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Deforestation as a result of GM soy plantations in the Brazilian Amazon
credit Maurício Araújo

Who benefits from GM crops?

February 2010

WHO BENEFITS FROM GM CROPS?

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Executive summary

Every year, the International Service for the Acquisition of Agri-Biotech Applications (ISAAA), which is partly funded by the biotech industry, publishes figures on the cultivation of genetically modified (GM) crops around the world. This annual review is never short on hyperbole and focuses almost exclusively on what it considers to be the successful expansion of GM crops. Every year, Friends of the Earth International publishes a fully referenced report analyzing the area of GM crops in the world, and providing evidence on their impacts in the countries that have planted them.

This year's 'Who Benefits from GM Crops' report shows that there is significant and growing opposition to GM crops in many parts of the world, with people and governments remaining extremely cautious about the adoption of GM crops due to escalating public concern about their socio-economic, environmental and health impacts. This is particularly the case in Europe, Africa, and, most recently, India, which placed a moratorium on planting of its first GM food crop due to widespread concerns about its health, environmental and socio-economic impacts.

Developments in the EU are particularly illustrative. 2009 was the fifth year in a row that fewer GM crops have been planted in the EU: the number planted decreased by more than 10%. Significantly, Europe's largest country and agricultural heavyweight, Germany, banned GM maize MON 810, the only GM crop authorized for cultivation in Europe, taking the number of countries in Europe with provisional bans on MON810 to six.

This report examines the promises of the biotech industry, including recent claims of the role of GM crops in tackling climate change, and finds these claims are exaggerated and premature. On the contrary, GM crops as part of the industrial model of agriculture could increase emissions (see below).

GM crops are also not feeding the world. They remain confined to about 2.6% of agricultural land worldwide, and 99% are grown for animal feed and fuels rather than for food crops. The US, Argentina, Brazil, India, Canada and China grew over 94% of GM crops in 2008, with the first three accounting for 79% of the total. The remaining 19 countries that ISAAA listed as growing some GM crops in 2008 grew just 6.7 million ha between them – equivalent to 11% of the US's crop (ISAAA 2008).

GM crops have still not lived up to their promise

Overall, there is increasing evidence to back up the argument that GM technologies have not lived up to the promises made by the biotech industry.

For example, the list of GM crops waiting in the wings is growing longer every year. More than 180 plant species have now been through the genetic modification process to the point where they have been field-tested, yet very few have progressed to the stage where commercial seed is available to farmers. After many decades of research, only two GM traits – herbicide tolerance (HT) and insect resistance (IR or Bt) have been successfully planted on a commercial scale. The proponents of the biotechnology industry blame this on excessive regulation and the EU's

opposition to GM crops. However, even in the US, with its combination of a large market and less stringent regulation, there is little sign of new GM traits reaching the commercial production stage.

In the US and South America, where significant planting of GM HT and IR plants has taken place, major environmental and social impacts have emerged.

Box 1: Accuracy of ISAAA data

The evidence provided to back up ISAAA's claims is weak, and there are questions concerning the accuracy of their data and conclusions. For example, ISAAA's 2008 Draft Status Report typically makes much of small areas of GM crops being planted in some of the 25 countries listed as growing GM crops. Yet a closer analysis of the data reveals that little progress is really being made outside the six countries that grow the majority of GM crops; and in some areas the expansion process has come to a standstill.

For example, ISAAA inflates its figures by recording very small areas of GM crop production (in the low hundreds of hectares in some countries) as <0.1 million ha. ISAAA also double counts 'stacked trait' crops (meaning that if a crop contains two genetically modified traits, the *"actual area"* will be considered to be double that planted). With the exception of the US, ISAAA (and others) generally have to rely on industrial seed sales data to estimate how many hectares have actually been planted with GM crops.

ISAAA also over-emphasises take up of GM technologies by small farmers. In its 2008 report it stated that the *"number of biotech crop farmers increased by 1.3 million in 2008, reaching 13.3 million globally in 25 countries – notably 90%, or 12.3 million were small and resource-poor farmers in developing countries."* But such figures need to be put into a global context to have real meaning. There are 513 million small and medium sized farmers in the world with land holding below 10 ha, so even if ISAAA figures are correct only 2.6% were growing any GM crops in 2008.

Impacts in GM growing countries

In the six key GM-growing countries, serious concerns have arisen on the social and environmental impacts of GM crops. This is particularly the case in the Southern Cone of America, which is a region of prime importance for global food production, as well as for its unique biodiversity. This region has been specifically targeted by transnational agribusinesses for the commercial production of GM crops. Along with the US, the Southern Cone is now responsible for more than 80% of the total area planted with GMOs worldwide. During 2009, several new GM varieties were approved in the region, and there is new evidence of GM crops varieties being cultivated without national authorization.

Land grabbing and increased pesticide use

In the Southern Cone of Latin America, vast GM plantations continue to displace peasant and indigenous communities, push the agricultural frontier deeper into the forests, and increase pollution and health problems due to the increased use of pesticides. This is accelerating the erosion of natural resources, and is destroying peoples' livelihoods and ability to feed themselves. GM soy has seen particularly rapid expansion in the last decade, with thousands of farmers being violently evicted from their lands.

