Genetically engineered crops. Sacrificing the rights of future generations?

World wide, the United States (US) grows the most genetically engineered (GE) crops with an estimated 42,8 million ha of GE crops produced in 2003. Argentina comes second with 13.9 million ha, followed by Canada, Brazil and China, and South Africa in sixth place. In addition, US companies largely own the technology and the commercial production of GE crops is confined to a small number of countries, mainly grain exporters. The adoption rate of GE crops is considered to surpass that of any other new technology ever embraced by the agricultural industry.

Apart from the six main producers, most other countries have adopted a cautious attitude to introducing GE crops and the few that grow them all grow less than 100 000ha. After initially imposing a moratorium on GE crops the European Union has now opted for strict labelling requirements to identify foodstuffs containing GE. Behind this caution lies consumer concerns about the potential impacts of GE crops on the environment and human health, amongst other things.

The technology continues to be controversial, with claims of increased yields and reduced pesticide use contrasted with claims of widespread contamination, increased use of agro-chemicals, and insurance companies refusing to insure GE crops. This briefing introduces GE crops by exploring the interests behind the rapid spread of GE crops, some of the controversial issues and an overview of the South African situation.

What is driving the expansion of GE crops?

▶ *Intellectual Property Rights on living organisms*

The global economy has become increasingly knowledge-based, and intellectual property assets now have more value for corporations than physical assets such as land and labour. For this reason corporations supplying agricultural inputs have shifted to biotechnology, which enables them to develop gene constructs and patent biological organisms. So-called 'life industry' companies are taking out monopoly patents on information, technology and biological organisms and are increasing their market share through mergers, acquisitions and vertical integration of their interests in pharmaceuticals, seed and agro-chemicals.

▶ *Expansion of the pesticide market*

There is a strong case for linking the introduction of GE seeds to the expiry of patents on major pesticides. The introduction of Roundup Ready (RR) GE crops enabled Monsanto to retain its monopoly on the use of the herbicide Roundup (glyphosate) after its patent expired in 2000. This is the reason why RR crops were the first to be introduced and why Monsanto, the leading supplier of RoundUp, has a complete monopoly on GE seed. These seeds are engineered to work exclusively with patented herbicides, with farmers signing contracts to prevent the use of generic versions. It costs under $1 million to bring a new plant variety to the market while it costs between $40-100 million to bring a new pesticide through the regulatory process. This demonstrates why the contractual obligation is so important to Monsanto.

▶ *Expansion and control of the seed market*

Five giant pesticide corporations now dominate the $4.5 billion global market for GE seed and account for 30 percent of the total commercial seed market, with income coming from seed sales and the technology fees farmers have to pay for using patented seeds. By 2003, through aggressive marketing and by offering farmers a package of seed, chemicals and fertiliser plus support, these five companies completely dominated the GE seed market. They are Monsanto (85% owned by Pharmacia), DuPont (owner of Pioneer Hi-Bred), Syngenta (a Novartis/AstraZeneca spin-off), Bayer and Dow. Between Du Pont and Monsanto they own 41 per cent of agricultural biotech-nology patents and share about 93 per cent of the GE seed market world wide, which amounts to 13 per cent by value of the global commercial seed market.

"The common denominator of our business is biology. The research and technology is applied to discover, develop and sell products that have an effect on biological systems, be they human beings, plants or animals." Daniel Vasella, CEO of Novartis.

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Extending global control of farming

Farmers are having a difficult time with rising input costs and the undercutting of their profits by monopoly buyers. While technology fees on GE seed push input costs even higher, companies promise that farmers will benefit from reduced labour and management costs. However, patents on GE seed enable companies to enforce payment of technology fees for growing crops containing specific genetic traits even when they have not supplied the seed. For example, in the United States and Canada non-GE farmers have had to pay licence fees for growing crops incorporating GE traits as a result of cross pollination from nearby fields of GE crops. Farmers who have resisted have ended up in drawn out court cases with Monsanto.

