The Impact of Biotechnology Advances on Quality and Marketing of Agricultural Products

Joline El Chakhtoura [1] and Rabih S. Talhouk [2]

Summary

Breakthroughs in biotechnologies have made it possible to manipulate genes and create modified organisms with desired characteristics and this has had a huge impact on agriculture and related economies. It has augmented productivity and diminished the spread of diseases thus impacting the growth of pharmaceutical businesses. Plants have also been genetically modified to better withstand harsh environmental conditions. Prime bioengineered products on the market today include corn, milk, rice, canola and cotton. Agricultural biotechnology, however, may have health-related consequences and ecological implications due to the possibility of creating 'super' genetically modified organisms hard to control. The food-testing market has grown rapidly with governmental organizations in developed and developing countries, including Arab countries, striving to ameliorate and attend to safety practices related to agricultural biotechnology. Agencies such as the United Nations FAO are stressing the importance of communication between public and private sectors in an effort to fight famine and to ensure safety in adopting relevant biotechnologies and resulting products thereof. Nevertheless, accepting biotechnology in the first place has raised a lot of controversy regarding its ethical implications.

Keywords: Biotechnology; Agricultural biopharming; Biosafety; Health and risk.

Introduction

Biotechnology can generate edible vaccines, disease-resistant hybrids, and aggressive weeds and has led to a worldwide uproar of even more aggressive protestors. What's going on?

The United Nations Food and Agriculture Organization (FAO) published its statement on biotechnology in March 2000 defining it as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use" (FAO site). Biotechnology covers the various techniques used to manipulate an organism s genes in order to alter its phenotype. These include gene transfer, tissue culture, DNA cloning. among other. The created genetically modified organisms (GMO's) are utilized in agriculture in order to produce crops with enhanced or altered characteristics. This has had a tremendous effect on the agriculture and pharmaceutical market. Although biotechnology has its pros and cons, this mounting field of science ought to be applied in resolving global problems, especially in developing nations. In this article an overview of the recent agricultural biotechnology products on the market, or the soon-to-be ones, is provided. The impact made by such technology on the global market and on public perception, and its status in developing and developed countries is looked upon.

Benefits of Agricultural Biotechnology

Agricultural biotechnology offers a broad range of benefits primarily by ameliorating plant genotypes. It has created crops that are nutrient-rich and longer-lasting, such as "beans with more essential amino acids" and potatoes with an enhanced starch content. Tomatoes have been engineered to resist decay and damage and this allows them to be shipped over long distances and periods. Several foods have also been manufactured to be free of certain fats and allergens. Another grand technique has engineered crops to resist herbicides and diseases and this in turn augments productivity. (Wieczorek, 2003 and Brookes & Barfoot, 2005). Will such high yields help meet the needs of our expanding world population? Below are few select examples of genetically modified crops and their impact on the related industry.

Canola and Corn: Canola oil, introduced in 1996 in Canada, is one of the major genetically modified (GM) products available on the market. It contains no trans fats and is suitable for cooking and storage. Because the GM canola is herbicide-tolerant, there is no need for pre-planting weed control practices. This permits earlier planting dates, without waiting for soil herbicides to take effect, thus allowing the product to be harvested early in spring. GM canola allows cultivators to use conservation tillage or "con-till" techniques without difficulty thus saving energy and minimizing erosion. This is highly advantageous for the environment, for agriculture and for the economy. Use of con-till with transgenic canola conserved [in the year 2000] 14.18 million gallons of fuel, with a cost savings to growers of $13.1 million (Biotech Basics site).

