NEPAD/AFRICAN BIOSCIENCES INITIATIVE

BUSINESS PLAN

2005 - 2010

PREPARED BY

NEPAD OFFICE OF SCIENCE & TECHNOLOGY
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PRETORIA
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Acronyms and Abbreviations

AAS	Atomic Absorption Spectrometry
ABCC	African Biosciences Cassava Consortium
ABI	Applied Biosystems
ABN	African Biosciences Network
ABS	Access and Benefit Sharing
ACGT	African Centre for Gene Technology
ACP	African, Caribbean and Pacific countries
AFLP	Amplified Fragment Length Polymorphism
AIDS	Acquired Immune Deficiency Syndrome
AMCOST	African Ministerial Council on Science and Technology
AMREF	African Medical Research Foundation
APRM	African Peer Review Mechanism
ARC	Agricultural Research Council of South Africa
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AU	African Union
BAC	Bacterial Artificial Chromosome
BecA	Biosciences East and Central Africa
Bt	*Bacillus thuringiensis*
BU	Business Unit
CAADP	Comprehensive Africa Agriculture Development Programme
CAD$	Canadian Dollar
CARAAS	Centre d'Etude Régional pour l'Amélioration de l'Adaptation à la Sécheresse (CERAAS) laboratory of ISRA (Sénégal)
CBD	Convention on Biological Diversity
cDNA	Complementary DNA
CE	Capillary Electrophoresis
CFA	Canada Fund for Africa
CGIAR	Consultative Group on International Agricultural Research
CIDA	Canada International Development Agency
CILSS	Comité permanent inter-Etats de lutte contre la sécheresse dans le
CIRAD	Centre de coopération internationale en recherche agronomique
CIRA	Centre international de recherche agricoles
CIRDES	Centre international de recherche-développement sur l'élevage
CIRES	Centre Ivoirien de Recherches Economiques et Sociales
CRESA	Centre Régional d'Enseignement spécialisé en agriculture
CNRA	National Centre for Agricultural Research
CORAF	Counseil Ouest et Centre Africain pour la Recherche et le Developpement Agricoles
CSIR	Council for Scientific and Industrial Research
DNA	Deoxyribonucleic Acid
ECOWAS	Economic Community of West African States
EDF	European Development Fund
EU	European Union
FABI	Forestry and Agricultural Biotechnology Institute

FAO	Food and Agriculture Organisation
FARA	Forum for Agricultural Research in Africa
FP	Framework Programme
GAP	Good Agricultural Practice
GC-MS	Gas Chromatography-Mass Spectrometer
GCP	Generation Challenge Programme
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GIS	Global Information System
GLP	Good Laboratory Practice
GM	Genetic Modification
GMO	Genetically Modified Organisms
GMP	Good Manufacturing Practice
HIV	Human Immune Virus
HPLC	High Pressure Liquid Chromatography
HPLC-MS	High Pressure Liquid Chromatography-Mass Spectrometer
IC	Ion Chromatography
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICP	Induction Coupled Plasma Spectrometry
IFPRI	International Food Policy Research Institute
IK	Indigenous Knowledge
IKS	Indigenous Knowledge Systems
ILRI	International Livestock Research Institute
IPR	Intellectual Property Rights
IR	Infra Red
iSC	interim Steering Committee
ISRA	Institue Senegalais de Recherches Agricoles
LAI	Leaf Area Index
LCB	Laboratoire Centrale de Biotechnologies
MALDI-TOF	Matrix Assisted Laser Desorption Ionization-Time of Flight
MAS	Marker Assisted Selection
MDG	Millennium Development Goals
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
mRNA	Messenger Ribonucleic Acid
NAB	North African Biosciences Network
NARS	National Agricultural Research Systems
NEPAD	New Partnership for Africa's Development
NEPAD/ABI	NEPAD/African Biosciences Initiative
NEPAD S&T	NEPAD Science and Technology
NIR	Near Infra Red
NMR	Nuclear Magnetic Resonance Spectroscopy
NRC	National Research Council
OI	Opportunistic Infection
PAGE	Polyacrylamide Gel Electrophrosis
PCR	Polymerase Chain Reaction

QTL	Quantitative Trait Loci
RAPD	Randomly Amplified Polymorphic DNA
R&D	Research and Development
SAAVI	South African AIDS Vaccine Initiative
SABONET	Southern Africa Botanical Diversity Network
SAC	Scientific Advisory Committee
SADC	Southern Africa Development Community
SANBio	Southern African Network for Biosciences
SC	Steering Committee
SME	Small and Medium Enterprises
SSR	Simple Sequence Repeats (microsatellites)
TB	Tuberculosis
TLC-UV	Thin Layer Chromatography-Ultra Violet Spectroscopy
UCAD	University of Cheik Anta Diop
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UP	University of Pretoria
WABNet	West Africa Biosciences Network
WECARD	West and Central African Council for Agricultural Research and Development
WHO	World Health Organization
WSSD	World Summit on Sustainable Development

Preface

The NEPAD/African Biosciences Initiative is a cluster of three of the 12 NEPAD Science and Technology flagship programmes areas, namely biodiversity science and technology, biotechnology and indigenous knowledge systems. This continent-wide business plan provides a framework on which business plans of regional biosciences networks are being developed.

The process of developing the business plan started with regional consultations where five regional workshops on science and technology were held, one in each region of the continent. From the workshops, projects and programmes that the regions would like to implement on the biosciences platform were identified. The projects and programmes have been refined through rounds of regional consultations between the NEPAD Secretariat and steering committees of the regional networks.

We are grateful to various stakeholders, too many to mention individually, who devoted their time to attend the regional workshops. We are also grateful to steering committee members of regional biosciences networks who have worked hard to contribute to this business plan.

The NEPAD Science and Technology Steering Committee members have guided the process of identifying the hubs and implementing the activities of the Initiative. We are grateful to them for their guidance.

Funding for designing the regional biosciences networks was provided by the the Government of Canada through the Canada Funds for Africa which is administered by the Canadian International Development Agency (CIDA). The NEPAD Secretariat is grateful is grateful to the Government of Canada for the support. We would also like to thank the International Livestock Research Centre (ILRI) through which the funding was received from CIDA and for the professional expertise that we have shared to implement the Biosciences Initiative. In addition, we thank ILRI for accepting to experiment with the hub hosting responsibility from which several lessons have been learnt and shared with the other networks.

Dr. John Mugabe
Advisor
NEPAD Office of Science & Technology

September, 2005

Executive Summary

Science and technology have a key to national development agenda. They are the main drivers of economic growth and development to the effect that an explicit correlation exists between a country's scientific and technological status and its economic growth; and indeed science and technology development has contributed significantly to defining an economic divide between rich and poor nations. Deliberate intervention in science and technology is therefore required for Africa to achieve the MDGs and integration into the global knowledge economy.

The role of science and technology in meeting sustainable development goals was recognised during the World Summit on Sustainable Development (WSSD) in 2002. In the Plan of Implementation it was recommended that science and technology should be mobilized to solve problems associated with energy deficiency, food insecurity, environmental degradation, diseases, water insecurity and many other sustainable development challenges. The plan calls the international community's intervention to assist in promoting technology development, transfer and diffusion to Africa and further develop technology and knowledge available in African centers of excellence; and support African countries to develop effective science and technology institutions and research activities capable of developing and adapting to world class technologies.

Establishment of centres of excellence on the continent is one of the undertakings that should lead to development of scientific capacity. Due to limited resources available in national institutions, the centres need to be regional in nature so that they concentrate capacity. They need to evolve with strong public-private partnership where products generated should be passed on to end-users. Strong and effective collaboration should characterize the centres of excellence involving local communities, universities, the government, the African diaspora and international partners.

In the NEPAD framework document, African countries have committed themselves to establish networks of centres of excellence as a significant way of pooling together Africa's scientific, technical and financial resources to achieve common goals. NEPAD/African Biosciences Initiative (NEPAD/ABI), a cluster of the science and technology flagship programmes of biotechnology, biodiversity science and technology and indigenous knowledge and technology, focuses on harnessing biological applications in the health, agriculture, environment and mining sectors. The Initiative is being implemented through establishment of regional networks of centres of excellence throughout the continent and complements the plans of action of the NEPAD priority sectors of agriculture, health and environment.

A regional biosciences network consists of a hub and several nodes distributed throughout the region. The choice of the hub is based on an institution that is active in scientific research in biosciences while the nodes are other institutions in the regions that are also involved in biosciences research in specific areas where they have comparative advantage. Four regional networks have been established; namely Biosciences eastern and central Africa (BecA) Network; Southern African Network for Biosciences

(SANBio); West Africa Biosciences Network (WABNet) and North Africa Biosciences Network (NABNet). Projects to be implemented on the network have been identified through extensive regional consultations that have been carried out since 2003. The projects are of two categories, those that are regional in nature and others that are continent-wide. In addition, the NEPAD/ABI has identified cross-cutting activities like establishing AU/NEPAD African High Level Panel on Biotechnology, designing a process for the bioinformatics platform and organizing biannual biosciences conferences which will be coordinated by the NEPAD Secretariat.

This business plans covers processes involved in the establishment of the NEPAD/African Biosciences Initiative. It starts off with background information on science and technology in Africa, the relevant NEPAD priority sectors where the Initiative will make direct contribution, establishment of regional networks and their activities, cross-cutting areas, governance of the networks, and resource mobilization. The process started in December 2003 in the east and central African regions while in the other three regions consultations on NEPAD/ABI started in September 2004 with identification of regional hubs being completed in May 2005. This pan-African business plan provides in depth description of the other three regional networks and makes reference to the BecA business plan for detailed coverage of the network. A business plan for the Biosciences east and central Africa (BecA) Network was completed in April 2005. The other three regions are currently developing their business plans which will elaborate some of the profiles and project outlines in this document.

Support for establishing the NEPAD/ABI was provided by the Government of Canada through the Canada Fund for Africa (CFA) where a total of CAD$30 million was earmarked for the design and implementation phases of the Initiative. Of this amount, CAD$27 million will be used for implementation of the BecA network while CAD$3 million will be used for supporting the NEPAD Secretariat to establish the other three regional networks and carry out cross-cutting activities for all the networks. This document outlines activities to be supported out of the CAD$3 million of which the Secretariat has already accessed CAD$0.5 million. Four clusters of activities have been identified for the three networks as follows:

1. **Implementing flagship projects**

Each of the three regional networks has identified a flagship project to be implemented so that early outputs can be realized out of the network activities and to catalyze interaction among institutions in the regions. The flagship projects identified are as follows:

Southern African Network for Biosciences

Scientifically validated remedies for the treatment of opportunistic infections (OI) for people living with HIV/AIDS

West African Biosciences Network

Inventory and characterization of West Africa sorghum genetic resources

North African Biosciences Network
Improving knowledge of the genetic diversity: from molecular tools to biotechnology for innovation and better life quality.

2. **Implementation of cross-cutting areas**

The cross-cutting areas identified by the Initiative are being implemented with overall coordination provided by the NEPAD Secretariat.

3. **Strengthening regional coordination**

Regional Secretariats have been established in all the networks and are currently being managed by individuals who are not serving on full time basis. For the networks to effectively generate and maintain their momentum in terms of activities and resource mobilization, full time staff will be recruited. Modalities of recruitment will vary among the regions whereby in some regions staff may be seconded by countries while in other regions, countries may contribute to the renumeration packages of secretariat staff.

4. **Support to the NEPAD Secretariat**

NEPAD is providing a platform on which the biosciences networks are being established. The networks shall belong to the countries of the regions while NEPAD shall provide policy guidelines. The office of Coordinator of the NEPAD/African Biosciences Initiative shall assist the regional networks in mobilizing political and financial support and awareness creation to policy and decision makers in African governments and among international partners.

5. **Preparation of regional business plans**

BecA has completed developing a business plan for the period 2005-2010 with its activities initially being funded by CFA. The other three regional networks are currently developing their business plans which will be used to solicit resources for implementing programmes and projects. Preparation of the business plans is supported by the funds provided by CFA and countries of the regions.

The Pan-African business plan is for the period 2005-2010 as a general framework upon which the regional business plan are developed. The major output of the plan is the development of networks which will be effective in delivering products and are sustainable. Products include human and physical capacity developed at national, regional and continental levels, knowledge generated, technologies on the markets, patents etc. Details of all these will be captured in the regional business plans based on the programmes that the networks will implement.

The challenge of sustainability of the networks is being considered from the highest level of the African Ministerial Council on Science and Technology (AMCOST) through to the regional steering committees which are supposed to provide overall governance of the networks. Factors that may affect sustainability of the networks include brain drain, lack of financial support, unequal benefit sharing among partners on the network, gender inequality etc. Most of these issues are being dealt with by the regional steering

committees and will therefore be articulated in the regional business plans. At the continental level, the NEPAD Secretariat has made proposals for consideration by AMCOST for averting the risk of financial insecurity of the networks and other programmes on science and technology.

1. Background

The challenge faced by African countries is enormous for them to realize comparable economic development as is the case with other continents. The countries constitute the poorest region of the world with their economies experiencing poor and deteriorating performance in the past three decades. Economic indicators suggest that in 1970 sub-saharan Africa's annual growth of real per capita Gross Domestic Product (GDP) was estimated at 3.2 percent, while South Asia's was 1.2 percent. The trend reversed by 1989 with Africa having a 2.2 per cent and South Asia averaging 3.2 per cent. There were more poor people living below absolute poverty level in 1998 than in 1987; 301 million and 217 million, respectively, living on less than US$1 per day. To the contrary, poverty declined most rapidly in South and East Asia during the 1990s (World Bank[1]).

Africa's population pressure has also imposed difficulties in keeping abreast with economic development. The populations of the African states are growing at the rates of 2.7% to 4.1% per annum to the effect that the total population doubles itself in every 20 years. At this rate of population growth, other demographic factors have been greatly affected, for instance arable land holding per capita has reduced from 0.86 – 5.99 ha in 1965 to 0.42-2.09 ha in 2000. Growth of agricultural production has stagnated between -1 and 3%. The rate of urbanization has increased from 2% in 1965 to 9% in 2000 (World Bank[1]). Current estimates indicate that some 200 million or 28% of Africa's population are chronically hungry. A number of factors have contributed to this alarming situation: low agricultural productivity, rapid population growth, and natural and human-made disasters such as drought, floods, land degradation, and civil conflicts.

Science and technology have a key to national development agenda. They are the main drivers of economic growth and development to the effect that an explicit correlation exists between a country's scientific and technological status and its economic growth; and indeed science and technology development have contributed significantly to defining an economic divide between rich and poor nations. A deliberate intervention is therefore required for the poor countries to experience positive economic growth by promoting science and technology in these nations. The realization has come at an opportune time when most of the economic coordination instruments and structures in the region and the world at large recognize the importance of developing science and technology capacities of the poor countries. For instance, the United Nations General Assembly in September 2000 adopted the Millennium Declaration which pledges 'to halve, by the year 2015, the proportion of the world's people whose income is less than one dollar a day and the proportion of the people who suffer from hunger, by the same date." In particular the Assembly agreed 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 transfer of technology" (United Nations, 2000). Several regional policy instruments and declarations have also emphasized the role of science and technology. For example, Africa, Caribbean and Pacific (ACP) and the European Union Forum on Research for Sustainable Development

[1] http://www.worldbank.org/poverty/data/trends/regional.htm#afr

held in Cape Town 29-30 July 2002, adopted a Cape Town Consensus stressing the importance of science and technology cooperation and called for appropriate and timely arrangements for most effective utilization of funding instruments in the 6th Framework Programme (FP6) and in the 9th European Development Fund (EDF9) in support of science and technology cooperation and research capacity building, respectively (NEPAD and DST, 2003).

The role of science and technology in meeting sustainable goals was recognised during the World Summit on Sustainable Development (WSSD) in 2002. In the Plan of Implementation it was recommended that science and technology should be mobilized to solve problems associated with energy deficiency, food insecurity, environmental degradation, diseases, water insecurity and many other sustainable development challenges. The plan therefore calls for the international community's intervention to assist in promoting technology development, transfer and diffusion to Africa and further develop technology and knowledge available in African centers of excellence; and support African countries to develop effective science and technology institutions and research activities capable of developing and adapting to world class technologies.

The Commission for Africa (2005) report has identified the need for scientifically and technically proficient staff in order to identify opportunities arising from innovation and scientific discoveries. It is therefore imperative that Africa strengthens science, engineering and technology capacity so that the countries can identify their own solutions to their own problems. This is a prerequisite for the countries to exploit the potential of innovation and technology to accelerate economic growth. The report acknowledges that there is scientific capacity in Africa but it is limited and restricted to a few regions leading to a widening of the scientific gap between Africa and the rest of the world. Establishing centres of excellence on the continent is therefore one of the deliberate undertakings that should lead to developing the scientific capacity. These should be regional in nature due to limited resources available to national institutions; hence the regional centres and networks would concentrate capacity. The centres also need to evolve with strong public-private partnership where they should generate products that should be passed on to end-users. The Commission calls for a strong and effective collaboration among centres of excellence, local communities, the government, the African diaspora and international partners. In the NEPAD framework document, African countries have committed themselves to establish networks of centres of excellence as a significant way of pooling together Africa's scientific, technical and financial resources to achieve common goals of the flagship programmes.

1.1 The New Partnership for Africa's Development (NEPAD)

The New Partnership for Africa's Development (NEPAD) is a socio-economic development programme of the African Union (AU). It is a new vision of African leaders in their quest for a socio-economic renewal of the entire continent. This initiative was adopted at the AU Summit in Lusaka, Zambia, 2001. African Heads of State and Government realize that Africa can only take its proper place in the international community if it gains economic strength, hence the objective of NEPAD is to stimulate Africa's development by bridging existing gaps in priority sectors which include

agriculture, health, education, infrastructure, information and communication technology, environment, tourism, science and technology, African Peer Review Mechanism and private sector and civil society (see NEPAD, 2001). The NEPAD Secretariat has been instrumental in raising awareness of the role of science and technology in sustainable development. The NEPAD objective for Science and Technology Platforms are spelt out as follows:

- to promote cross-border cooperation and connectivity by utilizing the knowledge currently available in existing centers of excellence on the continent;
- to develop and adapt information collection and analysis capacity to support productive as well as export activities;
- to generate a critical mass of technological expertise in targeted areas that offer high growth potential, especially in biotechnology and natural sciences;
- to assimilate and adapt existing technologies to diversify manufacturing production.

