RIS
Research and Information System
for Developing Countries

Asian Biotechnology and Development Review
Vol. 11 No. 3, pp 1-10

Status of Biotechnology in Africa: Challenges and Opportunities

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Abstract: For the past three decades Africa has been a net importer of food!! In recognition of this situation and the significant role agriculture plays in Africa's development, the continent, under the auspices of New Partnerships for Africa's Development (NEPAD), developed a number of initiatives to enhance agricultural growth, alleviate poverty and improve quality of life. Some of these initiatives are in the African Union (AU)-NEPAD Science and Technology Consolidated Plan of Action in which the flagship programmes on indigenous crops are contained and the NEPAD Comprehensive African Agriculture Development Programme (CAADP).

Agricultural biotechnology alone will not solve the multitude of problems that farmers in Africa face; however, it has the potential to make crop breeding and crop management systems more efficient thereby generating improved crop varieties and higher yields. The challenges facing the continent on biotechnology and biosafety include lack of fund; loss of trained technical expertise; slow development of the biotechnology sector; inadequate Intellectual Property Rights infrastructure; government not taking a more active political role in promoting the technology and the issue of public acceptance brought about by activism. The lag in development of a governance capacity for biotechnology is seen in the current status of the development of national biosafety frameworks (NBFs) in Africa. Out of the 53 countries of the African Union, only 16 countries have laws, regulations, guidelines or policies related to modern biotechnology. Of these, only South Africa, Burkina Faso and Egypt have had experience in the assessment of applications for commercialization of any biotech crops. The combination of inadequate policies and legal frameworks require urgent attention that is led primarily by Africans if it is to achieve credibility in the eyes of African governments, African civil society and African people.

Keywords: Africa, biotechnology, biosafety, NEPAD.

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Introduction

Africa has a wealth of natural resources with the potential to drive economic growth and social development: land, minerals, biological diversity, wildlife, forests, fisheries and water, although these are unevenly distributed. Africa's economies and people are vulnerable to environmental hazards such as droughts and floods, the frequency and extremity of which is likely to be increased by climate change. In addition, sub-Saharan Africa is experiencing faster degradation of many environmental resources, important to poor people, than any other region. Problems include land degradation, desertification, biodiversity loss, deforestation, loss of arable and grazing land, declining soil productivity, pollution and depletion of freshwater.[1]

One of the central messages emerging from the assessment of Africa's status in the global economy is the need for Africa to emphasize building the capacity to solve its own problems. Every problem enumerated above has one or more solutions in the application of science, technology and innovation. Application of science and technology has contributed significantly to defining an economic divide between rich and poor nations. It follows, therefore, that the rate of scientific and technological development largely determines the pace of socio-economic development. To close the gap between rich and poor nations will require deliberate measures to build scientific and technological capabilities of the poor countries.

Science and Technology in Africa's Development Agenda

African leadership, through the Africa Union (AU), has committed themselves to the economic and technological development of the continent as their priority. The objectives of the AU include the promotion of sustainable development at the economic, social and cultural levels as well as the integration of African economies and the advancement of the development of the continent by promoting research in all fields, in particular in science and technology.[2] Africa's Science and Technology Consolidated Plan of Action (CPA) was developed in 2006 under the auspices of the New Partnership for Africa's Development (NEPAD). In the field of biotechnology, NEPAD and the AU Commission have established a high level African panel on biotechnology to 'facilitate open and informed regional multi-stakeholder dialogue on, *inter alia*, scientific, technical, economic, health, social, ethical, environmental, trade and intellectual property protection issues associated with or raised by rapid developments in modern biotechnology'.[3] In the NEPAD framework

African leaders recognize that science and technology will play a major role in the economic transformation and sustainable development of the continent. One of NEPAD's overall objectives is to bridge the technological divide between Africa and the rest of the world. It recognizes that such technologies as information and communication technologies are critical in remote sensing, environmental policy-making and planning and agricultural development. These technologies will also enable African countries to establish efficient early warning and monitoring systems for conflict management and natural disaster prevention.