In the last planting season, 350 million liters of the herbicide glyphosate (marketed as Roundup Ready and applied along with HT soy) were applied to the area cultivated with GM soy. The development of resistant weeds means that a cocktail of herbicides is being applied on GM crops.

Around 200 million liters of pesticides were used on soy crops in the last season, including the highly toxic organochlorine endosulfan, which is banned in many countries around the world. This has serious consequences on both the environment and human health, particularly for rural populations.

In the US, new research in 2008 analyzed United States Department of Agriculture data and showed that in 2008 GM crop acres required over 26% more pesticide per acre in the US than conventional varieties.

In 2009, further controversy erupted following the publication of research into the impacts of glyphosate on embryo development.

The impact that the expansion of soy production is having on forests in the Southern Cone is also extreme. In Argentina, for example, 200,000 ha of native forest disappear every year as a direct consequence of the advance of the agricultural frontier, and this, again, is mainly driven by the expansion of GM soybean monocultures.

The agro-chemical industry's solution to this problem is to use yet more (and different kinds of) herbicide, and to develop new GM crops tolerant of a range of different herbicides, for use in areas with glyphosate-resistant weeds. Yet this solution will lead to further increases in dependency on fossil-fuel based chemical weed control.

Do GM crops tackle climate change?

GM crops are currently being promoted as an essential component in efforts to combat climate change, and feed people in a warming world. On the basis of these claims, biotech companies are lobbying hard at the UN's climate change negotiations to have GM crops and industrial farming methods recognized as mitigation techniques in the agriculture sector.

These claims are based on a range of arguments, including some addressed above – that GM crops reduce pesticide use and increase yields, meaning that they will be useful in both mitigating and adapting to climate change. An additional new argument is that GM crops will reduce the loss of carbon from soil by reducing tillage (plowing). It is also being claimed that new drought-resistant crops are about to be commercialized. The holy grail of GM crops are nitrogen-fixing crops that could reduce the need for artificial nitrogen fertilizers, reducing the use of fossil fuels to manufacture, pack, transport and broadcast the fertilizers, as well as reducing the use of the fertilizers themselves. Also being promoted is the potential for GM trees that can store more carbon than normal trees. A final key claim by the GM industry is that crops should be genetically modified to improve fuel production.

Yet a closer analysis of GM trends show that these claims have little or no substance:

- None of the GM crops so far developed for commercial cultivation have been yield enhancing, and there is no evidence to support this claim. The GM industry's focus has actually been on agronomic traits and over 99% of commercial GM crops are modified to create herbicide tolerance or insect resistance (or both). The vast majority of GM applications are for pesticide-promoting herbicide tolerant crop varieties.

- Much is also made of 'miracle' GM crops that would be capable of growing in 'marginal lands' or dealing with abiotic stresses such as salinity, high levels of aluminum in soils, or drought. But in reality such crops are nowhere near commercial cultivation and these claims are highly speculative. Furthermore, successful genetic modification conferring drought tolerance has so far proved impossible because it requires major changes to the metabolism of plants. It is also worth pointing out that no seed will germinate and flourish in the absence of moisture. Monsanto recently applied for an EU marketing consent for a drought tolerant maize trait which even Monsanto admits may not be especially effective in producing a viable yield in very dry conditions.

- Furthermore, the idea that there are vast areas of 'marginal land' ready to grow GM crops for food and agrofuels is increasingly recognized as spurious. Recent reviews of this important issue, found that that land is rarely idle. It is more likely to be used by pastoralists, smallholders, Indigenous Peoples and women who utilize the land in a sustainable low impact way for hunting, and gathering food, fuel and building materials. In addition, land may also be important for biodiversity and for protecting water resources.

- Similarly, there has been very little progress in terms of developing GM nitrogen-fixing crops. As an FAO report concluded in 2005, this may be technically difficult, because of the complexity of the nitrogen fixation process, which involves symbiotic relationship between two different organisms.

- Conservation (reduced) tillage, originally intended to enhance soil and water conservation, was developed well before the first genetically modified crops and can be used with any crop. Furthermore, the introduction of GM herbicide tolerant crops is undermining the sustainability of these earlier conservation tillage systems, by increasing the quantity of pesticides used and because of soil compaction by heavy machinery. Recent studies also suggest that 'no-till' techniques may not sequester any more carbon than conventional plowing.

- The potential to increase yields from GM crops for agrofuels is far from proven. There has been no success in improving crops' efficiency by genetically modifying their ability to metabolize carbon. The GM crop most widely used for agrofuel feedstock is, soya: 70% of the global crop is GM Roundup Ready soya. However, a recently published analysis concluded that, *"soybean biodiesel production, despite its high savings from a pure engineering perspective dramatically increases greenhouse gas emissions compared to conventional diesel when factoring in emissions from land use change across a broad range of assumptions."*

- The risks associated with GM trees are far more complex to assess since trees are organisms with large habitats and numerous interactions. In addition, both scientific literature and in-field experience show that contamination by and dispersal of GM trees will take place, and transgenic sterility is not an option. GM material from trees is likely to cross national borders making national regulation insufficient.

