

Food security and plant biotechnology applications in Africa

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Abstract

Africa is, paradoxically, a continent rich in resources, and yet, lacking and lagging in overall development. African Agriculture is facing great challenges. Accordingly, African countries have developed policies aimed at transforming agriculture to commercial business. Plant biotechnology has far-reaching consequences for agriculture such as tissue culture and other biotechnological tools, which can improve the efficiency of breeding of cultivars and overall agricultural productivity. Use of genetic modification (GM) biotechnology is however very limited and is so far confined to 14 African countries, but only 3 countries have commercialized GM crops. Africa must speedily embrace use of biotechnology to increase productivity. However, the agricultural and food security problems cannot be solved by applying plant biotechnology alone. Other processes as outlined in the Comprehensive African Agricultural Development Programme (CAADP) must be put in place and supported by skilled human capital.

Key words: Africa, biotechnology, food security, GM crops, plant tissue culture

Résumé

L'Afrique est, paradoxalement, un continent riche en ressources, et encore, en retard de développement global. L'agriculture africaine fait face à de grands défis. En conséquence, les pays africains ont élaboré des politiques visant à transformer l'agriculture pour les entreprises commerciales. La biotechnologie végétale a de lourdes conséquences pour l'agriculture comme la culture de tissus et d'autres outils biotechnologiques, ce qui peut améliorer l'efficacité de la sélection de cultivars et de l'ensemble de la productivité agricole. L'utilisation de la modification génétique (OGM) la biotechnologie est toutefois très limitée et est à ce jour limitée à 14 pays africains, mais seulement 3 pays ont commercialisé des cultures génétiquement modifiées (OGM). L'Afrique doit rapidement adopter l'utilisation de la biotechnologie pour accroître la productivité. Toutefois, les problèmes agricoles et la sécurité alimentaire ne peuvent être résolus par l'application de la biotechnologie végétale seulement. D'autres procédés

comme indiqué dans le Programme Compréhensif du Développement de l'Agriculture de l'Afrique (CAADP) doivent être mis en place et soutenues par le capital humain qualifié.

Mots clés: Afrique, biotechnologies, sécurité alimentaire, OGM, culture de tissus végétaux

Background

Africa is paradise and hell. Africa is the birthplace of mankind, it is the second largest continent in the world after Asia, in terms of population, wherein almost a billion human beings live and thrive, representing 14.2% of the world's population. It has an estimated area of 30.4 million km², representing 6% of the Earth's surface and 20.4% of the total area of dry earth, comprising 53 countries. Africa has all the features of the geography from the plains and valleys to the hills and mountains, deserts and arid lands to the flood-lands and dense forests, stretching wildlife on their territories to include more than half of the wealth of the world of plant and animal species. The continent is rich in all kinds of natural resources, yet Africa remains the world's poorest and least developed in terms of economic growth. It is a continent drained by colonial powers and left alone in suffering the effects of poverty and scarcity of resources, including wars and conflicts between tribes. Africa is, paradoxically, a continent rich in resources, and yet, lacking and lagging in overall development. When the wealth of Africa's people is compared with that of other continents a contrasting picture of poverty, stunted growth and famine resulting from inadequate food production is revealed. More optimistic international reports indicate that out of every three Africans living in the continent, at least one of them has suffered from hunger and/or malnutrition. The hot spots of hunger remains Sub-Saharan Africa, where extreme poverty is most pronounced. Underdevelopment, wars, and non-rational governance are largely responsible for these countries' high Global Hunger Index scores.

The increasing incidence of droughts and land degradation cause declining and highly variable land productivity that threatens the food security further in many African countries. Global climate change may even increase the number of droughts even further in the future. The already-difficult situation in some countries is exacerbated by repeated droughts and the rapid spread of AIDS. Poverty is the main cause of hunger and undernutrition in Africa.

After the attainment of independence in the continent, the people of Africa are looking for the bright future of their continent.

African Agriculture and Challenges

Advances in science and technology will be key in this process. Currently Africa has very limited S&T capacity, and its contribution to global knowledge is generally limited. Africa produced only 1.8% of the World's research publications and less than 0.1% of the world's inventions (Pouris and Pouris, 2009).