The first NEPAD Ministerial Conference on Science and Technology was held in Johannesburg in November 2003. At the conference, the ministers adopted twelve Science and Technology flagship areas (Fig. 1) that the Secretariat was mandated to coordinate a process of developing into concrete research and development programmes for implementation. These have been clustered into initiatives for instance the Biosciences Initiative which is a cluster of three flagship programme areas[2].

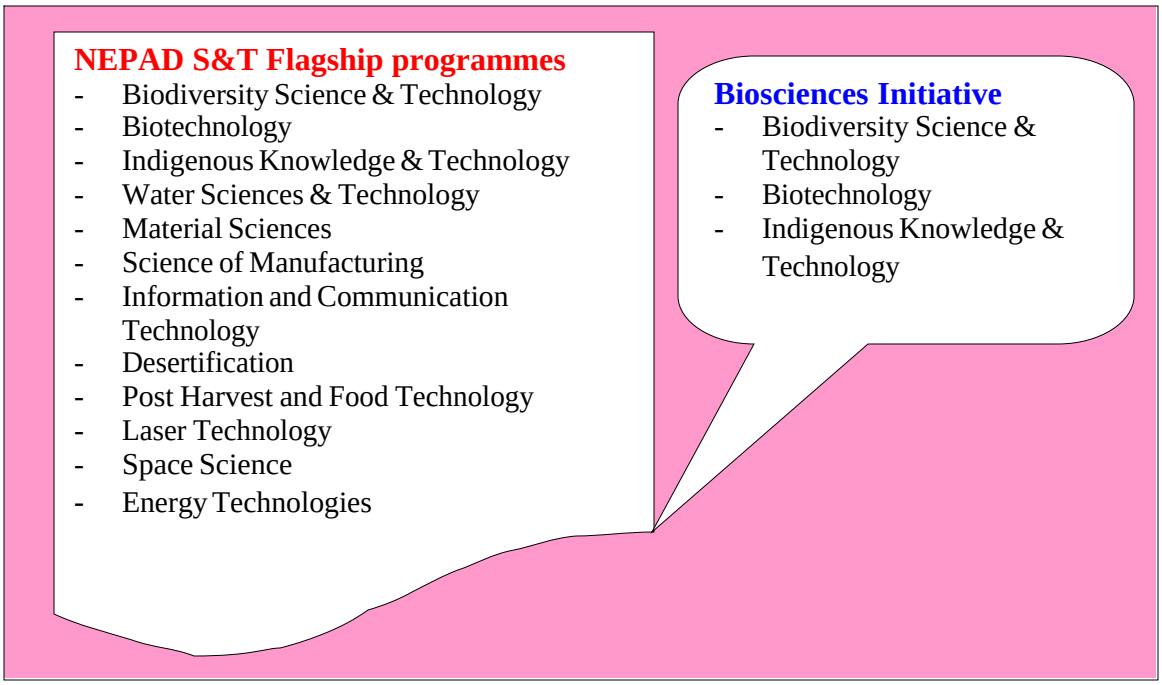

Figure 1. NEPAD Science and Technology flagship areas and a cluster of programmes in the Biosciences Initiative.

[2] Details of other clusters of flagship programmes are provided in the "*Africa's Science and Technology Consolidated Plan of Action*".

1.1.2 **NEPAD/African Biosciences Initiative**

Bioscience is the study of biological systems. It includes the application of techniques, whether biological or non-biological, to make or modify products or processes and to apply these in biological systems. Bioscience is multidimensional in nature, involving many types of research and innovation. Pharmaceuticals, biologics, bio-agriculture, environmental biotechnology, medical devices, manufacturing and material design are all disciplines that exist under the definition of bioscience. Biosciences are seen as one of the major engines of growth in the world in fields such as human health, industrial processes, environment and agriculture. Africa lags behind in biosciences. The two key problems are lack of sufficient funding from governments and shortage of skilled expertise. The problem is exacerbated by the lack of private sector activity to support and initiate research and take up products and processes that are the outcome of projects.

NEPAD/African Biosciences Initiative (NEPAD/ABI) focuses on harnessing biological applications in the health, agriculture, environment and mining sectors. Its strategic objectives are to:

a) Address African problems in agriculture, health, and environment through the application of bioscience technologies
b) Use new developments in biosciences to protect the environment and conserve biodiversity in Africa
c) Build and strengthen human capacity in biosciences in Africa
d) Promote access to affordable, world-class research facilities within Africa
e) Harness indigenous knowledge and technology of the African people for sustainable utilization of natural resources and wealth generation.

NEPAD/ABI is being implemented through establishment of regional networks of centres of excellence throughout the continent. The Initiative is feeding into three NEPAD sectoral strategies, namely agriculture, health and environment.

1.1.3 **NEPAD Agriculture**

Within the framework of NEPAD, agriculture is advanced as a driver for Africa to achieve it ambitions of self reliance and productive so that the continent can participate on the global economy. The goal for the sector is therefore to promote agriculturally-led development which eliminates hunger and reduces poverty and food insecurity, thereby enabling the expansion of exports and putting the continent on a higher economic growth path with an overall strategy of sustainable development coupled with preservation of natural resource base (NEPAD, 2003a). The Biosciences Initiative is addressing the NEPAD agriculture agenda by contributing to the following visions for agriculture for the continent by 2015 as outlined in the CAADP document:

- Improve the productivity of agriculture to attain an average annual growth rate of 6 percent, with particular attention to small-scale farmers, especially focusing on women.
- Be a strategic player in agricultural science and technology development.
- Practice environmentally sound production methods and have a culture of sustainable management of natural resource base (including biological resources for food and agriculture) to avoid their degradation.

NEPAD/ABI will contribute to these visions by contributing directly to CAADP Pillars No. 3 and No.4 where through the technologies developed, food security will be ensured through enhancement of production. NEPAD/ABI will provide the required scientific and technological underpinning required in order to sustain productivity gains necessary for Africa to remain competitive. This will be achieved through NEPAD/ABI's contribution to investment in research and technology development for agriculture, attracting private sector involvement in biosciences research and development and creating enabling environment for state-of-the-art research (NEPAD, 2003a).

1.1.4 **NEPAD Environment**

The NEPAD Environment Initiative has developed action plan and strategies to address the region's environmental challenges and at the same time combat poverty and promote socio-economic development This is consistent with NEPAD's emphasis on measures that will ensure that the continent is able to confront its short-term economic growth challenges without losing sight of the long-term environmental, poverty eradication and social development imperatives. The NEPAD environment programme of action takes a long-term approach. It is about processes, projects and related activities that are aimed at enlarging Africa's economic prospects through sustainable environmental management (NEPAD, 2003b).

The Action Plan of the Environment Initiative of NEPAD is organized in clusters of programmatic and project activities to be implemented over an initial period of ten years. The programme areas cover the following priority sectors: combating land degradation; drought and desertification; wetlands; invasive species; marine and coastal resources; cross-border conservation of natural resources; climate change; and cross-cutting issues. The plan of action builds upon the related problems of pollution, forests and plant genetic resources, freshwater, capacity-building and technology transfer.

Through projects to be implemented in its clustered flagship programmes the NEPAD/ABI will contribute to the strategy by addressing issues and challenges in the areas of wetland management, invasive species, marine and coastal resources and conservation of natural resources. In all the sub-regions of the continent, projects have been identified that will contribute to issues outlined in the NEPAD Environment action plan.

1.1.5 **NEPAD Health**

NEPAD recognizes that health is one of the central factor that impinge on poverty, social exclusion, marginalisation and lack of sustainable development on the continent. The Health strategy therefore addresses issues that would impact on the burden of diseases, disability and death. NEPAD/ABI has been designed to contribute to the NEPAD Health Sector by directly feeding into the following strategic actions (NEPAD, 2003c):

- Strengthening health systems delivery and services so that they can provide effective and equitable health care, built on evidence based public health practice, including incorporating the potential of traditional medicine

- Scaling up communicable and non-communicable disease control programmes. Especially recognizing the unprecedented challenge posed by HIV/AIDS and the burden of tuberculosis, malaria, childhood diarrhea and pneumonia, and malnutrition, the resurgence of trypanosomiasis and the burden of non-communicable health problems.

By providing interventions in the above strategic actions, the NEPAD/ABI envisages the following outputs that are relevant to the NEPAD Health agenda:

- Building capacity in Africa for health research relevant to the challenges and needs of the continent and its health systems
- Support the capacity for local production of essential drugs, including anti-retrovirals so as to make drugs more affordable
- Advocate and leverage support for development of the new drugs and vaccines needed by Africa.

1.2 NEPAD/African Biosciences Initiatives building on the African Biosciences Network

The African Biosciences Network (ABN) was established in 1981 as a regional arm of the International Biosciences Networks. The organizational structure of the ABN consisted of a Regional Executive Committee and National ABN Committees of scientists spread throughout the continent. The objective of ABN was to link biological institutions and bioscientists in sub-saharan Africa in a common effort aimed at improving the level of know-how and applications of the biological sciences throughout the region. ABN provided a forum for supporting scientists to consolidate their efforts focused on food production and health. It allowed scientists to identify problems to study, and to organize relevant research and/or training activities aimed at solving the problems. ABN came to and end in 2002 due to lack of funding.

The NEPAD/African Biosciences Initiative is adding value to the ABN in that regional networks of laboratories that have relatively better facilities and critical mass of scientists are being networked so that they can share their resources on a common platform. The resources to be shared in this case include research infrastructure, technical expertise and knowledge generated. NEPAD/ABI recognizes that science is expensive therefore effective ways of doing science need to be developed in order for the continent to participate in carrying out cutting-edge research. NEPAD/ABI is providing a platform on which the private sector is being invited to participate so that innovations coming out of the R&D can be developed into marketable products for the benefit of both, the scientific community and end users. The Initiative is cognizant of the fact that support for biosciences R&D should not be sole responsibility of the donor community, African governments and the business community on the continent need to contribute.

2. NEPAD/ABI Regional Biosciences Networks

A regional biosciences network consists of a hub and several nodes distributed throughout the region. The choice of the hub is based on an institution that is involved in cutting-edge scientific research in biosciences while the nodes are other institutions in the regions that are also involved in cutting edge research. Four regional networks have been established on the continent as follows (Fig. 2):

1. Biosciences eastern and central Africa Network
2. Southern African Network for Biosciences
3. West African Biosciences Network
4. North African Biosciences Network.

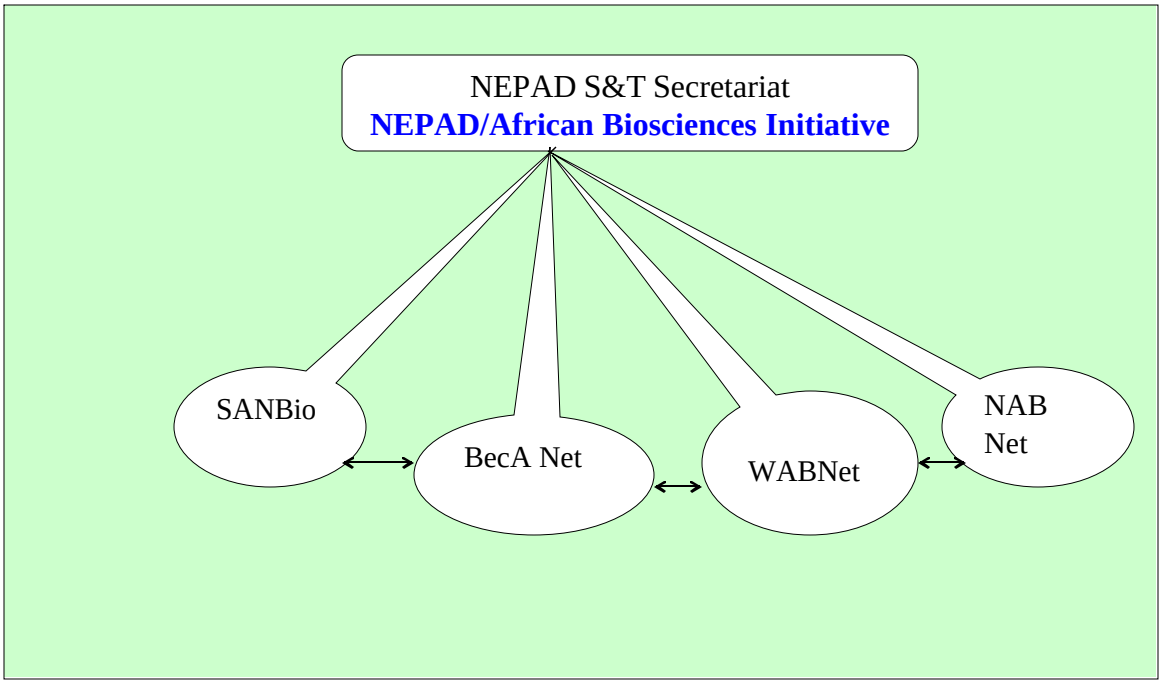

Figure 2. NEPAD/ABI regional networks linking to the NEPAD Secretariat and among themselves

2.1 Biosciences Eastern and Central Africa (BecA) Network

The network covers NEPAD-defined regions of East and Central Africa comprising Sudan, Ethiopia, Somalia, Uganda, Kenya, Tanzania, Rwanda, Burundi, Democratic Republic of Congo, Eritrea, Madagascar, Gabon, Congo Brazzaville, Central African Republic, Cameroon, Sao Tome and Equatorial New Guinea. The International Livestock Research Institute (ILRI) is hosting BECA hub and secretariat. Initial funding of CAD$4,500,000 was provided to cater for the design phase of establishing the network and major progress has been made in improving infrastructure at the hub.

The network has started off with projects in the agricultural sector which include the regional bioinformatics grid network, molecular markers selection, transformation, biofortification and disease resistance research programme. Expected outputs from BECA are development of improved crop varieties, molecular characterization and

analysis of microbial, plant and animal biodiversity, identification of genetic markers for desired traits, development of improved vaccines and development of diagnostic tests.

2.1.1 **Activities carried out at the BecA hub**

Main activities that have been carried out at BECA hub during the design phase include the following:

- December 2002: An interim Steering committee (iSC) was established to oversee the design of the biosciences network for eastern and central Africa.
- March/April 2003: ILRI and NEPAD submitted a proposal to CIDA.
- October 2003: NEPAD/ILRI MoU was signed to support the development of the biosciences facilities on ILRI's campus, as the hub of a regional biosciences network.
- March 2004: Contribution Agreement signed between CIDA/CFA and ILRI for the hub planning, design and initial capacity building activities in eastern and central Africa during 2004/5.
- Environmental assessments: An environmental impact assessment and strategic environmental assessment of the hub have been carried out.
- Hub technical design: The agreed core competencies and research requirements at the *BecA* Hub have been incorporated into the hub technical design.
- Consulting with stakeholders: A *Stakeholder Consultative Workshop* (January 2004) was attended by 60 people from 6 countries and representatives of several African organizations, including AU and NEPAD.
- Establishing a bioinformatics platform - including a dedicated website with data bases and analytical tools.
- Developing guidelines for the identification of scientific nodes in institutions that are willing to make their facilities available for regional use. These nodes will be distributed throughout eastern and central Africa and serve as an interface between the hub and other participating laboratories.
- Launch of fellowships for Doctoral Studies in January 2005, in specific areas related to *BecA's* research competencies and projects.
- Fostering an Africa Biosciences Cassava Consortium *(ABCC)*, and supporting website, to address priority constraints limiting cassava production and processing and involving about 30 participants from 7 countries, other regional bodies and cassava programs, including the NEPAD PanAfrican Cassava Initiative.
- Fostering an African Cereal Annotation Consortium for sorghum and pearl millet, and development of supporting website: participants include plant breeders from 15 African countries.
- Delivery of the first training course in eastern and central Africa for marker assisted selection in plant breeding, attended by approximately 40 participants from 15 African countries, including breeders involved in the cassava, sorghum and pearl millet research consortia.
- Appointing a substantive steering committee for the network with representatives from AU, FARA, ASARECA, ILRI, Kenya and some of the participating countries in the region.

A business plan which outlines activities that BECA will carry out during the "implementation phase" of the CIDA funded grant has been submitted separately (BecA, 2005). This business plan covers details on the other three regional networks.

2.2 **Southern Africa Network for Biosciences (SANBio)**

Southern Africa Network for Biosciences is being established with the regional hub being hosted by the Council for Scientific and Industrial Research (CSIR) in the Republic of South Africa. The network will cover 12 countries in the sub-region: Angola, Botswana, Malawi, Mauritius, Mozambique, Namibia, Lesotho, Swaziland, Seychelles, Republic of South Africa, Zambia and Zimbabwe.

At the regional workshop on NEPAD S&T flagship programme held in Johannesburg in November 2004, country delegations provided names of individuals that should serve on the steering committee for the network. The workshop also resolved that the network activities shall be in the areas of human health, animal health/production, industrial and mining bio-processing, environmental remediation, plant/crop biotechnology, biodiversity and IKS. The steering committee had its first meeting in June 2005 to consider for approval programmes on which the network should concentrate its activities. The network was officially launched on 5th August 2005 by the Bureau of the African Ministerial Council on Science and Technology (AMCOST).

