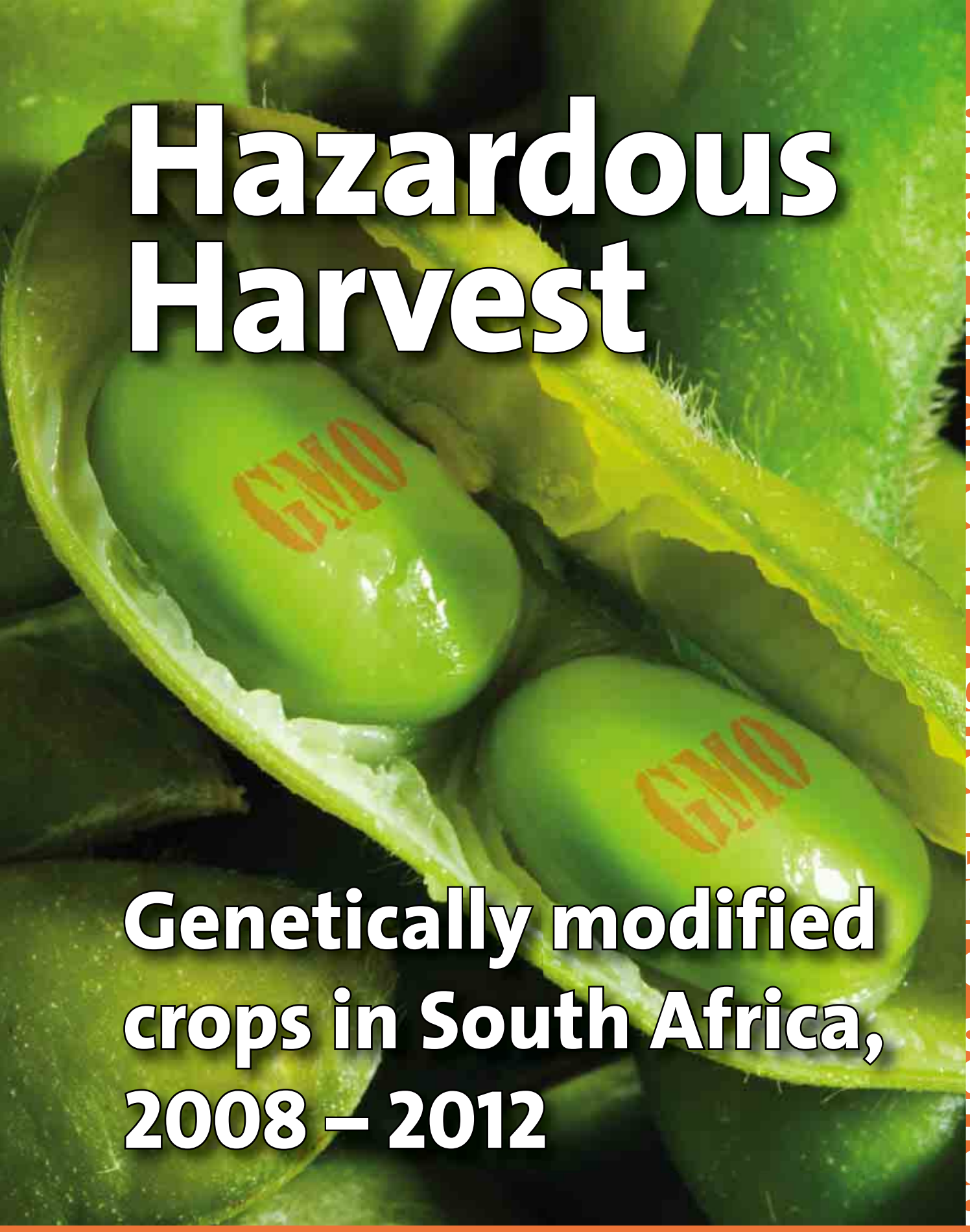

Hazardous Harvest

Genetically modified crops in South Africa, 2008 – 2012

GMOs in African Agriculture series

african centre for biosafety
www.biosafetyafrica.net

The African Centre for Biosafety (ACB) is a non- profit organisation, based in Johannesburg, South Africa. It was established to protect Africa's biodiversity, traditional knowledge, food production systems, culture and diversity, from the threats posed by genetic engineering in food and agriculture. It has in addition to its work in the field of genetic engineering, also opposed biopiracy, agrofuels and the Green Revolution push in Africa, as it strongly supports social justice, equity and ecological sustainability.

The ACB has a respected record of evidence based work and can play a vital role in the agro-ecological movement by striving towards seed sovereignty, built upon the values of equal access to and use of resources.

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Acronyms

AATF	African Agricultural Technology Foundation
ABS	Africa Bio-fortified Sorghum project
ACB	African Centre for Biosafety
AGERI	Agricultural Genetic Engineering Research Institute (Egypt)
AGRA	Alliance for a Green Revolution in Africa
AFMA	Animal Feed Manufacturers Association
AHBFI	Africa Harvest Biotech Foundation International
AC GMO Act	Advisory Council Genetically Modified Organisms Act
ARC	Agricultural Research Council
AU	African Union
BFAP	Bureau for Food and Agricultural Policy
BMGF	Bill and Melinda Gates Foundation
BSA	Biosafety South Africa
Bt	*Bacillus thuringiensis*
CGCSA	Consumer Goods Council of South Africa
CGIAR	Consultative Group on International Agricultural Research
CIMMYT	International Maize and Wheat Improvement Centre
CPA	Consumer Protection Act
CPB	Cartagena Protocol on Biosafety
COMESA	Common market for Eastern and Southern Africa
CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation (Australia)
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DoH	Department of Health
DST	Department of Science and Technology
DTI	Department of Trade and Industry
EC GMO Act	Executive Council Genetically Modified Organisms Act
EIA	Environmental Impact Assessment
EMBRAPA	Brazilian Agricultural Research Corporation
FABI	Forestry and Agricultural Biotechnology Institute (University of Pretoria)
Foc	*Fusarium oxysprorm f.sp cubense*
GHG	Greenhouse Gas
GMO	Genetically Modified Organism
HT	Herbicide Tolerance
IAASTD	International Assessment of Agricultural Science & Technology for Development
I&APs	Interested and Affected Parties
IR	Insect Resistance
ISAAA	International Service for the Acquisition of Agri-biotech Applications
IWBT	Institute for Wine Biotechnology (University of Stellenbosch)
KARI	Kenyan Agricultural Research Institute
KEPHIS	Kenyan Plant Health Inspectorate Service
MFPP	Massive Food Production Programme
MSU	Michigan State University
NAMC	National Agricultural Marketing Council
NARO	National Agricultural Research Organisation (Uganda)
NCC	National Consumer Commissioner
NEMA	National Environmental Management Act
NGO	Non-Governmental Organisation
OGTR	Office of Gene Technology Regulator (Australia)
PTM	Potato Tuber Moth

QUT	Queensland University of Technology
REC	Regional Economic Communities
RR	Roundup Ready
SABS	South African Bureau of Standards
SACAU	Southern African Confederation of Agricultural Unions
SADC	Southern African Development Community
SANBI	South African National Biodiversity Institute
SANS	South African National Standards
SANSOR	South African National Seed Organisation
SASRI	South African Sugar Research Institute
SPP	Surplus People's Project
TIA	Technology Innovation Agency
PAIA	Promotion of Access to Information Act
UCT	University of Cape Town
UNFAO	United Nations Food and Agricultural Organisation
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
WEMA	Water Efficient Maize for Africa

Executive Summary

The commercial cultivation of genetically modified (GM) crops began in earnest in 1998, when the first GM varieties were commercially planted; Monsanto's insect resistant (IR) cotton, known as 'Bollgard', and its IR maize, MON810. The first GM soybean variety (also owned by Monsanto) was cleared for commercial planting in 2001, genetically engineered to be herbicide tolerant (HT). To date cotton, maize and soybean remain the only three GM crops commercially grown in South Africa; these three GM crop plants also account for 94% of all GM crops planted globally. According to the International Service for the Acquisition of Agri-biotech Applications (ISAAA), an industry lobby group, during 2011, South African farmers had planted a total area of 2.3 million ha of GM crops. Statistics from the South African National Seed Organisation (SANSOR) indicate that presently, 77% of seed sales for maize, 100% for cotton and 78% for soybean are now genetically modified.

The Executive Council (EC) Genetically Modified Organisms Act is the legally authorized decision making body with regard to GMOs in SA. The EC operates under the auspices of the Department of Agriculture, Forestry and Fisheries (DAFF). Between January 2008 and the end of February 2012, the EC has granted GMO permits at an alarming pace: 1,458 in total, nearly 1,200 for maize alone (for commercial growing, field trails, imports and exports). The three largest seed companies in the country, Monsanto, Pioneer Hi-Bred and Pannar seed, were granted 76% of these permits. Together, these three companies dominate the local commercial market for GM seeds. In the case of GM maize, they own 84% of all registered varieties, though virtually all GM seeds sold in South Africa contain Monsanto's patented traits, giving the multinational giant a de facto monopoly over a market worth more than R1.5 billion.

Pannar Seed is presently subject to a take-over bid by Pioneer, though the Competition Commission and the Competition Tribunal have twice rejected the bid. The matter is currently pending before the Competition Appeals Court. If the deal is approved, the seed market for South Africa's staple food will vest in the hands of two multinational corporations: Monsanto and Pioneer.

Since 2008, four new GM maize varieties – two of them stacked for both insect resistance and herbicide tolerance - have been approved for commercial release. Two of these varieties belong to Swiss biotech giant Syngenta, whose inroads into the domestic maize market have been minimal, despite being the only company other than Monsanto to have a trait cleared for commercial use. The area planted with stacked GM maize in South Africa has already expanded from 8% in 2008, to 41% in 2011.

The expansion of herbicide tolerant (HT) (or Roundup Ready) crops is equally a cause for concern. Between 2008 and 2012, the number of GM maize varieties registered for plant breeders' rights that contain the HT gene nearly trebled. According to industry figures, 54% of all GM maize currently planted now contains the HT trait. The expansion of GM soybean, which is all HT, has been phenomenal; from 184,000 ha in 2008, to 480,000ha in 2011. From 2000 to 2010, of the 11 countries[1] that grow GM soybean, only Uruguay has expanded its GM soybean area at a faster rate than South Africa. The Bureau for Food and Agricultural Policy (BFAP) predicts that South Africa will be growing 650,000 ha by the end of the decade.

Since 2008, field trial permits have been granted for 24 new maize varieties, and 6 new cotton cultivars (all of which are stacked). Contained use permits were granted for GM sorghum in 2009, and GM cassava in 2010, after protracted appeals processes. Several varieties of GM sugarcane are being tested, though commercialization appears to be a very long way off. An application for field trials involving GM banana was submitted by Dr. Noelani van den Berg of the University of Pretoria during 2011, though the application dossier was so lacking in detail that it was returned to the applicant. In 2009, South African consumers and farmers were very nearly subjected to GM potatoes. However the Agricultural Research Council's (ARC) application for full commercial release was rejected by the EC. The ARC has appealed the decision and more than two years later, the case has not yet been finalised.

Prior to 2008, South Africa was a huge importer of GM commodities. For example, in 2007 over 2 million tons of GM maize was imported from Argentina. South Africa has since taken its tentative first steps towards the highly lucrative international export trade in GM commodities. As a result of the huge maize surplus in 2010, the EC approved the export of nearly 6 million tons of GM maize to destinations as diverse as Mexico, South Korea, Spain, Malaysia and Kuwait. Though an early shipment was prevented from entering Kenya in early 2010, nearly 300,000 tons have been exported to Mozambique and Swaziland. Despite these exports, South Africa is set on resuming the import of vast quantities of GM commodities. The global trade in GMOs is enormous, worth an estimated $160 billion annually, and is dominated by the large multinational grain traders. In 2011, several of them, including Bunge, Louis Dreyfus and Noble resources, all announced huge investment plans in South Africa. In the case of Bunge, it has entered into a joint venture with local trader, Senwes.

South Africa is an important conduit for the biotechnology machinery in the proliferation of GM seeds and commodities into the rest of Africa. Numerous GM research consortia investigating African staple crops, such as cassava and sorghum, include individuals or institutions based in South Africa. Indeed South Africa exports GM commodities to various African countries, including Mozambique and Swaziland.

The country's role as a biotechnology 'leader' on the continent has been hailed by industry lobby groups, such as the International Service for the Acquisition of Agri-biotech applications (ISAAA), and the US government alike, ostensibly in their fight to eradicate poverty and hunger. However, these claims remain largely unsubstantiated. In South Africa, a 5kg bag of maize meal cost 84% more in January 2012, than it did in January 2008, in spite of the increased adoption of GM maize seed by farmers. Attempts to foist GM seeds onto small-scale farmers in both KwaZulu-Natal and the Eastern Cape have ended in unmitigated disaster.[2]

Even commercial maize farmers are now experiencing some of the perils of the technology. In a recent article Corne Louw, a senior economist at Grain SA, stated that in 2004/05 season the cost of seed accounted for 6% of a maize producers overall costs, and that for the 2010/11 season this figure had more than doubled, to 13%.[3] More problems are likely, as the results of a three-year joint South Africa – Norway study revealed that in parts of South Africa's maize belt, insect populations have been found that have developed resistance to Bt maize.[4]

It is clear that the real beneficiaries of this GMO deluge have been the multinational biotechnology and agribusiness corporations. The Gates Foundation have donated nearly $90 million into GM research for 'drought tolerant' maize, and nutritionally enhanced cassava and sorghum; the research budget for Monsanto and BASF's collaboration was $2.5 billion in 2011, while Pioneer Hi Bred alone devoted $1.7 billion to Research and Development (R&D) that year. Even this is dwarfed by the mammoth farm subsidy regime underway in the US and the EU. From 2008 to 2010, farmers in the US who grew maize, soybean and cotton (the three major GM crops) were bestowed with over $21 billion in subsidies. In 2009, the combined revenues of the top 10 corporations in seed, agro-chemicals, fertilizers, grain and oilseed trading and processing, food processing and retailing were over $1.6 trillion[5]; larger than the economies of India, Canada and Russia.

According to the United Nations Food and Agricultural Organisation (UNFAO), over the course of the 20th century, 75% of the world's plant genetic diversity was lost, as local varieties and land races have been replaced with genetically uniform seed. A similar process in animal husbandry has put 30% of all livestock breeds at risk of extinction. At the turn of the 21st century, 12 plants and five animal species generated three quarters of the world's food.[6] This is no accident, but the result of a very particular system of food production that demands uniformity and yield over diversity and nutrition. GM crops fit perfectly into this system, where vast monocultures can be grown, harvested, processed and then 'freely' traded over thousands of miles. It is a system that, by some estimates, contributes up to 57% of global Greenhouse Gas (GHG) emissions.[i] A recent report from KPMG singled out the food industry as both the most environmentally damaging, and the most vulnerable

to what it terms 'sustainability megaforces'. Further, of all sectors analysed, the food industry was the only one that was more environmentally intensive in 2010, than it was in 2002.[7]

In 2008, the International Assessment of Agricultural Science & Technology for Development (IAASTD), the most comprehensive study into global agriculture ever undertaken, concluded that: *"If we do persist with business as usual, the world's people cannot be fed over the next half-century. It will mean more environmental degradation, and the gap between the haves and have-nots will expand. We have an opportunity now to marshal our intellectual resources to avoid that sort of future. Otherwise we face a world nobody would want to inhabit."* Instead, an alternative vision was put forward, that the *'greatest scope for improving livelihood and equity exist in small- scale, diversified production systems in developing countries."*[8]

The status of GMOs in South Africa

Commercially cultivated GMOs

The commercial cultivation of genetically modified (GM) crops began in earnest in 1997, when the first GM varieties were commercially approved: Monsanto's insect resistant (IR) cotton, known as 'Bollgard', and its IR maize, MON810. The first GM soybean variety (again, owned by Monsanto) was cleared for growing in 2001, genetically engineered to be herbicide tolerant (HT). To date these remain the only three GM crops commercially grown in South Africa. These three crops also account for 94% of all GM crops planted globally. South Africa still remains the only country in the world that grows GM varieties of its staple food, though GM maize field trials have been taking place in Mexico, the centre of origin of maize, since 2009.[9]

According to the International Service for the Acquisition of Agri-biotech Applications (ISAAA), an industry lobby group, during 2011, South African farmers planted 2.3 million ha of GM crops. Though statistics from the ISAAA have been criticized for methodological shortcomings[10], figures from South African organizations at least verify the upward trend of the adoption of GM crops. For example, the South African National Seed Organisation (SANSOR) states that in 2008, GM seed accounted for 42% of all maize seed sales. By 2011, this had risen to 78%.

Adoption rates for the other two commercialized GM crops are even higher. All the cotton seed sold during 2011 was GM, up from 81% in 2008. The overall cotton area has increased over this period, from 9,000 ha to 13,000 ha, though this is still a fraction of what was cultivated in late 1980s (up to 180,000 ha). GM soybean sales increased their overall share of the market from 78% to 85% over the same period. This only tells part of the story though, as the overall area cultivated with soybeans has increased dramatically, from 165,000 ha to 480,000 ha.

Pre-commercial trials

In South Africa, it can take up to six years from the first field trial of a GM crop until its full commercial release.[11] A number of field trials and enclosed greenhouse trials have been underway since the last GMO overview booklet was produced by the ACB in 2008.

