FOOD AND HEALTH

Genetically modified crops – playing a positive role in sustainable development in Africa

Jennifer A Thomson

It has been calculated that if sub-Saharan Africa continues to produce crops using current agricultural practices, we will have a cereal shortage of nearly a million tons by the year 2025. Clearly something has to be done. There is enough food produced in the world to feed everyone; the problem is how to get it to the people in need. Certainly we should stop wars and eliminate corruption so that food gets to the right people, and build roads and railways to transport food – but how long will that take? In the meantime genetically modified (GM) crops that give increased yields are just one of the ways in which we can tackle the problem. Because Europe and Scandinavia have enough food and don't want GM foods, should we allow them to dictate to us what is best for Africa?

At a meeting in Nairobi in 2001, agricultural experts from many African countries met to discuss how best to develop GM crops suited to our needs. The list, not in any particular order, included insect-resistant African maize varieties, crops resistant to African viruses, maize resistant to parasitic weeds such as Striga (witchweed) and drought-tolerant crops. Let us look at each of these.

Insect-resistant maize

Insect-resistant maize expressing the *Bacillus thuringiensis* (Bt) toxin has been very successful in parts of South Africa, grown by both small-scale and commercial farmers. The toxin is only harmful to the insects it is designed to kill, and has no effect on other animals, birds or humans. The reason for this is that it binds to specific receptor cells in the insects' gut lining and these are absent in other organisms. It then perforates the cells making holes in the gut, resulting in death of the insect (Fig. 1).

In addition to protecting the cobs against maize borer, the toxin could possibly also protect them against post-harvest fungus infection. These fungi can produce toxins that can

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Fig. 1. A small-scale farmer holds herbicide-resistant maize in his right hand and insect-resistant maize in his left. He is hoping to plant maize carrying both traits. (Source: David Tribe.)

cause toxic hepatitis and oesophageal cancer. Many small-scale farmers store their maize for home consumption in sacks in open enclosures year round, with the cobs exposed to rain and sun. Under these conditions if the maize has been attacked by borers, the small holes in the kernels are an ideal breeding ground for the growth of fungi. In some parts of Africa oesophageal cancer resulting from the production of mycotoxins has reached epidemic proportions.

Virus-resistant crops

Africa is home to a number of serious plant viruses such as maize streak virus (MSV) and African cassava mosaic virus (ACMV). Indeed, a few years ago Uganda nearly lost its entire crop of cassava (manioc) to the latter virus and ACMV is now spreading rapidly towards Nigeria, one of Africa's most important producers of the crop. Varieties of maize have been bred by conventional means to resist MSV, but resistance often breaks down when the varieties are grown in areas for which they are not entirely suitable. In addition there is considerable variability in the severity of MSV in different parts of Africa. If a variety of resistant maize is planted in an area where the virus is more severe than it was bred to resist, it can become susceptible. Scientists in the laboratory of Professor Ed Rybicki and myself at the University of Cape Town (UCT), in association with a local seed company, have developed

GM varieties that are extremely resistant, if not immune, to MSV. These will be subjected to regulated field trials and can then be crossed with a wide range of commercial varieties for testing in other African countries. An international consortium, including African scientists, is working on developing ACMV-resistant cassava.

Maize resistant to parasitic weeds

Striga, or witchweed, is a killer in many African countries. The weed attacks the roots of crops such as maize, becoming intertwined in the roots and literally strangling them. This means the weeds are very difficult to remove using conventional methods, except in the very early stages of infection. As Striga produces vast numbers of minute seeds that only germinate in the presence of germinating cereals, fields infected with witchweed are almost useless for growing crops such as maize. Field trials in Kenya using a non-GM maize variety resistant to the herbicide imazapyr have proved very successful. The maize seeds are coated with the weed killer. When the weeds attack the developing roots of the maize plant they are killed rapidly by the imazapyr, leaving the maize healthy. Other scientists are developing similar resistance using GM technology. It will be interesting to see which approach is more successful. But as far as African farmers are concerned, especially the women who do most of the back-breaking weeding, any solution will be welcome.

