

Egypt: Biotechnology from Laboratory to the Marketplace: Challenges and Opportunities

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The Government of Egypt places great importance on the significant role the agricultural sector plays in the national economy. Agriculture accounts for 20 percent of both GDP and total exports, and 34 percent of the total labor force. The agricultural sector contributes to the overall food needs of the country, and provides the domestic industry with agricultural raw materials.

The agricultural sector has undertaken major steps to reform its economic policy program such as:

1. Gradual removal of governmental controls on farm output prices
2. Increasing farmgate prices to cope with international prices
3. Removal of farm input subsidies
4. Removing governmental constraints on the private sector in importing and exporting agricultural crops
5. Imposing limitations on state ownership of land and sale of new land to the private sector
6. Adjusting the land tenancy system
7. Confining the role of the Ministry of Agriculture (MOA) to agricultural research, extension and economic policies.

As the government moves toward privatization, transfer of technology to the private sector has occurred (for example, in vitro micropropagation of virus-free potato). This shows the capacity and interest of the private sector to adopt new technology. Technology transfer is expected to grow dramatically in the short term as the research programs become more product oriented.

One of the major targets for biotechnology in Egypt is the production of transgenic plants conferring resistance to biotic stresses resulting from pathogenic viruses, bacteria, fungi, and insect pests, and abiotic stresses such as salinity, drought, and high temperature. These biotic and abiotic constraints are major agricultural problems leading to serious yield losses in many economically important crops in Egypt.

AGERI (Agricultural Genetic Engineering Research Institute) was established in 1990 at the Agricultural Research Center (ARC) to promote the transfer and application of this technology. AGERI aims to adopt the most recent technologies available worldwide to address problems facing agricultural development (Table 1).

Strategic Goals of the Agricultural Sector

1. Optimizing crop returns per unit of land and water consumed
2. Enhancing sustainability of resource use patterns and protection of the environment
3. Bridging the food gap and achieving self-reliance
4. Expanding foreign exchange earning from agricultural exports.

Opportunities for Deploying Modern Biotechnological Approaches

1. Producing transgenic plants resistant to indigenous biotic and abiotic stress
2. Reducing the use of agrochemicals and pesticides and their environmental risks

Table 1 Examples of current plant genetic engineering research at AGERI/EGYPT

Discipline	Potato	Tomato	Cotton	Maize	Faba bean	Cucurbits	Wheat	Banana	Date palm
Virus resistance		<input type="checkbox"/>			<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>	
Insect resistance	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>					
Stress tolerance		<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		
Genome mapping and fingerprinting		<input type="checkbox"/>		<input type="checkbox"/>					<input type="checkbox"/>
Fungal resistance		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>				

3. Improving the nutritional quality of food crops
4. Reducing the dependency on imported agricultural products (Seeds-Crops).

The private sector has access to biotechnology, and has invested heavily in research and development (R&D) of technology and the necessary ancillary expertise to bring a product to market. The competitive edge of a private company depends on the proprietary nature of its R&D and the protection offered by intellectual property laws.

A private company might engage in development of a product in conjunction with a developing country because (a) it addresses a technical problem critical to its own product development, (b) it presents an opportunity to enhance its public relations, and/or (c) it provides a window to an important market, technology, or germplasm of interest.

Developing country institutions may be interested in working with private companies to gain access to important technology, develop managerial and business expertise, build intellectual capacity, or form a partnership with an entity that has an existing capability of bringing a product to market.

Pioneer Hi Bred/AGERI; a Private/Public Partnership

The relationship between AGERI, an Egyptian public sector institution, and Pioneer Hi-Bred, a U.S. private company, was forged through a relationship that involved common business interests. The importance of codevelopment of technology as opposed to technology transfer is especially pertinent in the case of Pioneer Hi-Bred's relationship with AGERI. In this partnership, a public sector institution was able to bring a significant contribution to the table. AGERI has isolated a number of strains of *Bacillus thurin-*

giensis (Bt) that had pesticidal activity of interest to a private sector company. AGERI filed a patent in Egypt on January 11, 1996 (No. 019797) on Bt derived bioinsecticide against a wide range of insects, and in the United States on January 10, 1997 (No. 5178-3) on Bt isolates with broad spectrum activity.