In late 2009, the Executive Council (the GMO decision-making body in the country) rejected an application by the Agricultural Research Council (ARC) for the commercial release of a GM potato. The ARC appealed the decision and more than two years on, the case is still with an undisclosed appeal board, appointed by the Minister.

Nine field trial permits have been granted to the South African Sugar Research Institute (SASRI) since 2008, for GM sugar-cane experiments, though there is little indication that a full commercial release application is forthcoming. Field trial applications have been made for banana and cassava, while 'contained use' trials have been conducted on sorghum. A number of GM vaccines have been imported for the purpose of conducting human trials. Monsanto submitted a field trial application for GM Canola in September 2009, though they withdrew this application a year later.

In a bid to consolidate their hold on the commercial maize seed market, multinational seed companies such as Monsanto and Pioneer-Hi Bred have been conducting a spate of field trials since 2008, many for new 'stacked varieties' (see below), which combine IR and HT traits. Over the same period one trial release has been undertaken with GM soybean and 18 for GM cotton (again, many of these were for stacked varieties).

The proliferation of stacked GM crops, both in terms of commercial planting and the number of field trials for new varieties, has been significant development. A stacked GMO (sometimes known as gene stacking) occurs when two GM plants are bred together, the intention being to transfer the genetically added trait (for example IR or HT) to the resulting progeny. Gene-stacking is highly controversial; both in its implications for biosafety and the impact it has on higher seed prices and the further concentration of intellectual property rights (IPR). In short, in all of the major GMO producing countries, it is not deemed necessary to submit a stacked GMO for biosafety assessment if the parent plants have been previously approved. This approach has been severely criticised by many independent scientists on the United Nation's expert rosters on biosafety.[12]

Data from Grain SA, an industry organisation, shows that in 2010, the average price of stacked GM maize seed on the market was around 42% higher than single trait maize.[13] In 2008, just over 5% of the maize planted in South Africa was stacked. By 2010/11 this had increased 8 fold, to 41%.

One of the most significant GM research projects currently underway in South Africa is the Water Efficient Maize for Africa (WEMA) project. WEMA forms part of a monumental $2.5 billion research 'collaboration' between Monsanto and German chemical giant BASF. The Gates Foundation and the Howard G. Buffet[14] Foundation have provided funding for WEMA, some $47 million. WEMA's aim is to genetically engineer a 'drought tolerant' variety of maize. Five African countries have been targeted as potential markets: Kenya, Mozambique, Tanzania, South Africa and Uganda. Field trials have been underway in South Africa since 2007, and are set to continue throughout 2012. Monsanto has high hopes for WEMA as, not only would it represent the first new 'trait' to be released commercially in over 15 years, it also sees its 'drought tolerant' maize as a means to open up previously untapped markets for small scale farmers in Africa.[15]

The GMO seed and commodity trade

In addition to domestic cultivation and research, South Africa also plays a vital role in the international proliferation and trade of GM seeds and GM commodities. Since 2008, hundreds

of thousands of tons of GM maize, cotton and soybean seed have been imported for commercial planting purposes (including a sharp increase in HT and stacked varieties). Conversely, thousands of tons of maize and cotton seed have been exported to various destinations, including Honduras, Columbia, India and the Philippines.

The international trade in GM commodities (bulk shipments of GM grain) is extremely lucrative, with some estimates putting the annual global value at $160 billion. The majority of GM maize and soya grown globally is for animal feed (approximately 40% of the world's grain harvest is now grown for this purpose), though in the USA, the agro-fuel industry also consumes significant quantities. The Cartagena Protocol on Biosafety also governs the international trade in GM commodities, though intense industry lobbying throughout its negotiations resulted in the provisions of the Protocol for commodity trade in GMOs being substantially watered down. From 2005 until 2010, South Africa imported nearly 3.5 million tons of GM maize[16], plus several thousand tons of soya, mostly from Argentina. However, in the last few years, South Africa could no longer import certain GM commodities from these countries (see details below). This, coupled with a 4 million ton maize surplus, resulted in South Africa becoming a net exporter of GM commodities from 2010 onwards. To date, export permits for over 5.8 million tons of GM maize have been granted, including for 1.7 million tons to South Korea, 525,000 tons to Taiwan and nearly 600,000 tons to Europe. Most controversially, exports to several African countries were sanctioned from 2010 onwards, while during 2011 nearly 2 million tons were permitted for export to Mexico, the centre of origin of maize.

The legal framework

The main legal instrument governing GM activities in South Africa is the GMO Act (15) of 1997, which came into effect on the 1st of December 1999. In order to comply with the requirements of the Cartagena Protocol on Biosafety (which became binding on SA in November 2003), the Act was amended in 2006, and came into effect on the 26th of February 2010. All decisions regarding GMO permits in South Africa are made by the Executive Council (EC) of the GMO Act (assisted by an advisory committee of experts appointed by the Minister of Agriculture, Forestry and Fisheries). The Minister of Environmental Affairs may, at his or her discretion, call for a full environmental impact assessment (EIA) of a GM crop before it is approved for commercial release. However, to date, not one single EIA has been requested in response to any application.

The lack of a mandatory labelling system means that the appropriation of the nation's food system by multinational corporations has gone largely unnoticed. This is not the result of government oversight, but of sustained pressure by the biotechnology industry, as well as many sectors that benefit from the cultivation of GM crops (the animal feed and oilseed industries for example) to avoid mandatory labeling. Though regulations passed by the Department of Health in 2004, require the labelling of foodstuffs with GM ingredients that are significantly different to the norm, for example in terms of nutritional value, no GMOs commercially grown fulfill these requirements, thereby negating any requirement for labeling in terms of this legislation.[17] On the 1st of April 2011, the new Consumer Protection Act (under the auspices of the Department of Trade and Industry – DTI) came into effect. Section 24.6 calls for explicit disclosure, through a display on the packaging, of the presence of any GM ingredients in food.

From the 1st of October 2011, regulations in terms of the Consumer Protection Act came into effect and require food producers, importers and packagers to choose one of three mandatory labels for GM foods and marketing materials. Where the GM content is at least 5%, the food will be labeled as 'containing GMOs.' Where the food is produced directly from GMO sources, there will be no need for testing, and food must be labeled as 'produced using genetic modification'. Industry may also opt for 'may contain GMOs' labels in circumstances where they are able to argue that it is scientifically impractical and not feasible to test food for GM content.[18]

While it appears that some supermarket chains and food processors have tentatively begun to introduce GM labeling, this is not commonplace. In March 2012, the ACB submitted four household food products for testing of GM content to an independent testing facility. All four products, none of which were labeled, tested positive for GM content. The lowest score for any product, maize meal in this case, indicated that 66% of the maize was GM. In response, the Consumer Goods Council of South Africa (CGCSA), an industry representative body, issued a statement that it was still unsure of the items to which the GM labeling laws applied. At the time of writing, the matter remained unresolved pending the interventions of the National Consumer Commission.

The ACB, having sought a legal opinion on the matter, maintains that any foodstuff containing 5% or more of a GM ingredient that is produced, supplied, imported or packaged must be labeled in a conspicuous and easily legible manner and size, stating that the good, ingredient or component 'contains genetically modified organisms'. This applies irrespective of whether the goods were made in South Africa or elsewhere. Where a good, ingredient or component contains less than 5% GMOs, the notice can state that the level of GMOs is less than 5%. However, any good, ingredient or component containing less than 1% GMOs cannot be labeled as GMO free.[19]

Departmental responsibilities

The Department of Agriculture, Forestry and Fisheries (DAFF), through the EC, is responsible for the permitting of all GMO related activities in South Africa. The EC meets 4 to 5 times a year at the DAFF. Its membership is drawn from a number of government ministries whose activities are impacted by biotechnology: These are the departments of Environmental Affairs (DEA), Health (DoH), Science and Technology (DST), Trade and Industry (DTI), Labour (DoL) and the DAFF itself. The DAFF is also the national competent authority responsible for carrying out the administrative functions of the Cartagena Protocol on Biosafety within South Africa.

The DEA's GMO work is informed by the National Environmental Management Biodiversity Act (NEMBA), which led to the establishment of the SA National Biodiversity Institute (SANBI) in 2004. According to its mandate, SANBI 'must monitor and report regularly to the Minister on the impact of any genetically modified organism that has been released into the environment including the impact on non-target organisms and ecological processes, indigenous biological resources and the biological diversity of species used for agriculture.[20]

In 2008, SANBI, in conjunction with the GENOK biosafety centre in Norway, undertook a three-year study to monitor the environmental impacts of the insect resistant maize variety MON810. The results, published in January 2011, flagged a number of areas of concern. At the molecular level, it was found that the level of expression of the Bt gene (which infers the insect resistance in the plant) varied according to whether it was produced in a maize plant or a bacterial host. This is significant as the majority of risk assessment data provided is generated using a bacterial host rather than from the plant itself. In the field, GM and non-GM counterpart maize plants were found to react differently to similar environmental conditions. Most worryingly from a farmer's point of view, insect pest populations have been identified that have developed resistance to the MON810. The study concluded that

where resistance had already been reported, existing refuge requirements (see box) were unlikely to be adequate to stem this.

Though welcoming these long overdue biosafety developments, the published report left several key questions unanswered, including: how different role players are expected to liaise, how government departments will share information, and who will have access to information generated by future studies?[21] SANBI, admitting the MON810 study came 'a little late'[22], has begun consultations to establish a post-release monitoring study for glyphosate tolerant crops, which have started to spread at an alarming rate in South Africa. A preliminary workshop was held at the University of the North West, Potchefstroom, in March 2012. Many of the researchers involved in the MON810 project were present, and will contribute towards the projects design and implementation, which can only be beneficial both in terms of the expertise they will bring and for purposes of consistency. It was also clear from the workshop that industry is vehemently opposed to yet more 'onerous' regulation and monitoring of GMOs, and presented a largely united front in their opinion.

What is a refuge?
Farmers who plant insect resistant (Bt) crops are required to plant an adjacent non-Bt 'refuge' area. Insects that are continually exposed to the Bt toxin in the field will, over time, develop a resistance, which will impact upon the efficacy of the plant. Theoretically this process can be halted or significantly impaired if insects exposed to Bt crops mate with insects from the refuge area, that have not developed any kind of Bt resistance.

Further reading from the ACB:
- GMOs in South Africa: 2008 overview
- The GM stacked gene revolution: A biosafety nightmare
- Overview of GM regulatory regime in South Africa
- Traceability, segregation and labeling of genetically modified products in South Africa: A position paper on the implementation of the Consumer Protection Act and mandatory labelling of GM food
- GM labelling in South Africa: The law demystified

Main players in the GM seed market

Extreme levels of concentration at every stage of the value chain characterize the global industrial food system. In 2009, three corporations, Monsanto, DuPont (through its seed subsidiary Pioneer Hi-Bred) and Syngenta, controlled 53% of the $24 billion global commercial seed market. Monsanto is the world's largest seed company, selling over $10 billion worth of seed and agro-chemicals in 2010. Though originally a chemical company, by acquiring seed companies such as DeKalb genetics ($2.5 billion), Delta and Pineland ($1.5 billion) and Seminis ($1.4 billion), to name but a few, Monsanto took control of an enormous collection of germplasm and acquired a ready-made seed dealership[23] to start selling its new GM seeds.[24] Pioneer Hi-Bred was the world's largest seed company, with a vast germplasm library and readily established dealerships, when it was acquired by US chemical giant DuPont in 1999 for $9.4 billion. Since 2008, the global market value of GM seeds has rise from $7.5 billion to $13.2 billion in 2011.

The top three seed companies, Monsanto, Pioneer and Syngenta, have all firmly established themselves in South Africa. Pioneer established a research station at Delmas in 1991, and began selling seeds commercially the following year. Monsanto announced its arrival on the scene by purchasing two of South Africa's largest seed companies in 1999, Sensako and Carnia. Together with Pannar, the largest remaining domestic seed company, they dominate the local seed market for all three GM crops.

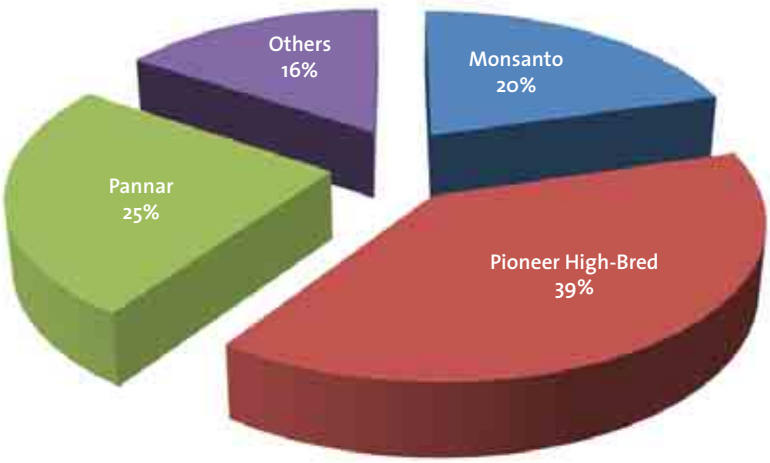
Of these markets, maize is by far the largest. Its total value in 2010/11, for GM and conventional seed, was R2.1 billion.[25] Considering GM seeds accounted for 77% of sales, it could be surmised that this market is worth at least R1.5 billion annually[26]. Using the same methodology for 2007/08, one comes to a conclusion that the GM maize seed market was worth just under R650 million,[27] indicating a substantial 130% increase in value in just four years! More detailed information on market shares per company are closely guarded secrets, though it is possible, through the maize variety lists kept by the DAFF, to get an idea of a company's presence in a particular market. The variety lists for GM maize are telling: The three largest seed companies in South Africa own 84% of all varieties registered (see figure 1 below). This dominance was already well established by 2008, when the top 3 owned 86% of registered varieties, though it needs to be contextualised that in that period, the total amount of registered GM varieties increased from 93 to 166. Most significantly, an ACB investigation of the maize market during 2011, found only one GM maize variety on the market that did not contain a Monsanto trait - a yellow maize variety sold by Klein Karoo seed containing Syngenta's Bt11. Every other GM maize (as well as all cotton and soybean) seed sold in South Africa is sold under license from Monsanto.

The huge increase in soybean plantings in the last four seasons has caused the value of the soybean seed market to jump fourfold, from R18 million to R78 million; a significant increase considering that 70% of the soybeans planted are from farm saved seed.[28] The top three companies own 18 of the 31 varieties registered. Although Monsanto only has two varieties registered, because all GM soybean seed sold in South Africa contains their 'Roundup Ready' trait, they effectively hold a monopoly over this market. According to its website, Monsanto controls 60% of the South African market for glyphosate based herbicides. The GM cotton seed market is much smaller, valued at just under R14 million (up from R10 million in 2007/08). Here again Monsanto is the dominant player, owning 14 of the 15 varieties registered.[29]

In September 2010, it was announced that Pioneer Hi-Bred and Pannar Seed had sought approval to merge from the Competition Commission. Under the terms of the agreement Pioneer would acquire an 80% stake in Pannar for an undisclosed amount. As a public interest group with many years of experience with issues pertinent to the case, the ACB approached the Commission and made two detailed written submissions as to the impacts that the merger might have, particularly with regard to the commercial maize seed market. As can be seen from figure 1 below, a Pioneer take-over of Pannar would create a duopoly, where two companies owned 84% of all registered GM maize varieties. For the GM soybean market this figure would be 58% (though all traits sold would still be registered with Monsanto). There would be little impact on the cotton seed market however, as Monsanto dominates this.

In December 2010, the Competition Commission concluded that the merger would lead to a substantial lessening of competition in the maize seed market, resulting in 'a high likelihood' of maize seed price increases, higher barriers to entry for new seed companies, and would create market conditions 'which are conducive for collusive behavior.' Pioneer and Pannar subsequently approached the Competition Tribunal to reverse the Commission's decision. The ACB was permitted to intervene in the public interest and Dr. Maxwell Mudhara, of the farmer support group at the University of KZN, on behalf of the ACB, argued that in the event of the merger going ahead and resulting in increased seed prices[30], this would have a devastating impact upon small scale commercial and subsistence farmers. During December 2011, the Tribunal similarly prohibited the merger. The merging parties are appealing the decision of the Tribunal decision to the Competitions Appeal Court (CAC). The ACB is participating in the appeals process. It is anticipated that during April/May 2012, the matter will be resolved once the CAC delivers its judgment.

Figure 1. GM maize seed variety ownership, 2011



Source: Department of Agriculture, Forestry and Fisheries

Further reading from the ACB:
- Biotechnology, seed and agro-chemicals: SA and global trends
- Heavy Hands: Monsanto's control in South Africa

GMO permits granted, 2008 – 2012

Crop	2008	2009	2010	2011	2012*	Total
Maize	226	293	325	314	35	1193
Soybean	7	12	25	14	4	62
Cotton	23	27	27	24	1	102
Sugarcane	0	5	0	4	0	9
Sorghum	0	1	0	0	0	1
Cassava	0	1	2	0	0	3
Vaccines	15	19	18	30	2	84
Other	0	0	1	3	0	4
Total	271	358	398	389	42	1458

Source: GMO permit lists, 2008 – 2012. Department of Agriculture, Forestry and Fisheries.
*At the time of writing, permits for 2012 had been published until the end of February. All subsequent references to permits issued in 2012 will be up to this date

Analysis of permits granted

In our previous study published in 2008, we noted that from January 2007 to July 2008, the GMO Executive Council granted 425 permits for import, export, commodity clearance and general and trial release[31] (379 for the 2007 calendar year). This level of enthusiasm has not abated; nearly 1,500 further permits have been granted since the beginning of 2008, the vast majority for maize, followed by cotton and soybean. It would appear that South Africa is on the threshold of a deluge of new GM crop releases; from 2008 to 2011 a staggering 79 field trial permits were granted for maize (60), cotton (18) and soybean (1). Four new GM maize varieties were granted environmental release in 2010, doubling the number of maize approvals. These trials are continuing, with the latest set being granted in October 2011.

