Chapter

GM Crops: The West versus the Rest

Jennifer Thomson

Abstract

This chapter will explore the reasons why some countries, broadly described as "developed," do not allow their farmers to plant GM crops. It will then go on to discuss the effects that these attitudes held by "the West" have influenced the uptake of GM crops by Africa and "the Rest." I will then investigate some of the myths that have been used to turn politicians, decision-makers, and inhabitants of such countries against GM crops, and to consider the importance of communication. As it is necessary to understand why and how certain countries "got it right" and are currently growing GM crops successfully, the last section deals with these issues. The conclusion points to the necessity for countries to learn from mistakes made in the past as we enter the era of new technologies such as genome editing.

Keywords: developed, developing, myths, regulations

1. Introduction

This chapter is based on a book I recently wrote, entitled: GM Crops and the Global Divide [1]. In the preface to that book, I talked about the need for the bridge across the agricultural genetic divide between African countries and those in the developed world to be crossed. This divide separates the use of genetically improved varieties available in the developed world from those being used by resource-poor farmers in Africa. Here, I consider how attitudes to GM crops found in countries in the "West," especially in the European Union (EU), have had a negative effect on their uptake in Africa and other developing countries. As much of the West's attitude is based on myths and disinformation (when untruths are deliberately spread as opposed to misinformation, which could be based on ignorance of the truth), I have included a section on how important truthful communication is in this debate. I then go on to discuss the countries that "got it right" and how this came about. I sincerely hope that we can learn from such success stories and use them to guide regulations going forward into new technologies such as gene editing, which can be enormously helpful in bringing about improved food security in countries that sorely need this.

2. The West's stand on GM crops

The global area where GM crops have been planted has grown from an initial 1.7 million hectares from the time they were first commercialized in 1996 to over 190 million in 2019. However, the current top 10 growers are the USA, Brazil, Argentina,

Canada, India, Paraguay, China, Pakistan, South Africa, and Bolivia. The only EU country to appear in the list of the top 21 is Spain, coming in at number 17 [2]. This is clearly a reflection of each country's approach to regulations of GM crops. For instance, Canada's regulations are based on a scientific analysis of the traits and whether they are beneficial. No attention is paid to the methods by which such traits had been achieved [3]. Many of the top growing countries took much the same approach as that taken by Canada. By contrast, in the EU, the traits themselves are of little consequence and the methods used in developing the GM crop are of paramount importance [3]. How did these differences in attitude come about?

The development of GM crops in Europe occurred at much the same time as initial steps were being taken to integrate national food safety systems into the European Food Safety Authority (EFSA). This was politically sensitive because individual countries in the EU were losing some of their influence over home-based regulations. In my book GM Crops and the Global Divide [1], I postulate that the US biotechnology industry blustered its way into the EU, hoping to sell their GM crops to European farmers in this already somewhat hostile regulatory environment. As pointed out by Wesseler and Kalaitzandonakes [4] "Never before has a new technology in the field of agriculture been so emotionally debated among stakeholders." I might add, however, that, according to the latest analysis carried out by the International Service for the Acquisition of Agribiotech Applications [2], GM crops have increased about 122-fold from 1996 to 2019 making biotechnology the fasted adopted crop technology in the world.

Many countries, including the EU, cite the precautionary principle as a reason for not allowing the cultivation of GM crops. This principle, in essence, states that if an action has a suspected risk of causing harm to the public or to the environment, the burden of proof (that it is or is not harmful) falls on those taking the action. A major problem with this is the difficulty of proving it negative, thus establishing evidence of the absence of danger is difficult. Indeed, on the basis of this principle why are cars allowed on the roads?

It should also be borne in mind that there is a great difference between the blanket statement of "risks of GM crops" and the specific statement of "risks of approved GM link MON810," or "risks of insect resistant soybeans in Argentina." In addition, should not there be an overriding proviso when benefit-risk ratios are taken into account, such as is obviously the case for cars? Here, again, the West might well say (as they often do): "We have enough food therefore we don't need food derived from GM crops." On the contrary, the Rest might answer (which I wish they would do more vociferously): "We need any technology that puts more food on our tables." Perhaps decision-makers in the EU could benefit by spending time living in rural India, Paraguay, or Bolivia (numbers 5, 6, and 10 of ISAAA's list [2]) before making up their minds on the usefulness or not of GM crops.