- While promoting the potential of their GM crops, companies such as Monsanto, Bayer, Syngenta, BASF and Dupont are, behind the scenes, systematically patenting naturally occurring genes which could at some point be included in crops modified to mitigate and adapt to the stresses brought about by a changing climate, such as drought, salinity, floods, and high and low temperatures. So far they have filed 532 patent documents covering 55 patent families. The privatization of genetic resources in this way restricts farmers' and researchers' access to seeds and knowledge.

Other less risky approaches exist

There is another successful approach to agriculture that already has a proven track record when it comes to addressing some of the challenges linked to food production and climate change: agro-ecology. This incorporates a range of sustainable food production systems, which focus on preserving biodiversity and increasing food productivity. The agro-ecological approach also ensures that carbon rich materials, such as manure and compost, are systematically returned to the soil to improve it. Many recent studies have identified agro-ecology as key to facing future food challenges.

In April 2008, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) concluded that a far greater emphasis on agro-ecological approaches was needed. The IAASTD did not endorse GM crops as the solution. 58 counties have endorsed the IAASTD findings without reservations.

In October 2008, the UNEP-UNCTAD Capacity-building Task Force on Trade, Environment and Development also published a report on “Organic Agriculture and Food Security in Africa,” which supported the IAASTD’s finding that agro-ecological approaches to land management provide the best options for dealing with the many tasks being asked of farmers.

However, many agro-ecological solutions to the major problems of drought and saline soils (which often result from the use of ecologically inappropriate crops and the overuse of irrigation on hybrid crops) have still to be extended to farmers. There is a persistent failure to make money available to fund extension services and infrastructure. In some countries land tenure for farmers, and especially women, also makes the adoption of agro-ecological practices more difficult.

Farming practices still need to change radically to meet the challenges of climate change. These will include feeding a growing population, protecting and restoring biodiversity and ecosystems services, and producing fuel and raw materials for industry. The good news is that with political will and support agro-ecology can do all this.

Genetically modified crops – the global picture

The biotechnology industry spends considerable amounts of time and money producing materials that claim to show a rapid expansion in the area of land planted with GM crops. They aim to use these materials to try to persuade countries or regions that have not wholeheartedly taken up GM crops that they will be left behind by the 'gene revolution'. They also contend that miracle GM traits about to be brought to the market are needed to feed people in a warming world. However, the evidence to support these claims is very weak.

GM crops are not being grown to feed people

Despite more than 30 years of research and development, GM crops have made little impact in terms of their contribution to global food supplies, despite their continued promotion as 'part of the solution' to alleviating hunger.

In fact, most GM crops are not grown to produce food for people. Instead they are grown to provide animal feed, agrofuels (in the form of bio-diesel and bio-ethanol) and cotton. For example, somewhere between 60% and 90% of the GM soya harvest is used for producing high protein soya meal for animal feed, and vegetable oil (MVO, 2009). Some oil is used for cooking, but in Argentina, Brazil and the US significant amounts are converted into bio-diesel.

GM maize is also converted into animal feed in the form of grain or maize gluten. Some maize oil and corn syrup is used in cooking and processed food, but significant quantities are now being diverted to agrofuels production. GM canola (oil seed rape) is also used to produce vegetable oil and crushed seed to feed to livestock.

According to industry sources over 99% of the GM crops planted commercially are either soya, cotton, maize or canola. In 2008 GM soya alone accounted for over half of all the GM crops grown (53%) and maize nearly one third (30%). (ISAAA 2009)

In contrast, there are no commercial GM varieties of wheat, barley, oats, rice, potatoes, sorghum, millet and other pulses. Similarly, the commercial production of GM fruit and vegetables is confined to just a few small locations: GM papaya in Hawaii and China, and GM tomatoes and sweet pepper in China. Thus nearly all the cereal, pulses, fruit and vegetables consumed on the planet remain non-GM.

The global area of 125 million ha of GM crops in 2008 also included an undisclosed area of poplar trees in China, and GM flowers in Columbia and China (ISAAA, 2009).

Resistance to GM crops remains strong

Every year, the International Service for the Acquisition of Agri-Biotech Applications (ISAAA), which is partly funded by the biotech industry, publishes figures on the cultivation of GM crops around the world. But this annual review is never short on hyperbole, focusing almost exclusively on what it considers to be the successful expansion of GM crops (ISAAA, 2009).

In reality there is significant opposition to GM crops in many parts of the world (other than in North and South America), with countries and governments remaining extremely cautious about the adoption of genetic technologies, especially in food crops. Eurobarometer figures, for example, show that public opposition to GM in the EU is 58%. India has just banned the planting of its first GM food crop due to widespread public opposition and South Africa has also stopped planting GM food crops due to safety concerns (Africa Biosafety, 2009) (India, MOES 2009) (EC, 2005).

The 2008 ISAAA report also makes much of small areas of GM crops being planted in the various countries. Yet a closer analysis of the data reveals that little progress is really being made outside the six countries that grow the majority of GM crops; and in some areas the expansion process has come to a standstill. The US, Argentina, Brazil, India, Canada and China grew over 94% of GM crops in 2008, with the first three accounting for 79% of the total. The remaining 19 countries that ISAAA listed as growing come GM crops in 2008 grew just 6.7 million ha between them – equivalent to 11% of the US's crop (ISAAA 2008).

