*2011 2nd International Conference on Biotechnology and Food Science*
*IPCBEE vol.7 (2011) © (2011) IACSIT Press, Singapore*

# Adoption of commercial biotech crops in Africa

Ademola A. Adenle [1 2*]
Science and Technology for Sustainable Societies
1) United Nations University-Institute of Advanced Studies (UNU-IAS)
6F International Organisations Centre , Pacifico Yokohama 220-8502, 1-1-1 Minato Mirai
2) National Graduate Institute for Policy Studies
7-22-1 Roppongi, Minato-ku, Tokyo 106-8677
Tokyo, Japan
Email:adenle@ias.unu.edu

***Abstract*—Commercial adoption of crop biotechnology in Africa is very low. Of 25 biotech crops producing countries world-wide, only three African countries like South Africa, Burkina Faso and Egypt are producing commercial biotech crops. This paper reviews the status of biosafety regulation and three countries with commercial production of biotech crops in Africa using a collection of relevant papers. The reports show that biotech crops production in those three African countries are growing steadily particularly in South Africa. In all the biotech crops producing countries including Africa, the results demonstrate that biotech crops have benefits in terms of socio-economic contribution and creating friendly environment. But limited resources, biosafety and inadequate infrastructure still remain major challenges in Africa. Crop biotechnology has potentials for improving qualities and yields of farm produce and ensuring adequate nutrition and food security in Africa.**

***Keywords- Africa, Biosafety, Crop biotechnology, Food security***

## I. INTRODUCTION

The adoption of crop biotechnology is steadily growing world wide. Over the last decade, the development of biotechnology for commercial crop production in the rest of developing countries has increased a great deal since 1996, particularly in Asia (China, India) and Latin America (Argentina, Brazil) which are dominant biotech crop producers [18]. However, only three African countries like South Africa, Burkina Faso and Egypt are producing biotech crops commercially (Figure 1). This is rather not encouraging for the Africa continent that needs crop biotechnology the most given high level of poverty, hunger and food security problem. Since 1996, the first year of commercialization of biotech crops, economic and environment benefits have been recorded [1]. And it has made significant impact in terms of increase in yields, income and improving the quality of life. Both small-scale and large-scale farmers have benefitted from biotech crops in developing and developed countries respectively [18]. This is evidence that crop biotechnology has a lot of potentials towards addressing some of the challenges in agriculture. The few biotech producing countries in Africa may be due to several factors which include lack of financial resources, poor infrastructure, low capacity building, biosafety, brain drain and many others. The application of biotechnology in biotech crops producing countries should be seen as opportunity to encourage biotech crops in Africa, thus embracing the technology for improved level of food security and agricultural production. This paper aims to review the biosafety regulation and the three African countries that grow biotech crops on a commercial basis. The main section of the paper discusses the background of biotechnology in each country, starting from the first year of commercialization and the benefits aftermath.

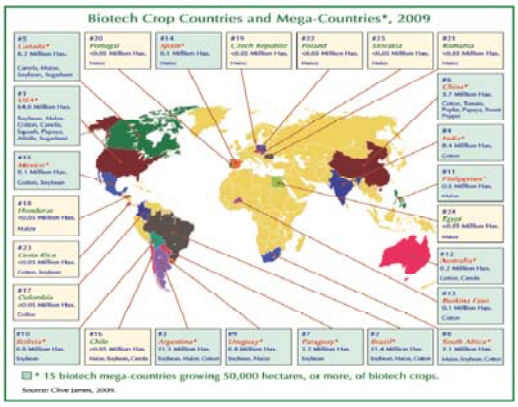


Figure 1. The world map of biotech crops producing countries in 2009

## II. DEVELOPMENT OF BIOSAFETY REGULATION SYSTEM IN AFRICA

Biosafety regulation is one of the major requirements for commercializing biotech crops in any country. The development of biosafety regulation still remains one of the challenges, perhaps the biggest limitation that hinders the growth of GM field trials and commercial biotech crops in African countries. As stated by Convention on Biological Diversity (CBD) that, the Cartagena Protocol on Biosafety addresses: *''an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health, and specifically focusing on transboundary movements''* [2]. The objective is to ensure that every recipient country has developed regulatory framework and the capacity (in terms

of people, expertise and technology) to undertake full risk assessment with respect to the development and the use of genetically modified organisms (GMOs).