2.2.1 **Capacity at the Southern African Biosciences Hub**

The Biosciences hub is being hosted by CSIR which has made available two sets of research facilities; CSIR Bio/Chemtek (to be renamed CSIR Biosciences in October 2005) and the African Centre for Gene Technology (ACGT). CSIR Biosciences is based at the CSIR campus in Pretoria, while ACGT is based at the University of Pretoria as a shared facility between CSIR and University of Pretoria.

2.2.1.1 ***CSIR Biosciences***

CSIR Biosciences is one of the CSIR's business units (BU) with a focus on the life sciences. It has a total staff complement of about 290 and is based on a programme structure. About 90 of the staff are in the biotechnology programme of whom 48 are research scientists/technologists (44% with PhDs). The programmes (biotechnology, food science, chemistry, bioprospecting and technology for development) are closely integrated to form a cohesive whole.

CSIR Biosciences is aligned with the National R&D Strategy which rests on three pillars, of which two (innovation and SET human resources) are central to its business. The strategy calls for the establishment and funding for a range of technology missions, including biotechnology, technology for manufacturing and technology to add value to the natural resource base. Collectively the three specified missions cover the total activities of the BU. In addition, it invests directly in SET human resource development, and supports a number of projects to build such competence in CSIR Biosciences. The business of the BU is also fundamentally linked with value addition to biodiversity and indigenous knowledge, with the aim to develop commercial opportunities. Thrusts and offerings in CSIR Biosciences are provided in Table 1.

Table 1. List of thrusts and offerings in CSIR Biosciences

Thrust	Description	Offerings[3]
Value addition to Africa's natural resources	The development of new capabilities, technologies, products and services based on natural resources and indigenous knowledge	• Bioprospecting • Gene and protein mining and characterisation • Genetic engineering of plants and micro-organisms • Extract, raw material and by-product utilization • Natural resource analysis • Utilization of indigenous foods
Process and product innovation across the life science R&D value chain	The development of new products, processes and services using expertise in food, chemicals and biotechnology process and product technology development	• Industrial (bio) catalytic processes • Extraction and purification technologies • Fermentation derived products • Novel food technologies • Bio-farming • Analytical methods and modeling • Reactor design and improvement
Manipulation of molecular structure and function	The development of capabilities and products through the modification of molecular structure	• Improvement of biomolecule function • Drug and vaccine target identification, modeling and characterisation • New chemical derivatives
Organisational development	Human resource development, and the development of novel science platforms in the division	• Skills development • Transformation

The product portfolio from CSIR Biosciences includes nutraceuticals derived from indigenous resources, minimally processed herbal remedies and botanical extracts derived from African traditional medicines, aroma, flavour and fragrance chemicals and extracts (including essential oils and end-formulations), health supplements, biological agents for agricultural and aquaculture applications, pharmaceuticals, with regional demand (*e.g.* anti-retrovirals against HIV/AIDS, malaria drugs and TB drugs) including advanced intermediates, food and feed additives and novel food, feed and beverage formulations, natural algal products and formulations as well as biological catalysts and enzyme formulations.

CSIR Biosciences's strategy is based on the following key technology platforms (Table 2):

- *Plant Biotechnology*: The focus of the plant biotechnology group has shifted to the use of plants as production systems for therapeutic products.

[3] An offering is a sub-set of a thrust and is in turn comprised of a number of projects

- *Systems Biology*: Previously a component of the plant biotechnology group, investment has in the past focused on the development of skills and capacity in genomics and proteomics as well as establishment of expertise and protocols for the establishment of indigenous plant cell cultures. The new focus will be targeted at integration of these activities, as well as the development of metabolomics expertise and skills, with a clear focus on seeking to add value to indigenous southern African Plants.
- *Chemical Biology*: Exploiting the interface between organic chemistry and biology, including investment in understanding structure activity relationships and protein-ligand interactions, pharmacophore determination, rational/semi-rational design, fast throughput synthesis, inhibitor design synthesis, molecular pharmaco chemistry and pharmaco dynamics and chem-informatics.
- *Fundamental expression systems* such as the microbial expression system using proprietary *Bacillus* expression systems, and investment in development of other plant, bacterial and yeast expression systems.
- *Bioprospecting science and technology*, including gathering of indigenous knowledge and biodiversity samples, extraction and biological evaluation of samples, bioassay-guide isolation and characterisation of new biologically active molecules.
- *Food Property Modification, Process Development and Immuno-nutrition,* the traditional areas of focus have been food property modification and process development which includes expertise in formulation, food preservation, food safety, food analysis, microwave technology, extrusion, drying technology, starch chemistry and indigenous foods. These areas will remain core to the BU, but there will be a continued focus on understanding the properties of food molecules, processes to modify the properties, and the effect on the food and its nutritional value. Specifically, the area of immuno-nutrition will be explored with a number of partners, as the basis for a new integrative platform for the BU.

Table 2. Bioscience platforms and the components

Platform	**Components**
Functional genomics	genomics, proteomics, bioinformatics and advanced analytical technologies
Structural biology	protein structure and function, structural bioinformatics, rational inhibitor design, pretein molecular dynamics, site-directed mutagenesis, enzymology, protein crystallography, NMR, ligand synthesis, activity screens
Plant biotechnology	plant genetics, crop improvement, 'bio pharming", plant propagation, biosafety and the development of transgenics
Industrial biotechnology	fermentation, biocatalysis, process and product development and validation, microbial expression systems, protein characterisation and purification

Pharmaceuticals and fine chemicals process and product development	natural product synthesis and analysis, reactor design, fine chemical synthesis, extraction and purification
Food science, food process and product development	agroprocessing, waste beneficiation, formulation, pilot scale testing, technology transfer, food analysis and process innovation
Bioprospecting and new chemical entity discovery	Value addition to medicinal plants, plant collection, extraction, screening, analysis and bioassay guided fractionation

In addition to the above, three new emerging platforms are envisaged:

Systems Biology Platform
The strategic vision for the systems biology platform is being approached in two ways, namely strengthening the supporting technologies that constitute this platform as well as ensuring full integration of this platform throughout the BU and across existing platforms.

Systems biology essentially is comprised of a number of tools and supporting technologies such as genomics, genotyping, transcriptomics, proteomics and metabolomics, all of which generate the quantitative data that are processed and modelled through bioinformatics.

Drug Development for Diseases Prevalent in Africa
The strategic vision for this platform is to exploit the strengths developed in all of the other platforms through a directed integration. It is projected that the contribution of the large pharmaceutical companies to new therapeutic agents for conditions which can be considered diseases of the third world (for example, TB, HIV/AIDS and malaria) will decline dramatically in the next decade. With the resistance to existing therapies becoming endemic, it is of critical importance that research into alternative treatments be carried out.

Immuno-Nutrition
In addition, as an important component in the overall battle against disease and in particular HIV/AIDS, a new emerging science platform within the food research area is immuno-nutrition. The BU intends exploring and further developing this with a number of partners, as the basis for a new integrative platform for the BU.

Commercialisation and Intellectual Property

The effective management of intellectual assets is recognised as a core business asset within CSIR Biosciences. The BU has established an impressive track record in the generation and protection of intellectual property and the experience in its exploitation is now considerable. However, a number of structural weaknesses have been identified which will be urgently addressed. These include; consideration of appropriate exploitation strategy often deferred until too late in the innovation cycle; inadequate

strategies for the specific management of intellectual assets which might be expected to contribute to "social good" rather than to private gain, and poor intellectual property valuation processes.

2.2.1.2 **Facilities and capabilities**

Process and Product Biotechnology Core Competencies and Expertise

- Process and product research, development and commercialisation. Toll manufacturing for market and product development
- Microorganism and enzyme improvement through rational design and genetic engineering
- Fermentation, biocatalysis, product and enzyme purification and recovery, product formulation
- Creation, development, packaging and exploitation of intellectual property
- Development of early stage research into products and processes with market relevance.

Plant Biotechnology Core Competencies and Expertise

- SA Biosafety compliant greenhouses
- Plant molecular diagnostics including genetically modified organism (GMO) analysis, DNA fingerprinting, molecular marker development and analysis in crops and trees
- Discovery and identification of genes and proteins through application of genomics using DNA micro-array technology and cDNA libraries constructed from indigenous plants.
- Discovery, identification and analysis of proteins from diverse sources including plant material using a Bruker autoflex® MALDI-TOF mass spectrometer with post-source decay technology
- In-vitro culture of indigenous medicinal plants for preservation and bio-prospecting activities via chemical elicitations and extraction of biologically active compounds.

Products and services

- Product and process development on a pilot scale
- Limited production runs for market research and development of innovative products and processes
- Shelf-life testing using a range of climate control cabinets
- Laboratory testing and evaluation of raw materials and products

Food science

Product and process development and small-scale production runs using a wide range of pilot scale equipment in many fields, typically:

- Drying (including spray drying, freeze drying and drum drying)
- Evaporation (scraped surface evaporator)
- Extrusion (single screw and co-rotating twin screw)
- Fruit and vegetable processing (pulping, pasteurising and filtering unit)
- Dry milling

- Mixing (dry and wet mixtures)
- Brewing (small brewing plant)
- Sterilisation and pasteurisation (retort steam tunnel)
- Agglomeration
- Wet milling
- Soya processing
- Baking.

Services

- Develop, transfer and implement competitive technologies to manufacture speciality and fine chemicals, generic pharmaceuticals and advanced pharmaceutical intermediates
- Production of toll quantities of intermediates and fine chemicals required for market testing and penetration, prior to committing capital expenditure in dedicated facilities
- Providing an incubator for entrepreneurs or SMEs where technology can be tested, risk minimised and market acceptance of product established.

Product areas

- Food additives
- Anti-oxidants
- Flavour and Fragrances
- Fine Chemical and Pharmaceutical Intermediates
- Speciality Chemicals.

Production facilities

- Stainless and glass lined reactors (with utilities) ranging from 650 to 1,600 litres
- Stainless steel centrifuges able to separate 250kg of solids per batch
- Tower gas/liquid reactors
- Vacuum tray-drying ovens
- High vacuum distillation column
- Stainless steel rotary dryer
- Pressure filters
- Milling facility.

Quality and environment

- Total Quality Management
- Production to GMP standards
- Environmental Management System
- Environmental, Health and Safety department support.

2.2.2 **The African Centre for Gene Technologies (ACGT)**

The African Centre for Gene Technologies (ACGT) is a virtual organization that facilitates and supports activities in advanced biotechnologies in the University of Pretoria (UP) and the CSIR, within the context of a strategic alliance between these two organizations. The offices of the ACGT management are situated at the University of

Pretoria, but the ACGT receives financial support from both CSIR and UP. In support of NEPAD Bioscience initiatives the ACGT therefore provides a formal link between CSIR (as the hub for Biosciences for Southern Africa) and UP.

UP is the largest residential university in South Africa, with around 30 000 full time students and the same number again enrolled in distance learning programmes. Three faculties, with over 10 000 students, are involved in biotechnology:

- Faculty of Natural and Agricultural Sciences
- Faculty of Health Sciences
- Faculty of Veterinary Sciences

Approximately 150 international students were registered in these faculties in 2004, of whom 70 were from Africa.

2.2.2.1 **Research focal areas**

Forestry and Agricultural Biotechnology

Activities are coordinated through FABI (Forestry and Agricultural Biotechnology Institute). FABI scientists include 18 PhD staff and 9 Post-docs. Research focal areas include:

- Genetic fingerprinting of cultivars and clones of commercial value
- Improved and efficient techniques for the propagation of fibre and food plants
- Discovery of novel genes of value to agriculture and forestry
- Harnessing of microbes for the bioremediation of forestry and agricultural waste products
- Deployment of new and valuable genes in crop and fibre plants
- Development of rapid techniques for the recognition of desirable traits in trees and other crop plants
- Production through selection and genetic engineering, of microbes with improved capacity to be used in the biological control of insects and pathogens
- Improved management of plant disease problems
- Development of rapid DNA-based techniques for the identification of plant pathogens and insects
- Understanding the origin and spread of pests and pathogens and through population genetic studies, reducing their impact.

FABI has recently been chosen to house the Centre of Excellence in Tree Health Biotechnology, one of only six Centres of Excellence created by Department of Science and Technology and the National Research Foundation.

Medical Biotechnology

UP has a well established medical school within the Faculty of Health Sciences, and the Pretoria Academic Hospital forms an integral part of the University. Health related biotechnology research is undertaken both at the Medical school and in the Faculty of Natural and Agricultural Sciences. Some focal areas of importance include:

- Cancer genetics and genomics

- Anti-malarial drug discovery and development
- Tuberculosis (TB) diagnostics
- Genetics of bacterial resistance to antibiotics
- Molecular genetics of HIV.

Veterinary Biotechnology
UP houses the only Veterinary school in the country, located at Onderstepoort to the north of Pretoria. Researchers at the veterinary faculty as well as scientists in the Faculty of Natural and Agricultural Sciences undertake veterinary biotechnology research. Focal areas include:

- Molecular genetics and vaccine development for heartwater disease (the genome of the causative agent, *Ehrlichia ruminantium*, has recently been sequenced by researchers at Onderstepoort. This represents the first genome sequenced in Africa).
- Wildlife molecular epidemiology and conservation genetics
- Development of viral particles from African horse sickness virus as a vaccine delivery system for peptide antigens
- Molecular fingerprinting of equine populations
- Development of tick vaccines and isolation of anti-clotting agents from ticks.

Industrial Biotechnology
There is a strong focus on industrial biotechnology based primarily on problems of microbial fouling and effluent treatment. UP houses the Centre for Water Biotechnology and work is undertaken on passive treatment of acid mine drainage, microbial community diversity studies in activated sludge, biotechnology of biofilms, and on solar pasteurisation of water supplies in rural areas.

2.2.2.2 **Biotechnology facilities and equipment**
UP has extensive laboratories and training facilities for biotechnology, equipped with all requirements for molecular biology work. Facilities include

A modern Bioinformatics unit with over 500m^2 of dedicated floor space, equipped with Sun V880 server, SGI Origin 2000 server, Storage Array, 64x Node Linux Cluster, SAN Backup Robot and storage facilities and a 24x PC training lab. The Bioinformatics Unit forms a major node of the National Bioinformatics Network, in partnership with the CSIR, University of Limpopo and the ARC Onderstepoort.

A DNA microarray facility (jointly shared with CSIR as part of the ACGT) incorporates a Molecular Dynamics GenIII spotter and Axon 4000B scanner. Microarray services are provided to both internal and external users.

DNA Sequencing facilities include ABI PRISM 377 and 3100 sequencers. This is a core facility providing services for DNA sequencing and DNA fragment analysis such as microsatellite and AFLP analysis. Two LI-COR automated sequencers are available for high throughput AFLP genotyping. A Roche Light-Cycler real-time PCR machine is also available.

Plant growth facilities including greenhouses and contained growth rooms for work with GM plants as well as plant pathogens.

2.3 **West African Biosciences Network (WABNet**)

The West African Biosciences Network covers the following countries; Nigeria, Benin, Togo, Ghana, Burkina Faso, Cote d'Ivoire, Mali, Liberia, Sierra Leone, Guinea Conakry, Senegal, Gambia, Guinea (Bissau), Cape Verde and Niger. The regional hub for the network is hosted by the Senegalese Institute of Agricultural Research (ISRA) of Senegal where the Regional Research Centre for the Improvement of Plant Adaptation to Drought (CERAAS) and the Laboratoire National d'Elevage et de Recherches Vétérinaires (LNERV) are the lead institutions, respectively in crop and animal sciences.

At the conference of the West African Ministers of Science and Technology held Abuja in November 2004, the ministers resolved that ECOWAS Centres of excellence in priority areas including biotechnology should be designated from existing specialized centres in member states especially in the areas where the member states have comparative advantage. It was also agreed further that ECOWAS should take ownership of all the initiatives in the subregion in the area of biotechnology. The establishment of WABNet is cognizant of these resolutions.

The west African regions held a regional workshop on NEPAD Science and Technology flagship programmes in January 2005 where the following constraints were identified in the cluster areas of biosciences:

- Low production potential of animal and plant genetic material
- Susceptibility of germplasm to biotic (insects, viruses, fungal diseases etc.) and abiotic stresses (acidity, salinity, heavy metal toxicity and drought)
- Poor utilization of agricultural products in agro-industrial processing
- Strong pressures exerted on the agricultural environment as a whole and on genetic resources and the soils in particular
- High cost of the technology aggravated by poor investment of both the public and private sectors
- Problems related to the environment such as gene escape, and to human health
- Intellectual property rights especially relating to patents, farmers' rights and biopiracy
- Lack of explicit domestic biotechnology policies exacerbated by uninformed legal entities
- Low biotechnology capacity including infrastructural and human resources
- Low biosafety capacity including lack of regulatory framework (policies and strategies, capacity evaluation, regulations and implementation mechanisms).

These constraints are similar to those outlined in the CORAF/WECARD Biotechnology and Biosafety business plan (CORAF/WECARD, 2004). The West African region has resolved to establish the biosciences network with its initial interventions centred around implementing activities outlined in the CORAF/WECARD proposal which include the following:

- Application of molecular markers

- Application of genetic engineering
- Application of molecular diagnostics for animal and plant diseases
- Plant tissue/cell culture and micro propagation
- Vaccines for livestock production
- Animal reproduction technologies
- Implementation of biosafety regulations.

The geographical scope of WABNet covers countries with two distinct agro-ecological zones; the Sahelian West African zone and the Coastal West African zone (Fig. 3). The sahelian zone comprises of Burkina Faso, Cape Verde, Guinea-Bissau, Niger and Senegal. Dominant crops produced in the region include cereals; millet, sorghum, maize and irrigated rice and two cash crops, groundnuts and cotton. It is characterized by frequent variations in rainfall and short rainfall periods with limited rain-fed agriculture being practiced in only one-third of the total area. Mean annual rainfall range from 350 to 800 mm with production being dependent on annual fluctuations between dry years (intense drought) and wet years (relatively abundant rainfall), although the last two decades have been dominated by shorter rainy period (CORAF/WECARD, 1999). Biosciences research in this area would therefore need to address the abiotic constraint of limited water supply.