3. The West versus Africa

The only countries in Africa that are currently growing GM crops commercially are South Africa, Sudan, and very recently, Eswatini and Nigeria. On June 22, 2021, Kenya announced that it had approved the environmental release of GM cassava resistant to cassava brown streak disease, which had been developed by the Kenya Agricultural and Livestock Research Organization (KALRO). This paves the way for national performance trials before it can become commercialized.

Why is this and why are not more African countries growing GM Crops? It is not as if South African farmers have had bad experiences, especially when growing GM white maize which can be eaten by some citizens up to three times per day. In

a recent article entitled Economic and Ecosystem Impacts of GM Maize in South Africa [5], the authors state that the key benefits of growing GM white maize were estimated to amount to US$5 million from 2001 to 2018, with lower pesticide requirements compared to convention white maize. In 2017, South Africa produced approximately 1.1 million hectares of GM maize varieties for direct human consumption, representing an 85% adoption rate. In light of food insecurity in African countries, which will only become worse with climate change, why do not grow more GM crops?

To understand the influence that Europe could be having in Africa, it is important to understand the role that Europe plays in both the economy and mindset of many African countries and their leaders. A statement by the European Commission reads: "in an ever-changing world, one thing is for sure: Africa and Europe will remain each other's closest neighbours. Africa's 54 countries and the European Union's 28 Member States have a shared neighbourhood, history and future." [6].

Moreover, Africa's farm exports to Europe are six times as large as exports to the United States, so it is European consumers' taste and European regulatory systems that Africans most often must adjust to. In addition, Europe provides three times the funding for the United Nations Environmental Program (UNEP) which, together with the Global Environment Facility, provided assistance to African regulatory authorities. Therefore, Europe could influence organizations to adopt EU-style restrictions on GM crops, and the EU has been waging a war on GMO foods for decades [7].

What is Africa losing by not planting GM crops? Justus Wesseler, an agricultural economist from Wageningen University in the Netherlands, published an article in 2017 in which he and his colleagues considered the cost of not growing three GM crops. These were disease-resistant cooking bananas (plantains), and insect-resistant maize and cowpea [8]. They estimated that in the past decade, between 440 and 4000 lives could have been saved in Kenya, while in Uganda the potential estimate was between 500 and 5500.

Of course, Europe is not the only entity trying to stop Africa from growing GM crops. Western non-governmental organizations (NGOs), such as Greenpeace, Friends of the Earth, GeneWatch UK, ActionAid, and GM Freeze, are all cited in an article written in 2017 by Margaret Karembu, Director of the ISAAA AfriCenter, soon to become BioTrust AfriCenter [9]. The title of her article is "How European-based NGOs block crop biotechnology adoption in Africa." She grew up in rural Kenya when her family struggled to put food on the table. She now realizes that the subsistence farming practiced by her family is what the "greens" in Europe and elsewhere in the West call "agro-ecology family farming." Although farming practices in Africa are beginning to modernize, this is being undermined by such organizations. She gives the example of the adoption by the European Parliament in June 2016 of a report by the "New Alliance for Food Security and Nutrition," which stated that any support to African agriculture should be confined to such "agro-ecology family farming level." The report was passed by 577 to 24.

Africa is not the only continent that has been the object of the anti-GMO lobby. The next section will look at how other continents and countries have been affected.

4. The West versus the Rest

What effects have the West had on other "developing" countries? I used quotation marks as one hopes that all countries are developing, although in the minds of most people, "developing" countries are those not as economically advanced as the

"West". Therefore, in this section, I will look at the effects that the West has had on eggplants (brinjals, aubergines, or talong) in the Philippines and Bangladesh, and on Golden Rice in Asia in general.