Most African countries are signatory to Cartagena Biosafety Protocol, which is indicated and interpreted as every member state of African country recognises the need for agricultural biosafety as stipulated in Cartagena Protocol. A larger percentage of these countries are still in the process of establishing their biosafety systems, which is a serious concern due to ambiguous handling process of biosafety matter. The Global Environment Facility of the United Nations Development Program (UNEP/GEF) and some other initiatives support the development of functional National Biosafety Frameworks (NBFs) in an effort to establish biosafety system in African countries by providing all the necessary guidance and capacity building. Due to slow progress in establishing biosafety system, UNEP/GEF initiatives are working with African Governments to ensure the following four key components of the NBFs are developed and implemented as stated: 1) national policy on biotechnology; 2) an evaluation for regulatory implementation of policy on biotechnology and biosafety; 3) qualified personnel and expertise, appropriate technology to develop and implement biosafety system; 4) a platform for participatory approach on biosafety decision-making.

The framework highlights important points on developing biosafety systems from a comprehensive plan for effective implementation of policy that will ensure safe application of GMOs for confined field trials and commercial release in developing countries. The stages of developments of NBFs vary from country to country in Africa. Currently, only 11 African countries (Kenya, Zimbabwe, South Africa, Togo and Tunisia Algeria, Egypt, Sudan, Burkina Faso, Mali, Mauritius) have developed their NBFs and 12 countries (Ethiopia, Madagascar, Senegal, Ghana, Nigeria, Namibia, Zambia, Tanzania, Mozambique, Uganda, Rwanda and Malawi) have interim NBFs and other African countries belong to the group of work-in-progress stage or no NBFs [21]. Based on the information provided on the development of NBFs, it shows that most countries lack clarity on policy or political matter coupled with ineffective planning on biosafety system [22; 23]. Therefore, more effort is required on the part of African Governments towards developing functional and effective framework. Although, African governments under the umbrella of African Union (AU), and Africa Panel on Biotechnology (APB) that emerged from this union are working together with other biosafety initiatives by fostering economic integration through capacity building to harness and govern modern biotechnology in Africa [19]

## III. STATUS OF BIOTECH CROPS AND ITS COMMERCIALISATION IN AFRICA

### A. SOUTH AFRICA

South Africa is the first Africa country to draft Genetically Modified Organism Act 1997 (GMO Act) for full risk assessment and to address biosafety issues about the concerns on biotech crops before commercial introduction. South Africa is arguably the best country on Africa continent with most sophisticated biotechnology programme. The South African Government established National Biotechnology Strategy in 2001, a policy framework that is responsible for funding, regulatory and legal issues and human resource development. In addition, South African Government initiated a programme that supports the establishment of biotechnology regional innovation centres (BRICs) which serves as embodiment for growth and advancement of biotechnology platforms with an initial commitment of R450 millions (US$75 million) to finance the project [3]. Further to this effort, a National Bioinformatics Network (NBN) was established to facilitate capacity building and expertise in bioinformatics in the country. Other various organizations and programmes with cross-sectional collaborations have been setup for rapid growth and expansion of biotechnology, and to ensure safe biotech products in the country and beyond [3].

South Africa is the first country in Africa continent to produce biotech crops commercially and ranked the eighth largest producer of biotech crops in the world [18] (Figure 1). It has consistently remained top ten of 25 biotech crops producing countries over the last ten years. The first 22 field trials of biotech crops were conducted in 1990 which was equivalent to 90% of trials in Africa and continued until the year of commercialization. South Africa joined the countries that produce biotech crops on commercial scale for the first time in 1998 with half of the field trials conducted on combined *Bt* cotton (approximately 12,000 hectares), *Bt* maize (insect tolerance) and *Bt* maize (herbicide tolerance) [7]. The growth of biotech crops in 1999 was less than 1%, of global biotech area (39.9 million hectares) [8]. There was a significant increase of about 100,000 hectares of biotech crops in the country which was projected to be almost double production of combined biotech cotton and corn of global biotech area (44.2 million hectares) in the year 2000 [9]. For the period of 1999/2000, a total of 100,000 hectares of *Bt* cotton was planted by 1530 commercial farmers and 3000 small-scale farmers in North Province including the Free State and KwaZulu-Natal [6]. South Africa grew more than 100, 000 hectares of global biotech crops area (52.6 millions hectares) in 2001, the year an important historical milestone of more than 50 million hectares (approximately 125 million acres) was achieved [10]. In the same year 2001, a significant increase of *Bt* corn was reported and an approximately 225,000 hectares for combined area of biotech corn and cotton was expected. One percent of global biotech area (58.7 million hectares) was planted in South Africa with an increase of over 20% of biotech crops from 225,000 hectares in 2001 to 275,000 hectares in 2002 [11]. South Africa became the sixth principal country of biotech crop and planted a combined area of *Bt* maize, *Bt* soybean, *Bt* cotton up to 0.4 million hectares of global biotech crop area (67.7 million hectares) in 2003 [12]. A significant increase of white maize growth (mostly used for food) from 6,000 hectares in 2001 to 84,000 hectares in 2003 was achieved. In 2004, South Africa planted 0.5 million hectares of global

biotech area (81 million hectares) for combined area of *Bt* maize, *Bt* soybean and *Bt* cotton [13].