Africa's Consolidated Plan of Action on Science and Technology

In 2003, the NEPAD Office of Science and Technology carried out surveys of Science and Technology (S&T) institutions on the African continent and the results were compiled into regional reports of S&T capacity status. Following this regional workshops, studies and consultations were held on key issues which led to the adoption of an outline of plan of action for S&T in Johannesburg, South Africa and the subsequent publication of the AU-NEPAD Africa's Science and Technology Consolidated Plan of Action (CPA). The CPA was adopted in 2005 by the African Ministerial Conference on Science and Technology (AMCOST) at its second conference in Dakar, Senegal. The same document was endorsed a year later by the AU Summit in Khartoum, Sudan. The CPA articulates Africa's common objective of socio-economic transformation and full integration into the world economy. It reaffirms the continent's collective action for using S&T for meeting the developmental goals of Africa with key pillars being capacity building, knowledge production and technological innovation. The CPA recognizes that S&T in Africa is plagued by such factors as weak or no links between industry and S&T institutions, a mismatch between R&D activities and national industrial development strategies and goals. The consequence of these weaknesses is that research findings in public institutions, including universities, do not get accessed and used by local industries especially small and medium enterprises.

The CPA comprises of three key areas: research and development programmes; improvement in policy conditions and building innovation mechanisms; and implementation, funding and governance strategies.

CPA R&D Programmes and Implementation

The programmes contained in the CPA are implemented through regional networks of centres of excellence, consisting of hubs and nodes. The

programmes engage existing institutions into regional networks in order to pool available human and technical resources and strengthen the development of high quality S&T. The objectives of these networks are: to improve quality of and access to infrastructure and facilities; develop further institutional and political regulations; improve the human skill base; obtain political and civil society support; strengthen the capacity of regional institutions; integrate R&D into sectoral programmes; improve the applicability of S&T towards the Millennium Development Goals and Sustainable Development; and to develop innovative funding instruments and build international partnerships.

Research and Development Programmes of the CPA consists of five clusters. Under each cluster there are several programmes. The clusters are:

Cluster1: Biodiversity, Biotechnology and Indigenous Knowledge: This cluster focuses on the conservation and sustainable use of biodiversity; safe development and application of biotechnology; and securing and using Africa's indigenous knowledge base.

Cluster 2: Energy, Water and Desertification: This includes building a sustainable energy base by increasing rural and urban access to environmentally-sound energy sources and technologies; securing and sustaining water to ensure sustainable access to safe and adequate clean water supply and sanitation; combating drought and desertification by improving scientific understanding and sharing of information on the causes of and extent of drought and desertification in Africa.

Cluster 3: Material Sciences, Manufacturing, Laser Technology and Post-Harvest Technology: This includes the development of new and improvement of existing infrastructure by building new skills or expertise in material sciences, promoting the sharing of physical infrastructure and exchange of scientific information and the promotion of public sector partnerships in material sciences research and innovation.

Cluster 4: Information and Communication Technologies; and Space Science and Technologies: This includes the creation of experts engaged in computer science, information systems as well as informatics; building skills in software research and development. It also includes the establishment of the African Institute of Space Science.

Cluster 5: Mathematical Sciences: This includes the establishment of an African Mathematical Institutes aimed at strengthening the African Mathematical Institutes network that was constituted in 2005 with the sole purpose of building a new generation of African scientists and technologists with excellent quantitative problem-solving skills.

Priorities in Biotechnology for Africa's Regions

Activities of Cluster 1 have been greatly enhanced with the publication of the book *Freedom to Innovate: Biotechnology in Africa's Development*' written by a High Level Panel on Modern Biotechnology with Juma, C and Serageldin (2007) as editors.

In order to address the issue of inadequate resources to develop and safely apply biotechnology (human, infrastructure, and funding) the AU through the NEPAD Office of Science and Technology established the African Biosciences Initiative in 2005. This led to the creation of networks of centres of excellence in strategically placed hubs around the continent, viz, BecANet in Kenya, SANBio in South Africa, WABNet in Senegal, and NABNet in Egypt; with these hubs are a number of nodes. Each of the five AU regions has the following biotechnology missions to carry out (Table 1).