While the majority of permits granted were for commercial crops, a number of research projects on 'climate ready' and African heritage crops have also been underway. The Water Efficient Maize for Africa project of the Gates Foundation and Monsanto (see below for more details) has been under way since 2007, when its first field trial permit was granted. Permits were granted for greenhouse trials for GM sorghum in 2009, and GM cassava in 2010. Nine permits were also granted for field trials of GM sugarcane.

During 2007, South Africa imported millions of tons of GM maize and soya, predominantly for the animal feed industry. A mixture of domestic surpluses, a moratorium on new variety imports spearheaded by the DTI spanning several years, and the prohibition of imports from Argentina and Brazil (who commercially grow GM varieties not yet approved in South Africa), has meant that since 2008, South Africa has become a net exporter of GM products. In 2010, for the first time, bulk shipments of GM grain were exported to other African countries, with permits being granted for exports to Kenya, Swaziland, Mozambique and Somalia, as well as to countries in East Asia, the Middle East, Italy and Spain. Following the approval of a 23 new GM events for commodity clearance during 2011, it appears that South Africa is again set on importing massive amounts of GM commodities.

Just as variety ownership is narrowly concentrated, the awarding of GMO permits is highly skewed towards the largest seed companies. Over three quarters of permits for all GMO activities involving maize, cotton and soybeans have been granted to Monsanto, Pioneer and Panaar, with Monsanto accounting for over 50% of the permits granted.

There has been a marked increase in the amount of GMO permits being granted for stacked events during the period 2008-2011. This is reflected in the increasing share of staked varieties, particularly maize, now being grown in South Africa. Presently there are only five available on the market, three maize and two cotton. Three of these maize varieties were only granted approval in 2010. However, the upward trend in stacked GMOs looks set to rise dramatically, as thirty new varieties (some stacking four genes) have been undergoing field trials; 6 varieties of cotton, and 24 for maize (see annex 3 & 4). In 2011, the first field trial permits were approved for stacked GM soybean. Pioneer alone is field-testing 21 stacked varieties, while all the stacked cotton varieties on trial are owned by the German chemical giant Bayer.

Company	2008	2009	2010	2011	2012*	Total
Monsanto	127	201	176	164	23	691
Pioneer	46	84	78	75	7	290
Pannar	13	19	8	8	0	48
Top 3	186	304	262	247	30	1029
Total for 3 commercial crops	256	332	377	352	40	1357
Top 3: % of all permits	73	92	69	70	75	76

Source: GMO permit lists, 2008 – 2012. Department of Agriculture, Forestry and Fisheries.

GMO activity by crop

Banana

The Banana is one of the world's most important food crops, with over 130 million tons produced annually. India is the world's largest producer, with annual production of around 30 million tons, while producers in Latin America dominate the international banana trade. It is in sub-Saharan Africa however, where the fruit contributes most significantly to health and nutrition; over 100 million people derive 25% or more of their energy requirements from bananas.

The Bill and Melinda Gates Foundation (BMGF), under its 'Grand challenges in global health' initiative, has been funding research into 'nutritionally enhanced' GM bananas (higher pro-vitamin A, Vitamin E and Iron content), and disease and pest resistance. The project involves scientists from Australia, the USA and Uganda;[32] bananas are a staple food for some 16 million Ugandans.[33] Research is being led from the Queensland University of Technology (QUT) in Brisbane, Australia, which has been conducting field trials (for both nutrition and disease resistance) since 2008. The Australian Office of the Gene technology Regulator (OGTR) granted further field trial permits in 2011.[34] Field trials commenced in Uganda, at the Kawanda research station outside of Kampala, in early 2010, and are ongoing.

In June 2011, the ACB learnt that scientists at the University of Pretoria had made an application to the EC to conduct the first ever field trials involving GM bananas in South Africa. The rationale for the genetic modification is to combat Fusarium wilt, caused by a soil born fungi *Fusarium oxysprorm f.sp cubense* (Foc). The idea is to genetically engineer bananas with a rice gene (NPRI homolog (NH1)) to confer resistance to the said Foc. The aim of the field trials was to evaluate Cavendish bananas that have been transformed to express the NH1 Gene for Foc resistance. The trials were planned to take place in Mpumalanga from November 2011 to December 2012.

Having obtained the biosafety dossier that was submitted by the applicant, the ACB was ably assisted by independent biosafety scientists in preparing an objection. We found that the original application and risk assessment information contained no biosafety data pertaining to any previous greenhouse trials, indicating that none had been carried out. Greenhouse trials are an 'indispensible' step between the laboratory and open field trials. Moreover, it was found that the application was lacking the most rudimentary information, from the molecular characterization of the event to procedures to prevent the bananas from being removed from the trial site or co-mingling with other non-GM bananas in the vicinity.[35] It appears that the Registrar was of a similar opinion, and has requested additional information from the applicant. At the time of writing this information has still not been received from the applicant.[36]

Domestic banana production has been in steady decline in South Africa for a number of years. Many farmers are either switching to Macadamia nut production, which has higher profit margins, or re-locating to Mozambique. In Mozambique, where production has increased by 200% in the last five years, climatic conditions are more suitable, and government more amenable to the kind of plantation agriculture associated with banana production. Virtually all new production in the south of the country[37] is by South African farmers, and many of the country's largest supermarket chains have started sourcing bananas directly from these producers in Mozambique.[38] What is clear, from speaking to members of the banana industry, is that Foc only represents one of many factors behind a decline, other factors contributing include: labour and land tenure issues, more profitable alternative crops (e.g. Macadamias), ecological and climatic constraints, and Panama disease.[39]

Links between the use of glyphosate based herbicides and Foc have been observed in the USA, Canada, and Australia.[40] In South Africa, though it is difficult to obtain detailed figures on glyphosate consumption, numerous chemical companies recommend its use in banana cultivation.[41] Additionally, Mpumalanga, which produces 50% of the nation's bananas, also grows 45% of all soybeans, nearly all of which are now genetically engineered for glyphosate tolerance. Between 2001/02 and 2010/11, the area planted with soybeans in Mpumalanga more than trebled, from 62,000ha[42] to 188,000 ha[43] (the expansion of Roundup Ready soy in South Africa will be discussed in more detail below). This immediately begs the question: how effective will a Foc resistant GM banana be under this onslaught of glyphosate. It also highlights the problems inherent in the biotechnology industry; the funneling of complex ecological, social, economic and political issues into an extremely narrow technological and productivist lens.

Further reading

- GM banana slips in South Africa: Key issues and concerns

Canola / Alfalfa

GM Canola is predominantly grown in the USA, Canada and Australia, accounting for about 5% of the total GM planted area (8.2 million ha).[44] The global market for GM canola, used principally for cooking oils and animal feed, is estimated to be worth $300 million. Canola as a plant is highly promiscuous, presenting a significant risk of gene-flow from GM to non-GM Canola plants. A recent study by the University of Arkansas in the US corroborates these fears. In North Dakota, (a large GM canola growing area), 80% of the wild canola plants studied have developed herbicide resistance by crossing with GM varieties. Studies in both Canada and Japan have reached similar conclusions. Although GM Canola is not grown in Japan, transgenic oil seed rape, a close relative of canola was found in areas adjacent to the ports where it is imported.[45]

In South Africa canola (non GM) production is mostly confined to the Southern Cape, and domestic demand usually outstrips supply. In 2009/10, canola was planted on 34,820ha (down from 45,000 in 2003/04).[46] Though there is little scope for increasing production in the Southern Cape, this could change given its inclusion as a potential feedstock for biodiesel in the government's national biofuels strategy. Its potential as a rotational crop and grow outside of its traditional area of production has been put forward by some players in the nascent biofuels industry.[47]

Monsanto applied to the EC for a permit to conduct field trials of its Roundup Ready Canola variety in 2009. The ACB lodged an objection to this, noting that the field trials would pose unacceptable environmental risks, including gene flow into wild populations. The South African biosafety authorities concurred, and twice requested that Monsanto provide additional biosafety information. At its May 2010 meeting, the EC noted that Monsanto had withdrawn its application[48] to our great relief!

http://www.flashinthepan.net/wp-content/uploads/2012/01/sprouts.jpg

Cassava

The Portuguese introduced cassava, which originated in South America, to Africa in the 16th and 17th centuries.[49] Today, it is considered the most important tropical root crop in the world, as its starchy roots are major sources of dietary energy for more than 500 million people worldwide.[50] In 2010, total world production was nearly 230 million tons, with Africa accounting for 53% of this, followed by Asia (33%) and South America (14%). Nigeria is the continent's largest producer by far, with total production of 37 million tons.[51] Though grown mainly as a food crop, Cassava also has applications as animal feed and for certain industrial products, as starch. In South Africa, what little cultivation takes place (predominantly by small holders) is for commercial and food grade starch, which is about 20,000 tons annually. The global starch industry is said to be worth around $20 billion annually.[52]

Research is currently underway into GM cassava resistant to the Cassava Mosaic Virus (CMV) in Kenya and Uganda, and bio-fortified Cassava in Nigeria.[53]

http://o.tqn.com/d/celiacdisease/1/0/I/0/-/-/Cassava_root.jpg

In South Africa the Agricultural Research Council (ARC) has been engaged in research into GM cassava to produce amylase-free starch (amylase needs to be removed with chemicals before starch can be used industrially). Collaborating institutions include the Universities of Michigan in the USA, Wageningen in the Netherlands, and the Witwatersrand in South Africa, the Monsanto funded Donald Danforth Plant Science Centre, and the Consultative Group on International Agricultural Research (CGIAR).

In 2006, the ARC sought permission from EC to conduct field trials for a GM cassava variety engineered to produce amylose-free starch, which makes it more suitable for industrial uses without the need to add chemicals. The cultivar, TMS 60444, comes from the collection of the International Institute of Tropical Agriculture (IITA) in Nigeria, though it was first genetically modified and tested in a contained greenhouse at the University of Wageningen. In March 2007, the EC, citing the dearth of biosafety information supplied by the ARC, rejected the application, proposing that more greenhouse trials were needed. After a lengthy appeals process (in which the ACB again made submissions) a field trial permit was granted in August 2010. The field trials, set to take place on a small 0.5 ha plot north of Nelspruit, were scheduled to last for 18 months, with harvesting to take place in April and May of 2008.[54] Given the delay, it would appear that harvesting will now take place in April and May of 2012. According to the GMO Registrar no subsequent field trials have been applied for thus far. [55]

Cotton

Permit type	2008	2009	2010	2011	2012	Total
Trial release	5	5	4	4	0	18
Commodity clearance	0	0	0	1	0	1
Import for trial release	7	6	4	4	0	21
Import for planting	6	6	5	6	1	24
Export for contained use	0	1	0	1	0	2
Export for planting	5	9	14	8	0	36
Total	23	27	27	24	1	102

In the global scramble for peasant farmers, no other GM crop has been foisted onto small-scale farmers with as much rhetoric and vigor as GM cotton. The biotech industry lobby group the ISAAA, claims that nearly 15 million peasant farmers planted Bt cotton in 2011, citing South Africa as one of the countries in the global south where cotton has 'made a significant contribution' to improving small holder livelihoods.[56] Overall, 21 million ha of GM cotton was planted worldwide in 2011, or 14% of the total area.

Bt cotton was the first GM crop to be commercially cultivated in South Africa. Since then, 5 more varieties, all owned by Monsanto, have been cleared for cultivation. All of the cotton now commercially grown in South Africa is genetically modified, and 95% of this is now stacked to include herbicide tolerance.[57] One of industry's main arguments in favour of Bt cotton is the savings famers will make from having to purchase extra pesticides. How big will these savings to be if the cotton varieties have been designed to be used in conjunction with masses of chemical herbicides? Cotton SA, an industry body, only recommends GM varieties to plant for the current crop season.[58] For the relative size of the cotton market, it still accounts for a significant proportion of GMO activity, with 101 permits granted since 2008. As mentioned above, German multinational Bayer (the world's second largest agro-chemical company), have tested 6 new varieties under field trial conditions. Two of these varieties, one double and one triple-stacked, were still under observation in the field in 2011.

In December 2010, thousands of hectares of Monsanto's new GM cotton variety Bollgard 2, or DP 210 BRF, its official name, failed to pollinate in the Northern Cape, particularly the Lower Orange River region. Monsanto had selected the region to test its new variety; lack of sufficient seed prevented it from testing over a wider geographical area. An unusually cold winter prevented the seeds from germinating. While the technology fee was waived for farmers who re-planted the seeds the following season, this was not enough to prevent many from exiting the market.[59]

The domestic cotton industry has been in a general state of decline since the late 1980s. Though the cotton area increased by 157% (to 13,145 ha) from 2010/11 to the present season, in 1987/88 total plantings peaked at over 180,000ha.[60] Even in the late 1990s, it still averaged over 90,000 ha a season.[61] As in other sectors within the nation's economy, the cotton sector has set itself quantitative targets to broaden participation by previously disadvantaged communities. A goal was set stipulating that 25% of local cotton production should come from small-scale farmers by 2007, which is to increase to 35% by 2014.[62]

According to one expert in the cotton industry, several emerging farmer support programmes have been established in Mpumalanga, Limpopo and KwaZulu-Natal towards this end, supplying production inputs and, in some cases, machinery. Seeds (which are all GM) are provided through an open tender process via provincial departments of agriculture. Unfortunately, the tender process is rife with irregularities, resulting in many contract winners lacking even the most basic knowledge of GM seeds, this in turn becomes a major problem when they have to pass on this knowledge to farmers with no prior experience of using these seeds. For example, many small-scale farmers are

not told about refugia plantings and are not planting the refuge areas that are required for insect resistant GM crops.[63] Experience has shown that, even where refuge requirements are generally met, insect populations will eventually develop resistance.[64]

Figures from the industry show a huge decline in small-holder cotton production over the last five years. In 2005/06, an estimated 2,849 small-scale cotton farmers produced around 15% of the total crop. By 2010/11, there was just 619 small-scale cotton farmers left, producing less than 2% of the national crop.[65] Over the same period the proportion of cotton under irrigation, beyond the means of all but a tiny minority of small holders, increased from 59% to 81% (this year the figure is 88%).

Grapevine

South Africa is the eight largest wine producer in the world, contributing 3.7% of global production in 2010. The 2012 grape harvest is expected to reach 1.3 million tons, which will produce 1,022 million litres of table, distilling and fortifying wine, as well as non-alcoholic juices and concentrates. The average figure since 2005 has been approximately 1,027 million litres. Production is heavily concentrated in the Western Cape; almost 85% of South Africa's vineyards are found in five wine regions in the province, namely, Malmesbury, Paarl, Robertson, Stellenbosch and Worcester.[66]

The wine industry makes an important contribution to South Africa's economy. In 2008 it accounted for 1.95% of national GDP, while in the Western Cape this figure was 7.3%.[67] Exports, mostly to Europe, are a lucrative source of foreign exchange. During 2010/11, South Africa exported R8.9 billion worth of wine and table grapes, more than double the value of all maize exports for the same year. Though Europe remains the primary market for wine exports, its relative share has declined, from 86% in 2005, to 77% in 2011. Exports to North America increased over the period from 8.4% to 12%, though the local wine industry sees enormous potential new markets in Russia, Japan, East Africa and Nigeria.[68]

http://www.fine-wines.ru/adminimages iStock_000005458419Medium.jpg

Though the sector is highly labour intensive (both directly and indirectly), employment in the sector is dwindling. In 2008 the wine industry supported 257,000 jobs, spread across 3,999 farms. In 2011 this had fallen to 275,000, on 3,596 farms (the number of farms in 2005 was 4,360).[69] Over this period the area under wine grape vineyards has remained static, at just over 101,000 ha, suggesting significant producer consolidation, labour casualisation and increased mechanization within the sector.[70]

In 2007, an application for the general release of a GM malolactic wine yeast was denied by the Executive Council (EC), as both the DAFF and the wine industry had expressed grave reservations over potential consumer resistance, both within South Africa and the European Union, our largest export market.[71]

In 2006 the Institute for Wine Biotechnology (IWBT) at the University of Stellenbosch submitted an application to conduct field trials with GM grapevines engineered to resist fungal disease. The ACB, having first interrogated the safety data IWBT had to submit as part of their application, came to the conclusion that the trial would pose an unacceptable contamination risk to adjacent fields, which could have serious implications for South African wine exports, particularly to Europe. These concerns were echoed by the EC, who compiled a list of questions for IWBT to answer before any decision would be made. In March 2009 the EC recommended approval of the application, pending submission of this information. The information was provided to the EC at their May 2009 meeting, with the permit being officially granted in August.[72]

It appears, however, that consumer attitudes towards GM wine have not shifted in the prevailing three years, as the field trials granted are not currently running.[73] Professor Melané Vivier, of the IWBT, gave this as a significant reason for the delay, as well as the demands (both financial and logistical) of complying with the GMO Act. According to Professor Maret du Toit, also of IWBT, GM grapevine research has shifted from an applied to a more pure research focus. Work on yeast includes low ethanol and high anti-oxidant producing strains. Greenhouse trials are currently underway focusing on drought and disease, particularly fungal, resistance grapevines.[74]

Internationally, GM yeasts have been given commercial approval in the USA, Canada and Moldova, while GM grapevines resistant to powdery mildew were recently grown in an Australian laboratory.[75]

Maize

Permit type	2008	2009	2010	2011	2012	Total
General Release	0	0	4	0	0	4
Contained use	0	2	3	2	0	7
Trial release	0	19	23	18	0	60
Import for contained use	2	9	5	0	0	16
Import for trial release	11	19	21	20	0	71
Import for planting	98	88	61	69	9	325
Import for commodity	32	0	3	0	0	35
Commodity clearance	0	0	0	19	0	19
Export for contained use	70	122	104	86	16	398
Export for planting	11	34	26	30	4	105
Export for commodity	2	0	73	70	6	151
Processing	0	0	2	0	0	2
Total	226	293	325	314	35	1193

After soybeans, maize is the most widely planted GM crop in the world; in 2010, GM maize was grown on 46.8 million ha (compared to 73.3 million ha of soya). It should be noted, however, that the majority of GM maize grown in the rest of the world is grown for animal feed and, in the case of the USA, to produce agrofuels. South Africa remains the only country in the world that grows commercial quantities of a GM crop that is consumed directly by humans in large semi processed quantities.