The coastal zone which extends from coast to savanna is comprised of Guinea-Conakry, Sierra Leon, Cote d'Ivoire, Ghana, Togo, Benin, Nigeria and Liberia. The area receives about 1500 mm rainfall a year with two distinct seasons, long rainy season and short dry season. Main food crops are root and tuber crops (cassava, yams, potatoes), and cereals (rice, maize and sorghum). Export crops include robusta coffee, palm produce, coconut, cocoa and para rubber with cotton being a major cash crop cultivated in the savanna region. Major biotic and abiotic constraints faced by agriculture in the zone include pests and diseases, obnoxious weeds, high soil acidity, leaching, erosion etc. The high rate of deforestation in the zone has led to several plant and animal species becoming endangered due to habitat loss (CORAF/WECARD, 1999).

With 75% of the farmers in the region owning livestock, there have been persistent demands for dual purpose cereal crops. Cereal crop research geared at solely grain yields at the expense of utilizable fodder biomass may not be wholly acceptable in agro-pastoral farming systems.

Mutual relationship exists between the sahelian zone and coastal zone agricultural enterprises. While the costal zone is favourable for cereal production, the sahelian zone is suitable for root and tuber crops, banana and plantain production. The Sahelian zones are favourable for livestock production, the costal zone provides market outlets for the livestock. When the pastures dry-up during summer in the sahelian zone, the coastal zone provides a rich source of grazing pasture for ruminants especially cattle.

Figure 3. Map of Africa showing the sahelian and west coastal zones.
Source: CORAF/WECARD (1999)

2.3.2 **Capacity at the West African Biosciences Hub**

The biosciences hub for WABNet is hosted by two leading institutions of ISRA, CERAAS and Laboratoire National de l'Elevage et de Recherches veterinaires (LNERV).

2.3.2.1 **CERAAS**

The Regional Centre for the Study of the Improvement of Plant Adaptation to Drought (CERAAS) originated from a research programme on the improvement of the adaptation of groundnut to drought. This programme was initiated in 1983 at the Plant Physiology Laboratory of the National Centre of Agricultural Research (CNRA) in Bambey, one of the research centres of the Senegalese Institute of Agricultural Research (ISRA). The programme was conducted in collaboration with the Centre for International Cooperation on Agricultural Research for Development (CIRAD). Taking into consideration the commitment of the National Agricultural Research Systems (NARS) of the member countries of the West and Central African Council for Agricultural Research and Development (CORAF/WECARD) and their Northern partners, of responding to the challenges of improving agricultural production in dry zones, the Plant Physiology Laboratory, evolved into a *Base Centre* in 1989, whereby it was made available to

regional and international scientific cooperation. This was a mandate accorded to CERAAS by CORAF/WECARD, the Permanent Inter State Committee for the Control of Drought in the Sahel (CILSS) and the Drought Resistant Research Network (R3S).

Since 1996, various initiatives and negotiations have been conducted by ISRA and CORAF/WECARD to strengthen the institutional status and sustainability of CERAAS. Financial and human resources for the operations of CERAAS have been obtained from northern partners (European Union, Belgian cooperation, French cooperation, German cooperation and Great Britain) and members of the NARS.

The year 1997 marked a turning point in the history of CERAAS, the Centre moved into its new buildings situated within the campus of the Advanced National Agricultural College (ENSA) in Thiès (Senegal). Its institutional set up and strategic location in the heart of the Senegalese NARS makes CERAAS a unique scientific platform in West and Central Africa, endowed with modern scientific equipment and a multidisciplinary team of high-level scientists.

2.3.2.2 **Objectives and mandate**

The mandate of CERAAS include providing technical solutions to militate the effects of drought on agricultural production, improving the living standards of populations and contributing to combating desertification. The research activities of the centre address the following objectives:

- identifying plant traits linked to drought adaptation and to integrate them into breeding programmes conducted by the NARS;
- utilizing knowledge acquired from research to develop tools, analytical and decision-making methods for limited-water agricultural systems;
- improving environmental and plant practices, which favour a better adaptation of crops to drought;
- strengthening the capacity of research teams of the NARS of member countries of CORAF/WECARD, by reducing their isolation while at the same time facilitating their access to knowledge and research facilities.

2.3.2.3 **Research thematic areas**

Thematic research areas at CERAAS include the following:

1. characterisation of the response of crops to drought
2. modelling the behaviour of plants
3. improvement of breeding methods
4. improvement of adaptation of cropping systems to drought.

Characterisation of response of crops to drought

This involves understanding how plants respond to water deficit conditions. Research is carried out in the following areas:

- classical traits (phenology, leaf gaseous exchange, fluorescence, plant water status, enzymatic activities, etc.) under water deficit conditions, taking into consideration the interaction between water and mineral nutrition

- membrane integrity under water deficit conditions (electrolyte leakage, membrane lipid content, etc.)
- expression of candidate genes in response to water stress.

Modelling the behaviour of plants
Research is mainly focussed on seasonal agricultural forecasts at national and regional scales, and identification of potential food deficit or surplus areas.

Improvement of breeding methods
Research conducted under this theme aims at identifying physiological and genetic parameters which will contribute to the development of more effective breeding methods. Research work in this area has been carried out on two crops, cowpea and sorghum using the following methods:

- genetic markers for identification of genomic regions that are involved in the variation of quantitative traits (QTL).
- inventory of variability in available plant material, identified genes and the accumulation of favourable alleles using marker-assisted selection.

Improvement of adaptation of cropping systems to drought
This theme addressed the following:

- modelling the behaviour of cropping systems in the semi-arid regions of West and Central Africa
- participatory evaluation of drought adaptation technologies developed by CERAAS (plant material, planting techniques, models, etc.) for dissemination to the end users
- improvement of cropping systems for optimising the adaptation of plant to drought.

2.3.2.4 **Training**
CERAAS serves as a regional platform for building capacities of NARs in the sub region especially on research on plant adaptation to drought. These are in form of short courses for scientists from NARS and degree programmes where students from universities in the region spend some time at the centre carrying out their thesis research.

2.3.2.5 **Partnership and capacity building**
CERAAS has established partnerships with several institutions in the developed and developing countries. Through these collaborations, the centres as made the following break-throughs:

- developed thirty groundnut varieties for multi-location trials which have been used in several national breeding programmes in Africa (Burkina Faso, Botswana) and in South America (Brazil) out of which high performing lines which have been disseminated
- developed eight varieties of sorghum, which are presently registered in the official catalogue of Mali and covering 95% of the sorghum growing area within the CMDT zone. One of these varieties, Migsor 86-30-03, is used as a genitor in selection programmes in Africa and the United States.

2.3.2.6 **Human resources**
CERAAS has staff establishment of 33 with the following breakdown:

- 10 research scientists
- 10 technicians
- 13 support staff.

2.3.2.7 **Infrastructure**
CERAAS has appropriate infrastructure for carrying out its activities. These include:

- 900 m^2 of offices and laboratories, equipped with an IT network and a high flow Internet connection
- nearly 10 ha of experimental land, located within the CNRA experimental station at Bambey and the ENSA campus
- a 180 m^2 glass-house, equipped with a hydrophonic system
- a 10 m^2 phytotron
- a 5 m^2 cold room.

2.3.3 **Capacity at LNERV**
The Laboratoire National de l'Elevage et de Recherches veterinaires (LNERV), established over 50 years ago, has extensive experience in the field of animal health and husbandry research, especially in developing diagnostic tools for a better surveillance of enzootic and epizootic diseases and implementing efficient disease control strategies in Senegal and West Africa.

More recently, strong effort has been made on the application of modern genetic based techniques towards the development of diagnostic kits and improved veterinary vaccine. The LNERV is well equipped, with laboratories for bacteriology, virology, parasitology, chemistry, for molecular work (RT-PCR), facilities for cells culture, virus isolation, and serological tests and antigen production. Some special facilities are available, like DNA thermal cyclers, ELISA readers, inverted microscopes, bench freeze dryers, bioreactors , fluorescence microscopes, HPLC, mosquitoes rearing rooms, high speed centrifuge and biosafety hoods.

The LNERV has made significant contribution to development of diagnostic kits for animal disease detection and monitoring, and ELISA kits for diagnosis of rinderpest and African swine fever.

LNERV is experienced in managing and participating in international collaborative projects. For example, during the year 2004, LNERV was involved in 29 projects (including 10 as co-ordinators). Recently, the evolution of emerging or re-emerging diseases, such as Rift valley fever and schistosomiasis led the laboratory to build partnerships with institutions like FAO, PACE, IRD, IAEA, CIRAD, Institut Pasteur in Paris and Dakar, to set up national and regional surveillance networks. LNERV coordinates the EDEN Africa (Emerging Diseases in an European Changing Environment Network, Africa Platform) financed by European Union, 6^{th} Framework Programme focused on Rift valley fever and West Nile fever as emerging diseases. The collaboration

within EDEN project emphasizes the interactions between North Africa and Europe and the use of GIS and Remote Sensing for animal diseases prediction in Africa. In addition, LNERV is the FAO collaborating centre for many animal diseases in Africa, such as Rinderpest, diseases of small ruminants, African Swine fever, Rift Valley fever, among others.

Production of veterinary vaccines is one of most important innovations at LNERV where about 25 different types of vaccines have been developed with throughput of about 50 millions doses per year. The development of new candidates vaccine is underway for anthrax (genetically recombinant vaccine), epizootic diseases such as Newcastle disease in rural poultry (thermostable vaccine, I2 viral strain), zoonotic diseases such as Rift Valley fever and hemoparasite disease, (attenuated and inactivated forms).

2.4 **North African Biosciences Network**

The network covers the following countries; Egypt, Libya, Algeria, Chad, Mauritania and Tunisia.

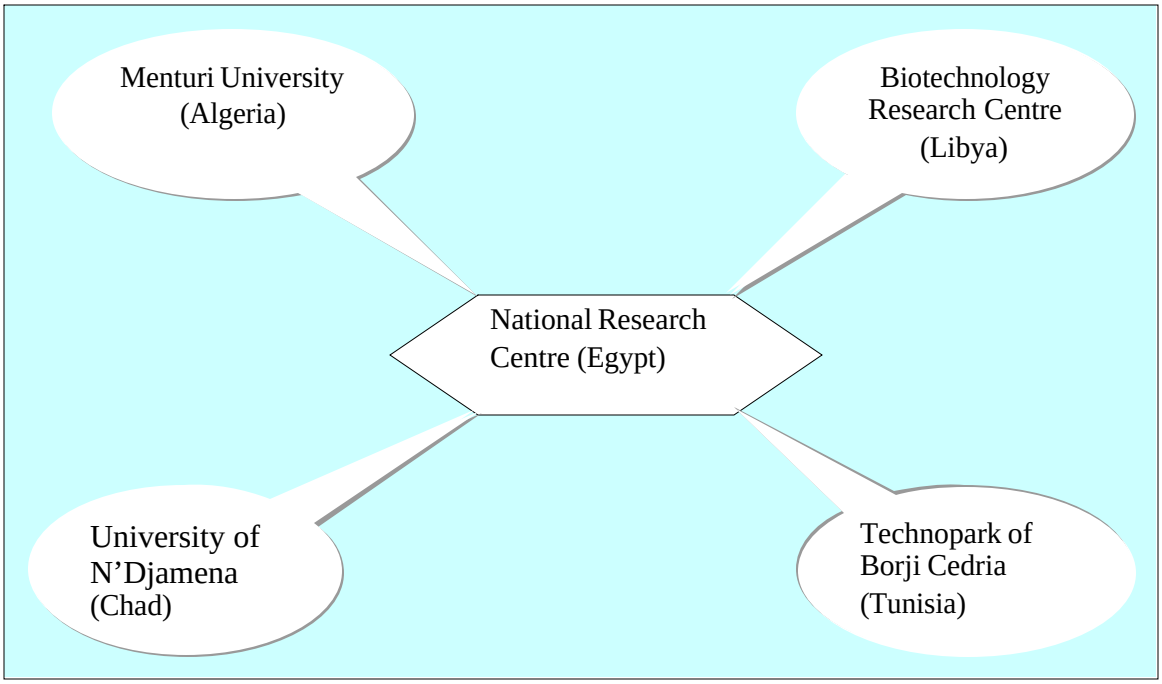

Figure 4. Nodes for the north African Biosciences Network

The hub for the network is hosted by the National Research Centre of Egypt and the nodes have been provided by the following institutions in the region (Fig. 4):

- Mentouri University in Algeria
- Biotechnology Research Centre in Libya
- Technopark of Borj Cedria in Tunisia
- University of N'Djamena in Chad.

2.4.1 **Capacity at the North African Biosciences Hub**

National Research Centre (NRC)

The National Research Centre (NRC) of Cairo is the largest and most competent research institution in Egypt that supports multidisciplinary research programs in the field of genetic engineering and biotechnology. It is the largest of all institutions affiliated to the Ministry of Scientific Research. Established in 1953, the national center conducts basic and applied research of national interest in its 13 main research divisions, namely;

1. Agricultural and Biological Research
2. Food Industries and Nutrition
3. Pharmaceutical Industries
4. Environmental Sciences Research
5. Medical Sciences Research division
6. Genetic Engineering and Biotechnology Research
7. Human Genetics and Genome Research
8. Veterinary Research
9. Engineering Research
10. Chemical Industries
11. Inorganic Chemical Industries and Mineral Resources Research
12. Physics Research
13. Textile Industries Research.

Over 2200 research scientists (with PhDs) supported by 3500 research assistants, technicians , and administrative staff are engaged in research and development. The NRC occupies an area of 12 acres on which laboratories, pilot plants, fermentors, green houses, central services laboratory , growth chambers, excellent library, documentation centre , instrumentation centre and computer services are located. Some of R&D activities running in this Centre (research divisions 1 - 9) are in fields directly or indirectly related to genetic engineering and biotechnology, i. e. genetics (plant , animal and human) , biochemistry , microbiology, enzymology , molecular biology , tissue culture, food technology , industrial fermentation. Research at the centre is carried out in the following areas:

- Improvement of fermentation processes and development of new strains of microorganisms
- Development of new enzyme preparations from different organisms
- Breeding for high yielding, early maturing, pest resistance and high protein crops using classical genetics
- Preparation of vaccines used against several endemic diseases that affects both animals and humans
- Transfer of the characteristics of N–fixation by *Rhizobium* to non legumes
- In the field of antibiotic industry, research work is progressing to make use of recent advances in the field of genetic engineering and biotechnology
- Assessment of human genetic disorders using modern diagnostic techniques, in addition to studies in the area of genetic diseases that are of obvious prevalence in Egypt and the African continent.

The centre's core competencies are in the following areas:

Bio-fuel research

- Technology of microbial immobilization on fixed supports for high fuel production.

Improving Livestock production using biotechnological methods

- To speed up genetic improvement of farm animals and to increase production of farm animals using embryo cloning and sexing and production of genetic mosaics.

Cytogenetics and Genetic Toxicology

- The effect of pesticides in inducing chromosome aberrations in bone marrow , micronuclei in polychromatic erythrocytes in bone marrow and sister chromatid exchange
- Mitotic index of the cell culture
- Chromosome aberrations in the cell cultures.

Plant cell and tissue culture for crop improvement

- Development of pathogen free plant materials
- Rapid mass clonal propagation (e. g. date palms, olives, banana, potatoes)
- Development of in -vitro techniques for selecting salinity and drought tolerant strains in some crops (wheat, corn, rice, tomato).

Molecular genetics and gene manipulation in plants and microorganisms

- Gene transfer for producing high yielding nitrogen fixing, pathogen resistant varieties of some crops
- Development of microbial pesticides for pest control to reduce environmental pollution (with a broad experience for 25 years in this domain)

Fermentation

- Applied research on the use of molasses and rice bran as raw materials for producing ethanol, acetic acid, ethyl acetate, butyl acetate, acetone and butanol by fermentation processes. Further research for the production of bulk chemicals such as citric acid (*Aspergillus niger*), lactic acid (*Lactobacillus* spp.) is in progress.

Recombinant DNA technology in the diagnosis of hemoglobinopathies

- The use of genetic engineering (DNA) probes for accurate diagnosis of other prevalent genetic disorders, its use in prenatal detection of diseases that cannot be diagnosed otherwise (e. g. thalessaemias and other haemoglobinopathies and leuchenne muscular dystrophy). In this area there is highly qualified research staff in clinical genetics, human cytogenetics, biochemical genetics, prenatal diagnosis and population genetics. Current research in this area is concerned with mental retardation, chromosomal aberration, primary amenorrhea, male infertility,

intersex problems, inborn errors of metabolism, multiple malformations and recurrent abortions.

3. Programme Focus Areas

During workshops held between November 2004 and March 2005 the regions identified areas of intervention in biosciences research and development. These have been refined further during follow up consultations with members of interim regional steering committees. The areas of focus for each region are as follows:

3.1 Southern Africa

3.1.1 ***Plant biotechnology***. The region is characterised by pockets of food insecurity and malnutrition, the latter is usually due to a staple cereal diet which results in poor levels of protein, mineral and vitamin uptake. Projects in this priority area will consider increased yields, increased resistance to abiotic stressors, improved nutritive content and traits to reduce crop inputs. The traits are particularly relevant as the effects of HIV/AIDS increase resulting into reduced potential labour available for agriculture. Benefits to both large commercial farmers and resource poor farmers shall be taken into account. Discussions led to a project proposal on drought tolerant and nutritionally enhanced cereals and legumes where South Africa with its cereal transformation expertise could act as a coordinating node and eight countries were identified as having relevant capacity.

3.1.2 ***Livestock production***. An important activity in the region as a contributor to food security and income generation and discussions have focused on tick-borne diseases and improving the gene pool of different species through breeding programmes using MAS. A project proposal has been defined as: “treatment, diagnostics and prevention of tick borne diseases”.

