government officials to new and emerging policy issues as well as to provide them with opportunities to share information and experiences on different ways of organizing and managing science, technology and innovation policy-making. The workshops will cover areas or issues such as: design and use of technology foresights, international negotiations on technology transfer, public-private partnerships for science and technology development, National Innovation Systems concept and its application, and principles of science policy.

The following actions will be taken to design the project:

1. Competent international and African institutions will be commissioned to establish a consortium to propose modules and workshop structure as well as work-plan;
2. A comprehensive reader (with concepts and case studies) will be developed by the consortium
3. A set of modules and criteria for conducting the workshops will be agreed upon
4. First two-three pilot workshops will be conducted in 2006.

Project 3: Establishing an African e-Library of Science, Technology and Innovation Policy

This project will be designed to promote dissemination of information on national, regional and continental science, technology and innovation policy instruments and processes. Its goal is to make information on national science, technology and innovation policies, laws and institutions available to African policy-makers, academics, industrialists, donors and other interested groups.

The core of the project will be an electronic or web-based library of science, technology and innovation policy documents. Specific actions to develop the project will include:

(a) developing an appropriate website and related framework to ensure that it is easily accessible to end users;
(b) collecting (through requests to government departments to submit their relevant national official documents) and organizing relevant materials/documents, including cataloguing for easy reference and use; and
(c) Developing and providing a users' manual to all relevant departments and stakeholders.

PROGRAMME 5.6: PROMOTING THE CREATION OF TECHNOLOGY PARKS

6.1 Overview

The transition from the conduct of science or research to the application of scientific knowledge to generate specific product and process innovations will require more than the establishment of R&D institutions and programmes. It will require the creation and/or use of business or commercial oriented enterprises for innovation. Such institutional arrangements can take different forms such as technology parks or innovation hubs. Whatever their form, these are really mechanisms for ensuring that R&D generate products and services.

Technology parks are created with multiple objectives. However, there are four overriding objectives, namely to:

(a) Create employment;
(b) Establish new firms;
(c) Facilitate the link between universities and these firms; and
(d) Encourage high technology development.

Technology parks are established to play an incubator role - nurturing the development and growth of new, small high technology firms; facilitating transfer of university know-how to tenant firms; encouraging development of faculty-based spin-offs; and stimulating the development of innovative products and processes. These parks also stimulate the formation and development of new technology-based firms by providing an important resource network. Finally, they are known to catalyze regional economic development and to ensure the competitiveness of traditional industries and growth of new ones through advancement of knowledge-based enterprises.

In many developing countries, the mission of promoting high tech industries is particularly important since the relative importance of traditional labor-intensive industries, which have been the engines of past growth, is declining. Many countries are depending on technology parks to serve as agents for economic development and revitalization, viewing them as a quick way to increase jobs and tax revenues with minimal environmental impact. Technology parks should provide companies and entrepreneurs with a range of services and infrastructures that will enhance their competitiveness and capacity. Such services and infrastructures include:

- High quality and adequate infrastructures (space, landscaping, communications and transportation accesses, good location, good facilities and buildings, etc.)
- Good common services (Office facilities, meeting rooms, parking, cafeteria, restaurant, hotel accommodation, security, etc.)
- Good value added services (telecommunication infrastructures, quality access to internet, videoconference, consulting services, commercial support to the companies, etc.)

- Efficient links to university and Research Institutions, to the researchers, lab and equipment facilities, etc.
- Incubation units, to encourage and facilitate the creation of new local companies.
- International links and contacts to facilitate the access to their companies to international networks.
- Technology/knowledge monitoring and observatory, helping their clients to be updated, to know what their competitors are doing, to know where are the sources of new and relevant technologies and knowledge, etc.

Although technology parks have a long history, first in the US and later in Europe and the rest of the world, their presence in Africa is still limited, as Africa continues to lag behind other regions of the world in terms of technological development and innovation. Only six countries (Morocco, Egypt, Senegal, Madagascar, Tunisia and South Africa) have initiated programmes of technology parks as an integral strategy of their sustainable development.