GM corn developed to harbor the glyphosate-resistant gene was introduced in the United States of America in 1997. It harbors genes that confer upon it insect and pest resistance (BIO site). A study in the USA shows that the total biotech corn grown relative to unmodified corn rose from 25% in 2000 to 45% in 2004, with a very high rise in corn yield (136 to 161 bu./acre). In another interesting attempt, scientists have also worked on introducing an altered *E. coli* gene in corn so the GM product develops antibodies against traveler's diarrhea. Only a portion of the bacterial toxin gene (LT-B) is introduced in the plant since LT-A causes the disease. This can be very helpful for people who suffer from this sickness and travel often. (SARE site)

1. **Department of Biology, American University of Beirut, Beirut, Lebanon..**
2. **Department of Biology, Faculty of Arts and Sciences, and Initiative for Biodiversity Studies in Arid Regions (IBSAR) Center, American University of Beirut, Beirut, Lebanon. Fax: +961-1-351706, E-mail: rtalhouk@aub.edu.lb**

Cotton, Milk and Papaya: GM cotton is another product available on the market. It was introduced in 1996 by the reputed Monsanto Company and contains a complex gene designated Bollgard . Bollgard cotton is prepared via the *Agrobacterium tumefaciens* technique. Usually caterpillars eat cotton seeds and damage the growing fibers, but transgenic cotton "kills" these budworms and thus reduced pesticide applications are required. This is of course a highly profitable product (Biotech Basics site). Milk is another common bioengineered product. Another firm called "Genencor International" has genetically modified the chymosin enzyme found in calves to chymogen, making the product purer and more plentiful (Rogelj *et al.,* 2001). This genetically modified version of the enzyme chymosin is used in almost sixty percent of dairy products available on the market today.

In 1998 the Cornell Research Foundation created two papaya hybrids named Rainbow and SunUp modified to resist the papaya ring spot virus (PRSV), a fatal disease that almost eradicated the papaya industry in Hawaii during the '90s. Scientists isolated and modified a mild mutant gene of PRSV. They then introduced it into the plant through the 'gene gun' approach leading to a GM papaya plant with enhanced resistance to PRSV. The fruit is now longer-lasting and disease-resistant. (NCFAP site and Gonsalves *et al.,* 2007).

Rice: Can bioengineered rice help feed impoverished populations? In 1995 forty percent of Filipino families lived below the official poverty line of 7'212 pesos (about U.S. $277) annual income, and twenty percent of Filipinos could not afford to feed themselves (Suppan, 1996). In the Philippines and neighboring countries as in India and Bangladesh, rice constitutes 50-80% of the caloric consumption of individuals. Thus, any enhancement of the nutritional value of rice would have significant impact on the populations health (HarvestPlus site and Lucca *et al.,* 2002). Via marker-aided selection rice has been bred to be resistant to the bacterial leaf blight (BLB) disease and to have higher iron and beta-carotene. This new and improved rice can reduce the micronutrient deficiency problems rife in third world countries (Powell, 2005). Recently in 2005 and for the first time, biotech rice was grown commercially on approximately four thousand hectares in Iran. Keetch and Akanbi (2006) described Iran and China as "the most advanced countries in the commercialization of biotech rice". This crop, grown by 250 million farmers, is noted to be the most important food crop in the world and the principal food of the world's 1.3 billion poorest people. Worth noting is that in recent years India has had a 192% increase in biotech crop production becoming the fifth largest producer in the world. (FFTC site)

Agricultural Biotechnology Products Soon To Be on the Market

It is apparent from the above that the potential of growth in crop production will prompt many companies worldwide to produce even more genetically modified crops and introduce them to the market. In fact, agricultural biotechnology is one of the fastest growing industries in the world today. Genetically modified crops were first commercialized in 1995, and today there are numerous products still under trial and will be available on the market within a couple of years. To list a few: apples protected against codling moth, strawberries and wheat resistant to fungal diseases, bananas that will serve as edible human vaccines against contagious diseases (such as Hepatitis B) and corn that can survive drought periods and provide more nutrients and higher energy. Transgenic rice is also being produced by a Californian firm to perk up therapy for diarrhea which is the number two killer of children in Africa and parts of Latin America and Asia (BIO site). In addition, today a variety of plants are being engineered to better endure water and nitrogen curbs, or survive intense growing conditions, such as high-salinity, acidic soils, or hot weather. Such traits can provide more dependable crop performance over an extensive range of cultivation conditions hence having a tremendous effect on agricultural production in adverse environments. Note however that commercially accessible plants with such alterations are still several years away (GMO Compass site).