3.1.3 ***Human health***. The region is affected by a range of diseases, in particular, TB, malaria and HIV/AIDS; the “diseases of poverty”. (This is Target 8 of the MDGs.) The HIV/AIDS pandemic is having a major impact on almost all aspect of life and with the mix of science and technology expertise in the region along with a deep understanding of traditional medicines, a project proposal is being developed: Integrating existing vaccine development programmes and the use of traditional medicine (WHO definition) in the treatment and prevention of HIV/AIDS. This project could build upon the work of the South African AIDS Vaccine Initiative (SAAVI), additionally, the proposed establishment of a virtual malaria centre could make a contribution.

3.1.4 ***Anthropogenic activities on the freshwater ecosystems***. The biodiversity of inland freshwater fishes in the region has been affected by anthropogenic activities which include over-fishing and habitat destruction. The biodiversity loss is exacerbated by limited knowledge of inland fish diversity and insufficient inventories of inland fish species. The research will therefore involve carrying out inventories and characterisation of key species in order to design conservation and management programmes for the stocks.

3.1.5 ***Mushroom production***. The programme will uplift the productivity and dignity of southern Africa's people in selected rural communities, especially women, who carry the heaviest burden of Africa's poverty. It will, additionally, promote sustainable livelihoods in selected peri-urban communities, refugee camps, and in orphanages harbouring children whose parents died of HIV/AIDS and other causes. It will, furthermore, provide new enlightenment and new direction to the unemployed youth, many of whom have lost direction, and are increasingly being dragged into drug addiction. This will be through promoting public awareness on unrealized wealth in one of Africa's most ubiquitous, most precious, most invaluable, yet most neglected and ignored natural resource: mushrooms. Many African communities, indeed, know what edible species of mushrooms occur in their ecosystems, but are not aware of the fact that some of the species can be farmed.

Some of the medicinal mushrooms contain a cocktail of unique biomolecules with anti-cancer and immune-boosting attributes, which indeed show great potential as a possible remedy for some of the major diseases of our time, and also as a source of preventive medicine therapies. Some are already being researched as potential candidates for addressing the HIV/AIDS challenge.

3.1.6 ***Indigenous knowledge systems (IKS)***. Over the past years, there has been a dramatic increase in interest in the role that African IKS can play in participatory approaches to sustainable development. This interest is reflected in a myriad of activities generated within African communities, who are recording their knowledge for use in their school systems and for planning purposes; within national institutions, where IKS is now being regarded as an invaluable national resource; and within the development community, where IKS provides opportunities for designing development projects that emerge from priority problems identified within a community, and which build upon and strengthen community-level knowledge systems and organizations.

The different forms of IKS have generally been marginalized and suppressed by colonialism and apartheid. IKS research has also suffered a similar fate to that of African economies, i.e., one of underdevelopment and disarticulation. The globalization process, however, has made it imperative that Africa's IKS cannot be ignored. Specific objectives are to promote the interface between IKS and technologies with other knowledge systems; to promote the use of IKS and assets to combat life threatening pandemics such as HIV/AIDS, TB and malaria in Africa; and to enhance interdisciplinary IKS research excellence in areas such as indigenous food security systems, traditional medicine and health systems, intellectual property rights, environmental and natural resource utilization, knowledge management, and socio-cultural systems.

3.1.7 ***Enhancement of capabilities of the gene banking facilities in Southern Africa***. The SADC Plant Genetic Resources Centre and a network of national genebanks have been established in the region. These genebanks have the capacity to handle and conserve seed propagated plants. However, they do not have the capacity to handle plant species that are vegetatively propagated and those that are agronomically difficult to propagate. The genebanks also lack capacity for molecular characterization and studies of plant genetic resources. Increased capacity should enable genebanks to study the collections,

improve them and make them more available for plant breeding and research. The general objective will be to broaden the range of species that can be conserved in the existing genebanks of the regions. The specific objectives will be to build capacity for handling vegetatively propagated species; build capacity in molecular characterization of genetic resources; develop mechanisms for collaboration between gene banks and relevant institutions and promote utilization of genetic resources kept by the gene banks.

3.2 **West Africa**

The priority areas for agriculture in West Africa have been identified in the CORAF/WECARD strategic plan for 1999-2014. The framework for action is based on the following commodities:

- Cash crops (cotton, para-rubber, cocoa, oil palm)
- Cereals (maize, millet, rice & sorghum)
- Livestock/Fisheries
- Grain legumes (cowpea & peanut)
- Fruits & vegetables (Banana/plantain)
- Root & tuber crops (cassava, sweet potato & yam)

Biosciences interventions in each of the commodity groups will address the following targets:

3.2.1 ***Genetic improvement of cash crops***, which would involve;

- Enrichment of existing cotton germplasm and establishing new base collections
- Identification of new genetic material with high variability in order to select for improved varieties with high yield, drought and disease/insect resistance
- Identification, isolation and characterization of relevant genes
- Development of genetic variability and gene banks
- Development of indigenous capacities in biotechnology.

3.2.3 ***Enhanced grain legumes and cereal production***, through;

- Characterisation and selection of improved planting materials with special emphasis on
    - Tolerance to drought
    - Resistance to common diseases and pests
    - Development of varieties adapted to the requirements of the market (including use of biotechnology)
    - Cultural techniques.

3.2.4 ***Banana/Plantain production for food and income***, through;

- Collection, characterisation, conservation and utilization of *Musa* germplasm;
- Use of biotechnology and conventional breeding techniques for the creation of new varieties.

3.2.5 ***Root and Tuber Crops production to ensure food security and poverty alleviation***, through:

- Use of advanced technologies for continued genetic improvement of root and tuber crops
- Collection, preservation and exchange of germplasm of cassava, yams, sweetpotato
- Multiplication and distribution of disease-free planting materials to farmers.

3.2.6 ***Conservation and Sustainable Utilisation of Plant and Animal Genetic Resources***, through;

- Strengthening of selected national plant genetic resource centres to undertake sub-regional responsibilities
- Eco-regional survey, exploration and collection of endemic, endangered, neglected and traditional cultivars
- Development of modern tools for germplasm collection, characterization, conservation, improvement, and use
- Germplasm characterisation (Description of the botanical, agro-morphological, molecular and potential economic characteristics of conserved germplasm)
- Identification of genetic traits of economic importance, through multi-disciplinary screening and multilocation evaluation including plants with potentials for livestock feeds
- *In-situ* and *ex-situ c*onservation and utilization indigenous livestock in tsetse-infested ecologies
- Collection and documentation of indigenous knowledge on conservation and use of plant genetic resources.

3.3 North Africa

3.3.1 *Genomics for improvement of human health in north Africa*

In north Africa there is an extensive network of universities and research institutions employing thousands of scientists in health related areas. Unfortunately productivity in terms of innovation and product development is low and does not match the existing institutional and human resources. The programme shall offers the opportunity for scientists in North Africa working in diverse areas of medical technologies to combine and coordinate their efforts in a post genomic project to lay down the foundation necessary for implementing a modern and advanced health care delivery system, developing therapies and management systems for prevalent diseases.

General objectives of the programme are to carry out population genetic studies to identify correlations between genes and disease and the molecular basis of heterogeneity in drug response in populations of North Africa. To conduct genomic and post genomic studies on disease pathogens, vectors of diseases as well as host – parasite interactions relevant to pathogenicity disease progression, response to therapy and the development of more effective therapeutic modalities and effective drugs.

The expected outcomes are to upgrade the health care delivery system in north Africa to take advantage of the improved modalities of disease management brought about by

molecular medicine and to provide a foundation for the development of new therapies for diseases prevalent in the region. Development of a mature technology base that is capable of generating the discoveries which fuel innovation and the development of products and technology platforms in the area of health sciences.

The studies will include screening for mutations and polymorphisms relevant to hereditary disorders, response to drugs and predisposition to disease. Additionally studies will include determining the impact of host and pathogen genetic heterogeneity on expression profiles, disease outcome and treatment results. Opportunities for training scientists from collaborating member states in the participating laboratories will be provided.

3.3.2 *Eradication of fruit fly (Ceratitis capitata Wed) in north Africa*

Citrus, vegetables, dates, apricots, peaches are heavily devastated by this pest. Some north African countries estimate the losses due to *Ceratitis* sp at not less than 50% which is substantial and highly affect the national incomes. The European markets do not accept infested products leading to total loss of revenue out of damaged fruits. This programme will assist in keeping the environment clean and minimize use of chemicals, for fruit preservation, such as ethylene oxide which is banned and prohibited in the developed countries.

3.3.3 *Development of biopesticides and biofertilisers for sustainable agriculture in north Africa*

Increasing the productivity of most economically important crops requires the application of agrochemicals including, pesticides and fertilizers. These agrochemicals are major sources of environmental pollution which might have harmful effects on human beings, livestock, natural enemies and aquatic organisms and may disturb the overall environmental balance.

In North-African countries, one of the strategic goals in the Agriculture sector is to increase productivity while reducing the use of agrochemicals, and their environmental hazards. Biopesticides and biofertiliszers are environmental friendly control agents. *Bacillus thuringiensis* (Bt) represents the major bacterial toxin against many lepidopteran, coleopteran and dipteran insects. Moreover, virus based biopesticides have been recently developed by mixing baculovirus and densovirus collected from local fauna.

Activities of the programme will involve producing biopesticides and biofertilizers to be used in north African countries; collecting *B. thurienginsis*, baculoviruses, other viruses, and other bacteria, for example Azobacter, Rhizobium, from the natural fauna in different places in African countries, characterizing the different strains, performing the bioassays against targeted pests and selecting the most efficient strains; preparing inoculants; small scale testing and large scale application.

3.3.4 *Biotechnological improvement of cereals in north African arid and semi-arid lands*

The challenge facing the world today is to provide food for an ever growing population without degenerating the environment or affecting the future productivity of natural resources.

The genetic improvement of cereals has always been a major focus of plant breeding efforts. In the last few decades, the development of plant biotechnology techniques has provided additional means to complement the traditional strategies of crop improvement. In North African countries, like in many parts of the world, the most important cereal crops are wheat, barley, maize and millet. However, expanding the cultivation and increasing the productivity of these crops are hindered by different environmental stress, including abiotic (drought and salinity) and biotic stress (e.g insect pests, viral and fungal diseases).

Therefore, the main objective of the proposed programme is to generate cereal plants tolerant to adverse conditions, i.e. salinity, drought and pathogens. The activities will involve collecting wheat, maize, barley and millet germplasm from different places in North African countries; fingerprinting the germplasm using molecular markers; screening for genes of interest (genes for increasing osmotolerance, resistance to pathogens); isolating and cloning genes of interest by constructing a series of chimeric constructs harbouring genes conferring resistance; establishing efficient regeneration and transformation systems for elite cultivars; transferring the genes encoding stress tolerance into commercially important cultivars; selecting putative transgenic cell lines; confirming integration of genes at the genomic level and the expression of genes at the mRNA and protein levels in putative transformed plants; evaluation of the transgenic plants under laboratory and greenhouse conditions for targeted traits(s) and field testing.

3.4 **Flagship Projects**

Initial funding for establishing the NEPAD/ABI was obtained from the Government of Canada through a funding facility called Canada Fund for Africa (CFA) where total funding of CAD$30 million was earmarked for the Initiative. Of the total, CAD$27 million will be used for designing and implementing the BecA network, the remaining CAD$3 million will be provided to the NEPAD Secretariat for establishing regional networks in southern, west and north Africa. A disbursement of CAD$4,500,000 to BecA through ILRI covered the design phase of the network while the remaining CAD$22,500,000 will be for the implementation phase.

The first disbursement of CAD$500,000 to the NEPAD Secretariat was made through ILRI to identify hubs, establish interim governance structures and develop business plans for the other three networks and support the Secretariat. The remaining CAD$2.5 million will be used to support activities identified in this business plan. Each regional network has identified a flagship project to be implemented using the start-up funds from CFA. After extensive consultations with the regions, the Secretariat has promoted the idea of supporting flagship projects as a means of galvanizing institutions that will form the networks. The flagship projects for each of the networks are as follows:

Southern African Network for Biosciences
Scientifically validated remedies for the treatment of opportunistic infections (OI) for people living with HIV/AIDS

West African Biosciences Network
Inventory and characterization of West Africa sorghum genetic resources

North African Biosciences Network
Improving knowledge of the genetic diversity: from molecular tools to biotechnology for innovation and better life quality

Concept notes for the projects are provided in Annex.

3.5 Cross-cutting areas

Cross-cutting activities are common to all the networks, the NEPAD Secretariat will implement activities that require central coordination and liaise with respective networks on those that may vary from region to region.

3.5.1 Establishing AU/NEPAD African High Level Panel on Biotechnology

African leaders have resolved to build regional consensus and strategies to address concerns emerging from advances in modern biotechnology, including genetic engineering. This is manifested in decisions of both the African Union (AU) and the New Partnership for Africa's Development (NEPAD). Decision EX.CL/Dec.26 (III) of the AU Summit held in Maputo 2003, calls for an African common position on biotechnology.

In July 2004, at the 2nd meeting of NEPAD S&T Steering Committee, a decision was made that the NEPAD Secretariat in collaboration with the AU Commission establish a high level panel of experts to prepare a comprehensive African strategy and common position on biotechnology, including applications in agriculture, health, environment, manufacturing and mining.

The Panel is an independent group of experts appointed by the chairperson of the AU Commission and draws on or use regional consultations being held by various institutions on the continent. The Panel has the ability to tap into the wider intellectual, political and administrative resources and expertise of existing institutions on the continent and abroad (See Box 1 for terms of reference of the Panel).

The output of these deliberations is expected in the form of a report to be submitted to the Chairperson of the AU Commission, who in turn will convey the findings of the Panel to the subsidiary bodies of the AU and finally to the AU Summit.

Box 1: Terms of reference of the High-Level African Panel on Biotechnology

During the 18 months period of its service, the Panel will carry out the following activities:

- Support consensus building on key issues and identify common priorities and approaches on how best to realize maximum benefits, especially in the areas of agricultural production, human health and environmental quality
- Propose strategies for regional harmonization in the regulation of biotechnology
- Begin discussions on an integrated approach to regulation encompassing ethical and social concerns with a view to dealing with commercialization of GM animals for human consumption
- Propose frameworks for consideration of ethical and social concerns
- Advise on the preparedness of African country delegations to international meetings of relevance
- Develop proposals for dealing with African capacity constraints
- Suggest ways and means of building public understanding of biotechnology and awareness of its implications, opportunities and challenges for human development

3.5.2 **Designing a process for the bioinformatics platform**

Bioinformatics is the application of computer science, informatics, mathematical and statistical techniques to biological data. Computational biology is offering enormous opportunities in the application of biosciences in health, agriculture, environment, mining etc. With the advances in molecular biology high throughput data is available for use to address developmental problems. Several constraints have been identified to hamper the application of bioinformatics in Africa. These include lack of human capacity, poor internet connectivity and powerful computer infrastructure and lack of high throughput wet laboratory facilities etc. Bioinformatics as a platform on biosciences will therefore be developed so that Africa can explore the enormous biological data that is currently available in the databases and data that will be developed in the biosciences networks.

The following progression is envisaged in the development of the bioinformatics platform:

Capacity assessment. An assessment of human and infrastructural capacity will be carried out throughout the continent. The assessment will provide information on the capacities available and identify gaps in human resources and infrastructural capacity in bioinformatics. The design of the bioinformatics platform will largely be informed by the outcome from the assessment.

Training in bioinformatics. For the continent to build critical masses in bioinformatics, training programmes will be developed based on results from the capacity assessment. Training modules will be developed, by a taskforce to be established, for short courses as well as long term courses leading to degree qualifications. The objective will be to train young investigators and encourage application of bioinformatics/computational biology to genome research and development of new products in agriculture and health delivery system.

Infrastructural development. Computer hardware, software and internet connectivity will be required for bioinformatics in the regional hubs and nodes.

Research in bioinformatics. Bioinformatics research will be carried out in the areas of gene expression biology covering ontology development, understanding of aberrant (cancer) and normal gene expression variation, and gene expression variation; HIV biology that integrates bioinformatics with the latest information on HIV-1 protein structure, gene expression, post-transcriptional/post-translational modification, functional activity, and protein-macromolecule interactions, and annotation of genome sequences of plants and animals.

3.5.3 **Mobility of scientists**

One of the important indicators for measuring success of the NEPAD/ABI is mobility of scientists within and between networks. Common niches based on commodities being worked on or laboratory procedures being applied are already emerging. For instance, the African Biosciences Consortium for Cassava will facilitate mobility of scientists between BecA and SANBio, the sorghum annotation progarmme at BECA and the planned inventories of sorghum germplasm of west Africa shall provide mobility of scientists between BecA and WABNet. The Bioinformatics platform shall also facilitate mobility of scientists among all the networks while interests in the application of biosciences in human health are likely to provide interaction between SANBio and NAB network.

3.5.4 **Information sharing mechanism**

Members of the network will share information generated through network activities. Each regional network will establish mechanisms for information storage, sharing, property rights etc. Information will also be shared between networks based on agreed terms and conditions.

3.5.5 **Communication strategy**

A strong outreach programme will be required to popularize the NEPAD/ABI and the regional networks. The Secretariat has started posting materials on biosciences on the NEPAD S&T website (www.nepadst.org). This will be reinforced by other communication channel which will include the following:

- Biannual conferences
- NEPAD/ABI flyer
- Coverage on mass media
- Poster presentations

In addition to the communication provided by the NEPAD Secretariat, regional networks will also develop their own communication strategies which will cover the nature of the network, technical and human competencies of the institutions forming the network, outputs, collaboration and marketing. Details of these will be provided in the regional business plans.

3.5.6 **Biannual Biosciences Conference**

Biannual biosciences conferences will be held amongst the participants in all the networks across Africa in order to provide a forum for the participating laboratories and members to share their findings and innovations. During the year 2005, networks will interact directly at a side event to be held during the second African Ministerial Conference on Science and Technology to be held in Dakar, Senegal in September.