Box 2: What is ISAAA?

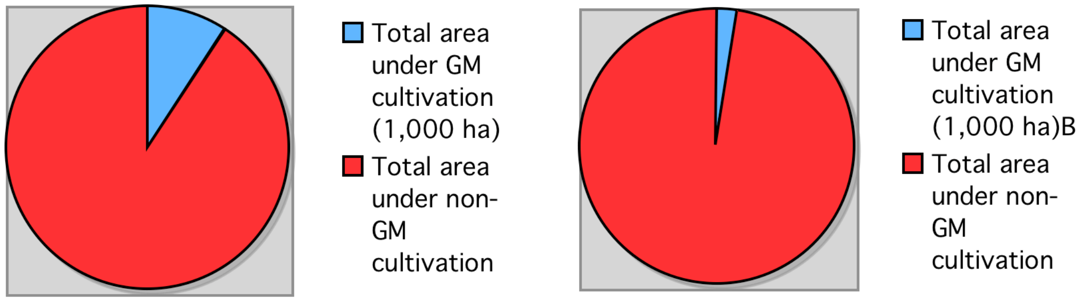
The International Service for the Acquisition of Agri-Biotech Applications (ISAAA) has a very definite pro-GM mission. As it explains on its website *"ISAAA is a not-for-profit international organization that delivers the benefits of agricultural biotechnology to resource-poor farmers in developing countries*." (ISAAA, 2009) ISAAA also describes itself as being *"principally sponsored by philanthropic foundations, and cosponsored by a donor support group consisting of public and private institutions.*" (ISAAA, 2009) However, this donor group includes Monsanto and Bayer Crop Science, CropLife International (a global biotech lobby group), USAID and the US Department of Agriculture, together with the governments of Kenya and the Philippines.

However, there are significant questions about the accuracy of the data they issue. In particular, the sources of data used in the global status report are sometimes unclear. For instance, the online PowerPoint presentation of the 2008 Global Status Report simply cites the source as "Clive James 2008" (Clive James is the Chair of ISAAA). However, apart from the US, very few governments record the area of GM and non-GM crops separately, so data is collected per crop. This means that ISAAA must generally rely on industrial data for seed sales to calculate how many hectares have been planted with GM crops. (Although China poses more difficult problems because the seeds come from several public institutions.) (ISAAA, 2008b)

According to ISAAA's 2008 report: "*Progress was made on several important fronts in 2008 with: significant increases in hectarage of biotech crops; increases in both the number of countries and farmers planting biotech crops globally; substantial progress in Africa, where the challenges are greatest; increased adoption of stacked traits and the introduction of a new biotech crop**.** These are very important developments given that biotech crops can contribute to some of the major challenges facing global society, including: food security, high price of food, sustainability, alleviation of poverty and hunger, and help mitigate some of the challenges associated with climate change."* (ISAAA, 2008)

However, the 2008 report's conclusion that there has been a *"new wave of adoption of biotech crops"*, because the number of countries planting biotech crops has *"soared"* to 25, was unjustified. The number of countries plating biotech crops in the previous year was 22 so the difference – just three countries - is not that dramatic (the additions were Bolivia, Burkina Faso and Egypt); and GM crop production remains insignificant in terms of world agricultural production, as Figure 1 shows. This hardly constitutes a 'historic milestone'. (ISAAA, 2008)

Figure 1: GM crops as a proportion of global agricultural and arable land



Arable land under GM

Agricultural land under GM

Table 1: GM crops as a proportion of global agricultural and arable land

	Total global land (ha)[A]	Total area under GM cultivation (ha)[B]	Total area under non-GM cultivation (ha)	GM as a percentage of global land (agricultural / arable)
Agricultural land	4,803,385,400	125,000,000	4,678,385,400	2.6%
Arable land	1,365,069,800	125,000,000	1,240,069,800	9.2%

Data sources: A (global) www.nationmaster.com/graph/agr_ara_lan_hec-agriculture-arable-land-hectares
http://www.nationmaster.com/graph/agr_ara_lan_hec-agriculture-arable-land-hectares;
B- International Service for the Acquisition of Agri-biotech Applications
http://www.isaaa.org/resources/publications/briefs/39/executivesummary/default.html

Table 1 also shows how little GM cropping really takes place, with non-GM food and fodder crops taking up over 97% of the world's agricultural land and over 90% of the world's arable land in 2008.

Data tricks

Organizations such as the ISAAA have a vested interest in inflating the uptake of GM to ensure a continuing supply of investment from donors (see box 'What is ISAAA?'). Thus they usually employ a number of tricks to boost the figures they present each year. These include double counting, inflating figures by rounding the smaller ones up to a minimum figure, the incorporation of uncertain data ('ghost hectares'), and exaggerating the impacts on small farmers.

Double counting

Two types of traits account for around 99% of GM crops grown – herbicide tolerance (HT) and insect resistance (IR). Biotech companies have started to combine these traits in one crop by cross-breeding to produced what are known as 'stacked GM traits'. Monsanto and Dow, for example, have developed a maize variety called SmartStax (Monsanto, 2007) containing two HT traits and 6 IR traits.