Phytoremediation and Biopharming: Other Benefits Reaped from Biotechnology

Phytoremediation is another chief benefit of agricultural biotechnology. This is when genetically modified plants detoxify or absorb pollutants in the soil, water or air and thus contribute to conserving the environment (Borisjuk *et al.,* 1999 and Schwitzguébel, 2002). Over seventy firms practice phytoremediation worldwide- in the U.S., Europe, Australia, and Japan. This technology can help nations treat wastewater and get rid of "organic or heavy metal contaminants". It also helps control erosion and maintain buffer zones (Glass, 1999). In addition, companies are learning how to alter cellulose in harvested agricultural grains and crops (such as corn stover, wheat straw and sugar cane waste) into sugars that can be fermented to produce bio-ethanol to be used as a source of energy and for transportation fuel.

A trend that will certainly impact agricultural industry in the very near future is biopharming. A marriage between agriculture and medicine has been made possible by biotechnology whereby splicing pharmaceuticals into the genes of staple crops is the governing rule to generate genetically engineered medicinal plants. Firms have already manufactured corn products containing an HIV protein and their aim is to produce foods such as cereals that "orally deliver an AIDS vaccine". Such proteins are highly stable and this is valuable for developing countries where keeping drugs refrigerated is difficult. More so, the notion of generating dairy animals capable of producing antibodies or drugs such as interferon or human insulin in their milk has been around for years. Biopharming allows for the production of high protein yields "very inexpensively compared to cell culture methods". But scientists worry that such crops or animals could find their way into the environment thus exposing people to microscopic levels of medications they don't need

(Zelina, 2004 and Murphy, 2007).

Risks and Biosafety Evaluation of GMO's

Agricultural biotechnology comes with several health-related risks. First, because we are manipulating genes, there is a possibility of transferring undesirable gene products or toxins between species and hence consuming contaminated hybrids. Also, biotechnologists may be introducing allergens into otherwise safe foods by knocking in/out different genes. Can this possibly make consumers allergic to GM products? (Pusztai, 2001 and Wieczorek, 2003). Agricultural biotechnology can also have copious ecological consequences. There is a possibility of transgenic crops cross-pollinating with related weeds by "outcrossing", thus creating 'superweeds' difficult to control. None of these weeds are known to exist but they do impose a severe risk (Wieczorek, 2003). More so, a pressing question emerges, if "less successful" crops aren't grown, will this promote a loss in biodiversity? Can all of this disturb the balance of our natural ecosystem (Gray, 2005)? Whatever is the answer to these questions, care should be taken to ensure proper biosafety evaluation and testing of GM agriculture products prior to introducing them to the market and for years thereafter. To ensure biosafety, the GM trait or protein is usually tested on animals in order to receive clearance. The new gene must also be studied to see whether it activates or deactivates existing genes and if it affects the plant s metabolism in any way. Interestingly, the GM-testing market has grown immensely with the rise of agricultural biotechnology. Worth $18 million in 2000, it has the fastest growth rate of 13.6% per year. A GM food must be recognized, using scientific data, as safe as a comparable conventional product before it can be marketed (GMO Compass site).

Because of all the aforementioned, biotechnology has had a huge impact on the agriculture market and related economies. First, GMO producers profit from lower pest control costs and bigger yields. Second, bioengineering firms profit from charging technology fees to adopters who plant the seeds. And third, consumers benefit from lower commodity prices due to increased supplies. Trade between nations however remains limited, but efforts to alleviate this are underway. For example some large U.S. grain processors reject biotech products unapproved by the European Union for fear of jeopardizing their exports. That is, American firms prefer to manufacture GM products accepted by European authorities so as to guarantee high trade profits (USDA site).

