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Genetically Modified Food and the Second Green Revolution

Mervyn Piesse
Research Manager
Global Food and Water Crises Research Programme

Key Points

- Just as the Green Revolution was made possible by multiple technologies, such as higher-yielding food crops, more efficient irrigation, fertilisers and pesticides, the second Green Revolution will be made possible by numerous innovations.
- While the Green Revolution is arguably still ongoing in parts of the world, most notably sub-Saharan Africa, other regions have reached a barrier and a new wave of research and development is required if agricultural production is to sustainably increase.
- Genetic modification has mainly been applied to crop production where it is mainly used for the control of pests and disease. In livestock it is used to speed up the rate of maturation or make animals more resistant to disease.
- Diligent testing, regulation and oversight of genetically modified food will help reduce any possible associated risk.

Summary

The genetic modification of food is heavily politicised and there are numerous arguments for and against the practice. Proponents of genetically modified (GM) food claim that it will increase food security, primarily by making agriculture more efficient, while detractors argue that the technology is potentially dangerous and the cultivation of GM food could have unforeseen consequences that will ultimately prove detrimental to food security. By examining the use of GM in plant and livestock agriculture, this paper will consider both sides of the debate. Ultimately, some varieties of GM food have the potential to strengthen global food security while others are likely to be self-defeating in the long-term.

Analysis

Genetic engineering, which involves the modification of the genetic makeup of living organisms, has been practiced for over 40 years and commercial applications have been available for the last two decades. Biotechnology, of which genetic engineering is a part, is a relatively young field and it is yet to reach its full potential. Equally, however, the possibility of unintended or unforeseen problems arising from the technology remains and it would be irresponsible to rush into the widespread production of GM food without first testing the safety of each product.

Just as the first Green Revolution was composed of multiple innovations that improved agricultural production, the second Green Revolution will also be made up of many technologies, one of which is likely to be genetic engineering.

The Green Revolution

The Green Revolution refers to a series of research and development projects that increased agricultural production globally. Prior to the beginning of this process, in the 1930s, there were fears that the world was facing a Malthusian future in which the population would grow faster than the food supply.

Despite increased land scarcity and the population roughly doubling, the Green Revolution ensured that cereal crop production increased three-fold. This increase in agricultural productivity was driven by international research organisations, such as the International Maize and Wheat Improvement Centre, the International Rice Research Institute and the Consultative Group on International Agricultural Research. Much of the research conducted by these organisations was, and continues to be, state-funded. Private companies now conduct significant biotechnology research, which is often profit motivated. This distinction, between public and private interests, informs a large part of the argument against the adoption of GM food. As private interests are perceived to be more profit-oriented there are fears that they will be less inclined to act in the public interest.

While these international research institutes mainly focussed on the development of high-yielding crop varieties, other improved inputs, such as fertiliser, irrigation and pesticides, also drove agricultural production increases during the Green Revolution.

Not all outcomes from the Green Revolution were positive, however, and solutions to these challenges are yet to be adopted in many parts of the world. Unintended consequences relating to unsustainably high water, pesticide and fertiliser use have degraded landscapes. Some of the reduction in yield growth since the mid-1980s is associated with this degradation. For the most part, these challenges were caused more by the policy environment in which these inputs were used. In some countries water and other inputs were, or continue to be, heavily subsidised. With these policy settings there is often little impetus for farmers to reduce the use of these inputs until yields begin to noticeably decline.

Arguably, the Green Revolution also increased global disparities in the agricultural sector, as some parts of the world missed out on most of its benefits. Sub-Saharan Africa, for instance,

did not experience the same level of agricultural development as other regions, leaving it even further behind. While the International Institute of Tropical Agriculture was established in Nigeria in the 1960s, it was not until the 1980s that its work began to increase yields in the region. Most of the yield increase came from the development of non-traditional crops, such as maize. Crops that are widely grown in sub-Saharan Africa, such as sorghum, millet and cassava, which many poorer, smallholder farmers continue to grow, largely went without any major increase in yield.

The first Green Revolution is not yet complete in sub-Saharan Africa. Many subsistence farmers are yet to adopt mechanised farming practices. They are also yet to switch to higher-yielding crop varieties, improved irrigation systems and increased fertiliser use. Sub-Saharan Africa is in an enviable position. It can learn from the mistakes made elsewhere, such as the overuse of groundwater and fertilisers that have left many regions of the world in a far less secure position. The region stands to benefit from the advances made in precision agriculture, which allow for more targeted use of water and fertiliser.

While sub-Saharan Africa is still able to reap rewards from the first Green Revolution, other parts of the world have reached a barrier. Agricultural research and development programmes are required to lift yields and identify new methods of sustainable farming that can produce more food with fewer inputs. Without continued effort to secure the food supply for future generations, global food security is likely to come under pressure. Over the course of the twenty-first century, the food supply is likely to be strained by demographic change (particularly population growth), and changing climate conditions.

The Second Green Revolution: The Role of Genetically Modified Food

There are calls for a second Green Revolution to drive new agricultural research and development programmes. Arguably, with the spread of precision agriculture and biotechnology, the second Green Revolution is already underway. Just as the first Green revolution was composed of multiple innovations, the second is also likely to be built on multiple technologies. Genetic engineering is one technology that will fuel the second Green Revolution and improve global food security.

GM is a broad field and there are many types of GM products available or in various stages of development. Some products use GM techniques to promote more rapid growth, resistance to disease and pests, or to deliver vitamins, minerals or nutrients through a process known as bio-fortification.

