Agricultural Biotechnologies in Developing Countries: Options and opportunities in crops, forestry, livestock, fisheries and agro-industry to face the challenges of food insecurity and climate change (ABDC-10). May 1-4, 2010. Guadalajara, Mexico.

FARA Issue Paper

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Introduction

Current socio-economic condition

In a continent in which agriculture is the mainstay of the economy (FAOSTAT, 2009), the indicators for socio-economic advancement attributable to this economic activity have not been attractive. . Africa remains the only continent where rising population, malnutrition, poverty and generally low agricultural productivity are the norm. Whilst cereal production in the developing world, projected to 2020 stands at 3.1 tonnes per ha, and appears to be catching up with the developed world's figure of 3.3 tonnes per ha, Sub-Sahara Africa (SSA), registers 1.4 tonnes per ha over the same period making this the lowest regional figure in the world (P. Pinstrup-Anderson in Karembu et al 2009)... Africa contributed only 2% to global GDP in 2006 (FAOSTAT, 2009). Fertilizer use for Africa (16 kg nutrient/ha) and irrigated land proportion (6.2%) are the lowest in the world and show a decreasing trend (FAOSTAT, 2009). African economies being largely rural and agric-based, most of the negative socio-economic indicators can be changed for the better if there is a conscious effort to apply science and technology to the production challenges of agriculture in an enabling policy environment. Research and development will play a significant role in this situation. An earlier study by Lusigi and Thirtle (1997) has shown that the effect of agricultural research and development on total factor productivity is important in Africa.

A proven, relevant science and technology discipline such as biotechnology, in support of traditional technologies within the enabling policy environment, should receive priority consideration by the African continent if the socio-economic indicators are to be improved. The SSA session at the ABDC-10 meeting, shall discuss modern biotechnology in its broadest sense to include genetic modification (GM) and non-GM approaches. The tools shall range from tissue culture through molecular approaches varying in complexity to the ultimate of genetic transformation or GM application. A cross-section of sectors in agriculture shall be considered.

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Possible role of biotechnology

Modern biotechnology provides the tools to address the challenges of various biotic (pests and diseases) and non-biotic (inorganic factors such as drought and soil fertility) in agriculture. The judicious application of the tools of modern biotechnology impacts positively on the environment and human health as it increases productivity and income of farmers (James, 2008). Modern biotechnology complements traditional technologies in effectively addressing the problems of food security and increased farmer incomes-challenges worsened by climate change threats.
Biotechnology, being a generic technology, has tools that are applicable to the various sectors of agriculture to be discussed by the session. These relate to crop production, animal, fisheries/aquaculture, forestry and agro-processing.

Current trends in sub-Sahara Africa for biotech development
There is growing awareness in various sub-Sahara African countries on the potentials of modern biotechnology in addressing agricultural productivity. Nearly all countries are applying the tools of biotechnology to agriculture but there is variation in the level of application associated with the complexity of the technology. Thus, whilst a vast majority use tissue culture techniques in micro-propagation, only 2 in the region (South Africa and Burkina Faso) have developed and commercialised GM crops. Six countries in the region (South Africa, Zimbabwe, Kenya, Burkina Faso, Togo and Mali) have laws in place to allow the safe commercialisation of GM products.

Engagement of biotechnology in various sectors of agriculture
Crops:
Most of the improved crop varieties in sub- Sahara Africa have arisen from traditional plant breeding approaches. Modern biotechnology tools in use in crop improvement have involved advanced tissue culture techniques as used in the development of the NERICA rice (Karembu et al. 2009) and revolutionised the production of bananas in Kenya (AHBF, 2008). Tissue culture techniques are also used in the cryopreservation of germplasm in gene banks. Molecular marker techniques are in use to assist selection in plant breeding. Molecular diagnostic procedures are in use, largely in laboratories, to screen plant diseases. The countries using this tool routinely are few in SSA. Fewer still use transformation (genetic modification) approaches.