6.2 Programme Objectives

This programmes aims at promoting the establishment of technology parks in Africa. It will stimulate actions that ensure that the following requirements are met:

1. Government subsidies such as land, buildings, services, infrastructure, and property tax reductions. This is very necessary considering that the median Park in the US, for example, has 200 acres, over 200,000 gross square feet of buildings, 12 tenant companies with a total of 300 employees, and a US$250,000 operating budget. Long term planning and construction in phases are also important.
2. A large high-tech labour force that is also low-cost and highly productive. Thus, specially designed education and job training programs are essential. Availability of quality management and other expertise are critical.
3. A combination of large firms and new start-ups.
4. Venture capital and venture capitalists. Thus, all the factors that attract investment are important, including specially designed economic development programs, a strong economy, security, a good political climate, and investment incentives including attractive fiscal and land policies, and efficient infrastructure, among others.
5. Infrastructure that supports high techno needs and allows access to more advanced services and technologies. A great attention must be paid to the implementation and use of new information and communication technologies (satellite communications, Internet, videoconference, fiber optics network etc.). In fact, such new technologies could be used to bridge the locational requirement and therefore help countries to avoid a critical minimum of clusters of knowledge institutions, service providers and firms by undertaking cyberspace investments in “virtual science parks“. Notably, some developed countries are able to directly transfer the expertise of a university to Small and Medium Enterprises (SMEs) through systems such as the Internet.
6. University connections and links to research institutions, to the researchers, laboratories and equipment facilities.
7. Development of regional projects (parks or hubs), for example within East African Community or COMESA, not only to exploit synergies across countries but also present a bigger market that is more attractive to foreign investment. AU and NEPAD can play a crucial role in facilitating the establishment of regional technology parks.
8. Attraction of talent by targeting the African Diaspora as the source of critical mass of scientists for a regional park. As a starting point, a census of skills and capacities will be critical and academic institutions may initially attract the technical personnel, but the role of the technology parks would be to keep them productively engaged, and to tap their technical skills for economic development purposes. Supportive policy frameworks for this strategy would include

special provisions for work permits for experts returning from abroad, or for foreign technical specialists who will work in the technology parks. Other issues of policy concern include economic attractions, research funding, subsidies, or specialized rights that enable intellectual workers to share economic returns of their companies.

6.3 Indicative Actions

The following actions will be taken to promote the establishment of technology parks:

a. A body of good practices and guidelines for establishing technology parks will be developed and disseminated widely to national governments;
b. An African workshop or roundtable on ways and means of establishing technology parks in Africa will be organized in 2006;
c. A proposal on how best to establish regional and continental technology parks will be developed and considered by the African Ministerial Council on Science and Technology (AMCOST)

SECTION 5: IMPLEMENTATION, FUNDING AND GOVERNANCE

This section outlines institutional and funding mechanisms as well as overall governance structure to ensure effective and efficient implementation of the 'Consolidated Science and Technology Plan of Action'. It places emphasis on the principles that should guide African leaders to establish the right institutional arrangements for the implementation of the programmes and projects.

5.1 Institutional Arrangements

This plan of action and its programmes are being designed in such away as to be implemented through networks of centres of excellence. These networks will be organized as consortia of institutions that bring their best intellectual, administrative and infrastructure as well as financial resources together. Success will depend on the voluntary participation and contributions of different governments and relevant institutions. The main objective of institutional networking approach is to benefit from the synergy of information exchange, the richness of diversity and shared resources. The agency networking will be deployed in the further development of the programmes through planning and coordination and its success depends on the principles outlined below:

(a) Commitment by groups of participating institutions to take responsibility to work collectively.
(b) Commitment by participating institutions to devote some of their existing resources to support the implementation of the programmes and projects.
(c) Recognition that no single institution can generate all the knowledge and information required to implement the programes and projects.
(d) Commitment by African countries to provide financial resources and technical capacities.

The networks of centres of excellence are being designed to reflect these principles. The distribution of functions between and among participating institutions will depend on the capability and location of the organizations. The networks will largely:

(a) enable African countries and their scientists to have access to world-class laboratories for the conduct of cutting-edge scientific research and innovation so as to contribute to human development;
(b) promote sharing expertise, financial resources, facilities and knowledge among institutions;
(c) contribute to the creation of a new generation of skilled African scientists; and

(d) contribute to the alleviation of poverty and enhancement of human development.

5.2 Overall Governance

In order to ensure the successful implementation of the programmes, the first Ministerial Conference took the following decisions on the governance structure:

5.2.1 African Ministerial Council on Science and Technology

The Ministers established the African Ministerial Council on Science and Technology. The Ministerial Council consists of all Ministers responsible for Science and Technology in African countries. It is responsible for the establishment of policies and priorities and for more coherent and coordinated approaches on strategies for S&T cooperation. The Council is expected to exercise policy oversight in the implementation of the programmes.