Expanding trade interests

The introduction of GE seeds for commercial use has sparked a huge debate, and has even led to a trade war where the United States, through the World Trade Organisation (WTO), has challenged the European Union for imposing strict permitting conditions for GMOs. WTO agreements that force market access, uniform intellectual property regimes and food safety standards, give immense power to corporations at the expense of the sovereign rights of nations and communities. Through the TRIPs (Trade Related aspects of Intellectual Property Rights) agreement of the WTO, the rights of corporations to patent and own life forms and seed on a global scale is elevated above the rights of farmers who have cared for and developed seed and plants over millennia.

Types of genetically engineered crops

Transgenic crops that have been approved include plants genetically engineered for agronomic traits (herbicide tolerance), pest resistance (insect and viral resistance) and to improve product quality (delayed ripening of fruit, fatty acid metabolism and nutrient content etc.). To date GE crop development has concentrated on the needs of commercial farming and corporations, developing input traits such as herbicide tolerance or insect resistance. However, the focus is shifting increasingly to output traits such as improved nutritional qualities, drought resistance and saline tolerance. Even though it is unlikely that these crops will be on the market in the near future, these hypothetical qualities are used extensively to promote GE crops.

Herbicide resistant

The most commonly grown GE crops are Roundup Ready (RR) soya and maize which allow farmers to spray herbicide without killing their crop. RR seed tolerates glyphosate herbicide, but only in Monsanto's Roundup formulation: so farmers using the seed have to use this formulation. Apart from Monsanto's RR soybeans, canola, wheat, cotton and maize, Aventis makes LibertyLink soybeans and maize, resistant to its glufosinate-ammonium herbicide Liberty, and Syngenta markets Bt11 maize resistant to the herbicide Basta.

Plants as Pesticides

The second most commonly grown GE crops are engineered with the *Bacillus thuringiensis* (*Bt*) gene and produce their own insecticide. *Bt* is a bacterial insecticide used by organic farmers to kill many lepidopteran insect larvae, including most butterflies and moths. Most *Bt* crops are manufactured by Monsanto and include YieldGard maize, Bollgard cotton and New Leaf potatoes.

Next on the market are GE crops that have what are called 'stacked genes' with for example, two Bt genes or a Bt and RR gene may be in the same crop. This combination of genes increases the genetic instability, thus increasing the risks the crop presents to human health and the environment.

Virus-resistant crops

Papayas, squash, sweet potatoes, tomatoes and other fruits and vegetables are also being engineered to be virus resistant. These plants are essentially genetically engineered to behave as vaccines. The greatest environmental and public health risk is that these plants may lead to the creation of new hybrid viruses.

Chemically dependent and sterile crops

Another type of GE crop, called 'suicide seeds' or 'terminator technology', are not able to reproduce. This forces farmers to buy seed every year so companies no longer have to police their patents. Another variant, called "traitor technology" or genetic use restriction technology (GURT), is chemically dependent ('junkie plants'). This requires farmers to spray proprietary chemicals that control germination, growth, flowering or sprouting. Syngenta is at the forefront of this technology and own 42% of the identified GURT patents to date.

Fish, Trees and Glowing Grass

One variety of GE salmon is claimed to grow two to thirteen times the size of conventional salmon. None have been approved for commercial use and sale. If such fish escape into the wild, they will have a competitive advantage and researchers predict that this will lead to the extinction of wild populations. GE trees are insect resistant and grow faster. Trees live much longer than crops, their pollen travels much further, and they have many wild relatives. All these factors indicate that GE trees will have a significant impact on the environment. GE has also been applied to horticulture, to create novel flowers and even fluorescent grass!