The tenth year of commercialization was marked in 2005 and South Africa planted 0.5 million hectares of global biotech area (90 million hectares) with 25% increase in its combined area of *Bt* maize, *Bt* soybean and *Bt* cotton [14]. South Africa has one of the largest percentage increases of global biotech crops area (102 million hectares) at 180% from 0.5 million hectares in 2005 to 1.4 million hectares in 2006 [15]. It was reported that biotech crops represent 90% of cotton, 59% of soybean, 30.5% of yellow maize and 28.8% of white maize production in South Africa during this year [15; 25]. South Africa planted 1.8 million hectares of global biotech crop area (114.3 million hectares) and 1.8 million hectares of global biotech crop area (125 million hectares) in 2007 and 2008 respectively, with 29% increase in its combined area of *Bt* maize, *Bt* soybean and *Bt* cotton from 2006 [16; 17]. The total biotech crop area of 1.8 million hectare in 2008 was the same as 2007, as a result of 7% reduction in total white maize area (from 1040,000 hectares in 2007 to 891,000 hectares in 2008). Of total area of 2.6 million hectares of white and yellow planted in 2008, 1.6 million hectares was biotech maize, equivalent to 62% of the total maize area, up from 57% in 2007. In 2008, total cultivation of soybean at 230,000 hectares was estimated to be significantly up from 2007 cultivation at 170,000 hectares as a result of high soybean import and reduction maize area. Of total cultivation area at 230,000 hectares, it was estimated that 184,000 hectares would be herbicide tolerant soybean, equivalent to 80% adoption rate in 2008 which was similar to adoption rate in 2007. The estimation of total cotton planted increased from 10,000 hectares in 2007 to 13,000 hectares in 2008, of which was 12, 000 hectares biotech cotton equivalent to 92% adoption rate . As one of the top eight countries of global biotech crops, South Africa reached 2.1 million hectares of global biotech crops area (134 million hectares) in 2009 with 17% increase from 2008 [18].

As a result of high yield and quality improvement of farm products with generation of better income through the application of biotechnology, farmers are embracing the technology. The majority of the farmers who are benefiting from this technology are resource-poor and small-scale farmers. When the farmers were asked the reasons for adopting biotech crops, in a case of *Bt* cotton, 58% attributed effective pest control as the main reason, 10% for higher yield, 20% for lesser labour requirements and 7% for reduced chemical costs, and no specific problem was raised with regards to using *Bt* cotton other than high cost of seed [24]. The economy of South Africa has benefited a great deal from adoption of biotechnology and it has been reported to have enhanced farm income from biotech maize, soybean and cotton by US$156 million in the period 1998 to 2006, with the 2006 alone estimated to be US$67 million [16]. South Africa plays a vital role in sharing its scientific knowledge and rich experience with other African countries to encourage the development and expansion of biotechnology across the continent of Africa for sustainable agriculture and betterment of life. The top biotech countries like India and Brazil have teamed up with South Africa Government to establish a platform called (IBSA) to share information and scientific knowledge through research collaboration on crop biotechnology. Given the success of crop biotechnology in South Africa among top 25 biotech crop countries for commercialization, it will encourage and create the opportunity to facilitate the collaboration with other emerging countries in Africa for the promotion and advancement of biotechnology.

### *B. BURKINA FASO*

Burkina Faso is one of the few countries in Africa that has developed functional National Biosafety Law on the use and management of genetically modified organisms (GMOs) for GM field trial and commercial release. Burkina Faso is the first West African country of two African countries that joined biotech growing countries for commercial purpose in 2008. The commercial production of biotech cotton has employed 2 to 4 million farmers in the country since 2008. However, the level of education among these farmers is extremely low, particularly reading of Biosafety Law written in French is a big challenge [5]. In May 18, 2010 at Ouagadougou, Mr. Joseph Paré; the Burkina Faso Minister of Secondary and Higher Education, Science and Technology launched a program to create awareness on the Biosafety Law [5]. This program was sponsored by the West Africa Cotton Improvement Program (WACIP) and the Agricultural Diversification and Market Development Project (ADMP). During the launch of the program, it was announced that the Biosafety Law has been translated into three most commonly spoken languages (Mooré, Jula and Gulmacema) in cotton growing areas. And 6000 translated copies (2000 per language) consisting of summaries of essential extracts of the Act have been printed and will be made available to the farmers through agricultural extension services. The Minister emphasised on the importance of Biosafety Law and encouraged the Journalist in the country to promote and enlighten the farmers, local and international public about the program.