In 1997, Monsanto's GM 'insect resistant' (IR) maize variety MON810 was approved for environmental release, meaning GM maize could now be grown on a commercial scale. The first commercial plantings took place in 1998. By 2003, over 280,000 ha of GM maize were being grown in the country, though this only represented 10% of all maize grown. During the 2004/05 cropping season, when the South African National Seed Organisation (SANSOR) began publishing such information, GM maize seed accounted for 20% of maize seed sales. By this time two further varieties were granted environmental release approval: Syngenta's Bt11 (also insect resistant), and Monsanto's herbicide tolerant variety NK603.

The adoption rate of GM maize seed in the intervening period has been astounding; SANSOR's 2010/11 annual report states that 77% of all maize seed sold that year was GM. Given that just over 2.3 million ha of maize were planted in that season[76], it is not unreasonable to assume that about 1.8 million ha of GM maize was planted that year. Preliminary information from the crop estimates committee indicates that an additional 300,000 ha of maize was planted this year.[77] If past trends continue, and there is every reason to believe they will, it is probably safe to project that close to 2 million ha is now being grown.

Since the beginning of 2008, the EC has granted close to 1,200 permits for GM maize. This included 60 for open field trials, and four general release permits (all granted in 2010). These general release permits are particularly significant, as until that point, only one such approval had been granted since 2003.[78] Three of these releases were for varieties containing the herbicide tolerance (HT) 'trait' (two of these were stacked for both HT and IR). Between 2008 and 2011, the number of HT varieties (including stacked varieties) listed under plant breeder's rights nearly trebled, from 30 to 89. This would appear to corroborate industry figures. For the 2008/09 season 29.4% of GM maize planted contained the HT trait. By 2010/11, this figure was 54.4%.[79]

Field trials have been underway for an astonishing 21 new varieties of stacked GM maize, six of which contain 4 or more transgenes. The incentives to industry for gene stacking stem from the higher prices they charge, and from the opportunity it gives them to increase their intellectual property protection, by stacking older genes that are coming off patent with new ones, which have much longer protection. Both Monsanto's MON810 trait and Syngenta's Bt11 have recently lost patent protection, while Syngenta's GA21 trait will come off patent in the second quarter of 2012. Though industry experts predict this will have a minimal effect upon technology licensing fees in South Africa,[80] stacking these older traits with newer ones nevertheless allows companies to hedge their bets. In 2003, Monsanto received approval for MON810 x NK603, which adds herbicide tolerance to the insect resistance found in MON810. As can be seen below, four of the stacked GMOs trialled since 2008 still contain MON810.

Organism	Trait	Company	Year of first trial	Year of latest trial
TC1507 x MON810 x MIR162	IR / HT	Pioneer	2009	2009
TC1507 x MIR162 x NK603	IR / HT	Pioneer	2009	2010
TC1507 x MON810 x NK603	IR / HT	Pioneer	2009	2011
98140 X TC1507 x MON810	IR / HT	Pioneer	2009	2009
TC 1507 x 59122 x NK603	IR / HT	Pioneer	2011	2011
TC 1507 x 59122 x MON810 x NK603	IR / HT	Pioneer	2011	2011

N.B. maize event TC 1507 is stacked for IR and HT

Equally significant has been the continuation of field trials for Monsanto's Water Efficient Maize for Africa (WEMA) project, which have been renewed annually since they began in 2007. WEMA is the brainchild of Monsanto, BASF and the Bill and Melinda Gates Foundation. Further details will be provided under the 'SA and Africa' section, as there are high hopes WEMA could be the 'breakthrough' that the biotechnology and seed industries have been looking for in Africa for nearly two decades. Much more pertinent to South Africa, however, has been the reaction of small-scale farmers living in close proximity to the field trial locations.

During 2010, members of the Lutzville community in the Western Cape objected to the presence of Monsanto's GM drought tolerant maize field trials (part of the WEMA project) in their area; AfricaBio, a biotech lobby group, and the Agricultural Research Council (ARC) were quickly dispatched to the area. Meetings between AfricaBio, ARC and the Lutzville farmers were briskly arranged, and the standard utopian promises surrounding GMOs were rolled out. Not wishing to take any chances in an open debate, AfricaBio and the ARC flatly refused any requests to involve other civil society groups in the process, such as the ACB. The resistance from farmers and civil society does appear to have been noted by the South African biosafety authorities, as the Executive Council (EC) meetings minutes for September 2010 show that representatives from Monsanto made a presentation to the EC on the WEMA project.[81]

SANBI's MON810 study

In 2008, the South African National Biodiversity Institute (SANBI), together with the Norwegian government, launched the Environmental Biosafety Cooperation project (EBCP). The aim of the EBCP was to develop a comprehensive post-release monitoring system for GMOs in South Africa, using the insect resistant variety MON810 as a model. The MON810 variety was chosen both because of its popularity with farmers, and because of the length of time it had been cultivated in the environment (nearly ten years at the beginning of the EBCP). SANBI was tasked with the overall coordination of the EBCP, which included researchers from three South African universities (the North West, the Free State and Fort Hare), and the GENOK biosafety centre at the University of Tromso, Norway.

A number of assessments were carried out including: comparisons of protein profiling and expression, gene flow studies, issues of refugia and pest resistance, and its impacts on non-target organisms. The results of the EBCP were published in January 2011, confirming a number of issues that have emerged from independent research both within South Africa and in other GM crop producing countries. Differences were observed in the responses of GM plants and their non-GM equivalent (the same hybrid, minus the GM trait) to environmental conditions, questioning the assumption that a GM and non-GM variety is 'substantially equivalent'. A study into the Cry1Ab gene, which confers the insect resistant trait in the plant, found that expression levels of the gene differed when genetically engineered in a bacterial host as opposed to the plant. This is highly significant as the majority of risk assessments primarily use the Bt protein engineered in bacteria, rather than plant version.

Finally, evidence has emerged in some areas of target insect pests developing resistance to Bt maize. The EBCP uncovered evidence that this resistance was being aided by both gene flow from Bt to non-Bt maize, and fluctuating levels of the Bt toxin within different parts of the GM maize plant that insect pests feed upon. Both cases were exposing insects to a 'sub-lethal' dose of the Bt toxin, in effect providing a vaccination against Bt. To minimize the risk of insect resistance, farmers must plant a 'refugia' area of non-Bt maize immediately adjacent to any Bt plantings (Monsanto stipulates between 5% and 20% of maize planted must be non Bt – but not necessarily non-GM - depending on the use of other chemical pesticides[82]). Insects who feed on the non-Bt maize will have a lower Bt tolerance, and by producing offspring with insects that have a higher tolerance will therefore dilute it in the next generation. However, farmer compliance with refugia requirements is problematic, not only in South Africa. The

conclusions from the EBCP were that where insect resistance had already developed, current refugia requirements would be inadequate to combat this.[83]

While welcoming these developments in the biosafety discourse, a number of issues arose from the process that will need to be addressed in order to further the encouraging work of the EBCP. It is unclear, from the proposed framework, how different role players will be expected to liaise, how government departments will share information, and who will own and have access to the raw data arising from future SANBI studies? Protocols for data collection and exchange will need to be clearly defined. Given the implications of the research findings, it would surely be pertinent to carry out animal feeding trials with Bt maize.[84] However, as SANBI's mandate is restricted to biodiversity issues, this may fall under the responsibility of the Department of Agriculture, Forestry and Fisheries (DAFF), who are the custodians of the GMO Act. However, the EBCP is the nearest we have come to an independent, nuanced biosafety approach in South Africa.

Potato

Between 2001 and 2006, the South African Agricultural Research Council (ARC) conducted field trials with Bt potatoes, genetically engineered to control the Potato Tuber Moth. Known as 'Spunta G2', the Bt potato was originally developed in the US, by Michigan State University, in conjunction with the International Potato Centre in Peru, and Syngenta. Project funding has also been provided by USAID. Due to consumer and industry rejections of GM potatoes in the US, the project was taken to Egypt, followed by Indonesia, before finally finding a home at the ARC in South Africa. Spunta's wanderings from one country to another did not prevent it from being portrayed as a 'home-grown' GMO, or indeed as a boon to small-scale emergent black farmers.[85]

In 2008, the ARC applied for a full commercial release of its Spunta G2 potato. The ACB submitted a detailed opposition to the commercial release and also produced a well-researched booklet 'Hot Potato: GM potatoes in South Africa – a critical analysis'. Significant reservations pertaining to biosafety were expressed, ranging from effects on the local ecology and non-target organisms, to the near impossibility of preventing mixing with non-gm varieties, as potatoes can be very easily vegetatively reproduced. Furthermore, two socio-economic studies commissioned by the ARC, focusing on the commercial and emerging farming sectors, both concluded that the technology would have no significant benefits in ether sector.[86]

At its July 2009 meeting, the EC rejected the ARCs application, citing no less than 11 agronomic, biosafety and socio-economic concerns, including: reference to both socio-economic studies, that no alternative pest management strategies were considered (the PTM was not even considered as a primary pest in most potato growing regions), difficulties in segregating GM from non-GM potatoes, and completely inadequate toxicity and allergenicity data being put forward.[87]

The potato appeal

Although the decision was made in July 2009, the EC minutes were only published in October on the DAFF's website; in the interim, the ARC had lodged an appeal. In November of the same year the ACB wrote to the Minister of Agriculture, Forestry and Fisheries, Tina Joemat-Pettersen, requesting an opportunity to participate in the appeals process as Amicus Curiae (friend of the court).[88] In addition, the ACB also submitted a PAIA request to access the ARC's appeal documents. The GMO Registrar informed us on the 26th of November 2009 that access to the appeal documents was denied on the grounds that it could prejudice the outcome of the appeal.[89] Thus began another long and arduous attempt to gain access to information and ensure transparency.

http://www.delo.si/assets/media/picture/20100823/krompir_afp.jpg

The ACB was forced to seek legal assistance, which finally secured us access to the documents on the 24th of February 2011.[90] In the interim, while the ACB had also requested an opportunity to approach the potato appeal board, it became apparent that the ARC's responses to the decision had been published, verbatim, on the biotech lobbyist website AgBioForum. The tone of the article suggests that the EC had 'overstepped its mandate' and calling for 'sound scientific reasoning'[91]

The appeal documents submitted by the ARC failed to adequately address the significant scientific shortcomings concerning the design and interpretation of its experiments around Spunta G2. Furthermore, no attempt was made by the ARC to address two of the fundamental shortcomings of the whole project; the fact that small-scale and commercial farmers had far more urgent production constraints than the PTM, and that the potato industry had explicitly stated it did not want the controversy that a GM potato would generate.[92]

At the time of writing, nearly three years since the initial appeal was lodged, it is still unclear when the matter will be resolved. Members of the EC appear as unsure as we are; all key decisions around the appeal, including the appeal board, are now handled under the office of the Director General of the DAFF. At our last meeting Dr. Julian Jaftha, head of genetic resources at the department, informed us that a discussion, with the possibility for interested parties to make representations, is still under consideration.[93]

Sorghum

Sorghum is a significant food crop many parts of Africa. It is second only to maize in importance as a grain crop. It also possesses several characteristics, such as drought tolerance, that are potentially very lucrative to the biotechnology industry.

The Africa Bio-fortified Sorghum (ABS) project is the Brainchild of the Africa Harvest Biotech Foundation International (AHBFI), an industry lobby group who lists DuPont, Syngenta and USAID amongst its partners. The stated aim of the research is to develop GM sorghum with increased levels of lysine, Vitamin A, iron, and zinc. The Bill and Melinda Gates Foundation have provided

funding, currently over $18 million, for the project. Pioneer Hi-Bred donated Germplasm worth $4.8 million, though this is the proverbial 'drop in the ocean' to Pioneer, who spent a whopping $1.7 billion on research and development in 2011.[94]

Though the project involves individuals and institutions from across the continent, much of the early research was undertaken in South Africa, at the Council for Scientific and Industrial Research (CSIR) in collaboration with Pioneer Hi-Bred. The CSIR initially applied for a permit to conduct laboratory and greenhouse experiments in 2006. The Executive Council (EC) rejected the application on the grounds that the scientific information provided by CSIR was 'wholly inadequate, erroneous and unsubstantiated'.[95] However, the EC's decision was over-turned on appeal in 2009. As a result of the delays in the implementation of the project, the majority of the R&D for the project has moved to Kenya.[96] It appears the issue has slipped almost completely off the agenda in South Africa. According to EC meeting minutes, no discussion of the ABS project appear to have taken place.

Soya

Permit type	2008	2009	2010	2011	2012	Total
Trial release	0	0	0	1	0	1
Commodity clearance	0	0	0	3	0	3
Import for trial release	2	0	0	1	0	3
Import for planting	4	11	22	6	1	44
Export for contained use	1	0	0	1	0	2
Export for planting	0	1	0	0	0	1
Export for commodity	0	0	3	2	3	5
Total	7	12	25	14	4	62

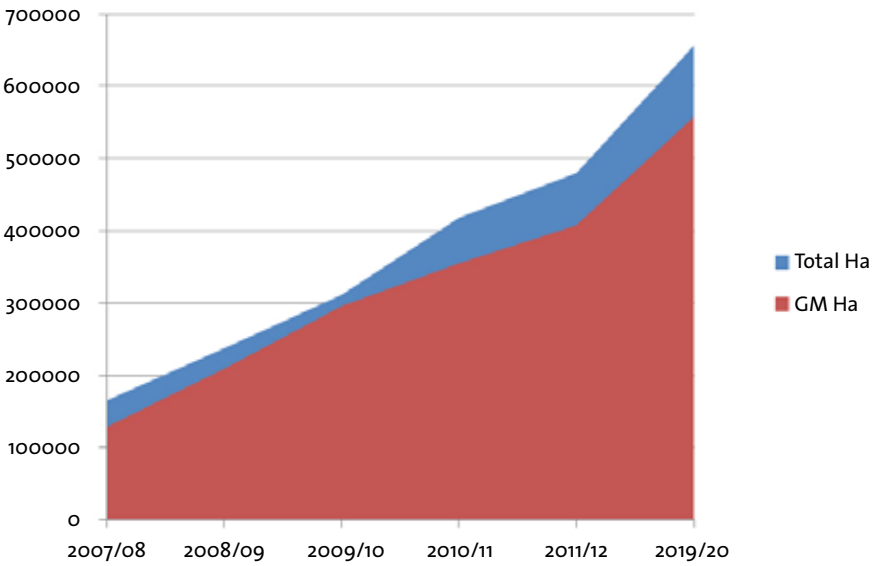
Soya, though now synonymous with mono-cultured GM agriculture, has been a staple in Asian diets for three thousand years. Asian emigrants introduced the crop to Europe and the America's in the 1800s. During the Green Revolution of the 1960s, soya became a key forage crop and the United States began exporting large quantities of soya beans, meal and oil to Europe and Asia.[97] With the onset of globalization in the 1980s and 1990s, agricultural value chains became even more transnational in nature. World soybean production is dominated by the United States, Brazil and Argentina, who between them produced 90 million, 70 million and 49 million tons respectively in 2010 (81% of total world production that year). GM soya accounted for 93% of total production in the USA that year, 75% in Brazil, and 100% in Argentina.[98]

In 2011, GM soybean covered an area of 75 million ha worldwide, equivalent to 47% of the total GM crop area.[99] This represents an increase of nearly 15,000% since the first GM soybeans were planted, on 500,000 ha, in 1996. The majority of this area is confined to the USA, Brazil, and Argentina, the three largest global producers of GM crops. All GM soy currently under commercial cultivation is engineered to withstand application of glyphosate-based herbicides, of which Monsanto's 'Roundup' is the most prominent. In relative terms, South Africa has been at the forefront of this soya boom; between 2000 and 2010, of the 11 countries that grow GM soybean, only Uruguay has seen its soybean area expand at a faster rate.

Last year marked a decade since the general release of the one, and to date only, GM soybean variety on the commercial market in South Africa: Monsanto's 'Roundup Ready' GTS 40-3-2. At that time, 134,000 ha of soybean were grown throughout the country. By the time of the ACB's last overview of GMOs in South Africa, in 2008, the area under cultivation had increased to 165,000 ha.[100] Figures from the DAFF for the current season are now 472,000 ha, the largest soy plantings ever recorded in South Africa. The Bureau for Food and Agricultural Policy (BFAP), a multidisciplinary network of researchers at the Universities of Pretoria and Stellenbosch, predicts that the soybean

area is likely to have reached 650,000 ha by 2020.[101] Presently, 50% of soybean cultivation takes place in Mpumalanga, with the Free State and KwaZulu-Natal accounting for a further 19% and 15% respectively.