Developed vs. Developing Countries

Despite a relative increase in scientific publications in Latin America, Kofi Annan, while Secretary General of the United Nations, highlighted obvious inequalities in scientific activity between developed and developing nations (Holmgren and Schnitzer, 2004). This has evident negative consequences on extending biotechnology globally. Many large-scale issues could be solved by incorporating insight from scientists in developing countries. Nevertheless, a significant setback is that agricultural biotechnology has been mainly driven by the private industry and has been largely geared by profit-making rather than by noble aims as alleviating world hunger and poverty. So... Does this have a negative impact on food security because of the focus on wealthy clients rather than small-scale farmers or the poor ? Another question that comes to mind addressed the gradual reduction of trade barriers through international organizations. If this becomes the common practice and if export of food from developed to developing countries became more commonplace, will biotechnology increase the dependency of developing countries? Is all this hype for agriculture biotech targeted for "marketing purposes", i.e. by increasing people's acceptance of biotech products? (FAO site and Osgood, 2006).

At this day and time investment in agro-biotechnological research is centered amidst the private sector in higher-income countries. FAO suggests that this needs to be solved through "increased public funding and dialogue between the public and private sectors". As it stands today, the United States is the world's largest producer of bioengineered crops while Argentina, Canada and China rank second through fourth (Biotech Basics site).

Biotechnology, GMO's and the Arab World

In the Arab world today academic research in basic sciences seem to take a back seat to other sectors such as construction and oil-related industries that seem to be developing quiet well in some of the Oil-Rich producing countries. Although these same countries have witnessed a boom in new universities, however the Research and Development (R&D) sector that may be affiliated with such universities will not witness any major developments soon. Research and production of knowledge lags behind in the Arab World in the various domains and certainly biotechnology and its potential application in agriculture is no exception.

Amongst the leading Arab Countries Egypt and Tunisia have advanced biotechnology institutes, and the Agriculture Genetic Engineering Research Institute (AGERI) in Egypt has produced, in collaboration with research centers in developed countries and via technology transfer agreements, a number of insect and virus resistant GMO's including cotton, potato, squash and wheat (Solh *et al.*, 2007). Other Arab countries have developed centers for molecular biology that are mainly concerned with DNA-based technologies that complement traditional plant breeding and germplasm conservation approaches. These countries include, but not limited to, Syria, Tunisia, Kuwait, and Morocco among others. Recently, the involvement of the private sector to promote biotechnology-based research has become evident in United Arab Emirates, and to a certain extent in Egypt and Kuwait (Solh *et al.*, 2007). The above clearly demonstrates the desire of researchers, as well as governments of the region to engage in biotechnology for enhancing the agricultural industry however several limitations still hinders their progress. For biotechnology to be integrated into agriculture R&D, governments should give priority to such indus-

try and strategize accordingly keeping in mind that decision makers should be well informed of recent developments to make sound scientific and economic-viable decisions. To move towards a biotech-knowledge based economy stakeholders must identify key priority areas for governments and private sector interventions, commit funds for biotechnology-based research, engage biosafety and upgrade related legislations into biotechnology development, and undertake capacity building in human resources (Solh *et al.*, 2007).

So far Arab countries have benefited of agriculture biotechnology products, mainly produced in developed countries, which are acquired by conventional breeding practices supported by DNA-based technologies such as improved strains of wheat, corn, and superior breeds of livestock, among other. However, with the recent advances of biotechnology, the GMO's are now amongst the fastest growing agriculture industry.

