Institute on Science for Global Policy

Adopting Genetically Modified Crops Worldwide for Food Security**

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Summary

One of the ways to increase food security with concomitant improvement of the agricultural environment is to adopt genetically modified (GM) crops. This method is used when crops cannot be improved by conventional breeding. Apart from the currently available suite of crops, mainly maize, soybean, cotton and canola resistant to insects and/or tolerant of herbicides, there are many more in the pipeline specifically adapted for use in less-affluent countries. These include nutritionally enhanced rice and sorghum, virus-resistant maize and canola, bacterial- and fungal-resistant bananas, insect-resistant cowpeas and eggplant, and drought-tolerant maize. Though these technologies have great promise, their deployment will require political will. Government, the private sector, academics and farmers' groups will have to be involved in order to allow countries to profit from these crops. Concrete steps that can be taken to further this technology include the development of bioeconomy policies, promulgation of biosafety acts, fast-tracking proven crops (such as herbicide resistant soybean), establishing public understanding of biotechnology platforms, encouraging the development of farmer-assistance organizations including extension officers, and using economists to determine losses due to the nonacceptance of GM crops.

Current realities

More than 840 million people suffered from chronic hunger in 2011-2013 (FAO 2013). While the vast majority of these live in rural areas in less-affluent countries, malnutrition is also prevalent in urban areas. While the demand for food is set to increase, many agricultural sectors will produce more non-food products for energy and feed. Natural resources needed for agriculture will be threatened by factors such as climate change and urbanization. While GM crops offer just one of many solutions to these problems, their adoption is being hampered by a number of factors including lack of political will, the spread of misinformation by anti-GMO lobbyists, and the exorbitant costs required to commercialize new GM crops (largely as a result of unreasonable regulatory requirements). In particular the antipathy to GM crops shown by many EU countries has had a detrimental effect on their development and introduction in Africa. One example is the now completely discredited paper published by Séralini *et al* in 2012 in *Food and Chemical Toxicology* in which they claimed that rats fed on GM maize developed cancer. This caused the Kenyan government to halt all imports of GM crops and continues to be cited by other governments as a reason for nonadoption of such crops. In addition, there is a fear that the less-affluent countries will lose their export markets if GM crops are introduced on a larger scale (e.g., GM soybean export by Brazil and Argentina).

Although obstacles to the implementation of GM crops remain, the positive environmental impacts of these crops are impressive. In a recent study of the key impacts globally from 1996 to 2011 it was found that insect resistance leads to a significant decrease in the use of insecticides. Furthermore, herbicide tolerance leads to important changes in the profile of herbicides in favor of more environmentally benign products and also facilitates changes in farming systems, enabling farmers to engage in conservation tillage. In turn, conservation tillage results in lower levels of greenhouse gas emissions from reduced tractor fuel use and additional soil carbon sequestration due to reductions in soil erosion. In the instances in which herbicide tolerance has led to overuse of glyphosate-based weed killers, leading to weed resistance in some regions, farmers are increasingly adopting a mix of reactive and proactive weed management strategies incorporating a combination of herbicides. The authors conclude that "the overall environmental gains arising from the use of GM crops have been and continue to be substantial."

In addition to positive environmental impacts, GM crops can also help with food safety and security. No food in the history of humankind has ever been subjected to such rigorous safety

tests as foods derived from GM crops. As long ago as 2004 the Food and Agricultural Organization (FAO) of the United Nations declared that there were no deleterious effects from the consumption of foods derived from GM crops discovered anywhere in the world, and it has had no cause since then to change this opinion. More recently the EU Commission Directorate for Research stated in 2010 that there are no new risks to human health or the environment from any GM crops commercialized thus far.

Regarding food security, the fact that farmers continue to increase plantings of GM crops worldwide speaks for itself. In its annual Global Status of Commercialized Biotech/GM Crops: 2013, the International Service for the Acquisition of Agri-Biotech Applications (ISAAA) reported that in the 18th year of commercialization, the hectarage of GM crops has steadily increased, with 12 years of double-digit growth rates, reflecting the confidence and trust of millions of risk-averse farmers. For the second consecutive year, in 2013, farmers in less-affluent countries planted more hectares than industrialized countries. Currently, the area planted with these crops is 50% more than the total landmass of China or the United States.

Scientific opportunities and challenges

There are important new GM crops in the pipeline, which, if adopted, could significantly improve food security. These include Vitamin A-enriched rice, called Golden Rice due to the yellow color of beta-carotene it contains, which is converted to vitamin A when ingested. Vitamin A deficiencies are common in less-affluent countries and some 1.9 million to 2.8 million people, mainly women and children, died from this deficiency in 2010.