Agriculture in most African countries accounts for a large share of wealth. It employs the majority of the labour force, provides most of the raw inputs for manufacturing industries and accounts for a large share of trade. Despite the predominance of agriculture in most African economies, spending on agricultural research has been declining leading to reduced capacities to address issues of farming technologies and weak infrastructure. African agriculture is facing great challenges today, as it has to confront climate change, loss of biological and agrobiological diversity, loss of soil fertility, water shortage and loss of water quality, leading to both droughts and floods, reduced crop growing periods, increased proliferation of pests and diseases, reduced crop yields and reduced fisheries production. The technological challenges currently facing agriculture are probably even more daunting than those in recent decades. With the increasing scarcity of land, water and climate threats, productivity gains will be the main source of growth in agriculture and the primary means to satisfy increased demand for food and agricultural products.

Revamping African Agriculture

African countries have, individually or in regional entities, developed policies aimed at transforming agriculture from being subsistence to commercial in nature. At the 2003 African Union Summit in Maputo, Mozambique, African Heads of State and Governments adopted the Comprehensive Africa Agricultural Development Program (CAADP). Under the leadership of the African Union (AU) and the New Partnership for Africa's Development (NEPAD), the CAADP was adopted as a framework for the restoration of agricultural growth, food security, and rural development in Africa. The primary goal of the CAADP is agriculture-led development that eliminates hunger, reduces poverty and food insecurity, and increases exports. The CAADP has four 'pillars' for improving Africa's agriculture including one on Improving agricultural research, technology dissemination, and adoption. Research is recognized as a key component in the agricultural modernization process, being a potential source for the required knowledge and technologies.

Harnessing biotechnology. Africa can benefit from previous experiences and results achieved in other developing regions in obtaining benefits from the applications of plant biotechnology. Investments in, and development of plant biotechnological research capacity in Africa is best accomplished in phases (Brink *et al.*, 1998). The first phase involves the use of plant tissue culture, which is appropriate for Africa as many of the important food crops such as cassava, sweet potato, yam and banana are vegetatively propagated. Specific techniques include *in vitro* mass propagation, the production of disease-free plants as well as regeneration systems for plant transformation. By focusing on tissue culture, the skills necessary to maintain and to manage a biotechnology laboratory can be developed. The second phase is the application of biotechnological tools, which can improve the efficiency of selection and breeding of varieties/cultivars. Techniques include more advanced tissue culture techniques (e.g. anther culture, embryo rescue and somatic hybridization) as well as molecular marker applications (diagnostics, fingerprinting and marker-assisted breeding). A prerequisite for this phase is to have an operational breeding programme in place. The third phase is the development of capacity to produce transgenic plants, which could include gene isolation and cloning, gene insertion/transformation, regeneration of transgenic plants as well as verification of successful transformation and gene function.

Agrobiotechnology requirements. In several African countries, basic infrastructure and facilities even for the simplest tissue culture techniques such as micropropagation are not available. A serious deficit of skilled human resources in the plant sciences and biotechnology is evident in Africa. The building up of such knowledge and development of human resource capacity is necessary to produce improved varieties through use of biotechnology as well as to handle imported engineered varieties that also demand changes in agricultural management. The successful production of transgenic plants requires an adequate infrastructure, expertise in tissue culture and molecular biology, and a critical mass of researchers with supporting sustainable funding to cover the high cost of such research. Only a few laboratories in South Africa, Egypt, Nigeria, and in Kenya have the capacity to produce transgenic plants, but still lack the ability to “commercialize” the product, or to ensure that these plants reach the end user, i.e., the African farmer. To bridge this gap, it is necessary to form partnerships with either seed companies, producer organizations or government

institutions which can ensure that the sophisticated technology be delivered in the most well known and accepted technology known to farmers – the seed. However, the agricultural, and food security problems in Africa cannot be solved by applying plant biotechnology alone.

Most of the plant biotechnology in Africa is being carried out in few African countries (Brink *et al.*, 1998; Thomson, 2004; FAO BioDev, 2010). For example, according to FAO data base, there are 14 African countries (Burkina Faso, Cameroon, Egypt, Ethiopia, Kenya, Madagascar, Morocco, Nigeria, South Africa, Sudan, Tanzania, Tunisia, Uganda and Zambia) that were conducting GM crops experiments, at research lab and /or field test (FAO BioDev 2010). But only 3 countries (South Africa, Egypt and Burkina Faso) have released GM crops at commercial scale (James, 2008). Moreover, there are still a public debate about GM crops in Africa as well as in the world.

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