AGERI also has a state of the art biocontainment facility, and a team of trained scientists. AGERI can provide access to the local Egyptian market and the broader Middle East market, both of which are sufficiently developed to be attractive. In turn, Pioneer Hi-Bred came to the discussion table with technology as well as with marketing, regulatory, and legal expertise of value to AGERI.

AGERI has therefore initiated a partnership with Pioneer Hi-Bred through a USAID R&D grant to achieve the following:

1. Research and training for AGERI scientists to be trained at Pioneer/Iowa in methodologies relating to agricultural biotechnology
2. Potential for product development; Pioneer was granted access to evaluate certain novel Bt proteins and genes patented by AGERI.

Four parties have signed this agreement: Pioneer-USA, AGERI-Egypt, ABSP/MSU-USA, and USAID-Cairo/Washington D.C. Both collaborators, Pioneer and AGERI, have provided inputs to this research and training effort.

Joint discoveries resulting from the work will be shared and patent rights will be sought according to terms of the USAID agreement. Pioneer Hi-Bred will retain sole ownership of its proprietary Bt gene(s) and proprietary germplasm, and AGERI will retain sole ownership of its proprietary Bt gene(s).

Under a separate agreement, AGERI granted material transfer agreements (MTAs) for Pioneer Hi-Bred to evaluate the Bt toxin protein. Options for possible commercial development of maize have been also considered. This is one of the ex-

amples of USAID-sponsored collaboration as also described by Lewis (this volume).

BIOGRO/AGERI; a Business Partnership

A second model of moving research into commercial application is elaborated through the successful interaction between scientists at AGERI and the University of Wyoming, who have been involved in collaborative research studies for the past six years on Bt. The research efforts led to the development of a biological pesticide based on a highly potent strain of Bt isolated from the Nile Delta. This strain is extremely effective against a broad range of insects: Lepidoptera (moths), Coleoptera (beetles), and Diptera (mosquitoes). An additional significant feature of this strain is its capacity to kill nematodes.

AGERI has successfully managed to manufacture its first biopesticide *Agerin* based on the insecticidal bacterium *Bacillus thuringiensis*. *Agerin* is capable of protecting a broad range of important agricultural commodities, of controlling a number of biomedically significant pests, and has the potential for sales on a worldwide scale.

To fulfill its commitments to bring research results into application and large-scale commercial distribution to the farmers, AGERI, in collaboration with a private investor, succeeded in establishing a commercial business entity under the name "BIOGRO International." This company is responsible for the commercialization of research results conducted in AGERI and will be in a position to sell AGERI products. This is essential to guarantee that sales revenue generated from product sales will be invested back into the Institute to support the continuation of its activities.

It is envisaged that BIOGRO will link with the Genetic Engineering Services Unit (GESU), which was established at AGERI to work out any commercial agreements to benefit both the institute and BIOGRO. It will also allow for the free flow of information and products related to genetic engineering being produced by the institute for commercialization purposes.

AGERI attaches a high priority to collaborating with the private sector, which will be fully informed of R&D in the field of genetic engineering and biotechnology in Egypt through (a) the circulation of newsletters and reports, (b) having representatives of the private sector participate in the design of product R&D, and (c) representation of

the private sector on the governing board of AGERI.

As one of the leading institutions in agricultural genetic engineering in West Asia, North Africa, and the Middle East, AGERI is planning to share its know-how and experience with other countries within the framework of Technical Cooperation among Developing Countries (TCDC). This will be achieved through specialized workshops, seminars, and internships. The institute can also provide professional consultation in the field of molecular biology and agricultural genetic engineering.

Role of the CGIAR centers

The CGIAR centers could usefully expand their activities in the following areas, to further assist national institutes in the applications of modern biotechnology:

Biosafety

1. Setting up regional linkages to share biosafety data and to pool information
2. Providing training and guidance on risk assessment and risk management issues
3. Providing technical training in biosafety reviews, prior to releases
4. Building consensus among nations on biosafety protocols and guidelines
5. Assisting in the development of media and information materials to increase public awareness

R&D collaboration

6. Increasing CGIAR/NARS collaboration in biotechnology R&D
7. Setting up programs for the use and management of technology

Intellectual property management

8. Increasing awareness on intellectual property and its fundamentals (copyrights, trademarks, patents, licensing, plant variety protection, plant breeders' rights)
9. Establishing intellectual property policy and institutional policies
10. Building capacity and human resources development in the field of technology transfer and intellectual property rights.