Figure 2: Soybean planted area increase in South Africa (Ha)



N.B. Figures for 2019/20 are projections from the BFAP's South African Agricultural Baseline, 2011.

In 2011, the first field trial permit for a GM soya variety was granted in three years, for Pioneer Hi-Bred's stacked variety (356043 x 40-3-2). In the same year three varieties of GM soybean were granted commodity clearance, all owned by Pioneer Hi-Bred. One of these varieties is a standard HT variety, though two of them are described as having 'higher oleic acid content'. The ACB submitted an objection to this in January 2010.[102]

In July 2011, an article appeared in the Business Day, 'Gene-modified soybean to boost SA crops', announcing the seed giant's plans to 'increase soybean production in SA with a new oleic-rich genetically modified seed'. According to the article, the oil produced by this GM soya variety will contain zero grams of trans-fat and 20% less saturated fat. It was also claimed to have increased mono-saturated fat.[103] However, when we followed the article up with the GMO Registrar at the DAFF, and cross checked on their GMO permit lists, it became apparent that Pioneer had not even applied for an open field trial, and subsequently were not even near releasing it commercially in South Africa. It can hardly be a coincidence that the article appeared in the middle of Pioneer's merger case at the Competition Commission, and was not the last incident where the company tried to influence public opinion through the media.

Sugarcane

Permit type	2008	2009	2010	2011	2012	Total
Field trials	0	5	0	4	0	9

The complex nature for the Sugarcane genome is not conducive to genetic modification when compared to other crops such as maize or soy. Hence, despite the first GM sugarcane trials being conducted 20 years ago in Australia, there is still no commercially cultivated GM sugarcane anywhere in the world. Australia is still at the forefront of research, with field trials ongoing for a variety of traits, including: herbicide tolerance, drought tolerance, enhanced nitrogen efficiency, altered sucrose production and improved cellulosic ethanol production.[104] Brazil, now the world's

http://curecane.com/images/background/4.jpg

number two GMO producer, is also working on its own varieties of GM sugarcane. Its state owned agricultural research agency, Embrapa, predicts the varieties it currently has in development will be ready for full commercial release in five years time.[105]

Although much of the country is unsuitable for its cultivation, sugarcane production in South Africa contributes significantly to overall agricultural income; 13.9% of the gross value of field crop production in 2010/11 (only maize was higher).[106] Nonetheless, the industry is currently battling with a one of the worst recorded droughts in its history, resulting in sugar production (refined as opposed to raw cane) in 2010/11, falling below 2 million tons for the first time since 1996. Figures from the South African Sugar Association indicate there are 29,130 registered cane growers in the country, with nearly 85% of the nation's crop being produced by just 1,550 large-scale growers. A further 6.7% is produced by milling companies who own their own sugar estates, with the remainder being produced by fewer than 14,000 small-scale growers who delivered cane to millers last year. [107]

In South Africa the SA Sugar Research Institution (SASRI), a division of the SA Sugar Association, is the major national player conducting GM sugarcane research. It has collaborated with the University of Stellenbosch and PlantBio, one of the Department of Trade and Industry's (DTI) national innovation centres for biotechnology.

Nine field trial permits have been granted to SASRI in the period since our last update, 5 in 2009 with another 4 in 2011. Two trials to produce altered sucrose and alternative carbohydrates were conducted (scheduled to finish in March 2014 and August 2012 respectively), and a further three to investigate yield and altered sucrose content took place in 2009. Four further field trials to alter sucrose content were granted in 2011, all scheduled to finish in late 2014.[108] In 2010, we canvassed opinion from a variety of experts in the sector as to GM sugarcane's prospects. Members of academia tended to be more optimistic, whilst those in the sugar industry predicted it would be at least another 8-10 years before commercial cultivation.[109]

Sugarcane and agrofuels

Developments within the sugar sector are likely to be further complicated by the South African government's wish to nurture a domestic biofuels industry. When the original national biofuels strategy was published in late 2007, sugarcane was designated as one of the feed stocks to produce bio-ethanol, which would then be blended at a rate of 2% with petrol. Since the strategy was published, of the numerous planned investments, only the Craddock bio-ethanol from sugar-beet project has got off the ground, though it is far from being fully established. Not being put off by lack of action on the ground, the Department of Minerals and Energy (DoE) released draft regulations for mandatory blending in November 2011, stipulating a 2% ratio for bio-ethanol and 5% for bio-diesel.

According to Tongaat Hullet, a 2% blending ratio would require 220 million litres of bio-ethanol, which could be achieved with 400,000 tons of sugar.[110] Researchers from SASRI have previously stated that GM sugarcane will enable ethanol yield to double, to more than 12,000 litres per ha by 2023.[111] The BFAP has cautioned however that ethanol produced from sugarcane will 'have to offer significant value if it is to attract investors', as it predicts world sugar prices will continue to rise until 2020 at least, making exports a more attractive proposition.[112] During 2009/10 alone, South Africa exported R2.3 billion worth of sugar.[113]

Sugarcane is not suited to growing in the USA and Canada, where sugar beet is grown for sugar production. GM sugar beet was first commercialized in 2008. Within 4 years, 95% of the United States' sugar beet crop is now GM, making it the fastest adopted GM crop in history.[114] This rapid rate of adoption has occurred in the US in spite of a district judge ruling in 2010, ordering the cessation of any further planting until a full environmental impact assessment had been carried out. Bowing to intense industry pressure, the United States Department of Agriculture (USDA) 'partially de-regulated' GM sugar beet in February 2011.[115] Sugar beet is not a crop traditionally grown in South Africa, being more suitable for the temperate climates of North America and Europe. A project to grow sugar beet for agrofuels has been initiated in Cradock in the Eastern Cape, though there is no indication that GM sugar beet is being considered for this, and no GMO permit applications have presently been made to the EC pertaining to the crop.

GM Vaccines for humans and animals

2008	2009	2010	2011	2012	Total
15	19	18	30	2	84

Though the ACB has not written extensively on GM vaccines since its 2007 booklet 'GM vaccines in South Africa – a case for the precautionary principle', a spate of permits over the reporting period, some of which were for human trials in babies, naturally has raised concern. Trials have included GM vaccines for West Nile disease (in horses), skin cancer and tuberculosis. The ACB plans to publish a more detailed account of GM vaccines in the near future.

Imports and Exports

Seeds

Over the reporting period, South Africa has imported and exported significant quantities of GM seed, most notably GM maize seed, with total imports topping 160,000 tons. Nearly three quarters of these have been for varieties containing the herbicide tolerant trait (either in single or stacked form), which would seem to support the rapid spread of HT crops in this period. Imports of two of Monsanto's newly commercialized varieties, MON89034 and MON89034 x NK603, have also begun. Though all the major companies have been involved in seed imports, over 99% of these contain Monsanto traits.

GM seed imports 2008 – 2012 (tons)

Year	mon810	nk603	mon810 x nk603	Mon 89034	mon89034 x nk603	Bt11	GA21	Total
2008	4 105.00	626.2	1 082.00			0.8		5 814.00
2009	40 882.00	110 772.00	5 020.00			3.9		156 677.90
2010	324.9	1 181.00	1.2	33	25.4	4.2		1 569.70
2011	42.6	151.2	60.1	4.9	36.9	0.6	1.1	297.4
2012	0.02	3.1	0	0.2	0.26	0	0	2015.58
Total	45 354.52	112 733.50	6 163.30	38.10	62.56	9.50	1.10	166 374.58

South Africa also acts as a vital conduit for the spread of GM seeds around the world, having exported nearly 50,000 tons of maize seed overseas in the last four years. The Philippines has been the major recipient, with smaller amounts going to France and Egypt, who, along with Burkina Faso, is the only other African country to commercially grow any GM crops. All permits for the export of GM maize seed since 2008, have been awarded to Monsanto.

Major destinations for GM maize seed exports, 2008* – 2012 (tons)

*year in brackets indicates when exports started over this period

Variety	Argentina (2009)	Egypt (2010)	France (2009)	Honduras	Philippines	Total
mon810	70.0	172.0	400.2	0.4	850.0	1 494.7
nk603	1.1	0.0	0.0	0.5	22 503.0	22 504.7
mon810 x nk603	0.0	0.0	0.3	0.0	24 650.0	24 650.3
mon89034	0.0	0.0	0.0	0.1	0.2	0.3
Total	71.1	172.0	400.4	1.0	48 003.2	48 649.9

E.g. In 2008, Argentina exported 66,000 tons of maize seed, 43,000 tons of soybean

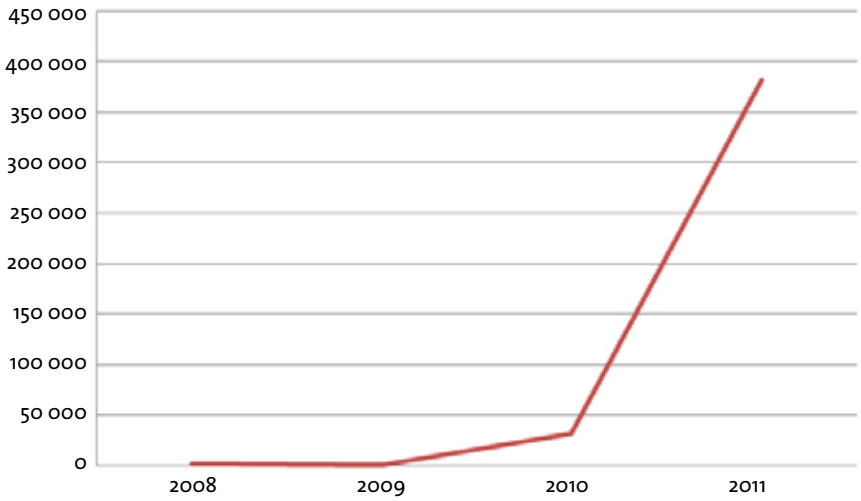
South Africa has exported small amounts of GM cotton seed to Latin America since 2008. Imports, by comparison, have been miniscule (see figures in brackets in totals column). As is the case with maize, all export permits to Latin America were granted to Monsanto. Bayer did export GM cotton seeds to the USA over this period but, in terms of volumes, these totaled less than 1% of exports.

GM cotton seed exports (tons), 2008 – 2011 (total imports in brackets)

Year	IR	HT (stacked)	Total	Major destinations (% of total)	
					Permit holders (% volume)
2008	0	220	220	Columbia (99)	Monsanto (99), Bayer
2009	0	395	395	Argentina (76), Columbia (23)	Monsanto (99), Bayer
2010	83	514	597	Brazil (80), Columbia (18)	Monsanto (99), Bayer
2011	0	389	389	Brazil (98)	Monsanto (99), Bayer
Total	83 (0.1)	1 517 (7.48)	1 600 (7.59)	Brazil (54), Columbia (26), Argentina (19)	Monsanto (99), Bayer

Perhaps most significantly of all, GM soybean imports since 2008, have increased by an incredible 29,000%!

Figure 3: GM soybean seed imports (tons), 2008 - 2011



Commodities

GM commodities refer to bulk shipments of GM grain - in the case of South Africa – to GM maize and GM soybean – traded for direct use as food, feed and processing and not for planting. Industry statistics place the value of the international GM commodity market in 2011 at $160 billion; more than ten times the value of the GM seed market. The multinational grain traders who dominate this trade rank among some of the largest corporations in the world. For example, in 2010, three of the world's largest traders, Archer Daniels Midland, Bunge and Cargill, had combined revenues in excess of $200 billion. All three, plus Louis Dreyfus and the Noble Group (a $60 billion company based in Hong Kong) have operations in South Africa. Expansion plans are inevitable. Last year Louis Dreyfus and Noble both announced plans to build two massive oilseed crushing plants in South Africa, while Bunge announced a joint venture with former South African agricultural co-operative Senwes to develop grain and oilseed operations.

South Africa has, in the last 3-4 years, become a major importer of GM commodities, particularly maize and soya, used principally by the animal feed industry. For example, in 2007, over 2 million tons of GM maize was imported from Argentina.[116] In late 2005, at the behest of the Department of Trade and Industry (DTI), a moratorium was put in place on the commodity import of any GM varieties not yet approved for commercial release in South Africa. The DTI was concerned that, by having access to GM varieties that local producers did not, foreign producers would have an unfair production advantage, and that this could have knock on effects in the local economy. A detailed study was completed in 2007, though is apparently unavailable to the public. The moratorium was lifted during 2011, when 23 new GM varieties were granted commodity clearance approval.

A record maize surplus of 4 million tons produced in 2010, put the issue of commodity imports temporarily on the backburner, as the producer price of maize fell so drastically that up to 30% of the nation's maize farmers were thought to be at risk of insolvency. An export scramble during 2010 and 2011, saw the EC grant export permits[117] for 5.6 million tons of GM maize, and over 70,000 tons of soya (permits have already been approved for 80,000 tons of soya this year). During 2010, South Africa also began exporting GM maize (and small quantities of GM soya) to African countries for the first time, and continued to do so during 2011.

In early 2010, Kenya became the first African country to receive GM maize commercially exported from South Africa. Though the South African DAFF issued a statement claiming the Kenyans had been informed that the shipment was GM, a counter statement showed the Kenyan government claiming ignorance of this. Following the controversy, no further exports of GM commodities have left for Kenya from South Africa, though Swaziland, Somalia and Mozambique have continued to receive GM maize (and soy in the case of Mozambique) exports. By the end of 2011, these exports had accumulated to over 285,000 tons.[118]

Much more lucrative, though much more competitive, is the international maize market. South Africa was successful in finding markets in Europe, the Middle East and East Asia over this period, only because the domestic price had fallen close to the export parity price. For example, permits for over 2.5 million tons of GM maize were granted for export to Japan, South Korea and Taiwan. However, local experts have warned that this is not a viable long term option, as South African maize farmers cannot compete with heavily subsidized (R26 billion in 2010, for example) maize producers in the United States, who traditionally dominate the this market.[119] Most surprisingly of all, throughout 2011, Mexico, the centre for origin of maize, became South Africa's number one customer. In all, permits for nearly 1.8 million tons were granted, including 1.2 million to the multinational trader Louis Dreyfus, and over 350,000 tons to local trader Senwes.[120]

South African GM maize export permits, 2010-2012 (metric tons)

Country	2010	2011	2012	Total
Italy	130 000	180 000	0	310 000
Japan	106 000	101 913	0	207 913
Kenya	280 000	0	0	280 000
Korea	961 000	791 569	0	1 752 569
Kuwait	82 000	33 000	0	115 000
Malaysia	35 200	0	0	35 200
Mauritius	16 000	0	0	16 000
Mexico	0	1 789 500	183 000	1 972 500
Mozambique	136 756	25 000	42 800	204 556
Portugal	20 393	30 000	0	50 393
Somalia	20 635	19 000	0	39 635
Spain	175 000	60 000	0	235 000
Swaziland	39 200	44 100	3 000	86 300
Taiwan	360 000	165 000	0	525 000
Total	2 362 184	3 239 082	228 800	5 830 066

N.B. SAGIS figures for January to December 2011 give total exports of 3,065,399 tons.[121]

Although exports were dominating the agenda during 2010, the import issue was further complicated when Brazil and Argentina were added to the list of countries (that also includes the USA) that South Africa could not import from on biosafety grounds. In the USA, and subsequently Argeninta and Brazil, GM crop varieties are grown that have yet to receive commercial approval in South Africa (known as 'asynchronous approvals'). Because there is no mandatory labeling or segregation systems in place in these countries, there would be no way to tell what GM varieties were being imported, and thereby running the risk of potentially importing illegal GMOs, since SA has a zero tolerance level for unapproved GMOs. This was the cause of much concern for agribusiness, particularly the Animal Feed Manufacturers Association (AFMA), as GM maize and soya are the backbone of this rapidly expanding industry. Even Grain SA, whose wider constituency also includes local farmers, has not ruled out the possibility of cheap imports.[122]

In order to overcome these barriers to imports, a committee was established under the aegis of the South African Bureau of Standards (SABS) in January 2009. The 'committee for the development of standards for handling of and processes around commodities' included members from the DTI, Department of Health (DoH), and industry bodies such as the AFMA. After frequent meetings throughout 2009 and 2010, the SABS published guidelines for the 'receiving, handling, transportation and storage of imported genetically modified commodities not approved for general release' in March 2011.[123] This appears to have lifted the moratorium on imports and opened the proverbial floodgates: in 2011, the EC approved 23 commodity clearance applications – 18 for maize alone (see table below). Prior to the moratorium being lifted, just ten such permits had been granted between 2001 and 2004.

Bayer Crop Science's GM rice, event LL62, was among the applications approved. The USA is the only country where this GM rice has been approved for commercial growing, although no planting has yet commenced. Canada, New Zealand and Australia have also approved the GM rice for commodity imports.