The strength in the application of biotechnology approaches to crops lies in the growing political will to apply the techniques. The weakness lies in the low investment of financial resources in research and human capacity development for the application of the tools. The growing challenge to crop production on the field from biotic and abiotic sources offers opportunity for the application of the tools. The threat to the application of the various tools is the slow pace of training of critical manpower, the low financial investment, poor infrastructure and inadequate institutional arrangements in support of agriculture. In-country and regional collaboration in research and training offer opportunities to address this threat. The attitude of anti-technology civil society groups that equate all biotech approaches with GM and the lack of understanding of

the role of the latter (GM) remain threats to the advancement of biotechnology in crop and other commodity sector production in agriculture. Public engagement should stress the complementarities between traditional and biotechnology approaches to enhanced crop production.

Animals:

Improved traditional technologies, like artificial insemination and embryo transfer, still provide challenges of widespread application in sub-Sahara due to the lack of the required infrastructural support- accessing frozen semen or embryos, record keeping on animals and the poor husbandry practices. The application of modern biotechnology techniques in animal agriculture is in the areas of diagnostics for disease, recombinant vaccine production and breed characterisation using markers (Rege, undated; FAO, 2000).

The presence of laboratory infrastructure and trained manpower in various national veterinary laboratories in sub-Sahara Africa is a source of strength to be further enhanced through support by national governments and the international community. The dwindling feed resources, pests and diseases including zoonoses (transferable from animals to humans such as the recent bird flu and swine flu pandemics), the long term nature of breed development in cattle and the rising cost in veterinary drugs remain threats to the animal industry. At the same time these present unique opportunities for international collaboration in research and development.

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Fisheries and aquaculture:

In 2007, SSA contributed only 6.1% to the world's capture fish stock of 90 million tonnes but only 0.3% to the world production of 50 million tonnes from aquaculture. Compare with China that produced 62.4% of global production from aquaculture (FAOSTAT, 2009). There is a considerable opportunity to develop SSA's capacity for aquaculture.

Declining levels of capture fish (from the wild in fresh water and from the sea) largely due to inappropriate fishing practices has given impetus to the production through aquaculture. Biotechnologies in use relate to the application of hormones to induce ovulation, sex reversal and the use of molecular probes to diagnose disease (FAO, 2009). The use of these techniques in sub-Sahara is on a limited scale due to the low deployment of aquaculture. The present low level application of these biotechnology technologies is a source of weakness. Greater awareness creation and investment in aquaculture research is an opportunity. The loss in biodiversity from escape of fish species from aquaculture installations is a source of threat. Molecular techniques can be used to determine the purity of fish stock (FAO, 2009).

Forestry:

Apart from providing a useful product, wood, shelter for wildlife and source for important non-timber resources, forests have a stabilising effect on the environment through carbon sequestration and protection of soils and water bodies. The increasing degradation of forests and the range in sub-Sahara Africa has contributed to the adverse effects of climate change in the region. Globally, plantation forests account for only 5% of forest cover but account for nearly 50% of the timber (FAO, 2009).

Biotechnology has a role to play in forest regeneration through the supply of large quantities of planting material from tissue culture. The use of the tool in sub-Africa for large scale forest regeneration is yet to be developed. Biotechnology offers an opportunity for the development and application of biofertilzers like rhizobia for nitrogen fixation and mycorrhiza fungus for enhanced phosphorus availability. The application of these tools to plantation agriculture is limited in sub-Sahara and offer opportunity for capacity strengthening in the area

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Food processing:

Food processing is crucial for the attainment of food security as it reduces waste from spoilage associated with raw foods. It also leads to the production of new products with desirable organoleptic properties. The greatest application of biotechnology in the food industry is in the area of microbial fermentation. Specific bacterial starter cultures may be developed with purity determined by molecular techniques. Bacteria may be genetically engineered to produce specific enzymes such as rennet for cheese manufacture. Lysine in use in nutrition is commercially produced from genetically engineered bacteria (FAO, 2009). Developing countries with the capacity to produce these include China and Taiwan. The application of modern fermentation in the food processing area is among the areas of the food processing sector which offer tremendous opportunities for capacity strengthening in sub-Sahara Africa.