An organisation called the African Agricultural Technology Foundation, based in Nairobi, Kenya, is brokering the transfer of the intellectual property of imazapyr-resistant maize to seed companies in East Africa.

Other traits and crops

And then we come to drought. Lack of water is surely one of the greatest problems facing agriculture in Africa. I recently talked with small-scale banana farmers in Kenya. Varieties of banana have been developed by tissue culture in that country to be virus-resistant and to produce dramatically increased yields. When asked about the major agricultural constraint on production, they all replied that lack of water was the problem. Attempts to breed crops tolerant to drought using conventional methods have not been successful. A growing number of scientists worldwide are working on the development of drought tolerance using genetic modification. Together with Professor Jill Farrant's laboratory at UCT, we are using genes from the South African indigenous 'resurrection plant', *Xerophyta viscosa*. This remarkable plant, which grows in cracks in rocks in the Drakensberg range of mountains, can dry down to 5% of its normal water content. It can survive for long periods in this state and look completely dead, having lost its chlorophyll. However, once water is available the plant resurrects within a period of about 72 hours. Quite remarkable! The first genes we have introduced into transgenic plants show tolerance to dehydration, heat and salt. It is, of course, unlikely that a single gene will render a crop tolerant to drought, so we are currently in the process of stacking two or more genes in a single transgenic maize plant.

Other important initiatives in Africa are aimed at developing improved varieties of local crops. These include cowpea, sweet potatoes, yams and sorghum. Many of these are extremely important in different regions of Africa. It is clear that multinational companies have little interest in improving yields of these African crops. Therefore we have to produce them ourselves. In India scientists are developing insect-resistant chickpeas and virus-resistant groundnuts, again crops that are of little interest to the major seed companies.

But how safe is food derived from GM crops? I will echo the words of Dr Craig Venter, of human genome fame, during his recent visit to Cape Town. He commented that no food crop has ever been tested for human safety as rigorously as GM crops and that, in contrast, certain conventional food crops can be extremely toxic. I will add that GM food is treated as if it were a toxin such as an industrial solvent. It is subjected to rigorous tests that can predict long-term safety.

It is also interesting to look at the situation regarding GM crops in Europe. Although very few countries grow GM crops, Europe is the world's biggest importer of soybeans, used for animal and chicken feed ever since the BSE scare turned them against using animal products for feed. But the vast percentage of soybean is GM!

Fig. 2 shows the increased cultivation of GM crops worldwide since they first appeared in 1996. It is interesting to note the significant increase in developing countries.

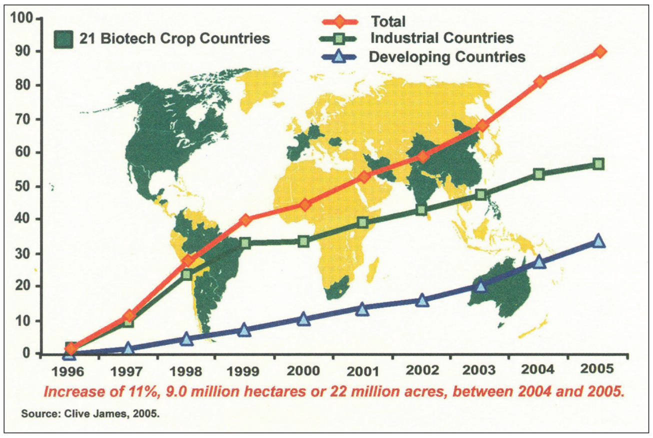

Fig. 2. Global area of biotech crops (million hectares, 1996-2005).

I defy any thinking individual to say that because Europe and Scandinavia do not want GM crops and foods they should prevent Africans from benefiting from this technology. I will go further and say it is immoral for them to do this. They are in effect committing many Africans to starvation in the years ahead.