In their 2008 report, ISAAA claimed global hectarage of biotech crops continued its strong growth in 2008 for the thirteenth consecutive year. But they characterize the 10.7 million ha increase in land area under GM cultivation (bringing the total to 125 million ha, equivalent to a 9.4% on the previous year) as *"apparent growth"*. They go on to describe the *"actual growth"* as growth in *"trait* *hectares*". This allows them to inflate the rate of growth to a 15% year-on-year increase, since the hectarage of "trait hectares" has increased by 22 million ha, to a total of 166 million. (ISAAA, 2008: pp v and xi hard copy) Thus for crops with two stacked traits, ISAAA is claiming double the area, or in the case of SmartStax eight times the area.

Inflating the figures

For countries that have only grown very small areas of GM crops, the ISAAA's Global Status Report records them as <0.1million ha. This can be extremely deceptive. In 2007, for example, ISAAA recorded the areas of GM maize planted in Poland and Romania as <0.1million ha when they were actually 327 ha and 350 ha respectively (Monsanto, 2008). Similarly, in its 2009 report ISAAA recorded the GM maize area in Spain as 0.1million ha, which inflated the actual figure of 79,267 ha by 26%.

Ghost hectares

In previous Global Status Reports, figures quoted for GM crop cultivation have been challenged or found to be inaccurate.

In 2005, for example, the area given by ISAAA for GM maize in the Philippines, where no official statistics were gathered, was challenged. ISAAA claimed that more than 50,000 ha were cultivated with GM corn. However, the Philippine government does not monitor the actual areas planted with GM corn, nor does it have a system to track the amount of GM corn seeds that have been sold to farmers. When ISAAA director Dr. Randy Hautea was asked about the source of these statistics, he replied that they came from the Department of Agriculture in the Philippines. However, the Philippine Bureau of Agricultural Statistics has no figures on the hectarage or number of farmers using GM corn, and an official from the government said that ISAAA claim was superfluous (FOEI, 2006:6).

The data for GM cotton in South Africa was also contested (De Grassi A, 2003) because the actual area appeared to be 20 times less than ISAAA's claimed 100,000 ha.

In 2006 the Global Status Report claimed GM rice was being grown in Iran, which was challenged by the International Rice Research Institute (Financial Express, 2006). The 2007 report did not mention GM rice in Iran.

Exaggerating the impact on small farmers

In its 2008 Global Status Report, ISAAA stated that the *"number of biotech crop farmers increased by 1.3 million in 2008, reaching 13.3 million globally in 25 countries – notably 90%, or 12.3 million were small and resource-poor farmers in developing countries."* But such figures need to be put into a global context to have real meaning. There are 513 million small and medium sized farmers in the world with land holding below 10 ha (Von Braum J, 2008) so even if ISAAA figures are correct only 2.6% were growing any GM crops in 2008.

In reality, GM crops are grown by a tiny proportion of small or medium scale farmers worldwide: at the most this is less than 1% of all farmers.

References

Biosafety Africa (2009) Press release 'South African Govt rejects GM potato' http://www.biosafetyafrica.net/index.html/index.php/20100207281/South-African-Govt-rejects-GM-potato/menu-id-100023.html

De Grassi A (2003). Genetically Modified Crops and Sustainable Poverty Alleviation in Sub-Saharan Africa: An Assessment of Current Evidence. Third World Network Africa.

European Commission research Biosafety (2005) http://ec.europa.eu/research/biosociety/public_understanding/eurobarometer_en.htm

Financial Express (2006). GM rice likely to make trade more complex, October 2006, Financial Express, See http://www.financialexpress.com/news/GM-rice-likely-to-make-trade-morecomplex/180508/

FOEI (2006). Who benefits from GM crops? Monsanto and the corporate-driven genetically modified crop revolution, Friends of the Earth International, January 2006, www.foei.org/en/publications/pdfs/gm-crops-2006-full-report

Indian Ministry of Environment and Forests (2009). Decision on commercialisation of Bt Brinjal http://moef.nic.in/downloads/public-information/minister_REPORT.pdf

ISAAA (2008). ISAAA Brief 39-2008: Executive Summary, Global Status of Commercialized Biotech/GM Crops: 2008 The First Thirteen Years, 1996 to 2008, ISAAA, http://www.isaaa.org/resources/publications/briefs/39/executivesummary/default.html

ISAAA (2008b) PowerPoint presentation on ISAAA 2008 Global Status Report, Dr Clive James, http://www.isaaa.org/resources/publications/briefs/39/pptslides/Brief39Slides.pdf

ISAAA (2009). See ISAAA Donor Support Groups webpage at http://www.isaaa.org/inbrief/default.asp
Monsanto (2007). Monsanto-Dow Agrosciences Collaborative Agreement, SmartStax: new industry-standard stacked-trait platform, PowerPoint presentation, 14 September 2007, http://www.monsanto.com/pdf/investors/2007/09-14-07.pdf

Monsanto (2008). Monitoring Report Mon 810 Cultivation Czech republic, France, Germany, Portugal, Slovakia, Poland, Romania and Spain 2007. Monsanto, 2008.