3.5.7 **Public-Private partnership**

Limited involvement of public and private institutions in biosciences R&D has been identified as one of the key factors that have contributed to Africa's lagging behind in biosciences. The private sectors will be engaged through the existing NEPAD Business groups, in addition the regional networks will directly engage the private sector in their R&D programmes. The private sector will be involved as investors, collaborators and promoters of innovations to be generated from the networks. The nature and extent of private sector engagement will vary among the networks and programmes. In the establishing governance structures for the networks, the public and private sectors' representation has been taken into consideration so that the spirit of ownership of the processes by the countries is planted right from the onset. NEPAD is cognizant of the fact that unless the networks are owned by the participating institutions and countries, their sustainability would be at stake.

3.5.8 **Development of regional biosciences business plans**

BecA has developed a business plan for the period 2005-2010. The other three regional networks are currently developing their business plans which should be completed before the end of the year. The business plans will have the following common elements:

- Vision, mission, nature, objectives and outputs
- Programme overview
- Capacity building and training
- Scientific and technical core competencies
- Regional and international linkages
- Communication and market strategies
- Public-private partnership
- Governance and management of the networks
- Financial strategy
- Costed programmes and/or projects
- Contractual agreements

3.5.9 **Contractual agreements**

Regional Biosciences Networks are formed by institutions that have agreed to share their resources and to work together in addressing African challenges that can be addressed by

biosciences research and innovation. Procedures for managing research facilities, activities and knowledge to be generated need to be established and agreed upon by the networks. The networked laboratories will be carrying out research that will lead to innovations for which intellectual property rights need to be agreed upon by members of the network. These will require contractual agreements that will be entered into by institutions and members forming the networks.

During the design phase of the BecA, several agreements were prepared. These will be made available to the other networks for adoption and where need be new agreements will be drafted. The agreements prepared by BecA include the following (BecA, 2005):

Establishment Agreement among members
This agreement covers the following:
- Contractual arrangement among parties to establish the regional network
- Sets out legal agreements amongst a number of parties who form the network (as members of the joint venture)
- Sets out rules, responsibilities and obligations of various parties
- Sets out hub hosting institution's role and responsibilities
- Accountability of hub hosting institution to the Steering Committee.

Regional node hosting Agreement
This agreement covers the following:
- Regional node hosting institutions – roles and responsibilities
- Accountability to the Regional Steering Committee.

Project Agreements
These cover the following:
- Project Principal Investigator(s)/lead institutions
- Roles and responsibilities of specific projects and participants
- Project scope, activities and budget
- Accountabilities

Contribution Agreements
These set out contribution arrangements for support of regional network activities by various parties.

3.5.10 **Monitoring and Evaluation**

Overall monitoring of initiatives established under the auspicies of NEPAD Science and Technology will be carried out by the NEPAD S&T Steering Committee which is mandated by the AMCOST to provide technical supervision. At regional level the programmes of the biosciences networks will be monitored and evaluated by the Regional Steering Committees. Indicators of success shall be identified from the common set that is currently being developed by the task team on the African Science, Technology and Innovation Indicators.

4.0 Governance of the networks

4.1 Continental level

At the NEPAD Secretariat, the NEPAD/ABI will be coordinated by a Coordinator who will be responsible for providing policy guidance for managing the networks and consolidating resource mobilization efforts with all the regional networks. The Secretariat will also be responsible for coordinating activities that are cross-cutting among all the networks for instance organizing bi-annual conferences and conducting monitoring and evaluation.

4.2 Regional level

The Biosciences Initiative is being implemented in form of networks of laboratories comprising hubs and nodes (Fig. 5). The governance structure of the regional networks comprises a steering committee, scientific advisory committee and a secretariat (Fig. 6).

4.2.1 Steering Committee

The overall governance is vested in the steering committee which has the following functions:

1. Define an appropriate legal structure for the network
2. Allocate resources and identify additional resources needed
3. Develop policy around resource/infrastructure sharing
4. Monitor projects with input from the Scientific Advisory Committee
5. Define performance indicators
6. Develop biosafety and IPR guidelines and ensure that projects undertaken comply with these measures
7. Develop guidelines on a commercialisation strategy
8. Identify, with advice from the Scientific Advisory Committee (SAC) on themes, criteria for node location and project approval
9. Identify network personnel requirements.

The composition of the Steering Committee will vary from region to region. The guiding principles for the steering committees will include the fact that there will be gender consideration, there will be representation from various stakeholder groups and the Regional Economic Centres.

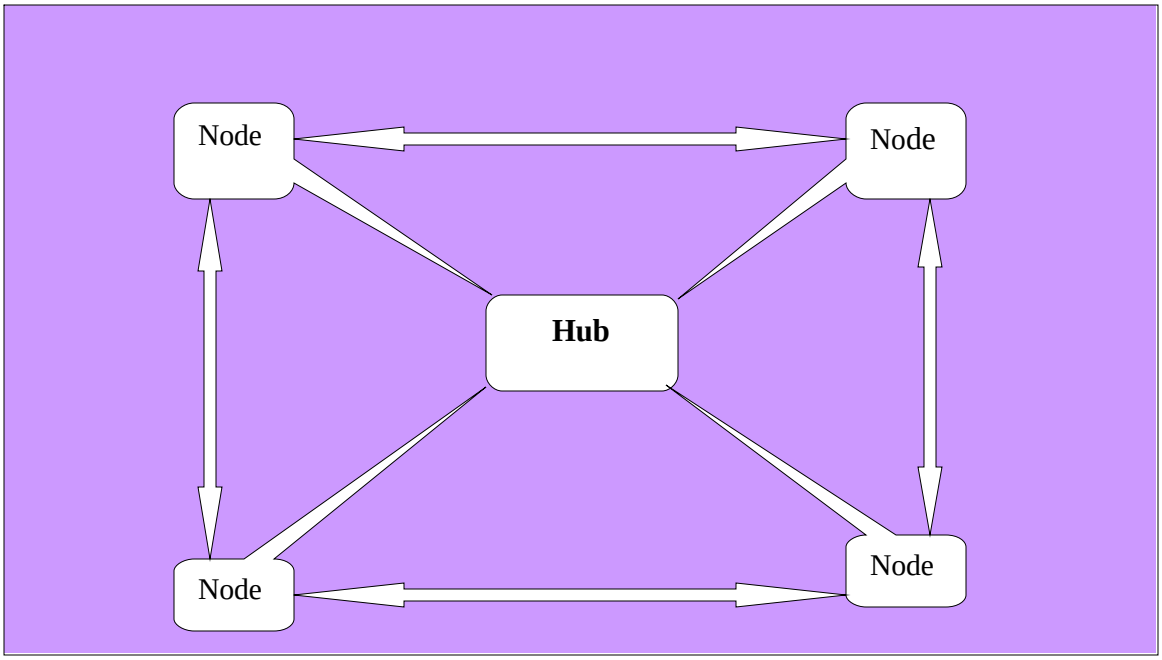

Figure 5. A model regional biosciences network comprising a hub and nodes.

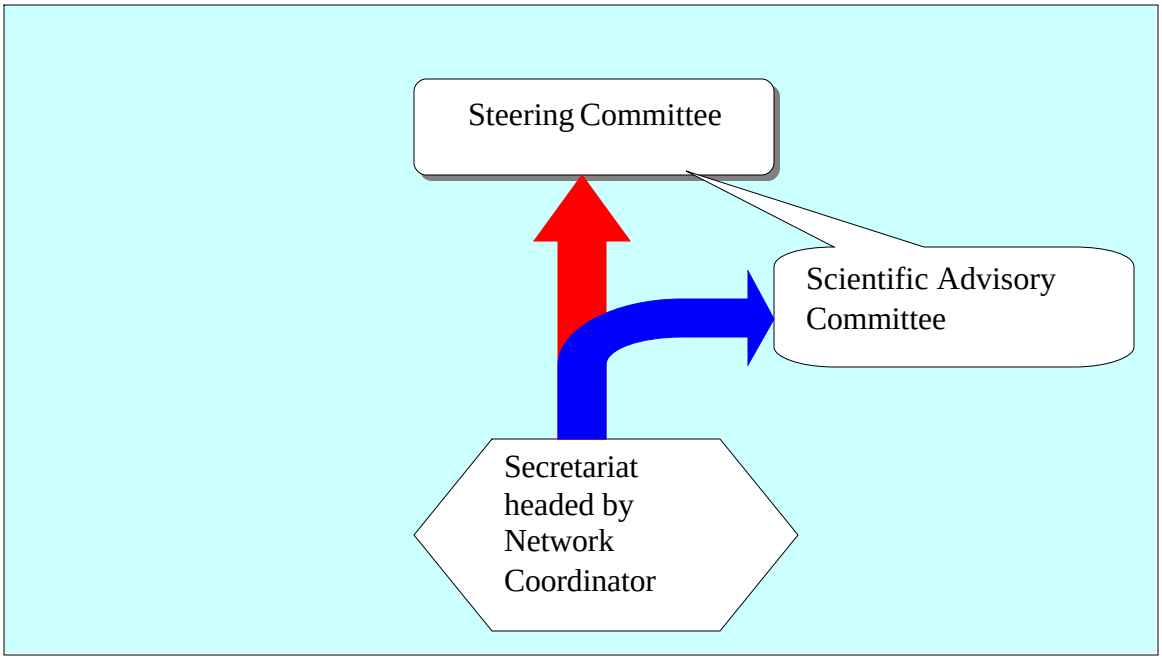

Figure 6. Governance structure of the regional network.

4.2.2 **Scientific Advisory Committee (SAC)**

This will consist of a group of experts in their fields drawn from across the region with international involvement if appropriate. They will develop project criteria, design a process to call for proposals, assess the projects with other peers and make recommendations to the SC. They will design processes to monitor the scientific progress and output of projects and make recommendations to the steering committee regarding changes.

4.2.3 **Secretariat headed by Network Coordinator**

The secretariat will be responsible for day-to-day management of the network. This will be a small secretariat led by a Network Coordinator.

The functions of the Network Coordinator are as follows:

- Directing the scientific and administrative activities of network
- Managing, administering and furthering the vision, mission and objectives of network
- Leading the management team
- Implementing all decisions of the Steering Committee
- Serving as the Secretary to the Steering Committee and the Scientific Advisory Committee.

4.3 **Relationship between NEPAD and the Regional Biosciences Networks**

NEPAD is providing a platform on which the biosciences networks are being established. The networks shall belong to the countries of the regions while NEPAD shall provide policy guidelines. The overall governance of the networks shall be provided by the regional steering committee which will comprise members from relevant regional bodies and institutions. NEPAD shall assist the regional networks in mobilizing political and financial support and awareness creation to policy and decision makers in African governments and with international partners.

5.0 **Resource mobilization**

The New Partnership for Africa's Development (NEPAD) has placed science and technology high on its priority of initiatives that are aimed at socio-economic transformation of Africa. NEPAD is exploring various options for funding regional and continental programmes. It has proposed a policy 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 regional funding scheme or facility. This would be for regional 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 NEPAD. (c) NEPAD Business Group of leading African industrialists and multinational companies operating in Africa
- the African funding scheme or facility would be created as partnership between NEPAD and the African Development Bank (and possibly the African Capacity Building Foundation). Flexibility would be created so that donors can also fund specific projects and programmes of the network
- Countries that are hosting NEPAD hubs and nodes would be required to make specified contributions to the activities in the hubs and nodes.

To implement the above policy elements, an elaborate proposal will be submitted to the 2nd ministerial conference on science and technology in Dakar, Senegal. NEPAD is further exploring the various options and designing a comprehensive strategy for creating the African Science Facility/Scheme. The following are some of the emerging recommendations:

1. A high-level task team or committee of donors and Bureau of AMCOST should meet to define ways of securing high level political endorsement, based on G8 resolutions
2. A presidential champion be identified to promote the African science facility proposal.

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Annexes:

The Annexes comprise of concept notes for the flagship projects proposed by the three regional networks.

Project #1

Scientifically validated, affordable remedies for the treatment of opportunistic infections (IO) for people living with HIV/AIDS

Submitted by

Southern African Network for Biosciences

The proposed project will be conducted by scientific institutions in the twelve southern African states comprising SANBio: Angola, Namibia, Botswana, Zambia, Malawi, Zimbabwe, Mozambique, Seychelles, Mauritius, Swaziland, Lesotho and South Africa.

Introduction

The statistics of people living with HIV/AIDS in Africa are staggering. More than 29 million people in sub-Saharan Africa are HIV-positive. Seventy percent of the world's HIV infections or AIDS cases are in Africa. Twenty million people in Africa have already died of AIDS and about 7 000 more African people die of AIDS every day.

A particular challenge associated with the disease is the treatment of Opportunistic Infections (OI) suffered by all people at different stages of progression of the disease. The treatment of such people using conventional therapeutic interventions is beyond the reach of most governments because of the cost of imported medicines. The availability of effective, safe and affordable herbal treatments for OI will not only improve the quality of life of people living with HIV/AIDS but will even allow a significant portion of those affected by the disease to return to work and contribute to the economy.

The biodiversity of Africa (e.g. plants and mushrooms) is a major resource that has not yet been exploited fully for economic and social benefit of people of the region. The rich heritage of indigenous knowledge on the medicinal plants and mushrooms of the continent may provide leads to effective treatments for OI. Biosciences are the key that can unlock the potential of these indigenous African resources to yield effective treatments for OI.

The goal of the project is to apply the collective biosciences capability of the Southern African Network for Biosciences (SANBio) to the indigenous knowledge and biodiversity of the region, with the aim of developing treatments of OIs suffered by people living with HIV/AIDS.

Africa's botanical wealth

A feature of the species biodiversity of southern Africa is the adaptation to a wide range of diverse ecological niches (such as desert, cold mountainous regions and sub-tropical forest) over many millennia. The African continent is home to approximately 50 000 plants species, which corresponds to nearly 20% of all plants known to man. For example, about 50% of all succulents on earth occur in Africa.

Biodiversity species such as plants and fungi on the African continent are 'ancient', compared to many other parts of the world. The significance of this is that species have had a long time to evolve sophisticated biological mechanisms that catalyse the production of biologically secondary metabolites. It is thought that the cure for many human diseases that cannot be treated effectively by modern medicines can be found in these biologically active secondary metabolites. Examples of plant metabolites are vinblastine and vinchristine, alkaloids from the Madagascar periwinkle that are used in the treatment of childhood leukaemia.

It should be noted that even today, approximately 25% of all prescription medicines are directly or indirectly derived from plants, and a further 25% from microorganisms.

Indigenous knowledge (IK)

The origin of man is intimately linked to the African continent, in particular southern Africa. Man has therefore been in contact with plant species for a very long time, using plants for food, medicine, shelter, fuel, etc. This knowledge system has been transferred from generation to generation for millennia.

IK on the medicinal use of plants can be described as ancient wisdom, but it is also an active system that continues to develop. It is estimated that at least 80% of the population in Africa consult Traditional Healers.

Traditional healing is a holistic system of treating a patient therefore the translation of traditional medicines into modern therapeutic agents is not necessarily a straightforward process.

Biosciences

'Bioscience is the study of biological systems. It includes the application of techniques, whether biological or non-biological, to make or modify products or processes and to apply these in biological systems. Bioscience is multidimensional in nature, involving many types of research and innovation. Pharmaceuticals, biologics, bio-agriculture and environmental biotechnology are some of the disciplines that exist under the definition of bioscience.' (Quoted from www.nepadst.org)

Biosciences are a powerful tool that can add value to the enormous biodiversity and rich heritage of IK in Africa, through a process of scientific innovation. No organization or country can claim to control the full complement of biosciences skills and capabilities required to harness the full potential of these resources. Success in this area requires the capability to establish meaningful research collaboration across organizational and geographic boundaries.

Very few African countries have to date managed to establish strong biosciences research institutes. While it is recognised that considerable funding and skills development will be required to remedy this situation, it is possible for the countries of the region to benefit from the latest developments in biosciences by combining their resources such as experiences scientists, research facilities and equipment.

Bioprospecting

'Bioprospecting is a systematic scientific research process in search of valuable chemical and genetic constituents of biodiversity.' (Quoted from www.bioprospecting.co.za)

Africa's biodiversity, IK and biosciences can be combined to create a bioprospecting platform that can compete with the best in the world (Figure 1). Many developed countries have invested heavily in modern biosciences, and in many developing countries biodiversity and IK have remained intact, but few countries or regions have successfully

harnessed all three components of a bioprospecting programme. SANBio creates a unique opportunity to create a world-class bioprospecting platform that can create economic and social benefit for the region based on scientific investigation of its biodiversity and IK.