Eggplants (*Solanum melongena* L.) are among the most important, inexpensive, and popular vegetables grown and consumed in Asia. In the Philippines, for instance, they account for more than 30% of the total volume of vegetables produced in the country [10]. The problem, however, is that they are susceptible to infestation by the eggplant fruit-and-shoot borer (EFSB; *Leucinodes orbonalis* Guenée), and farmers use chemical insecticides to control these pests. Indeed, farmers in the Philippines can apply these chemicals 20–72 times during the 5- to 6-month-long cultivation season, often resulting in skin irritation, redness of eyes, muscle pains, and headaches in farmworkers [11]. As there are no conventionally bred-resistant varieties, the Maharashtra Hybrid Seeds (Mahyco) developed GM resistance that gave 98–99% damage loss [10]. At first, the Supreme Court of the Philippines placed a permanent injunction on field trials, but this was later overturned.

The situation in Bangladesh is very different. Mahyco, working with the Bangladesh Agricultural Research Institute, developed nine varieties of Bt eggplant that eliminated the need to spray for EFSB. Four of these varieties received regulatory approval in 2013 and were grown by 20 farmers in 2014. Today, more than 27,000 farmers in Bangladesh grow Bt eggplant, and there are indications that more farmers are eager to reap the benefits of these improved varieties.

https://www.agrilinks.org/post/bt-eggplant-adds-revenue-safety-farmers-bangladesh.

In a recent article [12], the authors found that Bt eggplant varieties had a 19.6% higher average yield and 21.7% higher revenue. This amounted to $664 more income per hectare, a princely sum for resource-poor farmers in Bangladesh.

The study also found that Bt eggplant sold at the local markets, either to wholesalers or direct to consumers, fetched a higher price than non-Bt eggplant. Some buyers were prepared to pay higher prices for Bt eggplant because the fruit was less damaged than non-Bt eggplant.

What were the reasons for this success in Bangladesh? One is probably the partnership between Mahyco, the United States Agency for International Development (USAID), the Indian-based Sathguru Management Consultants who helped with technology transfer and innovation advice, and Cornell University. The group is now called the South Asia Eggplant Improvement Partnership (SAEIP) and they designated the Bangladesh Agricultural Research Institute (BARI) as the lead organization in producing and distributing Bt eggplants to farmers [12].

Another important factor was that the four Bt eggplant lines released were not hybrids, so farmers could save seed. In addition, BARI provided farmer training, explaining the importance of planting refuge non-Bt eggplants around the Bt eggplant plots to prevent the build-up of weeds resistant to Bt. The satisfaction of the farmers with their crops prevented the anti-GMO lobby, which was very active in the early days of the rollout of the crop, from turning away government support.

As mentioned above, the other case I am going to look at is that of Golden Rice. In many parts of Asia, rice is eaten almost every day, in some countries accounting for 70–80% of an individual's calorie intake [13]. Unfortunately, as rice is prepared by the removal of the husk and aleurone layer to prevent the grains from becoming rancid during storage, micronutrients, including vitamin A, are removed. This can lead to vitamin A deficiency (VAD), which has been estimated to kill approximately 670,000 children under the age of 5 years every year [14]. In addition, VAD can cause an additional 500,000 cases of irreversible blindness [15].

To address this problem, in the early 1990s two scientists from the Swiss Federal Institute of Technology (ETH) in Zurich, Ingo Potrykus and Peter Beyer, began to develop a variety of rice that would contain vitamin A. They introduced two genes, one from maize and the other from a very commonly ingested soil bacterium, *Erwinia uredovora*, which together produced lycopene. The rice converts this to β-carotene, which gives the rice a golden color and is converted to vitamin A when ingested. Hence the name Golden Rice. https://archive.gramene.org/newsletters/rice_genetics/rgn18/c41.html

This variety has been the subject of many attacks by anti-GMO activists, spearheaded by Greenpeace. Incensed by this opposition that has been ongoing for many years, some 150 Noble Laureates wrote an open letter to the leaders of Greenpeace, as well as to the United Nations and governments around the world urging "Greenpeace and its supporters to re-examine the experience of farmers and consumers worldwide with crops and foods improved through biotechnology.... and abandon their campaign against GMOs in general and Golden Rice in particular" [16].

Although Golden Rice has been approved for use in Australia, New Zealand, Canada, and the United States, these are the countries that hardly need it. At last, in December 2019, the Philippines approved its use in food, feed, and for processing [17], and finally, on July 28, 2021, Golden Rice was approved for commercial planting by the Philippine Department of Agriculture.

https://www.thepigsite.com/news/2021/07/philippine-department-of-ag-gives-nod-to-nutritious-gmo-golden-rice.