MVO (2009). Product Board for Margarine, Fats and Oils, Soy Factsheet 2009, http://www.mvo.nl/Portals/0/statistiek/nieuws/2009/MVO_Factsheet_Soy_2009.pdf

Von Braum J (2008). Poverty, Climate Change, Rising Food Prices and Small Farmers. Presentation to the International Fund for Agricultural Development Rome, April 2008. See www.ifad.org/gbdocs/repl/8/ii/e/presentations/IFAD_21-04-08.pps

Promises, promises – the claims of the biotechnology industry

Researchers in the field of biotechnology require an ongoing flow of funds to conduct their research, regardless of whether they are academic or working within the industry. They also compete with each other for both public and private funding. Consequently there is a strong tendency to exaggerate the future potential of the genes that have been identified.[1]

Ultimately, researchers expect the results of their GM research to be bought up by agri-biotech companies, which will then develop crops that can be sold to farmers on a commercial scale. From the companies' perspective, the potential for repeat sales will also be a significant factor in determining which traits to buy.

However, it is a very big step from identifying a gene with a particular function to being able to engineer that gene into a plant in such a way that it functions consistently and reliably in the field. Many characteristics, such as drought tolerance and nitrogen fixation, are controlled by more than one gene, which makes the task of genetic modification all the more complex. The overall genetic make-up of the plant is also critical in determining whether a crop variety will be able to withstand a range of abiotic stresses, from drought to flooding.[2]

Unfulfilled promise

The list of GM crops waiting in the wings is growing longer every year. More than 180 plant species have now been through the genetic modification process to the point where they have been field-tested (Dunwell J M and Ford CS, 2005) (ISB, 2010), yet very few have progressed to the stage where commercial seed is available to farmers.

The proponents of the biotechnology industry blame this on excessive regulation and the European Union's opposition to GM crops (US Senate Committee, 2009) (Hansard, 2008). However, even in the US, with its combination of a large market and less stringent regulation, there is little sign of GM traits reaching the commercial production stage. And even crops in the US face legal problems. For example, GM alfalfa deregulation was suspended in June 2009 (US Court of Appeals 2008) and GM sugar beet in September 2009, because of the US Department of Agriculture's failure to produce full Environmental Impact Statements (California, 2009). In both cases the judges were concerned that the environmental and socioeconomic impacts of cross-pollination had not been properly assessed by US regulators.

To date, tens of thousands of potential GM plants have been tested in the US yet only two main traits – herbicide tolerance and insect resistance – have resulted in significant commercial production. According to one recent review from the EU's Joint Research Centre, there are 25 traits in the regulatory pipelines around the world – 60% of which are for HR and IR (Stein AJ and Rodriguez-Cerezo E, 2010). The same letter predicted that by 2015 the proportion of HR and IR crops would increase to 65%. The remainder would be traits for product quality, virus resistance, abiotic stress (one in the pipeline) and other traits.

Golden Rice has been a particular flagship project for the biotech industry over the last decade, as it has been portrayed as a crop specifically developed to alleviate Vitamin A deficiency in the

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[1] In the early 2000s, for example, the UK Food Standards Agency (FSA) published an educational *"time line"* which predicted the availability of GM golden rice by 2004, high protein GM potatoes by 2004; salt tolerant tomatoes by 2005; sunflowers resistant to white mould by 2005; edible GM vaccines by 2010; disease resistant grapes by 2010; and caffeine-free tea and coffee bushes by 2010. None of these GM crops are anywhere near commercial development in 2010. (Wisely, however, the FSA included a disclaimer in its "educational" tool.) (FSA, undated) FSA (undated). *The Gene Revolution Timeline,* Food Standards Agency, webpage as at 22 February 2010: http://archive.food.gov.uk/gmtimeline/default.html)

[2] See Climate and GM chapter for detailed information.

Global South. However, major doubts still exist about its efficacy in tackling this one aspect of malnutrition, its performance as a crop, and public acceptance in target populations (ISIS, 2009) (Foodwatch, 2009).

One commentator summed up these doubts:

"Until today, no research has been published indicating the nutritional benefit of this new rice whether alone or integrated in meals or consumed for a short or long time. What we also do not know is whether this much touted transgenic biofortified rice approach is superior to other conventional strategies for preventing and overcoming vitamin A deficiency." (Krankwinkel M, 2007)

References

California (2009) US District Court Northern California, Case3:08-cv-00484-JSW Document139 Filed 21 September 2009, http://www.earthjustice.org/library/legal_docs/9-21-09-order.pdf

Dunwell J M and Ford CS (2005). Technologies for Biological Containment of GM and non-GM crops. Defra Contract CPEC 47, http://www.gmo-safety.eu/pdf/biosafenet/Defra_2005.pdf

Foodwatch (2009). A Critical Look at Golden Rice. 7 January 2009. http://www.foodwatch.de/english/golden_rice/index_ger.html

Hansard (2008). House of Lords Hansard text for 3 July 2008, http://www.publications.parliament.uk/pa/ld200708/ldhansrd/text/80703-0003.htm;

ISB (2010). Lists for Field Test Releases in the US, Information Systems for Biotechnology, as at 22 February 2010. See http://www.isb.vt.edu/cfdocs/isblists2.cfm?opt=1

ISIS (2009). The Golden Rice Scandal Unfolds, ISIS Report 18/03/09, Institute of Science in Society, http://www.i-sis.org.uk/goldenRiceScandal.php