Way Forward

Policy/strategy options:

There is the need for countries of sub-Sahara Africa to define their policies in biotechnology which must be part of the overall national policy to advance the course of agriculture through the deployment of modern technologies in an environment that addresses credit and input access, rural infrastructure development and market support. Biotechnology must not be treated as a standalone technology but part of an integral whole. The strategy for the application of modern biotechnology should include the development of the bosafety law to govern the safe use of biotechnology. The associated regulations and institutional arrangements to implement the law must be in place. The latter remains a weak point in the development of biosafety frameworks in sub-Sahara Africa. The political will to adopt and adapt modern biotechnology approaches has been expressed by the African Union (AU), Regional Economic Communities (RECS) and nations, but concrete action on the will expressed is minimal.

Institutional options:

Biotechnology is an expensive technology. At the national level efforts should be made to create and use central laboratory facilities where expensive equipment and reagents are involved. At the sub-regional level, laboratories of excellence such as the Biosciences East and Central Africa (BecA) hub in Nairobi, Kenya or similar arrangements should be available across sub-Sahara Africa. The African Biosciences Network of Expertise (ABNE) sited in Burkina Faso by NEPAD will backstop countries of Africa in information and regulatory capacity development on request. The Forum for Agricultural Research in Africa (FARA) with the support of the Syngenta Foundation for Sustainable Agriculture (SFSA) has started, for the first time in Africa, a series of training activities in biotechnology stewardship for 6 pilot sub-Sahara African countries (Burkina Faso, Ghana, Nigeria, Kenya, Uganda and Malawi) over the 2009-2011 periods.

The national institutional arrangement for agricultural advisory services (extension) should incorporate modern biotechnology into the package of new technologies for farmers. Extensionists must be trained on a continuing basis to attain the competence to enable them perform this emerging role.

FARA is the lead pillar institution for Pillar IV implementation of the Comprehensive Africa Agricultural Development Programme (CAADP)[2] and advocates for agriculture research technology dissemination and adoption on the Continent. FARA, through its advocacy activities, aims to ensure that national agriculture productivity programmes developed within the CAADP framework include investment for biotechnology and biosafety issues; ie – policy development, institutional and human capacity development.

At the sub-regional level the Sub-Regional Research Organisations (SR0s) such as the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA) and the West African Council for Agricultural Research and Development (CORAF/WECARD) have institutional arrangements to coordinate biotechnology and biosafety activities but resources limit their activities. The Regional Economic Communities (RECS) such as the Economic Community of West African States (ECOWAS) and the Common Market for Eastern and Southern Africa (COMESA) have developed frameworks to harmonise biosafety activities. These remain on paper for now.

Human resources options:
Various universities in sub-Sahara Africa are mounting courses in modern biotechnology at the undergraduate and post-graduate levels. Most of these courses address non-GM approaches to modern biotechnology. Short-term courses in specific areas of biotechnology or tools should be available in the tertiary institutions. FARA, with the assistance of the international community, should provide support for these specialised short term courses and provide support for analytical work in advanced laboratories within or outside Africa by scientists from sub-Sahara Africa. A permanent arrangement for such institutional support for human resource development is lacking in sub-Sahara Africa at the moment and should be provided along the lines suggested.

Concluding remark

It is anticipated that the participants of the session on sub-Sahara Africa will determine the priority actions to enable the sustainable deployment of biotechnology in the sub-region to address the challenges of food insecurity, rural poverty and climate change.

[2] The CAADP is the Africa Union/New Partnership for African Development (AU/NEPAD) initiative for the regeneration of the agriculture sector in Africa. A commitment was made by all Heads of State and Government in Africa, at the AU Summit of 2003 in Maputo, Mozambique, to commit 10% of national budgetary allocations to agriculture to achieve a 6% growth in the sector - www.caadp-nepad.net

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