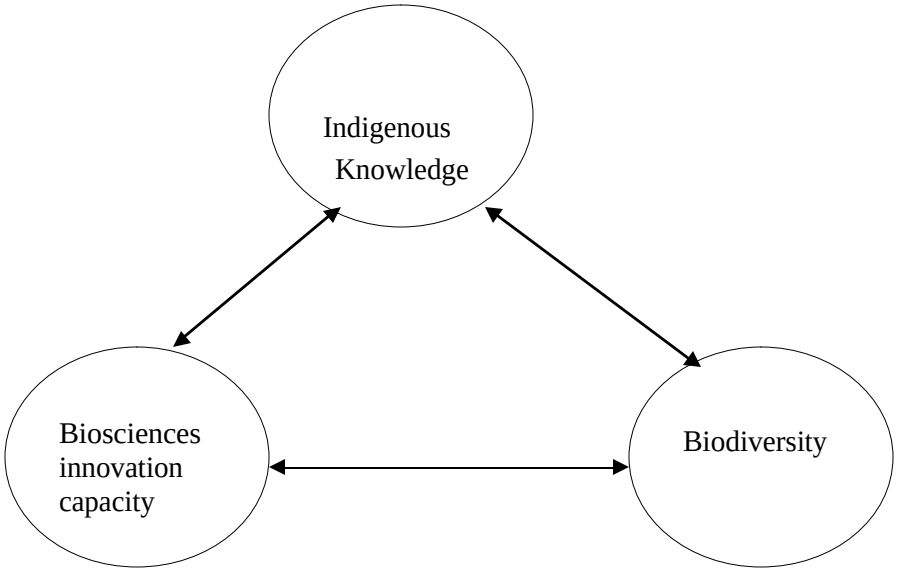

Figure 1. Bioprospecting strategy based on combining IK, Biodiversity and Biosciences innovation capacity

Table 1. Examples of opportunistic infections that may affect people living with HIV/AIDS

Type of opportunistic infection	**Symptoms**
Cryptosporidium parvum	Chronic diarrhoea
Pneumocystis jirovecii pneumonia	Pneumonia
Mycobacterium avium complex (MAC or MAI)	Disseminated infection manifests as fever, weight loss, adenopathy, diarrhea, anemia, neutropenia, and increased liver function tests
Mycobacterium tuberculosis.Pulmonary tuberculosis (TB) infection that attacks the lungs, and can cause meningitis	Fever and respiratory symptoms, is common; extrapulmonary involvement is more frequent in those with advanced HIV disease. Diagnosis is made presumptively based upon clinical presentation and sputum acid-fast bacilli (AFB) stain.
Cryptococcus neoformans (meningitis)	Enlarged mediastinal lymph nodes and a large pulmonary parenchymal nodule

Type of opportunistic infection	**Symptoms**
Candidiasis (Thrush):Candida alba, Candida albicans (fluconazole-susceptible strains), Candida glabrata, Candida tropicalis	A fungal infection of the mouth, throat, or vagina. A vicious cycle linked to poor oral intake, weight loss, malnutrition and wasting syndrome, with occasional mortality due to malnutrition
Gastrointestinal opportunistic infections: oesophageal candidiasis	
Pneumocystic carinii pneumonia (PCP)	Manifests as fever, non-productive cough, and dyspnoea. The chest x-ray usually shows diffuse interstitial infiltrates, but it may be normal in early infection. PCP is generally diagnosed by induced sputum examination
Candida pneumonita	
Vittaforma corneae	
Cytomegalovirus (CMV)	Infection that causes eye disease that can lead to blindness
Cytomegalovirus (pneumonia)	Lymphoid interstitial pneumonitis with persistent respiratory symptoms
Cytomegalovirus Encephalitis	Affects both the central and peripheral nervous systems. Neurological manifestations of CMV infection include encephalitis, ventriculitis, myelitis, retinitis, radiculoganglionitis, and peripheral neuropathies retinitis but may also manifest as colitis, oesophagitis, and polyradiculitis. Patients with retinitis complain of non-specific symptoms such as blurred vision
Herpes simplex viruses (HSV-1-oral); (HSV-2-genital)	Oral herpes (cold sores) or genital herpes
Herpes simplex encephalitis	
Herpes zoster virus	Shingles
Influenza	
Human papillomavirus infection	
Leishmaniasis (Leishmania major and Leishmania infantum)	
Acanthamoeba infection	
Malaria	More common and more severe in patients with HIV
Kaposi's sarcoma	
Toxoplasmosis (Toxo) infection of the brain caused by Toxoplasma gondii	Focal neurologic signs, seizures, and/or altered mental status. CT or MRI scan shows multiple ring-enhancing brainstem lesions

A significant body of scientific literature is available on the OI listed in Table 1. Prior art on African biodiversity species with possible use as treatments for OI will be determined as part of execution of the project as described in Table 2, to prevent possible duplication of research. In this regard it is noted that the plant *Pyrenacantha kaurabassana* is already in the early stages of development for treatment of shingles and oral thrush and will not be considered as a candidate for development by the project team.

Project goal and guiding principles

The goal of the project is to develop a lead for an effective, safe and affordable treatment for OI suffered by people living with HIV/AIDS.

The guiding principles of the project are as follows:

- Maximum participation by all member states in all aspects of the project wherever possible. It is recognized that all countries have the potential to contribute to the three elements of this bioprospecting project:
    - IK on use of traditional medicines as treatments for OI;
    - supply of plant material from the countries' biodiversity;
    - scientific and technical capability;
- Recognition that each member state is the sovereign owner of its own biodiversity and indigenous knowledge.
- Creation of maximum opportunity for shared learning amongst participants thereby ensuring development of the biosciences skills base of SANBio participating scientists.
- Recognition that as a flagship project of SANBio, the focus will be on delivery, shared learning and the development of suitable modalities for cooperation across the twelve member countries of SANBio.

Project objectives

The objective of the project is to establish research collaboration amongst SANBio members to allow harnessing of scientific expertise, indigenous knowledge and biodiversity to develop new treatments of opportunistic infections suffered by people living with HIV/AIDS.

The project has the following specific objectives:

1. Identification of research institutions in each member state that can contribute to the project;

2. Collection and evaluation of indigenous knowledge relevant to treatment of OI;

3. Decision on which biodiversity species (medicinal plants, fungi, etc.) to select for the study in a manner that is as inclusive as possible;

4. Share access to project information through web-enabled database;

5. Research (taxonomy, biological evaluation, chemistry, pharmacology, etc.) on selected biodiversity samples;

6. Sharing of information on the project with the National Focal point for the Convention on Biological Diversity (CBD) or appropriate authorities in each country to ensure transparency and that the project conforms to international as well as country-specific legislation;

7. Based on outcomes of the project, a plan for Phase 2 work to be undertaken to a point of proof of concept for each treatment will be developed and a document describing possible commercialisation models will be created.

The project will aim to establish a technology platform for the scientific evaluation of traditional medicines used to treat OI. This platform will be a significant asset of the region that can be used in future projects that focus on related drug discovery projects based on IK and plant biodiversity.

The project has an above average chance of success because it will benefit from access to two unique African resources: indigenous medicinal plants and a wealth of traditional knowledge on the use thereof with both areas supported by the collective scientific capability harnessed by SANBio eg CSIR has more than 50 years of natural product chemistry expertise. CSIR-Biosciences also has the only Clinical Supply Unit in Africa capable of manufacturing botanical extracts suitable for clinical evaluation.

Table 2: Project tasks, expected outputs, success indicators and budget per activity for Phase 1

Activity	**Due date**	**Deliverable and Success Indicator (SI)**	**Investment (CAD$)**
1. Meetings to determine the scope of a technology platform required to scientifically	End November 2005	Deliverable: Document describing the scope of technology platform to be	40 000

Activity	Due date	Deliverable and Success Indicator (SI)	Investment (CAD$)
validate claims of treatments for OI **1.1.** Identification and selection of most appropriate participating research institutes per country **1.2.** Decision on operating principles for project such as financial controls, disbursements, etc **1.3.** Interaction with local and international experts in commercial development of therapies for OI **1.4.** Determine which OI to focus on.		established, illustrating the role each country will play. Success Indicator: Agreement in principle amongst participants on details of technology platform, operating principles of project, identity and role of research institutes and which OI to focus on.	
2. Intellectual Property Rights (IPR) arrangements: establish protocols for appropriate agreements with traditional medicine practitioners (TMPs) and communities.	October 2006	Deliverable: Document that describes proposed IPR arrangements. Success Indicator: Agreement amongst participants on financial and non-financial benefits to be shared with owners of IK.	45 000
3. Identification of medicinal plants and fungi for research and development as natural products for the treatment of OI **3.1.** Literature studies on biodiversity species (e.g. plants, fungi, marine species) traditionally used for OI treatment **3.2.** Establishing selection criteria to prioritise biodiversity species for research **3.3.** Interaction with owners of IK on biodiversity	June 2006	Deliverable: A web-enabled database containing information on biodiversity species used traditionally to treat OI and selection criteria decided upon by the project team; as well as a registry of owners of indigenous knowledge. Success Indicator: A fully functional, web-enabled database that allows secure access by all participants to scientific information and indigenous knowledge relating to the project.	160 000

Activity	Due date	Deliverable and Success Indicator (SI)	Investment (CAD$)
species traditionally used for OI treatment that can be sourced from the region **3.4.** Developing and populating an information management system to safeguard IK			
4. Collection, taxonomic identification of the selected as well as related biodiversity species, extraction, isolation and characterization of drug leads: **4.1.** Collection, extract preparation and screening of selected and related biodiversity species **4.2.** Bioassay guided fractionation to isolate the active ingredient/s **4.3.** Structure elucidation of active metabolites using LC-MS-MS, GC-MS and NMR	March 2007	Deliverable: Report on identified species and related taxa that occur in the region; results of biological assaying of extracts and chemical profiles of lead/s. Success Indicator: At least one treatment for OI based on a biodiversity species from the SANBio region with proven *in vitro* efficacy and chemical description of biologically active fraction and/or compounds.	205 000
Total cost : PHASE 1			**450 000**
PHASE 2			
5. Proof of concept studies		Pre-clinical data on leads	
6. Decision on commercialisation strategy		Commercialisation documentation	

Assumptions

The project proposal is based on the following assumption:

- The deliverable dates for each activity are based on the assumption the project can start during August 2005. If the start is delayed the dates will adjusted accordingly.

- Each of the participating countries will send at least two delegates (biological and chemical) that can represent the technical capabilities of the country to the first project meeting to be held before November 2005

- New biodiversity species with potential to yield active ingredients for treatment of OI will be identified in one or more of the participating countries.

- The project participants will obtain regulatory approval from their respective governments to transfer biodiversity specimens and indigenous knowledge to other member states for research purposes.

Sustainability

The sustainability of the project will be determined by success in obtaining funding for Phase 2. The project has been designed to produce deliverables by the end of Phase 1 that are comprehensive and convincing, in order to attract further funding from donor agencies, the private sector and government bodies for Phase 2.

Risks

The project has specific technical and political risks.

Technical risks are limited to the identification of suitable biodiversity species for development as treatments for OI. An example of a low risk case is the development of a fast growing herb as a minimally processed herbal medicine in an economical dosage form such as a tea bag. An example of a higher risk case is the development of a new treatment based on synthesis of a novel, active molecule identified from the bark of a slow-growing tree. The organic chemistry and biological assaying required for the project can be harnessed by combining technical capabilities available in the different participating countries.

The political risk is that not all countries have progressed equally far with the adoption of Access and Benefit Sharing (ABS) legislation required at national level in terms of the Convention on Biodiversity. The lack of ABS legislation may hamper the free exchange of biodiversity samples amongst participants from the different countries.

Resources: participating institutions and scientists

The scientists and their research institutions in each of the participating SANBio countries are the most important resources available to the project. A fully participative process will be undertaken to ensure a comprehensive awareness of the project in all member states. The involvement of scientists, owners of indigenous knowledge and/or project leaders from each of the SANBio countries will be sought. The specific institutions and scientists that can possibly participate on behalf of each of the twelve member countries will be dictated by the needs of the project. The project tasks are described in Table 2 but will be refined through a logic frame process involving representatives of each country at the launch meeting of the project.

After approval of this proposal, a comprehensive process will be undertaken to identify all possible participating research institutes in each country. These institutes will all be contacted and informed of the project. Each country is required to conduct an in-country

process to decide on representatives to attend the key launch meeting of the project, within the constraints of the budget for this part of the project as proposed in Table 2.

The following preliminary information is provided only as an indication of the nature of organizations that will be informed of the project once approved:

- **Government Departments**:
  - e.g. Ministry of Science and Technology of Mozambique: The National Director. Ministry of Industry, Science and Technology of Malawi: Director of Science and Technology

- **Owners of Indigenous Knowledge**:
  - e.g. Traditional Healer Committee: The Chairman. Traditional Healer Solomon Mahlaba, Johannesburg, South Africa
  - Working Groups for Minorities in Southern Africa (WIMSA), Windhoek, Namibia
  - National Steering Committee for the Confederation of Traditional Healers Associations, Malawi

- **Regulatory Authorities:**
  - e.g. Department of Environmental Affairs and Tourism, Pretoria
  - The National Research Council of Malawi

- **Existing consortia of research institutions and universities:**
  - e.g. The Southern African Botanical Diversity Network (SABONET) is an existing and particularly valuable resource for the project. This international GEF/UNDP-funded project was implemented by the National Botanical gardens of Southern Africa and is aimed at upgrading facilities and strengthening the level of botanical expertise throughout the subcontinent. The participating countries are Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe. The key contacts established by SABONET at the national herbaria in each of the participating countries will be important initial contact points for this project. More information on SABONET is provided in Box 1.

  - The CSIR's Bioprospecting programme has a long track record of successful bioprospecting for new medicinal substances. This Programme collaborates with at least 17 different research institutions in South Africa. The Programme is already involved in a Bioprospecting Memorandum of Agreement (MOA) with Namibia and a similar MOA is being considered by Mozambique.

  - NABSA. A network for Analytical and Bioassay Services in Africa facilitates natural product scientists to undertake analytical and bioassay services within member university institutions. The Network office in

Southern Africa is housed at the Chemistry Department, University of Botswana.

Box 1. Description of SABONET activities

The Southern African Botanical Diversity Network (SABONET) is an international GEF/UNDP-funded project implemented by South Africa's National Botanical Institute and is aimed at upgrading facilities and strengthening the level of botanical expertise throughout the subcontinent. The participating countries are Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Zambia and Zimbabwe.

SABONET was one of only 14 projects highlighted in the second overall Performance Study of the GEF's (Global Environment Fund) programme of over 1 000 projects in 160 countries, with a total allocation of $4.2 billion during its first decade of operation

During the past year numerous training courses were presented under the auspices of SABONET. A Herbarium Managers Course, the first course for senior management presented by SABONET, was held at the National Herbarium and was attended by 14 herbarium curators and senior management from all ten participating SABONET countries. The first Botanical Gardens Management Course presented by SABONET, a two-week course aimed at botanical garden managers wanting to develop their managerial skills further, was attended by 24 people from 10 African countries. Other training courses held during the year included an Environmental Impact Assessment Course for botanists held at the Pretoria National Botanical Garden, and a plant identification course held in Maputo, Mozambique, as part of SABONET's Southern Mozambique Regional Expedition. Three individuals were funded by SABONET to attend a botanical art drawing course held at the National Herbarium in Pretoria.

SABONET furthermore hosted a national workshop for end-users of taxonomic information at the National Herbarium in Pretoria which was attended by 34 participants such as representatives of agricultural institutions, botanical societies, conservation agencies, universities, environmental consultants, ethnobotanists and traditional healers.

Computerization of southern Africa herbaria is a core activity within the SABONET project. All the data-capturing computers were upgraded at the participating herbaria and subsequently the computerization rate increased substantially. Currently it stands at 155 000 specimens per annum (70 000 more than in the year 2000), which means that on average 596 specimens are added to the data bases in the participating southern African herbaria per working day. Approximately 40% of the region's herbarium specimens have been computerized through the SABONET project to date.

In November 2001 the second SABONET Regional Expedition took place in southern Mozambique. The exhibition was attended by 35 participants from all 10 participating SABONET countries and approximately 1 500 specimens were collected. The Southern African Plant Red Data List Project reached its conclusion on 31 December 2001 and the first-ever Plant Red Data List for the region was prepared and will be published in 2002.

Eleven SABONET-sponsored students doing Masters and Honours degrees in plant systematics completed their postgraduate studies during 2001. Eight full-time postgraduate students and two part-time students are being sponsored by SABONET to pursue their Masters degrees during 2002. *Source*: SANBI Annual Report 2001-2002.

Project #2

Inventory and characterization of West Africa sorghum genetic resources.

Submitted by the

West African Biosciences Network

Collaborating institutions:

ISRA, BP 3120 Dakar – Bel Air, Senegal

IER, B.P:258 -Rue Mohamed V Bamako, Mali

INRAN, BP429 Niamey, Niger

INERA, Burkina Faso

CNRA, Cote D'Ívoire

University of Ghana,

Others to be identified

Duration of the project:

2 years

Collaborating countries:

Nigeria, Benin, Togo, Ghana, Burkina Faso, Cote D'Ivoire, Mali, Liberia, Sierra Leone, Guinea Conakry, Senegal, Gambia, Guinea (Bissau), Cape Verde, Niger.

Background and rationale

Sorghum is currently the fifth most important grain crop in the world and is grown under rain-fed conditions in many developing countries, especially in Africa and Asia. Its excellent drought tolerance and water-use efficiency characteristics make it one of the most important crops in areas with insufficient rainfall.

Extensive *ex situ* collections of sorghum germplasm exists within the international community. The largest is constituted of more than 30000 accessions of cultivated sorghum which have been collected over more than 30 years from 90 different countries and is conserved and maintained at ICRISAT.

With its relative small genome size, sorghum is emerging as a model for C4 tropical grasses. Sorghum genomic resources are therefore rapidly growing and a lot of results and molecular tools are becoming available to the scientific community. At least two high-density maps (one intraspecific *S. bicolor* and one interspecific *S. bicolor* x *S. propinquum*) provide several thousand of genetic markers (SSR, STS, AFLP, RFLP, etc.). Recent cytological characterization of the individual sorghum chromosomes has provided a generally accepted numbering system. Several BAC libraries are available and the physical map construction and its anchoring with the genetic map are ongoing. The complete sequence of the sorghum genome is expected in the coming years.

The characterization of genetic diversity within a species is a key step towards the integration of molecular tools in the breeding process. The use of molecular markers to analyse structural genetic diversity allows identifying shared pedigree or geographic origin of different accessions as well as the general population structure. This last point is determinant for further functional analysis that aims at relating gene polymorphism with phenotypic variation. Finally the characterization of genetic diversity within breeding programs is an important information in the pre-breeding step, in order to design crosses and identify the most promising donor lines for traits of agronomic importance.