As stated above, Acquiring GMO's into local markets for trade or the desire to produce such GMO's comes with possible associated risks to the environment, bio-diversity and human health. For that many Arab Countries have ratified the Cartagena Protocol and are either developing or implementing their National Biosafety Framework (NBF), which is a "combination of policy, legal, administrative and technical instruments that are developed to ensure an adequate level of protection in the field, safe transfer, handling, and use of GMO (resulting from modern biotechnology) that may have adverse effect on the conservation and sustainable use of biological diversity, taking into account risks to human health". Several Arab countries have developed their NBF and are now parties to the Cartagena Protocol including Algeria, Egypt, Jordan, Libya, Oman, Syria, Tunisia and Yemen. On the other hand, Kuwait, Lebanon, Morocco and Saudi Arabia are currently complementing their national processes for ratification (Mohamed, 2007). In other words, GMO's are yet to find their way into the Arab markets although Egypt has already produced, as mentioned above, GMO's. Worth noting is that Iran is well ahead of most countries in the region and is producing its own GMO's to suffice its national needs (Mousavi *et al.*, 2007). Thus, the main hindrance at this point, besides public acceptance, is for Arab Countries to undertake the needed capacity building in biosafety monitoring and in practices to ensure the proper handling, processing and marketing of GMO's. An overview of agricultural biotechnology status in several Arab countries is compiled by Baum and Ghosh (2007).

Public Perception of Biotechnology

In a very interesting survey, thirty five thousand people around the globe were asked whether they think the benefits of biotechnology outweigh its risks. The survey revealed that nations have diverse attitudes towards GMOs, and it was evident that most European countries disapprove of biotechnology while the U.S. and numerous third world nations believe that it offers more benefits (Fig. 1). Worth noting is that anti-biotech populace worldwide and Greenpeace volunteers have protested in an effort to promote natural food