Table 1: NEPAD OST Networks of Centres of Excellence in Biosciences

Networks	Nodal Point	Hub National	Centre Focus	Area of Work
NABNet (North African Biosciences Network)	Egypt	Research Centre (NRC)	Bio Pharma-ceuticals	**North Africa:** to lead the continent in research into bio-pharmaceuticals, drug manufacturing and test kits.
WABNet (WestAfrican Biosciences Network)	Senegal	Senegalese Institute of Agricultural Research (ISRA)	Crop Biotech	**West Africa:** to carry out research using biotechnology tools to develop cash crops, cereals, grain legumes, fruits/vegetables and root/tuber crops.
SANBio (Southern African Network for Biosciences	South Africa	CSIR, Bioscience Unit	Health Biotech	**Southern Africa:** to deliver benefits from health biotechnology by researching into the causes and prevention methods of a range of diseases, in particular, TB, malaria and HIV/AIDS.
BecANet (Biosciences East and Central Africa)	Kenya	International Livestock Research Institute (ILRI)	Animal Biotech	**East Africa:** to focus on research into livestock pests and diseases in order to improve animal health and husbandry.Central Africa: to build and strengthen indigenous capacity by identifying, conserving and sustainably using natural resources and also researching into the impact on biodiversity of events such as climate change and natural disasters.

Status of Biotechnology and Biosafety in Africa

The role that modern biotechnology can play in the economic transformation and sustainable development of Africa has been documented in several publication.[4] It has acquired increased significance as a result of a variety of factors including rapid scientific and technological advances, increasing commercialization of genetically engineered foods, increasing food insecurity, increase in food prices, and the roles of anti-Genetic Engineering and environmental activism.

James (Brief 37, 2007) enumerated the following as the most compelling case for biotechnology and more specifically GE crops in their capability to contribute to:

- Increasing crop productivity, and thus contributing to global food, feed, fiber and fuel security, with benefits for producers, consumers and society at large;
- Conserving biodiversity, as a land-saving technology capable of higher productivity on the current 1.5 billion hectares of arable land, and thereby precluding deforestation and protecting biodiversity in forests and other *in-situ* biodiversity sanctuaries;
- Reducing the environmental footprint of agriculture by contributing to more efficient use of external inputs, thereby contributing to a safer environment and more sustainable agriculture systems;
- Mitigating climate change and reducing greenhouse gases by using biotech applications for 'speeding the breeding' in crop improvement programmes to develop well adapted germplasm for changing climatic conditions and optimize the sequestering of CO_2;
- Increasing stability of productivity and production to lessen suffering during famines due to biotic and abiotic stresses, particularly drought which is the major constraint to increased productivity on the 1.5 billion hectares of arable land in the world;
- the improvement of economic, health and social benefits, food, feed and fiber security and the alleviation of abject poverty and malnutrition for the rural population dependent on agriculture in developing countries;
- the cost-effective production of renewable resource-based biofuels, which will reduce dependency on fossil fuels, and, therefore, contribute to a cleaner and safer environment with lower levels of greenhouse gases that will mitigate global warming; and
- as a result, provide significant and important multiple and mutual benefits to producers, consumers and global society.

He further suggested that the most promising technological option for increasing global food, feed and fiber production is to combine the best of the old and the best of the new by integrating the best of conventional technology (adapted germplasm) and the best of biotechnology applications (novel traits).

In the recent publication of the AU-NEPAD, *Freedom to Innovate*, one of the key recommendations was that biotechnology and biosafety '*should adopt the "co-evolutionary" approach in which the function of regulation is to promote innovation, while at the same time safeguard human health and the environment'*.

Genetic engineering (GE) techniques are employed in few countries in Africa with the commercialization in South Africa, Egypt and Burkina Faso in such crops and traits as insect-resistant cotton and maize, as well as herbicide-resistant soybean and/ or the combination of these traits. These are grown by both the commercial and small-scale farmers. Agricultural biotechnology research in Africa focuses on controlling diseases and pests; improving the storage properties of crops and food; improving weed control, improving yield and quality of foods; protecting natural resources; drought and salt tolerance and biofuel production. The crop of interest especially in Southern and East Africa is maize. Bioscientific researchable areas include insect resistance, virus and bacterial resitsance, drought tolerance and fungal resistance. Other crops of interest include: sorghum, millet, bananas, sweet potatoes, sugar cane, cowpea and cassava. Aside from pest and diseases protection, attempts are being made on nutritional quality improvements, such as biofortification of sorghum, cassava, etc. with vitamins and proteins.