Burkina Faso is ranked thirteenth largest producer of biotech crop out of 25 countries that planted biotech crops commercially in 2009 (Figure 1). In the first year of commercial biotech cotton production in 2008, approximately 4,500 Burkina Faso farmers successfully produced 8,500 hectares (*Bt* cotton) of global biotech crops area (125 million hectares) [17]. The following year in 2009, almost 115, 000 hectares of commercial biotech cotton of global biotech crop area (134 million hectare) was planted in the country. By comparing 8,500 hectares of biotech cotton planted in 2008 with 115,000 hectares planted in 2009, it shows 14-fold increase which was reported as a remarkable success in the history of biotech crops production world wide [18]. Given the unprecedented result and the massive tonnes of biotech cotton seed produced in 2009 to plant almost 380,000 hectares, it was estimated that a total of 475,000 hectares of biotech cotton would be planted in 2010 if the same trend was followed from the previous year and perhaps close to 665,000 hectares in 2012.

In terms of contribution to the economy of Burkina Faso, it was estimated that benefit of over US$100 million per year could be generated based on almost 30% increase in yield [26]. About close to 50% reduction in insecticides sprays may be realised, thereby saving fossil fuels and lowering greenhouse gases emission. The remarkable achievement in terms of fastest percent increase in hectarage (1253%) ever experienced in any biotech crop country in 2009 during two years of commercial biotech cotton production in Burkina Faso will be worth following by other African countries that are yet to join the club. Therefore, this outstanding result will set a good example for growing biotech crops commercially in West African region which is already making impact. For example, it was reported recently that the neighbouring West African country Nigeria (the most populous Africa country), as led by National Biotechnology Development Agency (NABDA) have indicated interest in growing biotech insect-resistant cotton that is in commercial production in Burkina Faso, and that the nation will kick start the production of biotech crops as soon as their pending Biosafety Law receives signature from the Nigerian Government [4].

### *C. EGYPT*

Egypt has one of most equipped biotechnology programmes in Africa. The Egyptian Government issued their biosafety guidelines in 1994 and the procedures were completed for commercializing biotech crops in 1998. The Academy of Scientific Research and Technology (ASRT) is the principal department responsible for biotechnology program development across different sectors in Egypt. Egypt has different technical divisions with research capacities to develop and expand agricultural productivities under the Ministry of Agriculture. The Agricultural Research Center (ARC) was established in the early 1970s for the development of new varieties and improved agronomic practices. The Agricultural Genetic Engineering Research Institute (AGERI) was set up in 1990 and specialized in developing pest-resistance and stress-tolerant varieties of crops. Under five year plan that was initiated by Egyptian Government in 2002, 14 research programs were established by 16 institutes including 13 central labs, 10 regional stations, 36 specific research stations, 21 research administrations and training centers of excellence [20].

Egypt is the first North African and at the same times the first Arab country to grow biotech crops commercially in 2008. In year 2008, Egypt first ever grew commercial biotech crops (Ajeeb YG) of 700 hectares of global biotech crops (125 million hectares) [17]. Almost 1000 hectares of biotech maize of global biotech crop area (134 million hectares) were planted in 2009 [18]. A small increase of about 15% was achieved when compared with 2008. The Egypt's plan to increase the hectarage of biotech maize more than those realized in 2009 was not successful due to the inability to secure the license for the enough tonnes of seeds needed for planting in 2009. Despite the inability to achieve more than 1000 hectarage of biotech maize, the Egyptian Government have intensified their efforts in terms of advancing and developing their biotechnology program towards growing more biotech crops for commercialization in few years to come. This effort is reflected in ongoing research and trials being conducted on crops such as cotton, wheat, maize, potato, melon, banana, tomato and sugar cane. The interest shown by the Egyptian Government as the first Arab country to recognize the importance of biotechnology as a tool for national and global development, and their initial efforts to commercialize the first biotech crops in Arab world will go a long way in convincing other countries in that region to seriously embrace biotechnology.

## IV CONCLUSION

The commercial productions of biotech crops have demonstrated that biotechnology is a useful tool for agriculture practices. This paper has shown examples of initial successes in those three countries that have adopted biotech crops in Africa. Therefore, Africa continent should seize the opportunity to embrace crop biotechnology as one of potential tools to fight poverty, hunger and food security problems. Before this can be successful, government must encourage good leadership and provide all the necessary facilities in terms of capacity building, enabling policy, efficient biotechnology research and development. A concerted effort should be made for the provision of biotechnology tools for the resource-poor farmers through participatory extension approach programs. In summary, when the right steps are taken coupled with harmonized and appropriate policy, the development of crop biotechnology will take place in Africa.