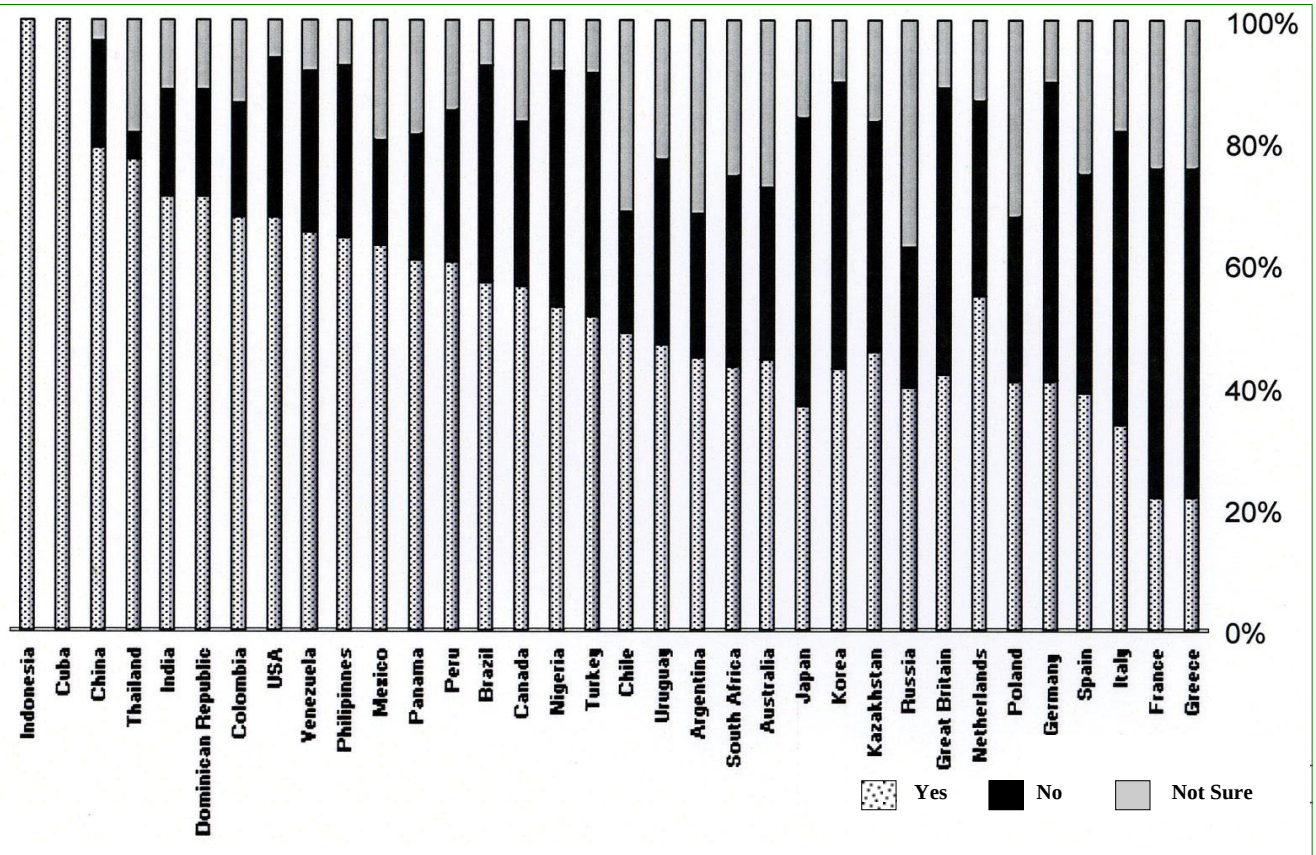

Fig. 1. Do the benefits of biotechnology outweigh the risks? (Adapted from Hoban 2004).

products free of GMOs (Hoban, 2004).

An obvious question that has resurfaced is whether the public perception of GMOs and agricultural biotechnology is driven by world politics and economic-based choices? This is best reflected by noting the politicians on either side of the globe and the obvious trend of European consumers vs. those in the USA. President George W. Bush has stated that bioengineered crops could "dramatically" enhance yields, and also remarked that "For the sake of a continent threatened by famine (i.e. Africa), I urge the European governments to end their opposition to biotechnology.". European critics, on the other hand, have also noted Bush for saying that his aim is to promote the biotech business instead of alleviating world hunger. U.S. corn farmers say the EU's five-year-old GM trade barrier is costing them about $300 million in annual sales to Europe and is blocking access to African markets. In return the European Union states that it has done nothing to turn African countries away from GM foods, and that it provides more aid to Africa than the USA (CNN site).

Conclusion

Biotechnology has had a huge impact on the agriculture market and related economies. Farmers profited from lower pest control costs and bigger yields and, bioengineering firms also profit from charging technology fees to adopters who plant the seeds and the consumers benefited from lower commodity prices due to increased supplies. Despite the varying public perception, it is evident that agricultural biotechnology may inflict medical and environmental threats, but the insufficient evidence should not preclude us from employing it for more humane purposes. Intergovermental and governmental dialogue can help expand the worldwide biotech market and this will help meet agricultural challenges across the globe. Biotechnology may hold ethical implications but the outcome of exploiting it in indigent regions of our planet is far more appealing.

References

Baum, M. and Ghosh, K. 2007. Harnessing Biotechnology and Genetic Engineering for Agricultural Development in the Near East and North Africa. International Center for Agricultural Research in the Dry Areas (ICARDA), Syria, P. 151.

BIO site. Biotechnology Industry Organization. http://bio.org/index.asp?stay=yes

Biotech Basics site: http://www.biotechknowledge.com/biotech/bbasics.nsf/biotech01_intro.html?OpenPage

Borisjuk, L. G.; Borisjuk, N. V.; Dushenkov, S.; Gleba, D.; Gleba, Y. Y.; Kneer, R.; Logendra, S.; Poulev, A.; Raskin, I. and Skarzhinskaya, M. 1999. Use of plant roots for phytoremediation and molecular farming. Proc. Natl. Acad. Sci. USA, 96 (11), 5973.

Brookes, G. and Barfoot, P. 2005. GM crops: The global economic and environmental impact - the first nine years 1996-2004. AgBioForum, 8 (2&3), 187.