5. How to bust myths and the importance of communication

A number of myths have grown over the years regarding GMOs and GM crops. It is, of course, important to use scientific facts to correct these myths, but it is equally important to understand that many people who believe them may be doing so to reinforce some beliefs that they hold. Simply giving them the facts may not be enough to dispel such myths, hence it is important to understand what lies behind their adherence to them. For instance, if a person is against the role of multinational companies, which they believe are monopolizing the production of GM crops, it is essential to present the facts as they relate to this issue. Above all, it is necessary to gain the trust of such opponents of GM crops before you have any hope of convincing them otherwise.

People often tend to base their decisions on opinions and values and then look for facts that support these. To counter this, you will have to obtain their trust, and one way to do this is to state that there are aspects of GM crops that you find problematic. For instance, you can acknowledge that the overuse of a single herbicide such as Roundup can lead to the development of herbicide-resistant crops. However, you should point out that this is not the fault of the technology but the use of such technology. So, let us look at a number of these myths.

5.1 Superweeds

This term is an emotive one aimed at inspiring fear. However, "superweeds" are no different from the herbicide-resistant weeds found in fields of conventional crops, which farmers have been dealing with for many years. The term also implies that there is no herbicide that can kill such weeds, which is patently untrue. In contrast, the development of "super bugs," referring to human bacterial infections that are resistant to many or even to all known antibiotics, are real threats. There

are, indeed, multidrug-resistant (MDR) and extremely drug-resistant (WDR) tuberculosis strains that are presenting formidable challenges to treatment [18].

That said, Roundup-resistant weeds are, indeed, a growing problem that needs to be addressed. However, to put it into perspective, by 2014, weeds have become resistant to 152 different herbicides, emphasizing the importance of managing weeds in a more integrated and sustainable manner [19]. Indeed, in the case of Roundup-resistant weeds, farmers are their own worst enemies—the more they continue to use this herbicide without rotation, the greater chance there will be for the development of resistant weeds.

Another common myth is that poor farmers in Africa have to buy maize seeds every year and cannot save seeds. However, since the advent of hybrid seeds in the 1930s, farmers who plant them have to buy seeds every year. This is because of the way in which hybrids are bred. Specific male and female lines that have been bred so that their offspring (hybrids) have advantageous traits such as high yield. If farmers plant their own seeds, the offspring will be a scramble of traits as their parental genes are randomly inherited, losing the "hybrid vigor."

A complaint, not a myth, that is often used against GM crops, is that they are in the hands of the multinationals who, and this is a myth, are plotting to control the food supply of developing nations. Why do multinationals produce most of the world's GM crops? This is, in fact, due to the anti-GMO lobby. They have stirred up such fears of harm to humans, animals, and the environment that regulations imposed by governments have become enormously expensive. As a result, only multinationals with deep pockets can afford to comply with these regulations.

I have seen this problem at first hand. Some years ago, colleagues and I developed GM maize resistant to the African endemic maize streak virus [20]. Our private sector partner was the South African seed company, Pannar Seed, who simply could not afford the costs involved in carrying out field trials. Some years later, they were taken over by the multinational seed company, Pioneer, but they too were unable to undertake such trials. Their reason was that MSV-resistant maize would only benefit African farmers who were too poor to recoup the costs of field trials. The seeds remain in the freezers at the University of Cape Town and Pannar Seed.

6. Countries that got it right and why

What do I mean by a country that got it right? In a nutshell, such a country needs to have a government that is supportive of innovations and new technologies that can improve agricultural production and make the lives of farmers more profitable and less stressful. It should have a regulatory system in place that is flexible, operates on a case-by-case system, and whose decisions are based on science. It is extremely important that these regulations should not erect barriers to the development and implementation of GM crops. The government should encourage private enterprises to develop and commercialize such crops, and should also support public enterprises such as universities, technical colleges, research institutes to conduct research that could be commercialized in public/private partnerships. I will now give some examples of countries that got it right and how they did this.