The EC's approval may open another potential market to rice farmers in the US, and encourage planting of LL62, which has been engineered to withstand applications of the highly toxic herbicide glufosinate (which the European Union looks set to ban in the near future). There is an added danger that this rice could be re-exported to other African countries, as South Africa re-exports rice to many countries in Africa. If the LL62 rice is eventually grown commercially, the rice markets may fall under the control of a handful of multinational companies as has happened with maize, soya and cotton.[124]

One variety that was initially not granted commodity clearance was Pioneer Hi-Bred's GM maize variety 98140. Pioneer first applied to the EC for commodity clearance of in late 2009. Their application was referred back to them for lack of data. Once the data was received by the EC, it recommended, on the 26th October 2010, that the advisory committee (AC) make a decision. Based on the findings of the AC, the EC did not approve Pioneer's application at its March 2011 meeting. However, at the following meeting this decision was suspended, as it appears new scientific evidence had come to light.[125] An ACB request to access this information was denied on grounds of confidentiality

SA and the GM push in Africa

> *"Countries can embrace modern technology and genetic modification or their citizens will starve", Bill Gates, 2012*

The development of biotechnology in South Africa has been somewhat of an aberration compared to the rest of Africa. In a country with a well established commercial farming sector, with experience of using hybrid seeds and the chemical inputs they require, and no mass peasant farmer base, GM seeds have found a receptive audience. This is not the case in the rest of the continent, where, for example, women grow 80% of staple crops,[126] yet receive less than 1% of agricultural credit.[127] Nevertheless, Africa's hundreds of millions of peasant farmers represent an enormous potential market to the biotechnology, seed and agro-chemical companies.

In 2008, Egypt and Burkina Faso became the second and third African countries to commercially cultivate GM crops.[128] Egypt grows small quantities[129] of GM maize, while Burkina Faso planted approximately 300,000 ha of Bt cotton in 2011.[130] Field trials are underway in a number of countries for a wide range of crops, including: banana, cassava, cowpea, cucumber, maize, melon, potato, sorghum, sweet potato and wheat (see table below). In Southern and Eastern Africa, Monsanto is anticipating much for its Water Efficient Maize for Africa (WEMA) project. South Africa is playing a vital role in this, having hosted WEMA field trials since 2007. In West Africa, it is anticipated that an

insect resistant cowpea (an important protein source in the region) will be the next commercially released GM crop (after Bt cotton).[131]

For the biotechnology industry, penetrating African agriculture has been a laborious process. Monsanto, in cahoots with the United States Agency for International Development (USAID), made its first overtures to Africa in 1990, by establishing a research project into a GM sweet potato resistant to the sweet potato feathery mottle virus. This was done in collaboration with the Kenyan Agricultural Research Institute (KARI), a long time ally of USAID.

Although the GM sweet potato never came to fruition, there were still numerous benefits for Monsanto. It opened up a conduit (in the form of KARI) by which Monsanto could shape the biosafety discourse amongst the country's research scientists, who would go on to form a powerful pro-GM domestic lobby. Monsanto's image, as well as the other biotechnology companies who would follow suit, would also benefit as it was seen to be 'donating' its technology and expertise to alleviating poverty and hunger amongst some of the world's poorest people.

Most significantly of all, however, is the unbridled access the endeavour would earn Monsanto with policy makers in the country. Before commercialisation of a GM crop, it must undergo field testing, which requires an operational legal framework (according to the logic of the biotech companies at least). Thus, a country that has neither the resources nor the inclination for biotechnology is compelled to enact biosafety laws that will facilitate its spread by transnational seed companies. As these countries typically lack the capacity to draft their own biosafety laws, USAID will provide its own 'expertise' to carry out these tasks, either directly,[132] or through Africa's regional economic communities (RECs).[133]

The Kenyan GM potato project is the archetypal model on which all subsequent attempts to infiltrate African agricultural systems with GM seeds have been based: Identifying a 'subsistence' or

'orphan' crop, establishing research partnerships with local institutions, engaging in a sustained PR and 'public education' campaign, and lobbying governments to adopting weak biosafety laws. The majority of the projects currently underway are co-ordinated through a plethora pro-GM research institutions and NGOs that have sprung up across the continent. Though ostensibly 'independent' bodies, they typically have direct links to the biotech industry. For example Harvest Plus, which is involved in the bio-fortified cassava project in Nigeria, counts the Gates and Syngenta Foundations and USAID amongst its donors.[134] The African Agricultural Technology Foundation (AAFT), based in Nairobi, and conducting research into cassava, cowpea and maize, receives funding from the Gates Foundation, the Howard G. Buffet Foundation and USAID. The Donald Danforth Plant Science Centre, which provides scientific capacity and training to a number of GM crop research initiatives throughout Africa, was established with the aid of a $50 million 'gift' from Monsanto, who even donated the 16ha of land where the centre was built.[135]

The Bill and Melinda Gates Foundation has been one of the largest single sources of funding for agricultural research in Africa since it entered the arena in 2006. By January 2012, the foundation claimed to have given away more than $2 billion to small-scale farmers around the world. Included in this has been $47 million towards the WEMA project, $18 million for the biofortified sorghum project, and $23 million to the Danforth Centre for its work on GM cassava. Gates has made no secret of his enthusiasm for GM crops, proclaiming their benefits with a religious-like zeal. In January this year, when questioned about the suitability of GM crops for peasant farmers, or their potential environmental impacts, Gates tersely responded that 'countries can embrace modern technology and genetic modification or their citizens will starve'.[136] That in 2010, the Gates Foundation purchased 500,000 shares in Monsanto, valued at $23 million, is far less conspicuous in the foundation's literature.

GM research underway in Africa

GM Crop	Trait	Countries*	Funding / research / other support
Banana	Bio-fortified	**Uganda**	Africa Harvest, Danforth Centre, Queensland University of Technology
Banana	Fungal resistance	**Uganda**	Rockefeller Foundation
Cassava	Bio-fortified	**Nigeria**, South Africa	African Agricultural Technology Foundation (AATF), Harvest Plus, Donald Centre, Gates Foundation, USAID
Cassava	Virus resistance	**Kenya**, Uganda	Danforth Centre, Kenyan Agricultural Research Institute (KARI), USAID
Cotton	Insect Resistant	**Kenya**, **Uganda**	KARI, Monsanto
Cowpea	Insect resistance	**Burkina Faso**, Ghana, **Nigeria**, Zimbabwe	AATF, CSIRO (Australia), Monsanto, Rockefeller Foundation, USAID
Maize	Insect resistance	**Kenya**	CIMMYT, KARI, Monsanto, Rockefeller Foundation, Syngenta Foundation
Maize	Drought Tolerant	**Kenya**, Mozambique, **South Africa**, Tanzania, **Uganda**	AATF, BASF, Gates Foundation, Howard G. Buffet Foundation, Monsanto
Melon & cucumber	Virus resistance	**Egypt**	AGERI
Potato	Virus resistance	**Egypt**	AGERI

GM Crop	Trait	Countries*	Funding / research / other support
Sorghum	Bio-fortified	Burkina Faso, **Kenya**, **Nigeria**, South Africa	Africa Harvest, ARC, CSIR, Gates Foundation, ICRISAT, Pioneer Hi-Bred
Sweet Potato	Virus resistance	**Kenya**	ARC, Danforth Centre, KARI, Monsanto
Wheat	Drought tolerant	**Egypt**	AGERI, International Potato Centre, USAID

*Countries in **bold** indicate where field trials have taken place
Source: Biosafety SA; USDA Foreign Agricultural Service biotechnology reports; Mtui (2011).137

The United States Department of Agriculture (USDA) describes South Africa as 'a leader in the biotechnology front in Africa' and 'an ally to the United States in that it has a progressive biosafety policy'.[138] As can be seen above, GM research into three of Africa's key staple crops (cassava, maize and sorghum) is taking place within South Africa at a number of universities and research institutions. Monsanto's 'drought tolerant' maize, arguably the most significant of these, has been undergoing field trials in the country since 2007, and was granted a further 12 month trial extension in 2011.

WEMA forms part of a huge $1.5 billion collaboration with chemical giant BASF and the Howard Buffet Foundation to investigate 'drought tolerance' crops, including both maize and wheat. The scientific claims of WEMA have been hotly disputed, and evidence has emerged that conventional breeding has already surpassed the gains that WEMA hopes to make. However, industry is highly determined to push it through, as it would represent the first new 'trait' being commercially released in over 15 years. WEMA has been targetting five countries: South Africa, Uganda, Kenya, Tanzania and Mozambique. The GM drought tolerant maize, MON87460, was approved for release in the United States in late 2011. Thus it seems highly likely that a commercial release permit will be sought in South Africa in the near future.

From the outset, Monsanto very publically 'donated' the technology for the WEMA project, and stated that the fruits of its research will made available to small-scale farmers royalty free. Missing from their own analysis, however, is that the largest biotechnology and seed companies have been patenting various gene sequences for use in crops to ostensibly deal with the threat of climate change. Between June 2008 and June 2010 alone, over 1,600 patent documents were lodged worldwide relating to traits such as flood, drought, heat and salt tolerance. Most of these are owned by Monsanto, DuPont and BASF – many involving traits found in African heritage crops such as cassava, millet and sorghum (see sorghum section above).[139]

Aside from financing much of this research directly, the Gates Foundation has channelled funds towards matters pertaining to policy and public awareness around GMOs in South Africa. In May 2011, it awarded the University of Pretoria a grant of $4.4 million 'to support policy research and to strengthen African agricultural economies', while in June 2010, the Southern African Confederation of Agricultural Unions (SACAU), based in Centurtion, was granted $3.3 million (over 3 years) for outreach activities to small-holder farmers.[140] The theme of SACAU's 2011 policy conference was 'GMOs in agricultural development', the policy framework adopted from the conference contained the usual references for the 'need for science-based decision making' and the need for 'harmonisation policies in the region'.[141]

The pro-biotech lobby group AfricaBio received $270,000 'to identify the most effective means of raising public awareness of biotechnology issues in Sub Saharan Africa' in late 2009.[142] Interestingly, the period covered by the grant corresponds with AfricaBio's 'outreach' work in response to the Lutzville farmer protests against the WEMA project during 2010. In September 2011, AfricaBio, together with the Gauteng Department of Agriculture and Rural Development (GDARD), hosted the

Agricultural Biotechnology International Conference (ABIC), one of the global industry's blue ribbon events. ABIC's 2011 theme being 'agricultural biotechnology for economic development.'[143]

Further reading from the ACB:
- Water Efficient Maize for Africa: Pushing GMO crops onto Africa
- Ongoing concerns about biosafety harmonisation in Africa

Who benefits from GMO crops in SA?

Between 2005 and 2007, the global price of wheat, rice and maize increased by 70%, 75% and 80% respectively. Writing of 'the end of cheap food' in December 2007, the Economist magazine said its food price index was higher than any time since its creation in 1845.[144] During 2008, food riots erupted in 40 countries, including 14 in Africa.[145] In June 2008, the United Nations (UN) convened an emergency summit, where a new task force composed of UN agencies, the World Bank and the International Monetary Fund (IMF) was established. Among its recommendations, the summit called for the promotion of a new 'Green Revolution'. Comments from U.S. Agriculture secretary Ed Schafer left observers in no doubt as to the direction that this would take, stating that *'biotechnology is one of the most promising tools for improving the productivity of agriculture and increasing the incomes of the rural poor.'* Schafer added, in a thinly veiled attack on anyone with an alternative vision, that *'the world's leaders have a responsibility to allow markets to provide food efficiently, without obstructing access to it or limiting the technologies that produce it'*.[146]

These comments were in stark contrast to the findings of another report, released earlier that year. The International Assessment of Agriculture, Knowledge, Science and Technology for Development (IAASTD) was a three year global study, initiated by the World Bank and the UN Food and Agricultural Organisation (FAO), that drew on the knowledge of over 400 experts on food and agriculture. In summary, the report concluded that GM crops had not lived up to their promise: there was no compelling evidence that they had led to increased yields, or reductions in pesticide use. Further, the IAASTD was dismissive of the argument that GMOs are well suited to small-scale farmers, and that they had, in fact, 'primarily benefited the better resourced groups in society and transnational corporations, rather than the most vulnerable ones.'[147]

Though recognised as the most comprehensive and rigorous study of its kind ever undertaken, the recommendations of the IAASTD report appear to have gained lip service at best from most governments, not least in South Africa. The biotechnology industry still dominates the discourse around food and agriculture, and has powerful figureheads, such as billionaire philanthropist Bill Gates, as champions!

In South Africa the situation is no different. In March 2012, the industry lobby group the ISAAA proclaimed another 'record year' for GM crops, at a press briefing for its annual report in Pretoria. South Africa, says the ISAAA, has produced more than 40 million tons of GM maize since 2001, which has been 'consumed annually by 40 million South Africans, 800 million broiler chickens, 1.4 million feedlot cattle, and 3 million pigs slaughtered at formal abattoirs, without any substantiated scientific or medically proved incidences of adverse effects to humans, animals or the environment.' This is a difficult claim to refute as currently, in spite promulgation of the GM labelling laws under the Consumer Protection Act, there is still no comprehensive system of labelling and segregation, making it all but impossible to establish a link between GM food and adverse affects. However, the results of SANBI's study into MON810 have quite clearly highlighted areas of substantial concern.

Consumers or 'the poor'?

The other implication of the above figures relates to the benefits GM crops presented to consumers, particularly the poorest. The myth that GM crops increase yields, discredited by the majority of

independent scientists, is still one that is perpetuated as justification for their use. In South Africa, after nearly 15 years of commercialisation, it is debatable as to what (if any) impact the increased adoption of GM crops has had on levels of food security and hunger. Since 2007/08, South Africa maize farmers have consistently produced huge maize surpluses averaging nearly 3.5 million tons per year, yet between January 2008 and January 2012, the price of a 5kg bag of maize meal increased by 83%. Statistics SA in its annual household survey for 2009/10, revealed that nearly 24% of people in South Africa were food insecure. Ironically, food insecurity levels were even higher than the national average in South Africa's two largest maize producing provinces: 35.7% in the North West and 25.3% in the Free State. Surveys conducted in three large urban areas in South Africa in 2009, found food insecurity levels at a staggering 70% amongst the urban poor. This compared with levels across 11 cities in the SADC region (where no GM crops are commercially grown) of 77%.[148]

Critics could rightly point out that these statistics take no consideration of other factors that affect people's access to food; unemployment or excessive transportation costs for example. However, the proponents of GM crops as a solution to global hunger rarely, if ever, take cognizance of the myriad of factors beside yield that contribute to global hunger. In South Africa, the issue of farming and agriculture is tied, for better or worse, to the unresolved issue of land reform and restitution. Activists in the food movement have been critical of the land reform model, as it mainly seeks to replace one class of large-scale commercial farm with another. Successful claimants have complained of a lack of assistance once the land transaction has gone through, and that government extension officers still offer little in the way of alternatives to the chemical intensive hybrid and GM seeds used in the industrial system.[149]

Small scale / subsistence farmers?

> *"The successful and rapid adoption of this more expensive technology in the Makhathini Flats provides an initial model for smallholder cotton farmers in Africa". (Monsanto SA)*[150]

In its 2011 global status of biotech crops, the ISAAA claims that Bt cotton has 'made a significant contribution to the income of 15 million small resource poor farmers in 2011'. Bt cotton represented the first systematic attempt at introducing GM crops to small-scale farmers in South Africa, in the Makhathini flats area of KwaZulu Natal. By the 1999/2000 growing season, just two years after its introduction, Bt cotton adoption rates had spiraled from 7% to 90%, prompting a flurry of academic and popular articles heralding the success of the technology. The chairman of the local farmers association was flown to thirteen different countries to tell policy makers and farmers first hand of the benefits Bt cotton had bought his community. Decision makers from Kenya and Uganda were flown in to see how, in the words of a senior figure at Africa Harvest, 'Makhathini...proves that the (GM) technology can be adopted by anybody, it is scale neutral'.[151]

That Makhathini is still perceived as a 'success' a decade later, despite overwhelming evidence to the contrary, is a reflection of the narrow prism of increased yields and lower input costs through which it has been viewed. A number of far less publicized studies that have attempted to dispel the myths around Makhathini have come to very different conclusions. Cotton production in the area was the only viable option for most farmers, who would have chosen to grow food crops had it not been for the lack of a viable local market. From its introduction in 1998 until 2001, the sole buyer of cotton in the region was the private enterprise Vunisa cotton. Vunisa became a one-shop-stop for cotton producers in Makhathini as a seller of seeds and inputs, provision of extension services and credit (in conjunction with the Land Bank) and the sole buyer of cotton. The company used its monopsonistic position to supply credit to farmers who did own their own land, by allowing the forthcoming crop to be used as collateral. Thus, the adoption of Bt cotton was intimately linked to the provision of credit. By 2002, Vunisa and the Land Bank (which had more than R22 million in defaulted loans on its books) ceased lending in Makhathini, resulting in a 90% fall in cotton farmers the following year. In 2005/06, the KwaZulu Natal Department of Agriculture stepped in, making R6,4 million available.