5.2.2 Steering Committee for Science and Technology

The Steering Committee for Science and Technology was constituted with membership at the level of Directors-General, Permanent Secretaries or officials of equivalent rank, two representing each of the five geographic regions of Africa. The Steering Committee oversees the development and implementation of programme activities, including the formulation of the business plans. It will be responsible for reviewing progress of implementation of the 'Consolidate Plan for Collective Action'.

5.2.3 AU Commission's Responsibilities

The AU Commission shall be responsible for providing overall political and policy leadership for the implementation of this Consolidated Plan of Action. Its specific roles will include: (a) convening meetings of AMCOST and ensuring that resolutions of such meetings are transmitted to the AU summits (b) initiating policy processes that are aimed at addressing specific science, technology and innovation issues (c) mobilizing financial resources for the implementation of the Consolidated Plan of Action (d) leading AU-NEPAD delegations to international processes and negotiations on science, technology and innovation issues (e) providing a focal point for liaising with the United Nations agencies on matters pertaining to policy, and (f) creating various schemes for promoting science and technology, including engaging the African youth, Diaspora and women in the implementation of the Consolidated Plan of Action.

5.2.4 NEPAD Office of Science and Technology

NEPAD Office of Science and Technology shall be provide overall technical and intellectual leadership for the implementation of this Consolidated Plan of Action. Its specific roles will include: (a) mobilizing and directing technical expertise, including networks of centers of excellence, to implement the programmes and projects (b) convening meetings of the Science and Technology Steering Committee of AMCOST (c) providing technical leadership for the establishment of the proposed African Science and Innovation Facility (d) providing technical support to AU Commission's policy processes and activities (e) monitoring international trends in science and technology and ensuring that the necessary adjustments are made to this Consolidated Plan of Action to respond to the trends, and (f) monitoring and reporting on the implementation of the programmes and projects.

5.3 A Technical and Financial Mechanism for Implementation

The implementation of the programmes and the 'Consolidated Science and Technology Plan of Action' as a whole will require a well configured institutional setup or system. The intra and inter programmatic linkages make it necessary to establish multidisciplinary approaches for implementation. At least four groups of institutional actors will be involved in the implementation phases. These are: policy making departments, R&D centres, industry, and funding agencies.

Programmes and their projects will be implemented by trans-African/continental networks of centres of excellence. The overall objective is to mobilize and ensure efficient utilization of scarce human and physical resources. Given the interconnectedness of the programmes and the need to promote synergies in implementation, a mechanism for coordination will be established. An African Science and Innovation Facility (ASIF) is being proposed to be established for this purpose. The ASIF would provide the pan-African mechanism necessary to sustain the networks of excellence, encourage creative individuals and institutions to generate and apply science and technology, and promote technology-based entrepreneurship. It would:

1. Mobilize technical expertise and financial resources to develop and implement the proposed projects;

2. Develop and implement guidelines and procedures for mobilizing and allocating African and international funding

3. Monitor and evaluate the implementation of the programme based on agreed upon policies and procedures

4. Provide technical backstopping to the AU Commission to implement science and technology policies adopted by the African Ministerial Council on Science and Technology (AMCOST)

5. Facilitate the emergence and growth of partnerships between African R&D networks and international ones e.g. European Research Area and the Networks of Excellence

6. Monitor global scientific and technological trends and mobilize expertise to advice AU

7. Support AU Commission to develop capacity for science and technology policy formulation and implementation

To ensure that the proposed facility is well endowed and functional, it is crucial that adequate financial resources are mobilized. AMCOST will explore various options for developing clear funding mechanisms and policies. It may consider a framework that has the following interrelated elements:

- substantial increase in national R&D budgets—with each African country taking concrete actions to allocate at least 1% of its GDP to R&D. The African Peer Review Mechanism (APRM) would be used to assess progress towards meeting the target. Each country would then be required to contribute at least 5% of its R&D budget to a funding facility. This would be for regional and continental R&D programmes
- a distinct African funding scheme or facility be established. This would be resourced through (a) annual assessed contributions by African countries based on agreed upon procedures (b) consortia of bilateral and multilateral agencies convened by AMCOST. Specific criteria and guidelines for establishing the consortia would be worked out by the Africa-UK-Canada Partnerships Working Group. (c) NEPAD Business Group. The

European Union (EU) Commission would work with AMCOST through AU and NEPAD to dedicate a portion of the EU-ACP funding to Africa.