CNN site. 2003. Europe hits back at Bush in GM row. http://www.cnn.com/2003/WORLD/europe/06/24/biotech.us.europe/

FAO site. Food and Agriculture Organization of the United Nations http://www.fao.org/biotech/

FFTC site. Food & Fertilizer Technology Center http://www.agnet.org/news/aspac/2007/2007011902.html

Glass, D. J. 1999. U. S. and International Activities in Phytoremediation: Industry and Market Overview. www.epa.gov/nrmrl/pubs/625r01011/625R01011bchap34.pdf

GMO Compass site. 2006. Stress Resistant Crops. http://www.gmocompass.org/eng/agribiotechnology/breedingaims/151.stressresistance.html

Gonsalves, C.; Gonsalves, D. and Lee, D. R. 2007. The adoption of genetically modified papaya in Hawaii and its implications for developing countries. Taylor and Francis Journals: J. Develop. Stud., 43 (1), 177.

Gray, A. 2005. Hybridization between crops and wild plants in the age of genetic engineering: new risks or new paradigms? Amer. J. Bot., 92, 768.

HarvestPlus site: http://www.harvestplus.org/rice.html

Hoban, T. J. 2004. Public Attitudes towards Agricultural Biotechnology. FAO Agricultural and Development Economics Division. ftp://ftp.fao.org/docrep/fao/007/ae064e/ae064e00.pdf

Holmgren, M. and Schnitzer, S.A. 2004. Science on the Rise in Developing Countries. http://biology. plosjournals. org/ perlserv /?request=getdocument&doi=10.1371%2Fjournal.pbio.0020001&ct=1

Keetch, D. and Akanbi, R. 2006. WTO Rules in Favor of GM. http://www.africabio.com/biolines/83.pdf

Lucca, P.; Hurrell, R. and Potrykus, I. 2002 Fighting Iron Deficiency Anemia with Iron-Rich Rice. J. Amer. College Nutr., 21 (90003), 184.

Mohamed, N. 2007. Experiences and lessons form Development of National Biosafety frameworks in West Asia and North Africa. P. 11-23. In: Baum, M. and Ghosh, K. (eds). Harnessing Biotechnology and Genetic Engineering for Agricultural Development in the Near East and North Africa. International Center for Agricultural Research in the Dry Areas (ICARDA), Syria, P. 151.

Mousavi, A.; Malboobi, M. A. and Esmailzadeh, N. S. 2007. Development of agricultural biotechnology and biosafety regulations used to assess the safety of genetically modified crops in Iran. J. AOAC Int., 90 (5),1513.

Murphy, D. J. 2007. Improving containment strategies in biopharming. Plant Biotech. J., 5 (5), 555.

NCFAP site: National Center for Food & Agricultural Policy. 2002. Plant Biotechnology: Current and Potential Impact for Improving Pest Management in US Agriculture. http://www.ncfap.org/40CaseStudies/CaseStudies/papayavr.pdf

Osgood, D. 2006. Living the promise? The role of the private sector in enabling small-scale farmers to benefit from agro-biotech. Int. J. Techn. Glob., 2 (1-2), 30.

Powell, D. 2005. Iron Biofortified Rice Studies Shows Improved Nutrition. http://www.foodsafety.ksu. edu/en/news-details.php?a=4&c=30&sc=311&id= 57029

Pusztai, A. 2001. Genetically Modified Foods: Are They a Risk to Human/Animal Health? http://www.actionbioscience.org/biotech/pusztai.html

Rogelj, I.; Perko, B.; Francky, A.; Penca, V. and Pungerar, J. 2001. Recombinant Lamb Chymosin as an Alternative Coagulating Enzyme in Cheese Production. J. Dairy Sci., 84, 1020.

SARE site. Sustainable Agriculture Research and Education http: //lists.ifas.ufl.edu/cgi-bin/wa. exe?A2=ind0405&L=sanet-mg&D=0&P=9245

Schwitzguébel, J. P. 2002. Hype or Hope: The Potential of Phytoremediation as an Emerging Green Technology. Federal Facilities Environ. J., 13 (1),109.