6.1 South Africa

Farmers in South Africa started to plant GM crops commercially as early as 1998. In 2019, it was number 8 on the list of countries planting the highest number of GM crops with 2.7 million hectares of maize, soybeans, and cotton. Maize, at 72%, accounts for the majority of these, with soybeans at 27% and cotton a mere

1%. Approximately 85% of white maize, used for human consumption, was GM. Indeed, white maize is often consumed three times a day by many inhabitants [2].

In a recent study of the economic and ecosystem impacts of GM maize in this country, the authors found that white maize food security was improved as, on average, 4.6 million additional rations were added annually. In addition, the environmental impacts per hectare of GM versus non-GM maize were decreased by US$0.34 per hectare, or US$291,721 annually. Decreases in pesticides accounted for the majority of the estimated US$5 million benefits from 2001 to 2018. The authors speculate that "as we face a hotter and drier future, agricultural technologies such as GM may be one of the most salient ways to combat food insecurity while simultaneously reducing the environmental impact of agricultural production" [5].

6.2 Canada

Canada regulates products derived from biotechnology processes as part of its existing regulatory framework for "novel products." The focus is on the traits expressed in the products and not on the method used to introduce those traits…Advertising or labeling the presence of GMOs in particular food is voluntary unless there is a health or safety concern.

Thus, reads the introduction to the Law Library of Congress's [21] article entitled "Restrictions on Genetically Modified Organism Canada." In keeping with this approach to GMOs, Canada, the world leader in canola production, was the first country to commercialize herbicide-tolerant (HT) varieties of this crop in 1996. By 2019, 82% of its country's soybeans were HT, 90% of its maize crop was either both HT and insect-resistant (IR) or either one, and 95% of its canola was HT [2].

While most countries growing GM crops concentrate on maize, soybeans, cotton, or canola, which are either HT or IR or both. However, Canada has recently commercialized three new crops. The first was HT low-lignin alfalfa, which makes it more digestible to livestock [22]. This also allows farmers to delay harvest by up to 10 days in order to obtain greater yields without losing quality [2]. This was developed by members of a partnership between Forage Genetics International, the Noble Foundation, the US Forage Research Centre, together with scientists from the universities of Wisconsin, Minnesota, and the University of California, Dave—a great example of public/private collaboration [23].

The second was the Innate® potato developed by the JR Simplot company. It has decreased levels of reducing sugars, reduced acrylamide potential (by reducing asparagine), and black spot bruising tolerance [24]. This crop has been further improved by protection against the late blight pathogen, which could result in up to a 50% reduction in fungicide application annually [2]. Reduced asparagine leads to lower levels of acrylamide (potentially carcinogenic) that can accumulate when potatoes are cooked at high temperatures, for instance over open flames.

The third new crop is the Arctic Apple produced by the Canadian firm Okanagan Specialty Fruits Inc. The development of these crops is a good example of how a country "got it right" as private companies, or public/private partnerships, are clearly encouraged by the fact that if their products are an improvement on what is currently available, Canada will allow their commercialization as long as there are no health or safety issues involved [2].

6.3 Argentina

GM crops are regulated in Argentina under the general Law on Seeds and Phytogenetic Creations. This law aims to promote the development and production of modern biotechnology as it grants tax incentives to research and production projects that meet safety and health standards. This forward-looking approach assures

farmers that the seed they acquire meets identity and quality standards, while the intellectual property of innovators is protected [25].

Argentina was among the first countries to plant GM crops commercially, with HT soybeans being introduced in 1996; in 2019, it was the third largest grower of such crops [2]. One of the major reasons for this uptake is that farmers can plant two crops per year, partly due to the reduced tilling required with HT crops as this reduces the production time. This is because the farmers grow conventional varieties of these crops, they need to till the soil before planting in order to allow weeds to grow. These are then killed with herbicides, many of which are not biodegradable. Farmers must, therefore, wait until the herbicide has dissipated before the crop can be planted; otherwise, the residual herbicide remaining in the soil will kill the crop. During this time, much of the topsoil may be lost due to wind erosion. Argentinian farmers learned early on that they could spray the fields of HT soybeans with minimal tilling and when it was convenient for them as only the weeds would be killed. They also noted that less topsoil was being lost. https://www.isaaa.org/resources/publications/pocketk/57/default.asp.