Krankwinkel M (2007). What we know and don't know about Golden Rice. Letter to the editor. *Nature Biotechnology* Vol 25 June 2007 p623, http://www.nature.com/nbt/journal/v25/n6/full/nbt0607-624a.html

Robert Paalberg (2009) EVALUATING, AND IMPROVING, AMERICA"S RESPONSE TO GLOBAL HUNGER, Statement To United States Senate Committee on Foreign Relations Hearing on "Alleviating Global Hunger: Challenges and Opportunities for U.S. Leadership" http://foreign.senate.gov/testimony/2009/PaarlbergTestimony090324a.pdf

Stein AJ and Rodriguez-Cerezo E (2010). International Trade and the Global pipeline for GM Crops. Stein AJ and Rodriguez-Cerezo E. Nature Biotechnology Vol8 no 1 January 2010 pp23-24. http://www.nature.com/nbt/journal/v28/n1/fig_tab/nbt0110-23b_T1.html

United States Court of Appeals for the Ninth Circuit (2008) Geertson Seed Farms and others Vs Secretary of the U.S. Department of Agriculture and others. http://www.ca9.uscourts.gov/datastore/opinions/2009/06/24/07-16458.pdf

GM Crops in the Europe

Another year of decreasing GM acreage in the European Union

For the fifth year in a row fewer GM crops have been planted in the European Union. The number planted decreased by more than 10% in 2009.

Table 2: GMO cultivation in European countries 2008/9

	2008 (ha)	2009 (ha)	year on year change
Spain (1)	79,269	76,057	-4%
Romania (2)	6130	3094	-50%
Germany (3)	3173	0	-100%
Czech Republic (4)	8380	6,480	-23%
Slovakia (5)	1931	875	-55%
Poland (6)	3000	3000	0
Portugal (6)	4,856	5,202	+7%
Total	106739	94708	-11%

Sources:

1. Spain (2009)
2. (INFOMG, 2010)
3. Nil after German national ban
4. (Greenpeace, 2010)
5. (Polonoinfo.sk, 2010)
6. Daily Rzeczpospolita, who quotes the estimates of Polski Zwiazek Producentow Kukurydzy (The Polish Association of Maize Producers) and Friends of the Earth 2008
7. Official Government figures. Available on request

GM crop cultivation in the European Union has been the subject of much controversy over the last 13 years, because of concerns about the safety of GM crops, contamination and, increasingly, about the socio-economic impacts of GM cultivation.

In 2009 this trend was strengthened when Europe's largest country and agricultural heavyweight, Germany, banned GM maize MON 810, the only GM crop authorized for cultivation in Europe. The ban was put in place on grounds of the threat posed to the environment and health by this crop. 70% of the German public supported a ban on GM crop planting, reflecting continuing public opposition to GM across Europe. Germany's cultivation of 3,173 ha of GM maize fell to zero in 2009 following the national ban (Guardian, 2009).

> *"I have come to the conclusion that there are legitimate grounds to accept that genetically-modified corn from the MON 810 strain constitutes a danger to the environment."*
> Germany's Minister of Agriculture, Ilse Aigner,
>
> Source: (Bloomberg.com, 2010)

Europe’s largest agricultural producer, France, decided to maintain its ban on MON810 in 2009; and Luxembourg also introduced a national ban, taking the number of countries in Europe with provisional bans on MON810 to six (these bans are based on the ‘safeguard’ clause in EU regulations).

New analysis on MON810’s potential toxicity, based on Monsanto’s own data, was also published in 2009 (Spiroux de Vendômois *et al,* 2009).

Four of the countries have never permitted MON810 cultivation; France (2008) and Germany (2009) are the first to have banned the crop after it was first cultivated. This was a major blow to the GM industry in Europe, especially as the total area under GM crops fell by 2% between 2007 and 2008 due to the French ban (FoEE, 2009) - despite ISAAA’s claims that *“All seven EU countries increased their Bt maize hectarage in 2008, resulting in an overall increase of 21% to reach over 100,000 hectares.”* (ISAAA, 2008)

In fact, no GM crops have been approved for cultivation in the European Union since 1998, and many applications that were pending in the late 1990s have been withdrawn. The same reluctance to cultivate GM crops is evident in other non-EU European countries as well, including major agricultural producers such as Russian and Ukraine where no GM crops have so far been approved for cultivation.

The European Commission did attempt to force member states to accept GM maize, but these efforts were met with resistance when the European Council of Ministers rejected an EC proposal intended to force Austria and Hungary to lift their national MON810 bans.

Spain is now the only country in the EU which has a substantial area of MON 810 cultivation but official data for the 2009 plantings show that even in Spain the overall area under cultivation dropped by over 4% between 2008 and 2009 (Spain, 2009). Similarly, official data from Romania shows a reduction of almost 50% in the area of GMO crops (INFOMG, 2010).

GM maize cultivation in the Czech Republic fell from 8,380 ha in 2008 to 5,745 ha as of July 2009. The number of cultivations fell from 171 to 100 (Greenpeace, 2010). In Slovakia, the area of MON810 also fell from 2008. 1,930.87 ha were cultivated in 2008 and 875 ha in 2009, a drop of more than 50%.