Accordingly, the number of farmers increased from 548 to 2,169 in the space of a year, only to fall back to 853 once these new credit lines dried up.[152]

In 2001/02, the Makhathini Cotton Company (MCC) replaced Vunisa as the sole purchaser in the area. The MCC's business model was based on volume; the company's head of operations estimated that that in order to turn a profit the company would need to process 10 million kg of cotton a year. By 2004, this figure had reached 8 million kg, though this rise (up from 1.5 million in its first year) was not down to increased small holder production, but a series of joint ventures whereby the company took over the management of individual farmer's fields and split the profits 50/50. Under this scheme the MCC was able to incorporate hundreds of ha of previously parceled land under a centre pivot irrigation system. In 2000/01, just 13% of the cotton in Makhathini was irrigated. By 2006/07, this had increased to 36%.The MCC also only purchased cotton in specially marked bags, provided by local seed dealer Wenkem, to farmers who purchased Bt cotton, not conventional seed. It is unlikely that most small-scale farmers would have purchased the non Bt alternative, as it was only available in 25kg bags, which were enough to plant 10ha. Bt seeds however were provided in much more convenient 5kg bags.[153]

It is clear from the above that the triumphant proclamations by the biotech industry around Makhathini should be viewed with caution. If, for example, markets or credit had been available to encourage the production of other crops, would Bt cotton have been adopted with such 'enthusiasm'? Previous attempts to stimulate cotton production in the area have met with similar consequences. In 1931, a series of surveys concluded that the region could support more than 200,000 ha of cotton under irrigation. In 1934, the Pongola irrigation scheme was completed, providing water to 5,500 ha. However, administrative problems, isolation from markets, heavy insect infestations and a series of droughts meant that, by the end of the Second World War, over R30 million had been spent without any cotton ever having been grown. Similar schemes, to attract white growers to the region, floundered during the 1960s and 1970s.[154]

http://www.sciencealert.com.au/images/stories/gmcanola.jpg

Monsanto's Bt technology was developed initially for the US market, where the Bollworm is a major cotton pest. In South Africa production is also affected by the Jassid, a small winged leaf hopper that breeds on the underside of the leaf. During the 1920s a concerted effort was made to breed cotton strains resistant to the Jassid. Despite some initial successes, a sudden Bollworm outbreak stalled progress. Reports have emerged from northern Zulu land that the Jassid is making a comeback, forcing farmers to increase their spraying of organophosphates by as much as 25%. Finally, the provision of Bt cotton seeds will do little to alleviate what farmers in the region say has always been the greatest obstacle to cotton production in Makhathini: highly variable rainfall.[155]

The failure of Makhathini has not discouraged further attempts at the dissemination of GM seeds to peasant farmers. Throughout South Africa, the estimated 2.5 million households engaged in subsistence agriculture are highly coveted by agribusiness; both as a new market in themselves, and for the opportunity they provide for the seed and agrochemical companies to test their Green Revolution packages. The Eastern Cape is one of the poorest provinces in the country, and has been subject to numerous developmental policies. The Massive Food Programme (MFP), initiated in 2002, forms part of the Eastern Cape's Provincial Growth and Development Plan (PGDP) and has been designed to facilitate 'a seamless trajectory from subsistence to commercial production'.[156]

Research carried out in the Amathole district of the Eastern Cape in 2010, has revealed the severe shortcomings of this kind of approach. The manner in which the projects were prescribed took away virtually all production decisions from farmers. The Uvimbo bank purchased seeds and agrochemicals directly from suppliers, while many farmers were unaware that they had been given GM cotton, maize and soybean seeds to grow. The growing of mono-cash-crops, particularly in the case of Bt cotton, did little to aid household security, and in many cases, at harvest time, the farmers' lack of bargaining power severely curtailed their incomes.[157]

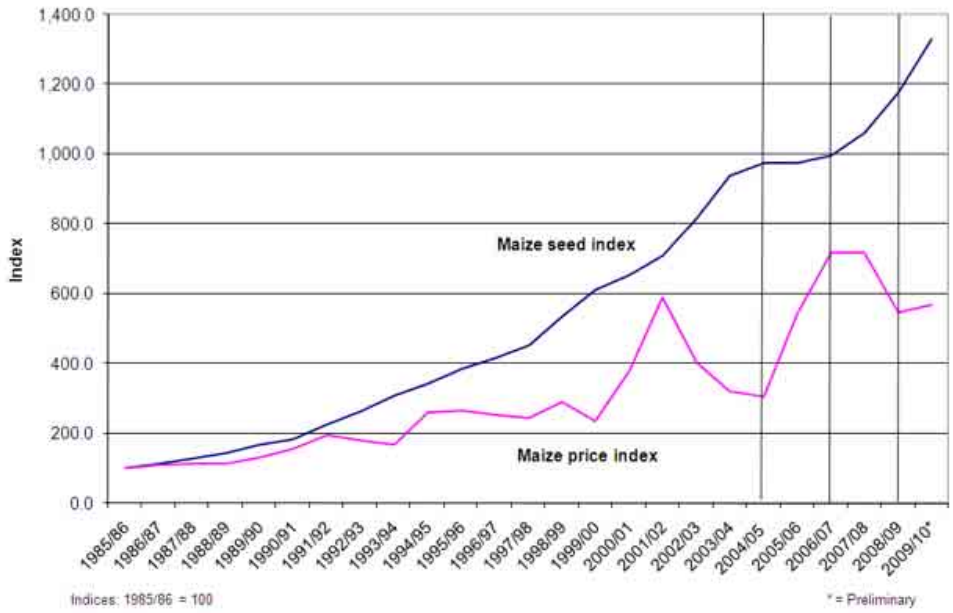
Issues around credit, debt and unequal power relations are not exclusive to GM crops, but rather are the symptoms of much wider systemic problems. However, it does highlight the shortcomings inherent in trying to address these issues through a technological lens. Moreover, the concentration of commercial markets and political influence that needs to be overcome are the very conditions that the multinational seed and agro-chemical companies have benefited enormously from; the 'solutions' they are proposing, such as GM seeds, are the result of an ideology whose very existence is dependent upon the perpetuation of the status quo.

Commercial farmers?

One group who would appear to have benefited from the introduction of GM seeds to date, are commercial famers. The sector has already undergone a huge transition, resulting from a programme of de-regulation that started back in the 1980s. Of the 60,000 commercial farming units operating in South Africa in 1996, less than 40,000 remain today.[158] Those farmers that have remained found themselves operating largely without state support, and subject to the vagaries of the free market, resulting in a marked reduction in their terms of trade. For example, between June 2008 and June 2009, the average price received by local farmers rose by 6.2%, while the prices paid by farmers for inputs rose by an average of 23.2%.[ii]

Focusing on seeds, the graph below shows how this trend has occurred in the maize sector since the onset of liberalisation in the 1980s. It is worth mentioning again that during the 2004/05 season, 20% of the maize seed sold was GM, which had risen to 58% by the end of the period shown in the graph (the latest figures are 77%). Over the period, while the price of maize seed (both hybrid and conventional) has risen steadily, the price that farmers receive for maize has been far more volatile. During 2010, a record maize surplus forced the price of maize to plummet, putting, according to industry sources, up to 30% of South Africa's maize farmers in danger of bankruptcy.[iii]

Figure 4: Indices of the prices of maize seed and the producer price of maize



Source: Grain SA

As the proportion of GM maize seed sold in commercial markets has increased, so too has its price. As the price list data (below) from Grain SA for seeds from the largest players in market, Monsanto, Pannar and Pioneer Hi-Bred clearly illustrates. It should be noted that this is not necessarily the end price farmers pay for seed, as some scope for discounts are offered;[iv] for early or bulk purchases for example. However, it does provide a good indication of the general upward trend, with the average price for yellow GM maize seed being 35% higher, as offered by the three companies in 2011 than it was in 2008. For white maize the figure is 30%. Of further interest is that price increases were highest for single gene Bt varieties which, though still the most popular varieties, have seen their share of total plantings fall from 71% to 46% over the same period.[159] This is consistent with practices in the United States, where seed companies raise the prices of their older, single trait varieties in order to encourage farmers to use their latest products.[160] In a recent article Corne Louw, a senior economist at Grain SA, stated that in 2004/05 season, the cost of seed accounted for 6% of a maize producer's overall costs, and that for the 2010/11 season this figure had more than doubled, to 13%.[161]

In 2009, three of Monsanto's GM maize varieties, MON810, NK603 and the stacked variety MON810 x NK603, failed to pollinate, leaving over 200,000 ha of maize fields barren across the country. Though the farmers were compensated for their losses, this was conditional upon them signing non-disclosure agreements. Further, at the time, the ACB was of the opinion that the matter had been dealt with very haphazardly by the Executive Council, as they gave conflicting explanations at the time, and would not grant public access to any of the data they had collected during their own investigation.[162]

The development of insect resistance to Bt maize, as identified in SANBI's study, has caused alarm bells throughout the industry. According to Farmer's Weekly, members of Grain SA's maize working group recently accepted a notion to prohibit farmers who fail to plant refuge areas access to Bt maize seed. It was agreed that Monsanto, as owner of Bt technology in South Africa, would be given the mandate to turn down any application from 'known perpetrators'. Industry is clearly very worried by these developments. Monsanto's commercial manager for Seed, Bennie Bester, claimed 'this could have catastrophic consequences for the local maize industry'.[163] Industry is clearly attempting to exonerate itself by shifting the blame onto commercial farmers, rather than question the appropriateness of the technology. This is not the first incidence of problems that have been reported in relation to GM seed in South Africa (see maize and cotton sections above), and

is indicative that further issues are likely. With GM seed taking an ever greater market share from conventional hybrids, what choices for alternatives are farmers likely to have in the future, should their experiences with GM varieties continue in this vain?

Further reading:
- The dirty politics of the global grain trade: GM Maize farmers face ruin in SA

Maize seed price increases in SA, 2008 – 2011

Yellow maize seed	Average 2008 price (Rs)	Average 2011 price (Rs)	Average % change 2008 – 2011
Bt	1,287	1,838	43
RR	1,359	1,802	33
Stacked	1,686	2,149	28
Average	1,418	1,917	35
White maize seed	**Average 2008 price**	**Average 2011 price**	**Average % change 2008 – 2011**
Bt	1,444	2,046	42
RR	1,455	1,938	33
Stacked	1,757	2,163	23
Average	1,543	2,008	30

Source: Grain SA

Who really benefits?

Seed and chemical companies

The real beneficiaries of the biotech revolution have been the developers of the technology themselves, the seed and agro-chemical companies. The global market for biotech seed is estimated to be worth $13.2 billion. Though small by international standards, the market for GM seeds in South Africa is still highly lucrative, and has more than doubled in value since 2008. The commercial seed market remains, despite industry proclamations to the contrary, the major focus of plant breeding and biotechnology research. Although the Gates Foundation may have donated close to $90 million towards 'pro-poor' maize, cassava and sorghum, this is dwarfed by what the industry at large spends on R & D. For example, the $47 million Gates gave to the WEMA project is equal to about one week's budget of Monsanto and BASF's $2.5 billion a year R&D collaboration.[164]

GM crops are still heavily reliant upon chemical inputs, despite frequent claims to the contrary. Maize cultivation, for example, accounts for 36% of South Africa's fertiliser consumption (60% of which has to be imported). The domestic fertiliser industry is heavily concentrated involving four companies, SASOL, Omnia, Farmsecure (formerly Kynoch) and Foksor.[165] Likewise, the rapid adoption of herbicide tolerant crops is a boon for Monsanto who, through clauses in their technology user agreements, can compel farmers to purchase their own Roundup brand rather than generics. In this way Monsanto, by its own admission, controls 60% of the country's glyphosate market.[166]

Further reading:
- Biotechnology, seeds and agro-chemicals: Global and South African industry trends.

Agri-business

According to the United Nations Food and Agricultural Organisation (UNFAO), over the course of the 20th century, 75% of the world's plant genetic diversity was lost, as local varieties and land

races have been replaced with genetically uniform seed. A similar process in animal husbandry has put 30% of all livestock breeds at risk of extinction. At the turn of the 21st century, 12 plant and five animal species generated three quarters of the world's food.[167] This is no accident, but the result of a very particular system of food production that demands uniformity and yield over diversity and nutrition. GM crops fit perfectly into this system, where vast monocultures can be grown, harvested, processed and then 'freely' traded over thousands of miles. It is a system that, by some estimates, contributes up to 57% of global GHG emissions.

It is also a system that, particularly in the USA and European Union, is propped up by a vast subsidy apparatus. In the USA, total farm subsidies to growers of maize, cotton and soybean during the years 2008, 2009 and 2010 topped $21 billion. During 2010, 83% of all maize subsidies went to the largest 20% of maize farmers. The corresponding figures for cotton and soya were 81%.[168] To put this in perspective, in 2008, total official development assistance to agricultural projects in Africa was $1.7 billion.[169]

US farm subsidies, 2008 – 2010 ($ 000,000)

Crop	2008	2009	2010	Total
Cotton	1,582	2,217	835	4,635
Maize	4,194	3,788	3,520	11,502
Soybean	2,048	1,675	1,561	5,284
Total	7,824	7,680	5,916	21,421

Source: Environmental Working Group Farm subsidy database

The global area now planted to GMOs is bigger than South Africa and Zimbabwe combined, while the annual global trade in GM grains is now worth $160 billion.[170] In 2009, the combined revenues of the top 10 corporations in seed, agro-chemicals, fertilizers, grain and oilseed trading and processing, food processing and retailing were over $1.6 trillion[171]; larger than the economies of India, Canada and Russia.

The South African agribusiness sector has become highly concentrated, involving only a few key players. The market for grain storage and trading is dominated by Senwes, Afgri, and NWK all former regional agricultural co-operatives who privatized in the 1990s. These three companies now own approximately 74% of the country's grain storage capacity. In 2011, it was announced that Senwes were to enter a joint venture with Bunge, the world's largest soybean exporter. Louis Dreyfus, Cargill, and Noble group, three other giants of the global grain trade, all have thriving operations in South Africa, the latter two recently announcing plans to build mammoth oilseed processing facilities, no doubt hoping to capitalize on the huge expansion of GM soya taking place.[172]

The GMO explosion has benefited the factory farming system handsomely. In a dazzlingly inefficient allocation of resources, over 40% of all the grain grown in the world is now used to feed animals. The factory farming system has spread, thanks largely to an abundance of cheap (if the wider environmental and health costs are discounted) GM maize and soybean. In South Africa the poultry sector has experienced phenomenal growth. Since 1993, the per capita consumption of poultry has doubled, and poultry now accounts for 20% of agricultural GDP. Afgri and NWK have both aggressively entered this lucrative market, in which seven firms control 78% of capacity. The maize milling industry is equally concentrated; between them, Premier Foods, Tiger Milling, Pioneer Foods and Afgri control 75% of all maize milling capacity.[173]

The Competition Commission has been particularly concerned with the food and agro-processing sector, making it a priority in 2006. Since then it has investigated and applied sanctions to companies in the grain trading, processing and retail sectors. In November 2010, it fined Pioneer foods a record R800 million.[174]

Further Reading:

- Corporate concentration and control in the grains and oilseed value chain in South Africa – a case study of the Bunge / Senwes joint venture

Looking forward

The 'transgenic treadmill' – More false solutions to Bt maize's failures

As noted above, Monsanto's 'insect resistant, or Bt, technology is failing. When this was confirmed by the publishing of SANBI's MON810 study in January 2011, industry was at first dismissive. For example, SANSOR's 2011 annual report claimed that this affected less than 1% of the total maize crop.[175] Within the space of twelve months, the situation is now being described, by Monsanto officials no less, as 'catastrophic'; Monsanto has even been given a mandate to refuse to sell its Bt seeds to farmers who do not comply with its refuge requirements. According to SANBI this will not make a great deal of difference, as they concluded that the existing requirements will be insufficient to prevent the further spread of resistance.[176]

The biotech industry is too heavily invested to propose any genuine solutions to this problem, such as inter-cropping varieties and utilizing intergrated pest management (IPM) techniques. Rather, the 'solutions' they are proffering involve more of the same: new insect resistant traits and stacked varieties. Monsanto's insect resistant variety MON89034 was granted approval in 2010, along with a variety stacked with the herbicide tolerance trait. During 2011 approvals were granted for field trials of a further 11 GM maize varieties that contain stacked insect resistance genes (many of them are also herbicide tolerant). One of these varieties contains four insect resistant genes. In the United States, Monsanto and Dow released an eight gene variety in 2009 called Smartstax. This contains six different genes inferring insect resistance into the plant. Aside from the serious biosafety implications of this, laboratory studies (which admittedly will require further investigation) have indicated that stacking different insect resistant traits together can actually accelerate resistance development in insect populations![177]

Stacked GM maize seeds were, on average, 18% higher than single trait yellow maize seeds, and 8.6% higher than single trait white maize seeds. However, since 2008 the average price of a single Bt maize seed has increased by 42%, compared to 23% and 28% for white and yellow stacked varieties respectively. This would suggest that the seed companies are keen to 'encourage' farmers away from their older varieties, onto their newer (still) more expensive varieties. Should they be successful with this strategy, it will be interesting to note just how long it takes before reports of new insect resistance, together with the 'new and improved' varieties to combat this, will emerge.

Monitoring glyphosate tolerant crops

SANBI's Dr Lukeshni Chetty, who managed the MON810 research project, acknowledged that after a decade of cultivation, the study into MON810 came 'a little late'. As such, SANBI are keen to consolidate their biosafety work, and utilise the extra biosafety capacity that has been developed in South Africa as a result of the EBCP, and have set the wheels in motion for a project to focus on herbicide tolerant crops. As illustrated above, herbicide tolerant (or Roundup Ready) crop adoption in South Africa has rapidly increased in recent years. A 2009 study from the United States revealed that since HT crops were introduced in 1996, an additional 144,424 tons of pesticides[178] had been used in US agriculture (net of reduced insecticide use where Bt crops had been planted).[179] The detrimental impacts of herbicides, particularly glyphosate, on human health and the environment have been well documented in a number of countries, particularly the USA and Argentina, which have grown HT crops the longest. Laboratory research from France has also revealed significant health impacts that at least require further study.[180]

The project is still very much in its infancy, with the first stakeholder workshop, aimed at defining the research parameters, held in early March at the University of the Northwest in Potchefstroom. Many of the researchers involved in the MON810 project were present, and will contribute towards the projects design and implementation, which can only be beneficial both in terms of the expertise they will bring and for purposes of consistency. However, the cooperation of the GENOK biosafety centre is contingent upon funding, which remains precarious. It was also clear from the workshop that industry is vehemently opposed to yet more 'onerous' regulation and monitoring of GMOs, and presented a largely united front in their opinion.