One of the other things that Argentina "got right" was that its government recognized that GM crops have the potential to increase agricultural output. In March 2017, the agriculture minister, Dr. Luis Miguel Etchevehere, said that the promotion of GM crops was designed to increase the "leadership of our country in the development of agricultural biotechnology" [26]. They also implemented regulatory measures aimed at speeding up the approval of new GM crops, resulting in the time taken for such assessments dropping from 42 to 24 months [26]. This has resulted in the country approving HarvXtra® Alfalfa, which contains less lignin thus improving its digestibility for livestock. In addition, Argentina is the first country to approve drought-tolerant GM wheat [27]. Both crops were developed by BiOceres, a local agri-industrial company.

6.4 Brazil

In September 2003, Brazil decided to allow farmers to grow GM soybeans for a 1-year period. As Bob Callanan, head of the pro-GM American Soybean Association, said: "We have long been frustrated by Brazil growing illegal GM seeds" [28]. These seeds were being brought over the border by farmers seeing how much better off farmers were in Argentina due to their growing GM varieties. Far from limiting its planting of GM crops to a single year, Brazil's farmers have grown them continuously and, in 2019, they were growing the second largest area of these crops, 52.8 million hectares, with the USA, at 71.5, growing the largest [2].

6.5 China

Since 1997, China has approved 64 GM crop events, including canola, cotton, maize, papaya, petunia, poplar, rice, soybeans, sugar beets, sweet pepper, and tomatoes [2]. This sounds impressive, so why then in 2019 is China planting only 3.2 million hectares, the seventh in the list of countries planting the highest area to GM crops? [2] The answer may lie in the country's regulators being risk-averse. As in many countries in the 1900s, Greenpeace was a major player in China and the specter of risk was high on its agenda. Thus, after its initial early entry into GM crops, China, hopefully for the moment, has dropped by the wayside [29].

6.6 Burkina Faso

In 2008, farmers in Burkina Faso, one of Africa's largest cotton producers, began to plant IR cotton commercially. By 2014, about 74% of cotton grown in the country

was IR, grown by some 140,000 smallholder farmers. Advantages included a 20% yield increase, a reduction in insecticide use of about 67%, and an estimated profit increase of US$64 per hectare, despite the increase in the cost of seed [30].

However, although the farmers were happy, the cotton ginning companies were not. The cotton had shorter staples and lower lint quality undermined their profit. As a result, the cotton companies, which also control the provision of seed to the farmers, unilaterally phased out GM cotton [31]. This is an example of the importance of having all involved in the crop production and processing involved in the decisions taken as to which varieties of cotton should be converted into GM, in this case by inserting the *Bt* gene.

7. Conclusions

Why is it that people in the West, particularly those in the European Union but also in the Nordic countries and parts of the USA, are so against GM crops? Since 1996 when such crops became available commercially, not a single proven case of ill health related to their consumption by either humans or animals is registered. Every major regulatory body in the world has concluded that GM crops are as safe for consumption as conventional crops, whether organic or not [3].

Is it possible that there are vested interests involved in this antagonism? One of the most prominent organizations lobbying against GM crops is Greenpeace, which receives funding from other anti-GMO bodies such as the Tides Foundation. https://www.tides.org/project/grantee/greenpeace-canada/.

Another organization working against GM crops is the Norwegian Institute of Gene Ecology (GenØk), which has been fiercely opposed to this technology since it was founded in 1998. Their staffs travel widely promoting perceived risks associated with this technology. They also hold conferences such as the one in 2003 with the inflammatory title: "Regulating a privatized genetic industry which has the potential to destroy the future." [32].

http://fafdl.org/blog/2016/10/14/how-norway-became-an-anti-gmo-powerhouse/.

Looking to the future, will the public and regulators around the world accept the newer technology of gene editing? [33] The potential that this technology has for improving crops and food sustainability is enormous. Let us learn from the mistakes made over GM crops and not repeat them. In particular, let us be aware that decisions made in the West can have a huge impact on the actions taken by the Rest.

Author details

Jennifer Thomson
University of Cape Town, South Africa

*Address all correspondence to: jennifer.thomson@uct.ac.za

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