Forty-five member states of the African Union recognized the need for agricultural biosafety by signing or acceding to the Cartagena Biosafety Protocol. They committed to develop national biosafety systems as well as set out "*appropriate procedures in the field of safe transfer, handling and use of living modified organisms resulting from biotechnology that may have adverse effect on conservation and sustainable use of biological diversity and taking into account risks to human health"***.** In practice, these commitments translate into the development of functional National Biosafety Frameworks (NBFs) to oversee the development and utilization of GE products. However, as recognized by the AU and NEPAD programme, the safe development and application of biotechnology to address heretofore intractable problems in food production, environmental degradation and human disease face a number of constraints. Seventy seven per cent of AU member states have been making slow progress towards developing the key components

of the NBFs that include: (a) a policy on biotechnology; (b) laws and regulations on biosafety constituting a regulatory regime for biotechnology; (c) an administrative system for handling applications and issuance of permits; and (d) a mechanism for public participation on biosafety decision-making.

As of now 11 African countries (South Africa, Egypt, Burkina Faso, Kenya, Togo, Tunisia, Mali, Mauritius, Algeria, Sudan and Zimbabwe) have developed their NBFs with 12 countries (Senegal, Ghana, Nigeria, Cameroon, Uganda, Tanzania, Malawi, Mozambique, Ethiopia, Namibia, Madagascar and Zambia) with interim NBFs and the remaining 30 countries with no NBF or at best at 'work-in-progress' stage. Morris (2008) observed that despite the well-intentioned GEF strategy, the efforts of the UNEP team in assisting AU member states in the development of NBFs and the science-based approach to risk assessment and management advocated in the Cartagena protocol, it appears that individual countries are placing a variety of interpretations on the protocol and taking a variety of paths towards dealing with the issue of GE crops.

In view of the constraint of inadequate policies and legal frameworks urgent attention is needed and this attention has to be led by Africans if it is to achieve credibility in the eyes of African governments, African civil society and African peoples. With this goal in mind the NEPAD African Biosciences Initiative initiated the establishment of the African Biosafety Network of Expertise (ABNE) with the support of Bill and Melinda Gates Foundation and in collaboration with the Michigan State University. ABNE responds to a real need, recognized by the continental community of nations, the AU, to ensure that its societies have the capacity to assess if, and when and how biotechnology products may be judged to pose no safety risk to the environment or human health; the ability to regulate these biotechnology products using the latest science and applying the highest standards of global practice.

The main objective of ABNE is the provision of biosafety resources for African regulators which is to support regulators as they make decisions on safe use, deployment and management of biotech products that are locally developed, imported and adopted in Africa. The main focus of this service network includes:

- Building an African Biosafety resource for regulators with focus on the members of the National Biosafety Committees (NBCs), Institutional Biosafety Committees (IBCs) and staff in the plant quarantine (PQ).
- Long term goal to build functional regulatory systems in Africa

Table 2: Status of the Member States with regard to the Development of their National Biosafety Frameworks, as of June 2009

Function NBFs	Algeria, Egypt, Sudan, Burkina Faso, Mali, Mauritius, Kenya, Zimbabwe, South Africa, Togo and Tunisia	11
Interim NBFS	Senegal, Ghana, Nigeria, Namibia, Zambia, Tanzania, Mozambique, Ethiopia, Uganda, Madagascar, Rwanda and Malawi	12
Work in Progress	Botswana, Burundi, DR Congo, Congo, Gabon, Cameroon, Central African Republic, Benin, Ivory Coast, Sierra Leone, Liberia, Guinea Bissau, Mauritania, Niger, Libya, Eritrea, Djibouti, Burundi, Swaziland, Lesotho, Guinea, Gambia, Madagascar and Seychelles	24
No Action Yet	Angola, Somalia, Equitorial Guinea, Chad, Guinea Bissau, Western Sahara and Morocco	7

What Do We Need to Develop Biotechnology in Africa?

These include among others: aiming for more coordination between strategic policy making in sustainable agriculture and agricultural research. There should be political will and commitment to use the tools. There is need to have adequate resources, human and infrastructure and capacity building/strengthening. Regulatory frameworks that will work and enforcable should also be established. All stakeholders' should also be involved. There is also need to promote intra-Africa trade through harmonization of biosafety regulation as our borders are quite porous and remove trade barriers among the traditional trading partners. Public understanding and acceptance of the products of the technology should also be enhanced.

Endnotes

1 Commission for Africa (2005).
2 African Union (2000).
3 African Union (2006).
4 Kalibwani, Fred *et al*. (2004).

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