- the African funding scheme or facility would be created as partnership with the African Development Bank, the African Capacity Building Foundation and the World Bank as well as with other donors. Flexibility should be created so that donors can also fund specific projects and programmes of the networks.
- Countries that are hosting hubs and nodes of the networks would be required to make specified contributions.

To implement the above policy elements, it is recommended that the Science and Technology Steering Committee be tasked with the responsibilities to causing the development and adoption of a specific instrument for the creation of the proposed African Science and Innovation Facility. The Committee would also design and adopt a system for allocating resources to maximize impact, ensure transparency and accountability. This would be embodied in the proposed facility. The facility could be created through a Memorandum of Understanding or a Charter to which countries would subscribe.

CONCLUSION

This 'Science and Technology Consolidated Plan of Action' marks the start of an African process that offers many opportunities to strengthen scientific and technological capacities. Its implementation will go a long way to ensure that Africa achieves its aspirations embodied in the AU and NEPAD and meet the MDGs. It will boost investments in R&D and technological innovation. However, this will require determined and coherent actions by all member states of the AU. AMCOST will play a leading role to ensure that the necessary steps are taken to implement the Plan.

INDICATIVE BUDGET 2006-2010

Estimated Budget 2006 - 2010

Programme Area/Activity	**US$ ('000)**
1.1 Conservation & Sustainable use of biodiversity	2,500
1.2 Safe Development and Application of Biotechnology	45,000
1.3 Securing and using Africa's Indigenous Knowledge Base	650
2.1 Building a Sustainable Energy Base	15,000
2.2 Securing and sustaining Water	45,000
2.3 Combating Drought and Desertification	8,000
3.1 Building Africa's Capacity for Material Science	4,500
3.2 Building Engineering capacity for Manufacturing	2,500
3.3 Strengthening the African Laser Centre (ALC)	20,000
3.4 Technologies to Reduce Post Harvest Food Loss	2,500
4.1 Information and Communication Technology	2,000
4.2 Establishing the African Institute of Space Science	500
Improving Policy Conditions and building Innovation Mechanisms	
5.1 African Science, Technology and innovations Indicators Initiative (ASTII)	5,000
5.2 Improving Regional Cooperation in Science and technology	450
5.3 Building Public Understanding of Science and Technology	800
5.4 Building a Common Africa Strategy for Biotechnology	350
5.5 Building Science and technology Policy Capacity	850
5.6 Promoting the Creation of Technology Parks	300
Institutional Arrangements, Overall Governance and Resource Mobilization	
1. Secretarial/Administrative Services	1,000
2. Steering Committee	250
3. Ministerial Conferences and Inter-Ministerial Forum	600
4. Resource Mobilization	150
GRAND TOTAL	**157,900**

ANNEX 1: CRITERIA FOR ACCREDITATION OF NEPAD SCIENCE AND TECHNOLOGY PROJECTS

1. Introduction

The aim of this document is to outline criteria that will be used to accredit project proposals as NEPAD projects in the area of Science and Technology. These criteria are intended to provide the Steering Committee with a clear and uniform standard to apply in endorsing NEPAD projects. This is intended to protect NEPAD as a brand and limit the possibility of confusion as to the identity of approved NEPAD Science and Technology projects.

2. Accrediting Authority

2.1 The Steering Committee for Science and Technology shall be the ultimate authority responsible for accrediting NEPAD projects.

2.2 The Steering Committee may enlist the services of individual experts or organizations in making preliminary assessments prior to the decision. The organizations that could be involved in this exercise include regional institutions, continental bodies and other international formations that have the requisite expertise and experience.

2.3 The NEPAD Secretariat shall serve as the point of entry of all applications for accreditation, before they are submitted to the Steering Committee for consideration.

3. Accreditation Criteria

It is expected that most Science and Technology cooperation projects would emanate from the processes directed by the Steering Committee, particularly in the Business Plan approved by the Ministerial Council. However, countries and organizations based in Africa or abroad, could present project proposals for consideration as NEPAD projects. The following criteria would be applied in considering the proposals:

3.1 Source, Nature and Content of the Project

3.1.1 The projects must be based on one or more of the 12 flagship programmes, in particular, and be designed to advance the Science and Technology Plan of Action, in general.