There are also two ways to genetically modify an organism. The first, known as transgenic modification, involves the movement of genetic material from one variety or species of organism to another. The second involves changing, or editing, the existing genetic material of an organism.

Genetically Modified Crop and Livestock Production

There are two groups of GM crops that are currently widely grown. The first are altered to make them resistant to herbicides, such as glyphosate. These crops allow farmers to control weeds without harming their crop. The second type, known as Bt crops, produce a natural

insecticide inside the parts of the plant that pests eat. These crops have genes from a common soil bacterium, *Bacillus thuringiensis*, which has been used as a natural bio-pesticide for nearly a century and continues to be widely used in organic agriculture. Other GM crops that are currently in development, such as non-browning fruit and vegetables, could reduce food waste, which is a major contributing factor to global food insecurity.

In livestock production GM technology is used to make animals grow at a faster rate or more resistant to disease. Commercial applications of genetic engineering in the livestock sector are currently limited to salmon. AquAdvantage salmon, a genetically modified breed of Atlantic salmon, is an early example of GM livestock. The fish has two genes from other fish species: a growth hormone gene from Chinook salmon that is under the control of a genetic "switch" from Ocean Pout. Conventionally, Atlantic salmon produce growth hormone only in summer months, but with these two genes AquAdvantage salmon produce it throughout the year. Uninterrupted exposure to the hormone means that AquAdvatage salmon reach maturity in 18 months instead of the 36 months taken by conventional Atlantic salmon. The faster growth rate allows producers to grow and harvest more salmon in a shorter period of time.

The Case for and Against Genetically Modified Food

Advocates of genetic modification maintain that people have manipulated plant and animal genetics since the beginning of agriculture and all biotechnology does is speed up this process. While GM techniques enable scientists to quickly alter the genetic makeup of organisms, and do away with the laborious and time-consuming task of traditional selective breeding, they do result in organisms that probably would not have occurred naturally. This, however, does not necessarily mean that GM food is unsafe or environmentally harmful.

Many opponents of GM food argue that because these foods do not occur naturally they are somehow dangerous to the environment or are unhealthy. GM products undergo rigorous tests to ascertain their risk to human health and the natural environment prior to being released to the market. Of course, not every product can be declared absolutely safe, and unforeseen or unexpected dangers can arise, but these tests certainly reduce the risk of GM crops being unsafe.

Reducing the amount of food that is lost to pests and disease is the main reason for developing GM food. GM cassava, which is widely grown in some parts of Africa, for instance, is protected against cassava mosaic virus and brown-streak virus. Resistant crops are not without their problems, as eventually the pests and diseases are likely to evolve to overcome the resistance gene. This process locks genetically modified organisms (GMOs) into an ever escalating battle against harmful organisms. GM crops cannot eradicate pests and disease, but they do give farmers another tool to manage outbreaks. An overreliance on the technology, however, is likely to be self-defeating in the long-term.

It is also correct that there is no consensus about the safety of GM food, but, equally, there is no consensus about the danger of GM food. The debate on scientific consensus is a moot point, designed more to distract than inform. If every innovation or technology were required to pass the consensus test, there simply would be no technological advancement.

A more pertinent argument relates to intellectual property and the right to own and propagate seed. Some biotechnology companies have developed genetic use restriction technology (GURT), colloquially called "terminator genes". When activated, these genes make the seed and the crop it produces incapable of reproducing and results in farmers having to purchase new seed from the owner of the seed technology. A major argument against GM food maintains that farmers will become overly dependent on a handful of biotechnology companies that could adopt extortionate practices. As many farmers rely on hybrid crops, which give a mixture of inferior varieties if re-sown, many of them were already purchasing seed every year prior to the introduction of GM crops. Furthermore, biotechnology companies have never made GURT commercially available and have no plans to do so. While they could renege on this commitment and introduce extortionate practices, as they operate in an industry that has clear and significant effects on the public interest they would be foolish to do so.

Biodiversity, which is an integral part of a secure global food system, could also be reduced because of GM crops. There are fears that GMOs will either interbreed or compete with natural varieties, thereby driving them to extinction. Some GMOs are less likely to enter the natural environment than other, further ensuring their containment. GM salmon, for instance, is generally farmed in aquaculture conditions far from natural water bodies. In these cases, GMOs are unlikely to interact with non-GMOs. GURT could also resolve this problem, as any GMO that escapes into the wild would be unable to breed and compete with other organisms, but taking this course of action could re-invigorate the fears of corporate domination previously discussed.

Conclusion

As GM food production has the potential to disrupt food security, a vitally important component of human survival, due diligence is not just necessary, but obligatory. At the same time, however, ignorance and fears of the unknown should not retard the growth of an industry that has the potential to considerably strengthen global food security.

Biotechnology standards, developed by the World Health Organisation, maintain that all new GM food should be tested on a case by case basis. National food safety authorities should be encouraged to adopt these standards. If these standards are not strong enough for consumers, many regions are introducing labelling laws. Labelling GM food products will help ensure that consumers have greater choice over the food decisions they make, but it is unlikely to enable them to completely avoid GM products. GM crops are often fed to livestock, especially in the US where more than 90 per cent of all corn and soybeans are genetically modified in some way.

On its own, GM food is unlikely to make the world food secure. Instead, it is part of a much larger, multifaceted and complex solution to the challenge of achieving global food security in the twenty-first century.

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80 Birdwood Parade, Dalkeith WA 6009, Australia.
Tel: +61 8 9389 9831 Fax: +61 8 9389 8803
Web: www.futuredirections.org.au