Lessons Learned From the Introduction of GM Crops

Relevance to Gene Drive Deployment

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Introduction

GM Crop Status

Crops that have been genetically engineered or genetically modified (GM) have been in commercial production for 24 years, since the planting of the first GM soybean crop in 1996. As of 2018, 26 countries grew 192 million hectares of GM crops, with the United States, Brazil, Argentina, Canada, and India growing the vast majority of that area. In addition to these countries, 44 are importing GM crop products ({ | ISAAA, 2018 | | |zu:5334702:QDQ4ENZ7}). In the United States, GM corn accounted for 92%, GM soybeans 94%, and GM cotton 96% of the acreage planted in 2020 [1,2].

This level of adoption throughout the world has resulted in significant socio-economic, health and environmental benefits. In 2018, farm income worldwide from GM crops was US$18.95 billion, with a cumulative total income of US$ 225 billion ({ | Brookes, & Barfoot, 2020 | | |zu:5334702:2CQHPIIA}). The 2018 annual farm income is equivalent to the Gross Domestic Product of many African countries [3]. Animal and human health benefits were also realized, with the reduction in total active ingredient use of 51.7 million kgs ({ | Brookes, & Barfoot, 2020 | | |zu:5334702:2CQHPIIA}). This reduction has direct benefits in terms of reducing farmer pesticide poisonings as has been reported for China, India, Pakistan and South Africa ({ | Smyth, 2020 | |and references therein|zu:5334702:CFXPFW3M}). For insect resistant maize, health benefits are also inferred by the reduction levels of mycotoxins, which are toxic—causing neural tube defects—and carcinogenic ({ | Smyth, 2020 | | |zu:5334702:CFXPFW3M}). These effects are particularly beneficial in those developing countries where maize is the staple food. Environmental benefits are also implied to be the result of reduction in pesticide use, through the known impacts of these pesticides on wildlife ({ | Brookes, & Barfoot, 2020 | | |zu:5334702:2CQHPIIA}{ | Siegrist, & Hartmann, 2020 | | |zu:5334702:WCDRBP8C}).

Opposition to GM Crops

Despite these documented benefits to farmer income, health and the environment, opposition to GM crops remains strong in many parts of the world, in particular Europe ({ | ISAAA, 2018 | | |zu:5334702:QDQ4ENZ7}{ | Zilberman, et al., 2013 | | |zu:5334702:A5LLMP5T}), with its consequent impact on Africa ({ | Huffman, et al., 2003 | | |zu:5334702:R3839H27}). Even in countries where there is widespread adoption by farmers, the consuming public remains divided over the safety or simply the overall acceptability of these products. The acceptance or rejection of GM crops by different populations has been studied extensively over the years. The lessons learned from the experience of deployment of GM crops could provide lessons for the development and deployment of gene drive technologies, which are currently receiving attention similar to that which was experienced by GM crops while they were being developed and when they were initially introduced. Interestingly, in the light of GM organisms containing gene drives, GM

[1] https://www.ers.usda.gov/webdocs/DataFiles/47649/alltables.xls?v=6605.8
[2] https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption
[3] https://data.worldbank.org/indicator/NY.GDP.MKTP.CD

crops and other “traditional” transgenic products recently seem to be viewed in a more benign light, due to their familiarity, even by long-term opponents of GMOs.

A story from Africa

In 2002, Southern Africa (Zambia, Mozambique, Malawi, Zimbabwe, Swaziland and Lesotho) faced a food crisis ({ | Huffman, et al., 2003 | | |zu:5334702:R3839H27}, { | Zerbe, 2004 | | |zu:5334702:6NV9SJNL},{ | Dorward, & Kydd, 2004 | | |zu:5334702:VHXWK3TG}). More than 15 million people were “dangerously hungry”, and 3 million faced starvation due to a number of factors, including climate (leading to drought), HIV/AIDS, structural adjustment, debt, collapsing public services, and poor governance ({ | Huffman, et al., 2003 | | |zu:5334702:R3839H27}, { | Zerbe, 2004 | | |zu:5334702:6NV9SJNL}). Despite this crisis, these six nations rejected food aid in the form of maize (a staple crop in that region) because the maize, from the United States, was genetically modified (GM).

Why the resistance of Presidents of southern African countries to food aid in 2002?

There was a food crisis in southern Africa 2011-2003, due to drought and bad public policy.

> 15 million people were “dangerously hungry in Zambia, Mozambique, Malawi, Zimbabwe, Swaziland and Lesotho. Up to 3 million people faced starvation.

Maize is the staple.

In the summer of 2002, despite their need for food aid, these six nations rejected food aid.

September 2002: WHO convinced Lesotho, Malawi, and Swaziland to accept grain, but Zimbabwe and Mozambique required milling of GM-containing grain before import.
The governments refused GM corn because they feared Europe would ban their agricultural exports if they became contaminated with transgenic materials from Bt corn.

Authors’ thesis:
1. NGOs let by Greenpeace and Friends of the Earth are disseminating information claiming that GM foods are dangerous to human health and are “Frankenfoods.”

2. People in European Union countries, who are not in any danger of starvation, have strong

preferences for non-GM foods, which they can easily afford.

European Opposition

GM Science Review, 2004

By 2004, GM crops were grown extensively in North and South America,
and in China,
but not in Europe.

The British government went to great lengths to provide scientific and ethical support for growing GM crops.
However, this did not sway public opinion.

Scientists did not realize that the public views risk very differently from them.

NGOs have also been very skillful about their messaging.

The benefits of the technology were not obvious to the average consumer.

Since there was not compelling reason to support the technology,
the easiest course of action was to be precautionary.

Zerbe ({ |-Zerbe, 2004 | | |zu:5334702:6NV9SJNL}) argued that food aid was a tool to promote biotechnology in Southern Africa, and thereby advance interests of multinational corporations in the region, undermine local production and result in further food insecurity.

Opposition Elsewhere

Studies on GM Crop Acceptance

Lessons Learned