Solh, M.; Martinez, A. and Ghosh, K. 2007. Agriculture biotechnology for meeting the needs of developing countires: Priorities and policy focus in the Near East and North Africa. P. 1-10. In: Baum, M. and Ghosh, K. (eds). Harnessing Biotechnology and Genetic Engineering for Agricultural Development in the Near East and North Africa. International Center for Agricultural Research in the Dry Areas (ICARDA), Syria, P. 151.

Suppan, S. 1996. Rice, Trade and Biotechnology in the Philippines. http://www.tradeobservatory.org/library.cfm?refID=23722

USDA site. *United States Department of Agriculture*. "Size and Distribution of Market Benefits from Adopting Biotech Crops". http://www.ers.usda.gov/publications/tb1906/tb1906a.pdf

Wieczorek, A. 2003. Use of Biotechnology in Agriculture- Benefits and Risks. University of Hawaii at Manoa. http://www2.ctahr.hawaii.edu/oc/freepubs/pdf/BIO-3.pdf

Zelina, M. 2004. "Oregon Attempts Moratorium on 'Biopharming'". http://www.slogefree.org/newsletters/News_Item.2004-12-11.2124/

تأثير التقانات الحيوية على جودة و تسويق المنتوجات الزراعية

جولين الشختورة[1] وربيع ش. تلحوق[2]

الخلاصة

مع التقدم الملحوظ الذي أحرزته التقانات الحيوية أصبح بالإمكان التلاعب بالجينات و تكوين كائنات معدّلة بالمواصفات المرغوبة وهذا ما أثر بشكلٍ كبير على الزراعة والتجارة الزراعية. إن هذه التقانات أدت إلى الزيادة في الإنتاج وتخفيض انتشار الأمراض، علاوةً على ذلك، أدّى التعديل الجيني إلى جعل بعض النباتات قادرة على تحمّل العوامل البيئية الصعبة. يوجد في السوق العديد من المنتجات المعدّلة بواسطة التقانات الحيوية ومن أهمها: الذرة والحليب والأرز والكانولا والقطن. ولكن من الممكن أن يؤدي، نظرياً، تعديل المنتوجات الزراعية بواسطة التقانات الحيوية إلى تأثير سلبي على الصحة والبيئة. وأدَّت تلك الأسباب المذكورة أعلاه، إلى نمو قطاع حماية المستهلك لضمان سلامة المأكولات بشكلٍ كبير ضمن تنظيم حكومي في البلاد المتطورة كما في البلدان النامية والبلدان العربية. والهدف من ذلك هو تحسين وحفظ إجراءات السلامة المرتبطة بتأثيرات التقنيات الحيوية على القطاع الزراعي. وتشدّد منظّمة الأغذية والزراعة التابعة للأمم المتحدة (FAO) على أهمية التواصل بين القطاع العام والخاص وذلك لمكافحة المجاعة وتأمين السلامة من خلال تبنّيها للتقانات الحيوية وما ينتج عنها.

تجدر الإشارة إلى أن إدخال التقانات الحيوية في مجال الزراعة قد أثار الكثير من الجدل نظراً لقدرتها على تعديل الجينات وما يترتّب على ذلك من عوامل قد تكون سلبية أخلاقياً وبيئياً وصحياً.

1. دائرة العلوم الطبيعية، كلية الآداب والعلوم، الجامعة الأمريكية في بيروت، بيروت، لبنان.

2. دائرة العلوم الطبيعية، كلية الآداب والعلوم، مركز دراسات التنوّع البيئي في المناطق الجافة (IBSAR)، الجامعة الأمريكية في بيروت، بيروت، لبنان. فاكس: 351706–1–961+

بريد إلكتروني: rtalhouk@aub.edu.lb