3.1.2 Projects, whichever source proposes or promotes them, must demonstrate "African ownership" in terms of the basis tenets of NEPAD.

3.1.3 Member countries would have decisive inputs in the conceptualization of the project and be responsible for their successful implementation.

3.1.4 The projects that would be considered for accreditation as NEPAD projects shall be of such a nature as to add qualitative or quantitative value to existing programmes.

3.1.5 Projects would be considered across the entire knowledge spectrum, namely, the production of new or cutting edge knowledge; technology development, transfer and extension; and, the rendition of services on the basis of established technologies and know-how.

3.2 Scope

3.2.1 Projects that would be considered as NEPAD projects shall consist of at least three participating member countries of the African Union.

3.2.2 The project should be of a nature that is likely to deliver a cross-border impact in one or more of the regions of the continent.

3.2.3 A project that is initially intended to be implemented in one region should have the capacity for replication in other regions, should it be necessary.

3.3 Funding

3.3.1 Projects that are commissioned by the Steering Committee in terms of the adopted Plan of Action and the approved business plan shall be funded from the funds raised by the NEPAD Secretariat.
3.3.2 The NEPAD Secretariat shall assist in raising funds for other approved projects.
3.3.3 Approved projects could also be funded from sources raised independently by member countries or organizations that promote the projects.

3.4 Project Finance and Accounting

3.4.1 Networks of institutions and other agencies that implement projects shall be formally constituted in a manner that would facilitate the raising, transfer, disbursement and accounting of funds.
3.4.2 Proper accounting provisions should be made explicit in all project proposals, including auditing provisions.
3.4.3 The Steering Committee reserves the right to demand financial statements and institute financial audits on all approved NEPAD projects.

4. Project Implementation

The responsibility of project implementation shall reside with the implementing authority designated in the project plan. The NEPAD Secretariat shall provide guidance under the oversight of the Steering Committee.

5. Conclusion

The Steering Committee shall review the above criteria regularly to ensure that they continue to serve their intended purpose.

ANNEX 2: SELECTED AU COMMISSION POLICY RELATED PROJECTS

a. **African Union Scholarship Programme**: As part of its commitment to develop the requisite human capital for Africa, and its recognition of the need to have an adequate supply of qualified S&T personnel in its development agenda, the African Union has provided $300 000. 00 seed funding to initiate a scholarship programme for African students wishing to study in the various fields of science and technology. This programme will enable students to start basic science degrees and to pursue further training in masters and doctoral courses. At post-graduate levels, preference will initially be given to staff at African universities wishing to improve their qualifications. To address the low participation of women in the sciences, the scholarship programme will also give preference to women students.
Initial cost: $2 80000.00

b. **S&T Policy Development and Training**: A key function of the African Union Commission is the facilitation of the development and harmonization of policies in Member States towards African integration. To this end the Department of Human Resources and Science and technology recognizing the importance of adequate policies to create enabling environment for S&T in Member States and the fact that a number of African countries formulated their Science and Technology policies in the 1970 and 80's, will commission a survey of Member States to determine which have S&T policies, and the adequacy of these policies to meet the present S&T demands. The survey will also include training needs analysis in terms of capacity to develop policies. The HRST Department in partnership with suitable training agencies will develop the required training programme.
Cost of Survey: **$50 000. 00**
Training: **$500 000. 00**

c. **Increasing Investment in S&T**: In line with the decisions of the ACP-EU S&T Ministers Conference (2001), the first African Ministers Conference of Science and Technology (2003) where African Ministers committed themselves to investing at least 1% of their GDP to Science and technology and to give effect to AU Executive Council Decision (EX.CL/125(V)I to "pursue all measures possible to increase public expenditure on research and development to at least 1%GDP per annum," the Department of Science and Technology will commission a study to investigate creating ways of increasing investment in S&T, explore best practice from other regions of the world in this regard and develop guidelines for increasing investment in S&T for adoption by organs of the AU.
Cost of Study: $50 000

d. **Promotion of Public Understanding of Science**: In recognition of the dynamic relationship between R&D on the one hand and the use of the products of research on the other, the Department Human Resources Science and Technology will set out to promote public understanding of science and to develop a African constituencies for S&T which R&D programmes will take into account. Societies, which have a high R&D investment are also characterized by a strong public opinion on matters relating to science and technology with the result that there is a symbiotic relationship between the public and science such that R&D programme are perceived as serving public interests. The public in turn often exerts pressure on governments to increase funding of science. Australia is an interesting case in point in this regard where a public poll revealed that many people called for more funds for science since they felt science did more good for them than any other sector.