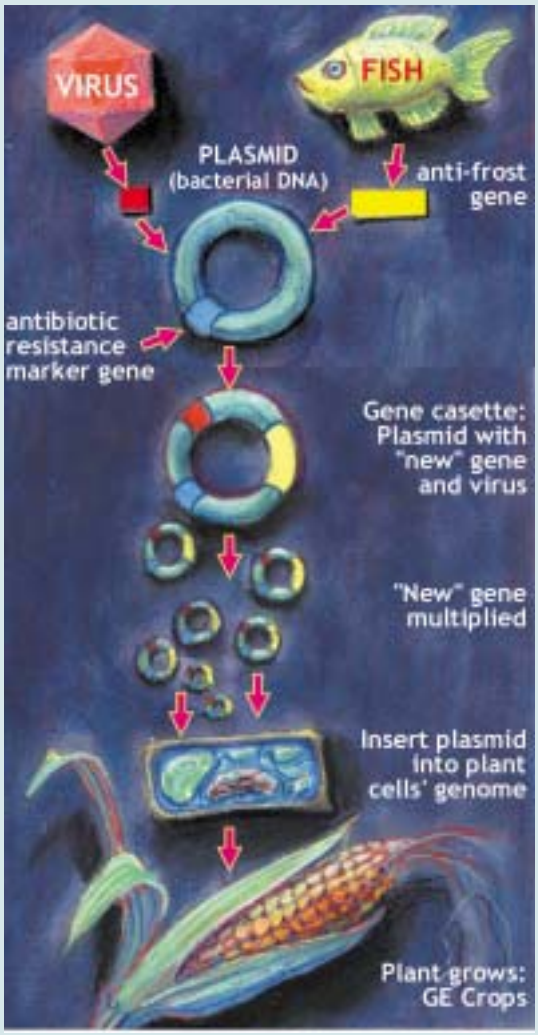
Pharmacrops

Pharming is the term used to describe raising plants or animals to produce industrial chemicals or pharmaceuticals. Applications include the production of hepatitis vaccines in bananas, and antibiotics and digestive enzymes used for food processing. Maize, an important food crop is often used for pharming, representing enormous risks to humans and animals. The locations where these crops are grown are designated 'confidential business information' and are not disclosed to people living nearby, even though the genes and products from such sites can easily contaminate crops, groundwater and surface water.

What is genetic engineering?

Another term for genetic engineering is 'recombinant DNA technology'. It involves taking genetic material from one or more organisms and combining it with the genes of another organism. GE technology combines genes from organisms that are completely unrelated in nature and would never combine naturally or through normal breeding methods. The first step in GE is to isolate the desired gene, then to modify it by combining it with a range of other genes, and then to put this 'gene cassette' into the plant thus incorporating the desired trait into the crop.

Genes, made up of deoxyribonucleic acids (DNA), are often called the blueprint of life, the building blocks of all living things. The science of GE is based on genetic determinism, which holds that scientists can 'design' transgenic organisms and can predict how the genes will behave generation after generation. However, this scientific dogma is outdated and scientists now have realised that DNA does not account for all the traits handed from generation to generation. In fact, a host of other factors, including the environment, enzymes and proteins play a role. Therefore the stability and predictability of transgenic organisms decrease with each succeeding generation.



Issues raised by GE crops

GE proponents argue that GE crops are no riskier than traditional hybrids and that they reduce pesticide and herbicide use, lower environmental impacts and improve yields and food production. In Africa these crops are promoted as the solution to low agricultural yields and therefore hunger. However, current evidence does not support many of these claims and there is widespread concern that the huge profits at stake impair scientific objectivity.

▶ *Narrow technological approach to farming*

Critics argue that technology alone cannot solve problems such as rising pest and disease populations, low or declining yields, economic inequality, land degradation or food insecurity - all key problems in Africa. GE crops are designed for large-scale commercial farming and largely ignore the circumstances of small-scale farmers. It is now widely acknowledged that solutions to agricultural problems must be part of a holistic approach that addresses social, ecological, economic, cultural and political systems.

▶ *Results cannot be universally applied*

Studies done on the benefits for farmers using GE seed have shown variable results depending on the context and methodology. Controlled scientific experiments and field surveys produce different results and performance depending on a wide range of variables such as climatic conditions, market prices and access to inputs and technical services.

▶ *Insecticide use*

Some global studies show that crops engineered with the *Bt* bacteria, have led to decreases in insecticide use in the first three years (discounting the fact that the crop itself is a pesticide) and to increases in yield due to less damage to the crop. However there have been cases where unexpected outbreaks of secondary pests have devastated crops. In the long run, Bt crops lead to insect resistance - as has now happened in China - making *Bt* obsolete and requiring the next step up in chemical or GE crop use. In fact, total pesticide use has increased significantly since the introduction of GE crops.