An international initiative, the Generation Challenge Programme (GCP), initiated by the Consultative Group on International Agriculture Research (CGIAR), has undertaken, for the 22 mandates crops of the CGIR system, the extensive characterization of genetic diversity in the world collections hosted by the different CGIR centres. As far as sorghum is concerned, a subset of 3000 accessions has been selected among the 30000 accessions of the ICRISAT collection, and is being analysed with 50 microsatellites markers. A first output of this work is a huge dataset describing the genetic diversity of the sorghum species, and constituting a reference for further studies. A second output is the constitution of a microsatellite marker kit, made available to the crop community and constituting a tool that allows the characterization of any new material in relation with the reference dataset. One of the main applications will be to use this information to constitute relevant subsets of material suitable for association genetics (studying the association between a phenotype and the variability of a functional locus).

Africa and particularly the Soudano-Sahelian zone constitute the center of origin and diversity of sorghum. African material accounts for more than 50% of the accessions currently maintained in existing world collections. It is also admitted that much of existing *in situ* diversity lacking from those collections is located in Africa. The Soudano-Sahelian zone is also an agro-ecological system in which drought frequently occurs and a

wide range of variability in tolerance to drought is known to exist in local varieties of Sahel. This diversity remains little understood and underutilized by research.

Aim and specific objectives

The aim of the proposal is to characterize the genetic diversity of the sorghum germplasm grown in West-Africa for better utilisation and management of genetic resources in breeding programs. This proposal will ensure the identification of germplasm with distinct traits existing within the sub-region and foster an integrated approach in analyses of genetic diversity.

Specific objectives

- Take inventory of available collections in the different national breeding programs of West Africa and evaluate the redundancy existing among them in comparison with the international collections.

- Maintain or update national sorghum collections in the different countries within the sub-Region.

- Characterize the genetic diversity of a composite set of accessions representing the wide range of environmental adaptation in West Africa

- Ensure a sustainable technology transfer in the field of molecular markers analysis by intensive training of national scientists in the different nodes involved in genetic analysis.

Key activities

- *Inventory of available collections in the different national breeding programs of West Africa*

A meeting will be organized bringing together the sorghum breeders from the different countries involved in the project to develop modalities for executing project objectives. A comprehensive review of available collections including information on passport and breeding data of landraces and breeding lines will be undertaken.

All the information (nomenclature of accessions and passport and breeding data) related to the collections will be integrated in a single database. This database will be designed as simple as possible (a set of well documented table files that will be shared by all the partners).

- *Collection of landraces in participating countries*

Depending on the level of overlaps between the national collections and the international collections (mainly ICRISAT), gathering of additional landraces may be required in all or part of the countries involved in the project. Taking into account the level of funding available, we will have to find a balance between the number of samples to be genotyped and the germplasm collection activities. This point will be discussed during the meeting of the previous activity.

- *Definition of a composite set*

Once information about West Africa sorghum germplasm is assembled, it will be used to define a set of 1000 accessions to be analysed for genetic diversity. For this purpose, the selection process will have to take into account the wide range of environmental conditions encountered across the sub-region. Methodologies of sampling used to build core collections will be applied, taking into account different levels of structuration (geographical, racial, photoperiod sensitivity, etc.). The composite set will also include all specific material which may have some distinct traits for further functional study:

-Lines showing a known resistance to a pathogen (Shoot fly, Stem borer, Midge, Hed bug, Striga, Grain mold, Anthracnose, etc.)

-Lines with good end-use characteristics (grain quality, forage quality, dual purpose lines, sweet stalk sorghum, etc.)

-Advanced breeding lines

- *Genotyping*

The composite set of sorghum accessions will be analysed with 50 microsatellites markers already used for genetic diversity in the sorghum scientific community. These markers have been selected to have an optimal genome coverage as well as technical robustness across different laboratories.

Genotyping activity will be shared across the different labs involved in the project. The work will be shared on a marker basis, each laboratory will genotype all the accessions with a subset of markers. Microsatellites will be analysed using an automatic sequencer and results will be scored as allele size in base pairs relatively to well known reference samples that will be shared by the different labs.

DNA samples can be produced either in a single laboratory using material shipped by the different partners (seeds samples or dry leaves tissues), or in each country using standardized procedures. This depends on the facilities available for DNA isolation in each participating country and the material exchange constraints. Issues concerning exchange of genetic material between the partners are important for this step. For technical reasons, it appears to be much more efficient to collect seed samples in a single place, to grow all the plants and to produce DNA at the same time and with the same protocol.

- *Training*

Genotyping will be carried out in the different labs of the Network that have the facilities required. Each participating country will identify one scientist to be trained in molecular marker technologies in the hub or in the closest node of the network involved in genotyping.

Once genotypic data collection is achieved, a data analysis meeting will be organized with all the actors of the project in order to cover the different aspects of diversity analysis and interpretation of the results.

Expected outcomes

- A comprehensive database of the sorghum accessions and breeding lines grown in West Africa with for, each accession, as much as possible information on agronomic performance and environmental adaptation.

- An understanding of structural genetic diversity of West Africa sorghum germplasm and its relation with the known diversity of the species

- An African network of sorghum breeders sharing the same molecular toolkit for genetic diversity assessment and the same laboratory procedures.

- A reference genetic dataset that can be used in different ways:

  - To sub-sample different set of accessions for further functional studies focused on specific agronomic targets.
  - To help breeders to select genotypes to broadening the genetic basis of breeding populations and mapping populations.

- An increased capacity of scientists of the National Agricultural Research Centres in using molecular marker technologies for genetic diversity and integrating genetic information in breeding.

Facilities and resources

Centre d'Etude Régional pour l'Amélioration de l'Adaptation à la Sécheresse (CERAAS) laboratory of ISRA (Sénégal)

The Centre has a 900 m2 office and laboratory space, with modern scientific equipment, a phytotron, a cold room, a 180m2 glasshouse, a generator which comes on automatically in case of power failure, continuous water supply, and a computer network with high speed (1Mbps) internet connection. The molecular biology laboratory has all necessary equipment to carry out DNA isolation (-80°C freezer, beads grinder, refrigerated plate centrifuge), PCR amplification (3 primus96 thermocyclers) and agarose and PAGE electrophoresis. By the end of 2005, all the genotyping activities will be organized around a Licor DNA4300 genotyper.

The core scientific team of CERAAS is made up of 11 scientists involved in both research and training (4 plant physiologists specialised in eco, agro and molecular physiology, 2 molecular geneticists, 1 soil scientist, 1 agro-climatologist, 1 plant breeder, 1 agronomist and 1 biometrician). The core scientific team of CERAAS is back–stopped in complementary research areas by specialist scientists within ISRA as well as other partner institutions both in the North and the South. Twelve research technicians and a 13-man technical and administrative staff support the scientific team.

Laboratoire Central de Biotechnologies of CNRA (Côte d'Ivoire)

LCB have good facilities and equipment for molecular biology studies and is on the phase of acquisition of a DNA sequencer. The lab has 5 permanent molecular biologists, 10 specialised technicians and 15 PhD students, back stopped by scientists of all CNRA's research programs (22).

The Biotechnology Centre, College of Agriculture, University of Ghana

The biotechnology centre has facilities for DNA genotyping and has been involved in root-tuber and cereals characterisation using microsatellites, RAPDs and protein profiles. There are four plant Geneticists/Molecular biologists and one Animal Molecular Biologists. The centre will soon be moving into a bigger facility with two main laboratories each of which can sit over 30 people. The centre also benefits from facilities at the Nuguchi Memorial Institute which has start of art facilities with a sequencer.

Other nodes to be identified

Proposed budget summary

Activity	**Year 1 CAD$**	**Year 2 CAD$**
Training	37 500	37 500
Salaries	31 000	61 000
Genotyping	116 325	166 675
Sub-total	184 825	265 175
Grand total		**450 000**

Project # 3

Improving knowledge of the genetic diversity: from molecular tools to biotechnology for innovation and better life quality

Acronym:
BIOTOOLS

Submitted by the
Biosciences North Africa Network

Collaborating institutions:
National Research Center, EGYPT
Centre de Biotechnology de Borj Cédria, TUNISIA
Université Mentouri Constantine, ALGERIA
Biotechnology Research Center, Tripoli, LYBIA
Faculté des Sciences Ndjaména, TCHAD

Budget requested:
CAD$450 000

Collaborating countries:
Egypt, Lybia, Tchad, Tunisia, Algeria, Mauritania.

Background

The region of North Africa has a human population that is generally related or has a common history. This demographic continuum seem to manifest a human genetic patrimony including genetic diseases. The seven countries of North Africa cover about 28 % of the continent, climatic and soil conditions are generally severe; such that crops and livestock need to be tolerant to these conditions to survive. The constraints prevailing in these areas are generally abiotic, particularly salinity and drought. Native adapted flora, fauna and microorganisms have recently been favoured to imported germplasm, for sustainable agriculture.

Accumulation of knowledge in biosciences is an integral process where the developed approaches (genetics, biochemistry etc) have been introduced in the society by routine exchange of scientific knowledge on humans, plants, animals and microorganisms.

In North Africa, investments into research in biosciences are still needed for expected advancement of biosciences for development. Moreover the levels of investment vary widely from one country to another. However, in spite of these limiting conditions the region has built, through concomitant national efforts and international collaboration, some powerful potential in various areas of biosciences. These capacities have yielded some interesting results in some of the North African countries and need to be networked.

Many countries today are decreasing their support for basic sciences or are simply providing insufficient funding. This approach which exclusively seeks short-term returns, is having an adverse long-term effect on basic science and its contribution to society. There is, therefore, a pressing need for commitment to develop basic science and allow it to exercise its creative power in response to the needs of the societies.

On the other hand the difference between the scientific background in the North African region and in developed countries makes it very difficult to develop effective collaboration. This fact has lead to ineffective scientific exchange between north African scientific community and that of developed countries, which has resulted in a significantly widened gap in the level of biosciences research and innovation.

Development of biotechnology in north African countries requires establishment of sound network of the existing facilities and implementation of common activities. In the region it is very important at this step to have a commitment to strengthen capacities in biosciences through national efforts and international co-operation. This is in fact the result of a concomitant advance through science in health, agriculture and environment. The input of genomics, proteomics and bioinformatics will be more and more required for the near future and their dissemination in the region will be necessary. This is the only way the region can be prepared for the post genomic era, and enable it to develop required capacities for international collaboration and partnership.

General objective

From the analysis of the situation in North Africa it appears that it is now time to further develop the scale of co-operative projects on capacity building in biosciences. The present project called "BIOTOOLS" will be a long term action of NEPAD/ABI destined to improve the human capacities in North Africa for biosciences. BIOTOOLS is designed to ensure enhanced co-operation with a view to increasing the outcome of the ongoing local programmes, while putting emphasis on regional actions.

The project will be implemented with active participation of various national centres of excellence and there will be commitment of member states to assist in ensuring logistical support and participate on the project on a cost-sharing basis. Priority will be given to development of basic and reliable approaches and protocols, that could be used on common projects. The use of molecular tools appears to be a major common interest from all participating countries. The first phase is therefore necessary to build the assurance that the network is able to develop common scientific protocols for working on similar problems. This first phase is also necessary to collect and assemble common biological materials for the network, and to initiate well targeted training activities.

At regional level the priority is to establish a network with basic materials and tools and common and well shared objectives. The project will provide the north African region, a common biosciences research platform, research-related services and capacity building and training opportunities.

Work packages and expected achievements

The main activities are presented into five work packages

1)Work package 1: Training

This activity needs to be particularly performed in the short term targeting teams and specific activities, that would lead to a high level of interaction and integration among institutions.

Objective: To establish efficient networks in common fields with adequate competences and procedures for sharing materials and approaches.

2)Work package2: Designing of premarital chip

Heritable genetic diseases are a big challenge for health systems in the North African countries where they show a high rate of prevalence. Devising a premarital carrier-screening program has been demonstrated to be an efficient preventive strategy to minimise heritable diseases. It is therefore necessary for North African populations to elucidate the disease mutational patterns among related populations of the region.

Objective: to devise a carrier screening tool (i.e. premarital chip) for the prevalent heritable disorders among the North African populations

3)Work package3: Improvement of Barley

Productivity of the Barley is seriously affected in the north African region by abiotic stresses such as drought, salinity and high temperatures. Improvement of stress resistance will be a crucial factor in the near future to increase yield stability, grain quality and to expand growing area for the crop. This can be achieved either by exploiting the genetic variability or by introducing new or modified genes.

Objective: to generate barley tolerant to abiotic stress conditions through investigating the genetic variability among the available germplasm in the region and introducing new genes into elite varieties

4)Work package4: Improvement of Legume-rhizobia symbiosis

N_2-fixing legumes offer an economic advantage for plant-protein production under limited N-inputs prevailing in extensive farming systems and marginal lands devoted to dryland pastures and rangelands and soils reclaimed or with low rhizobial populations. They help to improve soil fertility by symbiotic nitrogen fixation and protect ground water from toxicity due to excessive application of N-fertilizers. Productivity of legumes in North africa is frequently limited by water insufficiency and salinity. This leads to high importation to meet deficits in markets. Faba bean, chick pea, cow pea, are the most affected grain legumes. *Medicago, Trifolium,* and other legumes from arid areas are affected as forage and pastures.

Objective: To improve legumes production through symbiotic nitrogen fixation.

5)Work package5: Management

Each Work Package will be managed by a leader who will handle:

1.The organisation of the Tasks described in the WP and the co-ordination of the activities developed in the different countries.

2.The preparation of drafts of technical reports arising from the WP.

3.The preparation of the Deliverables arising from the WP.

The working groups need to have their first meetings together. They will deliberate ways of developing specific projects based on WP2, WP3 and WP4 which are dedicated to premarital chip, improvement of barley and legume-rhizobia symbiosis.

Workplan

1)Work package 1: Training

Individual training will be done when needed. There will be: (i)a “Call” for nominating North Africa laboratories to host training in the frame of the BNA project, (ii)after identification of hosting laboratories a call for training will be circulated through the consortium.

2)Work package2: Designing of premarital chip

Task1: establishing a regional north Africa genomic network (month 1-6)

Integrating interested research groups for generating and collection of data and material for the prevalent genetic diseases in the region. This process will involve meeting of the working group and establishing a data base and editing a report on prevalence of heritable genetic diseases in the region. The working group can foster the creation of North African Society of Human Genetics at that stage.

Task2: initiating use of molecular tools to detect mutational patterns (month 7-12)

Each collaborating centre will be charged with analysing the molecular basis, using adequate marker, of a particular disorder related to a specific disease. This phase would be dedicated to improving and harmonizing protocols for large scale analysis. While experienced labs will begin to get results, those with limited experience would benefit through training.

3)Work package3: Improvement of Barley

Task1: establishing a regional barley network (month 1-6)

Barley research interested local groups will be networked. The established working group will collect, generate and conserve accessions and data. This will be based on a survey of germplasm available in the different North African countries. Inventory of available collections in the different national breeding programs of North Africa will be taken and detection of redundancy existing among them in comparison with the international collections will be done.

Task2: Investigation of the genetic diversity (month 7-12).

This will be performed using the available molecular markers in the competent groups. While experienced labs will begin to generate results, those with limited experience will benefit from training.

At the end of this period the working group would be able to draw its future research project based on the yet established common background of group.

The project would plan for: (i)development of a high resolution map through the application of DNA, (ii) tagging genes or QTLs linked to abiotic stresses and transformation for improvement of commercially useful cultivars

4)Work package4: Improvement of Legume-rhizobia symbiosis

Task1: establishing a regional legumes-rhizobia network (month 1-6)

Local groups interested in the improvement of legumes via symbiotic nitrogen fixation will be networked. The working group will establish an inventory of the available rhizobia collections in the region, and summarize the nodulation status of the most important legumes. Legumes limited by N_2-fixation under well described conditions will be identified. The working group will create a North African Society of Nitrogen Fixation.

Task2: Evaluation of the genetic diversity in legume-rhizobia symbiosis (7-12).
This will be initiated by using the available molecular markers in the competent groups to characterise bacteria and to identify in the two partners genes or QTLs involved in tolerance to abiotic stresses.

The project would plan for: (i) investigation of the mechanisms and genes involved in tolerance to water deficit and salt stress for symbiotic nitrogen fixation in legumes and rhizobia, (ii) evaluate the benefit from "*in situ* improvement of legume-rhizobia symbiosis" and inoculation by selected strains, (iii)disseminate of the results, and initiate technology transfer towards professionals and policy makers.

Deliverables

WP1:
1.Bilateral collaboration and common supervision of students
2.Common protocols and reference material
3.Acquiring new approaches by some laboratories

WP2:
1.Databases of prevalent genetic diseases in the region
2.North African Human genetic society/consortium/group
3.Identification of biological material and molecular tools to be used for through mutation analysis
4.Screening of samples from the north African population and inventorying using PCR, DNA sequencing
5.Drawing a full project to continue the process of designing premarital chips for the region

WP3:
1.Establishing a database of barley germplasm in the region
2.Collection, generation and conservation of a useful set of accessions
3.Establishing a North African Group for Barley
4.Initiation of diversity analysis of the regional collection based on molecular markers (SSRs, AFLPs..) and identification of various existing patterns, toward understanding the genetic diversity of Barley
5.Drawing a project for continuing the process of improvement of Barley.

WP4:
1. Establishing a database of rhizobia and legume collections in the region
2. Identification, exchange and conservation of a useful set of rhizobia strains and legumes cultivars/ecotypes/lines
3. Establishing a North African Group for legume-rhizobia symbiotic nitrogen fixation
4. Identification of rhizobia (PCR/RFLP and sequencing) and typing of legumes collections (microsatellites) and research of molecular markers related to the tolerance of

drought and salt by the symbiosis and partners, towards understanding the genetic diversity of legumes and rhizobia symbionts
5. Drawing a project for continuing the process of exploitation and improvement of legume-rhizobia symbiosis under abiotic stresses.

WP5:
1. One meeting for each one of the three research groups
2. One general meeting for the overall consortium of north African biosciences
3. Progress reports