In Africa, however, the relationship between the public and R&D is not only weak but often public opinion is ignored by the science sector, let alone the common practice of using people as guinea pigs. Until the African public and politicians can, of their accord, speak of the benefits of science, improved investment in science and technology will remain an illusive dream. An improved public understanding of science will also yield an increased number of students taking up science and technology careers. The Department of Human Resources Science and Technology will therefore embark on a Public understanding of Science programme by:

- Develop S&T material for parliamentarians and engage politicians through the Pan-African Parliament **$100 000.00**
- Introducing the S&T Week continentally **$500 000 per annum**
- Develop in partnership with suitable institutions, a training programme for journalists in science and technology. **$500 000 per annum**
- Partner with the African media to promote science and technology. **$1,000000**

e. Improving Regional Cooperation

African Heads of State and Government signed the Abuja Treaty 1991 to signal the importance of regional integration as an important tool for accelerating the economic, social, cultural and political development of African countries. The regions were later identified as the platforms for the implementation of the AU and NEPAD programmes. However, there is a presently a great deal of variation with the regard to the regions ability to implement their mandates. Whereas some regions like SADC have progressed significantly even in terms of establishing Ministries of Science and Technology and national policies for S&T, others are still struggling to get organized. One of the key mission of the African Union is thus to rationalize and strengthen regions by providing the capacity required. In this regard the Department of Human Resources Science and Technology will establish and empower S&T focal points in the various regions to enable them to monitor and facilitate S&T programmes in the regions.
Cost: $700 000

ANNEX 3: INSTITUTIONAL ARRANGEMENTS FOR IMPLEMENTATION

AU/HRST	NEPAD	Implementing Institutions/Partners
Political Leadership	Leadership in Technical and Operational Matters	Lead Centers of Excellence and Championing countries
Policy Directions & Guidance	Facilitating Conceptualization, design and implementation of policies and programmes; Identifying and promoting continental programmes	Regional Economic Communities (RECs); STRC, Centers of Excellence, Research Institutions, Universities, Academies of Science and Engineering, Private Sector (NEPAD Business Group)
Advocacy vis-à-vis African States; facilitating dissemination of information on African science and technology development through the Member States Coordinating representation of Africa's interests and position in negotiations in international arena ;	Advocacy vis-à-vis the Network members and other Technical Bodies and stakeholders of Science and Technology including the private sector; Establish and promote effective platforms for collaboration within and between programme networks Use of ICT and media to disseminate information ;promote regional programmes Networks. Preparation of necessary IEC material and policy documents to influence international negotiations	All Stakeholders (public and private support institutions, Media Houses
Management: managing Intergovernmental framework for policy and programme through the Ministerial Council on S&T Development, the Steering Committee of the Ministerial Council and Intergovernmental Committees on Programme Networks Establishing and managing Inter-governmental processes on Programme Networks Guiding the establishment of Protocols and common standards	Management of Implementation Processes: Providing technical backstopping for the Inter-governmental Organs; Promoting capacity building for Regional Economic Communities and Centers of Excellences and Innovation Hubs, drawing on the requisite capacities for programme implementation, promoting and directing institutional Networking, including programme Networks,	Use of RECs, STRC, EAC, ECOWAS, SADC, etc. Private Sector and Institutions for capacity building purposes

	Managing the process of the formulation and implementation of Protocols, ; common standards and progress reports	
Monitoring and Evaluation: Reporting progress on programme activities to high level decision making organs of AU	Monitoring and Evaluation : Act as a score card keeper for the implementation of programmes and policies reporting on deliverables on goals to the AU ; Use of APRM process to ensure champions and Networks are meeting established targets	Eminent Persons identified to guide the APRM process; Members of networks and stakeholders in S&T Private auditing and evaluation Firms/Teams.
Resource Mobilization: Mobilizing members States ownership of programmes and promoting their commitments to programme priorities by championing in the development of S&T; Providing political and material support for the successful functioning of an African Science and Innovation Financing Facilitiy	Mobilization of Resources: In collaboration with AU/HRST mobilize the necessary resources through the development of marketable programmes and projects	