▶ *Herbicide use*

Studies show that RR crops, especially soya, leads to slightly lower yields than conventional soya, but farmers experience benefits in management as they can spray Roundup after they have planted. Despite an initial reduction, United States Department of Agriculture (USDA) data on GE crops shows a 22% increase in glyphosate applied per hectare of soybeans between 2001 - 2002 and this trend is expected to continue. Similar reports of huge increases in the use of Roundup are coming from Argentina. This is in line with warnings by scientists on the effects of reliance on a single herbicide and its twin crop. The increased use is attributed to increased resistance of weeds to Roundup and a price reduction in glyphosate. Glyphosate, although touted as an environmentally friendly herbicide, is now well known to have a variety of toxic effects on non-target plants and animals.

Claims made	Current evidence of the impact of GE crops
Higher yields	▶ No GE crop is designed for this purpose yet and there are reports of both increased yields and crop losses with current crops. A USDA study states that it is unclear why farmers buy GE crops, as there is no evidence of yield increases.
Reduced management requirements and labour saving for farmers	▶ Commercial farmers find GE crops reduce management and labour. ▶ Increased dependence of farmers on input suppliers. ▶ Labour saving on commercial farms is not a social advantage in developing countries. ▶ Contamination risk presents new management challenges for non-GE farmers. ▶ Identity preservation requirements place the onus and cost on non-GE producers and processors.
Increased food security	▶ Farmers cannot save or exchange seed, putting small scale farmers at risk. ▶ Increased dependence of farmers on external agencies for inputs. ▶ Farmers excluded from local and export markets because of consumer preference for non-GE products. ▶ Monocrops and cash crops (eg. cotton) reduce food security through negative impacts on indigenous low input food production. ▶ Debt accumulation with Bt cotton. ▶ Loss of agro-biodiversity and of access to a range of crops and varieties. ▶ GE doesn't address real issues of food security, such as land tenure, limited access to food, due to poverty and drought.
Environmental benefits	▶ Increased dependence of farmers on chemical input. ▶ Contamination of non-GE crops and relatives. ▶ Weeds and pests develop resistance to single factor strategy. ▶ Initial decrease in insecticide use, but within three years there is an increase in chemical use due to development of insect resistance to *Bt* crops. ▶ Huge increase in herbicide use when RR crops are planted.
Reduced risk of pest and diseases	▶ Transgenic flows lead to herbicide resistant 'superweeds'. ▶ Unintended impacts on non-target insects such as ladybirds, lacewings, bees and butterflies. ▶ Loss of biodiversity. ▶ Negative impact of Roundup and Bt on soil organisms.
Safety and improved nutritional quality	▶ GE maize not approved for human consumption but has found its way into the food supply. ▶ Loss of micronutrients and change in nutritional quality. ▶ GE crops do not break down in the human gut. ▶ Allergies and new toxins are a real possibility. ▶ Negative impact of Roundup on groundwater and human health.

▶ ***High dependence on input suppliers***

One of the biggest concerns of GE crops is that growing corporate control of the world's seed supply and food production system is squeezing farmers' profits and posing a serious threat to food sovereignty. Intellectual property rights on seed and chemicals, combined with the demise of government extension services, leave farmers increasingly dependent on the companies that sell inputs for information and support.

▶ ***Inappropriate research and development***

In addition, vertical integration is concentrating ownership of the supply system and research facilities, reducing crop variety and halting development of appropriate seed for the marginal conditions that face many food insecure small-scale farmers.

In conclusion

Despite many promises, GE crops have not brought significant advantages to humankind. Many of the predictions of risk have proven to be true. The question remains whether the resources spent on this technology cannot be more appropriately applied to improve farming and market conditions, particularly in developing countries. Without doubt the problems farmers face today are not due to a lack of technology but to international market conditions, a dependency on input suppliers, unequal resource distribution and poverty. Many ask the question as to whether we can afford to ignore the genetic revolution and its purported benefits. Perhaps the question should be rephrased: can we afford to carry the risks of this new largely untested technology, and thus sacrifice the rights of future generations to a secure and healthy environment?

References

Research in this briefing paper is based on that done by Biowatch researchers. Other key references include:

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