Sorghum is the only viable food grain for many of the world's food-insecure populations and is uniquely adapted to Africa's climate, being both drought-resistant and able to withstand periods of water logging. However, it is lacking in vitamins and micronutrients. To solve this, a consortium under Africa Harvest is developing an improved GM variety.

Maize streak virus (MSV) is endemic in Africa and can cause huge losses to both commercial and small-holder farmers. Although traditionally bred resistant lines are available, these are not adaptable to all maize varieties. Laboratories at the University of Cape Town have developed MSV-resistant GM maize lines that can be readily crossed into many varieties. However, because of the enormous costs of bringing these to the market they have not even undergone field trials despite having been available for many years. A similar situation exists for Cassava mosaic virus, resistant lines having been developed by scientists in Uganda and the U.S.

In countries such as Uganda, Burundi, and Rwanda, plantains are an important food source. The two major diseases are caused by a bacterium resulting in wilt, and a fungus that causes black sigatoka. Scientists in Uganda and Kenya have not only pioneered methods to genetically modify bananas and plantains, they have also developed varieties resistant to both diseases. They have subjected them to confined field trials and the results are extremely impressive.

Insect-resistant crops such as maize and cotton have been grown commercially for many years with great success. The same type of gene has been introduced into cowpea, one of the most important food legume crops in the semiarid tropics. It is being subjected to confined field trials in Nigeria, Burkina Faso and Ghana and preliminary results show good protection.

In Bangladesh, insect-resistant brinjals (eggplants) have been introduced with notable farmer acceptance. Unfortunately, their introduction into India and other Asian countries has been blocked. Farmers sometimes must spray with insecticides every second day.

The Water Efficient Maize for Africa (WEMA) project is giving excellent results in confined field trials for drought-tolerant maize in South Africa, Kenya, and Uganda. Its commercialization will be a boon for farmers throughout the continent.

Policy issues

In almost every country where GM crops are flourishing (e.g., South Africa and Burkina Faso), the lead has been taken by the government. Without political will, very little can be achieved. However, more public awareness about the realities of GM crops, undertaken by academics, the private sector and by farmers themselves is necessary to ensure the successful and timely adoption of this technology. Awareness by politicians of how successful GM promotion strategies could lead to positive influences on elections could aid in increasing political will. To facilitate the adoption of GM crops the following steps are recommended:

- Develop a bioeconomy policy including GM crops, preferably under the Department of Science, with buy-in from other relevant departments such as Agriculture, Health, Trade, Environment and Education. The term "bioeconomy" encompasses biotechnological activities and processes that translate into economic outputs, particularly those with industrial applications. These could include, in agriculture, the development of crops that address the challenges of climate change, including diminishing water and grazing; in health, the manufacture of drugs, vaccines and other biologicals locally; and in industry and the environment, biobased chemicals, biomaterials and bio-energy.

- Promulgate biosafety acts (e.g., the GMO Act of 1997 of South Africa) with reasonable and enforceable regulations, though not inhibitory, preferably under the Department of Science. Once established, have "fast track" capabilities for GM crop approval, as is being done in Brazil and Canada.

- Establish a Public Understanding of Biotechnology entity in the responsible government department to educate and debate with the public, especially at schools and tertiary education establishments, using professional communicators. Stress the importance of food security, food safety and environmental safety.

- Encourage the private sector, including farmers' groups, to establish information dissemination platforms (e.g., South Africa's AfricaBio and Open Forum on Agricultural Biotechnology in Africa [OFAB]) to share experiences and foster responsible stewardship, including the running of Open Farmers' Days. Relevant politicians should be invited to these events to see the advantages of GM crops and to hear the views of farmers, their constituents.

- The Department of Agriculture should employ and empower Extension Officers to assist farmers in the use and stewardship of GM crops.

- Economists from both the public and private sectors should determine what has been lost to individual countries, in terms of income and human health, by not introducing specific GM crops. One such study estimated that the delay in implementing Golden Rice has cost at least USD$1.7 billion since 2002, with USD$199 million lost to India alone. The latter translates into the prevention of 600,000 to 1.2 million cases of blindness and about 180,000 deaths of children in that country.

In conclusion, now is the time to act to prevent further suffering and loss of life due to food insecurity, especially in less-affluent countries. Finding ways to build political will for this technology and to counter misinformation about GM crops are two ways to help encourage the adoption of valuable food products.

References

Brookes, G., and Barfoot, P., *(2013*) Key environmental impacts of global genetically modified (GM) crop use 1996–2011. *Agriculture and the Food Chain.* 4-2: 109-119

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