This new GMO monitoring project represents an important step towards closing more knowledge gaps around biosafety in South Africa, particularly given the issues that have arisen elsewhere. For instance, how much glyphosate is being used in South Africa with GM crops compared to their conventional counterparts? Who are the main users of glyphosate? Is this a suitable system for small-scale farmers? Further, are there any incidences of weeds developing resistance, as has been the case in the United States?[181]

Conclusion

Since our last South African update on genetically modified crops, and the transnational companies that control the technology, published in 2008, GMOs have become even more entrenched in the country's agricultural landscape. Over three quarters of South Africa's maize is now GM, while Roundup Ready soybean cultivation has increased nearly fourfold. If Pioneer Hi-Bred's acquisition of Pannar seed is accepted, we are about to relinquish all control over our seed system to two US multinational corporations. During 2010 and 2011, nearly 6 million tons of GM maize was exported to destinations in Africa and Mexico, the centre of origin of maize. Far from showing concern for these shocking statistics, the South African government has actively facilitated them. Over the reporting period, the Executive Council (EC), the country's main GMO decision making body, continued to dole out permits at an alarming rate, while policymakers speak proudly of the South Africa's 'leadership' role in bringing the technology to the rest of Africa.

Dozens of new GM crops are currently being field-tested; most of them belonging to the new generation of far more risky (and expensive) stacked GMOs. Additionally, research is being undertaken into 'orphan' and African heritage crops by institutions in South Africa, and in collaboration with the biotechnology industries attempting to penetrate African agriculture with its patent protected, chemically dependent seeds. Having been gutted by the 'structural adjustment' of the 1980s and 1990s, public agricultural research in Africa is now dependent upon the private sector and, increasingly, the new philanthropic sphere. No one has been more prominent in supporting this new research than the Gates Foundation. However, its motives must be questioned when it simultaneously 'donates' funding for biotechnology research and invests in the multinational seed giant Monsanto. The majority of its funding is goes to endeavors that directly contradict what the IAASTD, the most comprehensive study of global agriculture ever undertaken, points to as genuine solutions to the food and climate crises.

The alleged 'promises' that biotechnology has to eradicating poverty and hunger have not been borne out in South Africa. Over the review period, food prices have continued to rise. A 5kg bag of maize meal, the staple of the poorest members of society, has increased by a staggering 84% since January 2008. The suitability of GM seeds for the empowerment of small-scale farmers is also highly questionable. The ISAAA claims in its latest annual report that South Africa is one of the countries of the global south where Bt cotton has 'made a significant contribution' to improving small-holder livelihoods. The experience of the Makhathini farmers is indicative of how this message has, and continues, to be distorted. Peering beneath the empty rhetoric reveals that small-scale cotton production in South Africa has all but collapsed. Even commercial maize farmers, who would seem to be the obvious beneficiaries of GM seeds, are beginning to experience its shortcomings. In 2004/05, seed accounted for 6% of maize farmers overall costs. By 2010/11, this figure had shot up

to 13%. The discovery of insects developing resistance to Bt maize will add further pressure to their operating margins.

It is clear that the real beneficiaries of this GM invasion have been the multinational agribusiness companies, and that South Africa is seen as a beach-head from which to penetrate further into Africa. The model of industrial agriculture being perpetuated by these corporations, and the governments who support them, is wreaking havoc on the climate, on human health, and on the peasant farmers who still provide 70% of the food eaten in the world. There is now enough evidence to suggest that an alternative system, one that marries the biodiversity found in nature, the encyclopedic knowledge of peasant farmers and publically funded and transparent research, is not only a possibility, but also a necessity.

Annex 1: Events granted conditional environmental release

Event	Crop	Trait	Company	Year approved
BT11 x GA21	Maize	Insect resistance (IR) Herbicide tolerant (HT)	Syngenta	2010
GA21	Maize	HT	Syngenta	2010
MON89034 x NK603	Maize	IR x HT	Monsanto	2010
MON89034	Maize	IR	Monsanto	2010
Bollgard II x RR flex (MON15985 x MON88913)	Cotton	IR x HT	Monsanto	2007
MON88913 (RR flex)	Cotton	HT	Monsanto	2007
MON810 x NK603	Maize	IR x HT	Monsanto	2007
Bolgard RR	Cotton	IR x HT	Monsanto	2005
Bollgard II, line 15985	Cotton	IR	Monsanto	2003
Bt11	Maize	IR	Syngenta	2003
NK603	Maize	HT	Monsanto	2002
GTS 40-3-2	Soybean	HT	Monsanto	2001
RR lines 1445 & 1698	Cotton	HT	Monsanto	2000
Line 531 / Bollgard	Cotton	IR	Monsanto	1997
MON810 / Yieldgard	Maize	Insect resistant	Monsanto	1997

Annex 2: Events approved for commodity clearance into South Africa

Event	Crop	Trait	Company	Year Approved
Bt11 x GA21	Maize	IR	Syngenta	2011
Bt11 x MIR 604	Maize	IR x HT	Syngenta	2011
MIR x GA21	Maize	IR x HT	Syngenta	2011
BT11 x MIR604 x GA21	Maize	IR x HT	Syngenta	2011
BT11 x MIR162 x MIR604 x GA21	Maize	IR x HT	Syngenta	2011
BT11 x MIR162 x GA21	Maize	IR x HT	Syngenta	2011
BT11 x MIR162 x TC1507 x GA21	Maize	IR x HT	Syngenta	2011
TC1507 x NK603	Maize	IR x HT	Pioneer	2011
59122	Maize	IR	Pioneer	2011
NK603 x 59122	Maize	IR x HT	Pioneer	2011
356043	Soybean	HT	Pioneer	2011
305423	Soybean	Higher Oleic Acid content HT	Pioneer	2011
305423 x 40-3-2	Soybean	Higher Oleic Acid content HT	Pioneer	2011
TC1507 x 59122	Maize	IR x HT	Dow Agroscience	2011
TC1507 x 59122 x NK603	Maize	IR x HT	Dow Agroscience	2011
LLRice62	Rice	HT	Bayer	2011
LLCotton25	Cotton	HT	Bayer	2011
MON863	Maize	HT	Monsanto	2011
MON863 x MON810	Maize	IR	Monsanto	2011
MON863 x MON810 x NK603	Maize	IR x HT	Monsanto	2011
MON88017	Maize	IR	Monsanto	2011
MON88017 x MON810	Maize	IR	Monsanto	2011
MON89034 x TC1507 x MON88017 x 59122	Maize	IR x HT	Dow Agroscience & Monsanto	2011
MON810 x NK603	Maize	IR x HT	Monsanto	2004
MON810 x GA21	Maize	IR x HT	Monsanto	2003
TC1507	Maize	IR x HT	Pioneer Hi-Bred	2002
NK603	Maize	HT	Monsanto	2002
GA21	Maize	HT	Monsanto	2002
BT11	Maize	IR	Syngenta	2002
T25	Maize	HT	AgrEvo*	2001
BT176	Maize	IR	Syngenta	2001
Topas 19/2, Ms1Rf1, Ms1Rf2, Ms8Rf3	Oilseed Rape (Canola)	HT	AgrEvo	2001
A2704-12	Soybean	HT	AgrEvo	2001

*AgrEvo merged with Rhone-Poulenc Agro in 2000 to form Aventis Crop science. In 2002 Aventis was purchased by Bayer.

Annex 3: Field trials for stacked GM maize events in SA, 2008 – 2011

Event	Crop	Trait	Company	Year of first trial	Most recent trial
Bt 11 x MIR 162	Maize	IR / HT	Syngenta	2008	2008
Bt 11 x GA21	Maize	IR / HT	Syngenta	2008	Released 2010
TC1507 x MON810 x MIR162	Maize	IR / HT	Pioneer	2009	2009
TC1507 x MIR162 x NK603	Maize	IR / HT	Pioneer	2009	2010
TC1507 x MON810 x NK603	Maize	IR / HT	Pioneer	2009	2011
98140 X TC1507 x MON810	Maize	IR / HT	Pioneer	2009	2009
MON810 x MIR 162	Maize	IR / HT	Pioneer	2009	2010
TC 1507 x MIR 162	Maize	IR / HT	Pioneer	2009	2010
TC 1507 x MON 810	Maize	IR / HT	Pioneer	2009	2011
98140 X MON 810	Maize	IR / HT	Pioneer	2009	2009
TC1507	Maize	IR / HT	Pioneer	2009	2011
MON89034 x NK603	Maize	IR / HT	Monsanto	2009	Released 2010
PHP36827	Maize	IR / HT	Pioneer	2009	2009
PHP 37046	Maize	IR / HT	Pioneer	2009	2009
PHP 36824	Maize	IR / HT	Pioneer	2009	2009
PHP 37048	Maize	IR / HT	Pioneer	2009	2009
PHP 37049	Maize	IR / HT	Pioneer	2009	2009
PHP 36826	Maize	IR / HT	Pioneer	2009	2009
PHP 37047	Maize	IR / HT	Pioneer	2009	2009
PHP 37050	Maize	IR / HT	Pioneer	2011	2011
TC 1507 x 59122 x NK603	Maize	IR / HT	Pioneer	2011	2011
TC 1507 x 59122 x MON810 x NK603	Maize	IR / HT	Pioneer	2011	2011
TC 1507 x NK603	Maize	IR / HT	Pioneer	2011	2011
TC 1507 x 59122	Maize	IR / HT	Pioneer	2011	2011

Annex 4 : Stacked GM cotton field trials, 2008 – 2011

Event	Trait	Company	Year of first trial	Most recent trial
GHB 614 x LL cotton 25		Bayer	2008	-
T304-40		Bayer	2008	-
BGII x LL cotton 25	IR / HT	Bayer	2008	2011
GHB 119		Bayer	2008	-
GlyTol x LL Cotton 25	IR / HT	Bayer	2009	2010
BG II x GlyTol x LL Cotton 25	IR / HT	Bayer	2010	2011

Annex 5: Government and public institutions involved in biotechnogy in South Africa

Department of Agriculture, Forestry and Fisheries (DAFF)
The DAFF is fundamental to the research, development, and commercialization of GM crops in South Africa, as it houses the main decision making body within its biosafety directorate, the Executive Council (EC). The DAFF is also the 'competent national authority' for performing administrative functions of the Cartagena Protocol on Biosafety.

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Agricultural Research Council (ARC)
Established by the Agricultural Research Act 86 of 1990, the ARC is 'the principle agricultural research institution in South Africa'. The Act sets out the objectives of the ARC as 'conducting of research, development and technology transfer in order to: promote agriculture and industry, contribute to better quality of life, and facilitate/ensure natural resource conservation'. This is carried out across 11 research institutions that are divided into four research focus areas: horticulture, livestock and animal health, natural resources and engineering, and field crops. The Grain Crops Institute (GCI), under field crops, is mandated to work with some of the country's most important crops, including maize, sunflower, sorghum and soybeans. The GCI conducts annual cultivar trials for both maize and soybeans in South Africa.

Biosafety SA
Biosafety SA (BSA) was launched on the 18th of February 2010 under the auspices of the DST. BSA is publically funded by the DST, through the recently established Technology Innovation Agency (TIA – see below), with its annual budget being around R5 million. It also generates income through consulting and capacity building services rendered to the biotechnology industry in South Africa. BSA's goal is to contribute to a strong South African biotechnology sector by: assisting individuals or organizations with navigating the GMO permitting process, provision of post graduate bursaries, and general capacity building work with organizations in the biotechnology field.

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Council for Scientific and Industrial Research (CSIR)
The CSIR was founded in October 1945 by the Scientific Research Council Act, Act 33 of 1945, and was constituted as a science council by the Scientific Research Council Act (Act 46 of 1988). In 1999 the CSIR was listed as a public entity, in terms of the Public Finance Management Act, Act 1, 1999.

Technology Innovation Agency (TIA)
The TIA is an initiative of the DST that came into existence through the promulgation of the TIA Act No.26 of 2008, merging seven previously separate DST entities responsible for supporting and promoting innovation. Of the seven entities, four were involved in biotechnology: Cape Biotech trust, PlantBio trust, Lifelab and BioPAD trust. PlantBio, established in 2004, was dedicated to R&D and commercialization of plant biotechnology products.[182]

Within the innovation value chain the TIA's principle role is to bridge the gap between the results of applied research and early commercialization. The organisation comprises nine operational divisions, with each division supporting a number of business units. Under the biotechnology division can be found units for biotech in agriculture, health and industrial biotech. In 2010, out of a total of 147 investments projects, 37 were in agriculture, and a further 21 in industrial biotechnology.

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South African National Seed Organisation (SANSOR)
SANSOR was established in 1989, and serves South African seed industry in both an administrative and a promotional capacity. It manages all seed certification schemes in South Africa, on behalf of the DAFF. This is carried out by a team of over 200 authorised seed inspectors linked to private companies in the seed industry. Recognising the shifting dynamics within the sector, SANSOR also serves an international role to 'promote the visibility of the South African seed industry through active participation at international level so as to assist industry to survive and derive benefits from globalization and concentration of power' and to 'provide access to new technology, particularly seed treatments and genetic modification with the aid of modern biotechnology...'[183]

SANSOR maintains a standing committee on GM seed. During 2010/11, the standing committee made inputs in response to the findings of the SANBI's investigation into MON810, and participated in the drafting of the GMO labeling regulations under the CPA. The committee worked with a number of organizations on this issue, including the agricultural business chamber and AfricaBio, a well-known GMO lobby group with strong ties to the biotech industry. Together the groups sought GMO labeling regulations that were 'pragmatic and workable'[184] or, to diverge from industry speak, limited and weak. SANSOR's agronomy division meets twice a year, including a joint meeting with Grain SA's Input and production working group. One of the main discussion topics over the last 18 months has been the limitations on GMO commodity clearance imports.[185]

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Department of Trade and Industry (DTI)
The DTI's involvement in biotechnology in South Africa can be divided between its trade policy work (for example, requesting the moratorium on GM commodity imports) and its business incubation activities. Support has been given to small and medium size enterprises operating in the biotechnology field through its Small Enterprise Development Agency (SEDA). The Technology and Human Resources for Industry Programme (THRIP) is a partnership between government and the private sector and is based matching funding for R&D in higher education..

University of Cape Town (UCT)
Scientists at UCT, in collaboration with Pannar Seed, have been attempting to create a GM maize variety that is resistant to the Maize Streak Virus (MSV) for a number of years.

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Prof. Ed Rybicki. Ed.rybicki@uct.ac.za

University of Fort Hare
Scientists from the University of Fort Hare were involved with SANBI study.

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University of the Free State
The University of the Free State hosts one of South Africa's few GMO testing facilities, which is managed by Professor Chris Viljoen, one of the lead investigators on the SANBI GM maize study.

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University of KwaZulu Natal (UKZN)
The African Centre for Crop Improvement (ACCI) at UKZN aims to train African plant breeders in Eastern and Southern Africa on improvements to African cereals, root crops and pulses. Both the Rockefeller Foundation and the Alliance for a Green Revolution in Africa have provided funding for the ACCI.

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University of the North West (UNW)
The faculty of agriculture, science and technology at UNW currently hosts a plant biotechnology research group. It was also one of three South African universities that contributed expertise and capacity to the SANBI MON810 report.

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University of Pretoria, Forestry and Agricultural Biotechnology Institute (FABI)
FABI, University of Pretoria, established in 1997, is now home to over 180 academics, post-graduate students and support staff. It houses the joint DST / NRF Centre of Excellence in Tree Health Biotechnology (CTHB), which has a focus on tree health and the application of biotechnology to reduce the impact of pests and diseases on indigenous trees in South Africa. From 2004 to 2009, the CTHB was one of two partially funded DST/NRF centres of excellence. In September 2010, this was upgraded to fully funded status until the end of 2014.[186]

Other research being carried out includes: identification of potential genes and regulatory sequences that could aid pathogen resistance in the Eucalyptus tree, 'either by conventional breeding or genetic manipulation'; the improvement of wood in plantation tree species grown in South Africa; research into avocado and banana diseases (for banana see below); identifying genes for maize disease resistance and drought tolerance in Cowpea. Funders include Banana Growers Association of SA, BASF, Bayer, DTI, DST, Hans Merensky Holdings, Sappi, Syngenta.

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University of Stellenbosch
The Institute for Plant Biotechnology at the University of Stellenbosch focuses on carbohydrate partitioning in higher plants, the engineering of biopolymer synthesis, plant growth and resistance of plants to abiotic stress. It has done extensive work on GM sugarcane in South Africa. Its list of industry partners and funders includes Bayer Crop Science, the South African Sugar Research Institute and USAID.

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Stellenbosch also houses the Institute for Wine Biotechnology (IWBT), which was established in 1995, in alliance with the Wine Industry Network or Expertise and Technology (Winetech) and the Department of Trade and Industry.

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University of Witwatersrand
Research is being conducted to genetically engineering cassava for resistance to the Cassava Mosaic Virus (CMV) and whitefly resistance.

Contact:
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