## ACKNOWLEDGMENT

Ademola A. Adenle would like to acknowledge the support of the Japan Society for the Promotion of Sciences (JSPS).


## REFRENCES


[1] G. Brookes, and P. Barfoot, GM crops: global socio-economic and environmental impacts 1996-2008, PG Economics Ltd, UK. (2010).

[2] CBDSecretariat, Cartagena Protocol on Biosafety to the Convention on Biological Diversity: text and annexes. Montreal: Secretariat of the Convention on Biological Diversity. www.biodiv.org/doc/legal/cartagena-protocol-en.pdf. (2000).

[3] T.E. Cloete, L.H. Nel, and J. Theron, Biotechnology in South Africa. Trends Biotechnol 24 (2006) 557-62.

[4] M.A. David, Agricultural biotechnology report: Nigeria. USAID Foreign Agricultural Service. (2010).

[5] ISAAA, International Service for the Aquisition of Agri-Biotech Applications: Crop biotech update, Newsletter. (2010).

[6] Y. Ismael, R. Bennett, and S. Morse, Farm level impact of Bt cotton in South Africa. Biotechnology and Development Monitor (2001) 15-19.

[7] C. James, Global Status of Commercialized Biotech/GM Crops: 1998 (ISAAA Brief No. 8), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (1998)

[8] C. James, Global Status of Commercialized Biotech/GM Crops: 1999 (ISAAA Brief No.12), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (1999).

[9] C. James, Global Status of Commercialized Biotech/GM Crops: 2000 (ISAAA Brief No. 21), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (2000).

[10] C. James, Global Status of Commercialized Biotech/GM Crops: 2001 (ISAAA Brief No. 24), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (2001)

[11] C. James, Global Status of Commercialized Biotech/GM Crops: 2002 (ISAAA Brief No. 27), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (2002).

[12] C. James, Global Status of Commercialized Biotech/GM Crops: 2003 (ISAAA Brief No. 30), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (2003).

[13] C. James, Global Status of Commercialized Biotech/GM Crops: 2004 (ISAAA Brief No.32), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (2004).

[14] C. James, Global Status of Commercialized Biotech/GM Crops: 2005 (ISAAA Brief No.34), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (2005).

[15] C. James, Global Status of Commercialized Biotech/GM Crops: 2006 (ISAAA Brief No. 35), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (2006).

[16] C. James, Global Status of Commercialized Biotech/GM Crops: 2007 (ISAAA Brief No. 37), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (2007).

[17] C. James, Global Status of Commercialized Biotech/GM Crops: 2008 (ISAAA Brief No. 5), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (2008).

[18] C. James, Global Status of Commercialized Biotech/GM Crops: 2009 (ISAAA Brief No. 41), International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY. (2009).

[19] C. Juma, and I. Serageldin, (eds.) "Freedom to Innovate: Biotechnology in Africa's Development" (A report of the High-Level African Panel on Modern Biotechnology) African Union and New Partnership for Africa's Development, Addis Ababa and Pretoria. (2007).

[20] L.N. Lewis, Egypt's Future Depends on Agriculture and Wisdom. http://www.egyptianagriculture.com/present_day_research.html. (2009).

[21] D. Makinde, L. Mumba, and A. Ambali, Status of Biotechnology in Africa: Challenges and Opportunities. Asian Biotechnology and Development Review 11 (2009) 1-10.

[22] E.J. Morris, The Cartagenal Protocol: Implications for Regional Trade and Technology Development in Africa. Dev. Policy Review 26 (2008) 29-57.

[23] R. Paarlberg, The Politics of Precaution: Genetically Modified Crops in Developing Countries. Baltimore: Johns Hopkins University Press. (2001).

[24] C. Thirstle, L. Beyers, Y. Ismael, and J. Piesse, Can GM-technologies help the poor? The impact of Bt cotton in the Makhathini flats of KwaZulu-Natal. World Development 31 (2003).

[25] W.J. van der Walt, South African GM crop adoption in 2006. ACNS6 (http://www.africancrops.net/news/may06/gm-southafrica.htm) (2006).

[26] J. Vitale, H. Glick, J. Greenplate, and O. Traore, The Economic Impact of Second Generation Bt Cotton in West Africa: Emperical Evidence from Burkina Faso. . International Journal of Biotechnology 10 (2008) 167-183