Public Opinion

The majority of the EU public remains opposed to the use of GMOs in food and farming. The latest Eurobarometer poll (European Commission, 2008) published in 2008 showed that 58% of EU citizens opposed GMOs. Earlier surveys also found that GMOs used in food and farming were more strongly opposed than other applications of biotechnology (Gaskill G *et al*, 2006). Ukrainian consumers were polled in 2009, and more than 93% supported a ban on GMO imports (Unian, 2009).

This overwhelmingly negative response to GMOs has also prompted many Member States to try and keep the locations of GM test sites secret. In 2009 Europe’s highest court, the European Court of Justice, ruled that EU member states cannot cover up the location of sites where genetically modified organisms have been released, even if they fear that the information could provoke public disorder (GM-Free Ireland, 2009).

GMO–free regions

The deeply held opposition to GMOs has also been demonstrated across the whole of Europe by the official declaration of GMO-free zones in 28 countries: 169 regions, 123 sub-regional bodies and 4,587 local government organizations have signed up in 28 different countries (GMO-free regions.org, 2010). Individual consumers and farmers are also joining the growing movement to oppose GMOs in Europe.

GM-free labels for non-GM animal feed a big hit

Current EU legislation only requires the labelling of GM animal feed. Animals reared on GM animal feed do not have to be identified. This has led to consumers unknowingly consuming GM in meat and dairy products. But major companies are recognizing the market for non-GM fed animals - in Germany legislation allows for products produced from animals fed non-GM feed to be labelled 'without biotechnology' and major companies are adopting this approach, including supermarket chain Lidl, the major dairy company Campina and chicken meat producer Gebrüder Stolle. Similar 'without GMO' labelling legislation is planned in France and Ireland (ISSA, 2009).

GMOs crops in the pipeline

The vast majority of GM applications in the EU are for pesticide-promoting crop varieties. These are GM applications that are not designed to increase yields or reduce resource use. Of the 23 applications for GM cultivation in the EU, 21 are also for herbicide tolerance (HT) or insect resistance (IR) traits (GMO Database, 2010).

Outstanding applications for the cultivation of GMOs in the EU including the renewal of the application for MON810 are shown in Table 3.

Table 3: outstanding EU GM crop applications

CROP	APPLICATIONS	TRAIT
Cotton	2	HT, IR
Flowers	2	Altered color, longer shelf life
Maize	14	HT, IR
Oilseed rape	2	HT
Potatoes	2	Increased starch content
Soybeans	1	HT
Sugarbeet	2	HT

Source: GMO Database (2010). GMO Database, Genetically Modified Food and Feed: Authorization in the EU. http://www.gmo-compass.org/eng/gmo/db/

There are specific concerns about the safety of the most advanced application for a starch-altered potato, which is intended to facilitate the production of industrial non-food starch. These have so far prevented its approval. The presence of antibiotic resistant marker (ARM) genes, which are restricted under EU regulations, has meant the safety of the GM potatoes, now owned by BASF, was reviewed again by the European Food Safety Agency (EFSA) and the European Medicines Agency in 2009: EFSA was unable to reach a unanimous opinion on the safety of the ARM genes (EFSA, 2009).

There are also many applications for importing GMOs to be processed for food and feed. Of the 119 GM crops pending approval for import to the EU, more than 80% are herbicide tolerating or insect resistant traits or combinations of the two. All but one of the remaining applications are for non-food crops such as GM flowers (GMO Database, 2010).

One maize application (MON87460) is for a drought tolerance trait which even Monsanto admits may not be effective in producing a viable yield in very dry conditions (GMO Database, 2010a).

"Under water-limited conditions, grain yield loss is reduced compared to conventional maize. However, like conventional maize, MON 87460 is still subject to yield loss under water-limited conditions, particularly during flowering and grainfill periods when maize yield potential is most sensitive to stress, by disrupting kernel development. Under severe water deficit, maize grain yield for MON 87460, as well as conventional maize, can be reduced to zero."

Syngenta SAS has also applied (GMO Compass, 2009) for a maize that is genetically modified to produce alpha amylase enzyme, for the production of bio-ethanol in the EU.

Analysis of the available data therefore shows that despite a huge public relations effort on the part of the GM industry there are still no GM crops to increase yields or cope with climate change in the pipeline. This follows a long history of unfulfilled promises from GM proponents.[3]

References

Bloomberg.com (2010). Germany to Ban Monsanto MON810 Corn, Joining France (Update 2), 14 April 2010, http://www.bloomberg.com/apps/news?pid=20601202&sid=aQGg.HOIcKv8

EFSA (2009). 'Consolidated presentation of the joint Scientific Opinion of the GMO and BIOHAZ Panels on the "Use of Antibiotic Resistance Genes as MarkerGenes in Genetically Modified Plants" and the Scientific Opinion of the GMO Panel on "Consequences of the Opinion on the Use of Antibiotic Resistance Genes as Marker Genes in Genetically Modified Plants on Previous EFSA Assessments of Individual GM Plants", The European Food Safety Authority Journal, 2009, http://www.efsa.europa.eu/en/scdocs/doc/gmo_biohaz_st_ej1108_ConsolidatedARG_en.pdf

European Commission (2008). Special Eurobarometer 295.Attitudes of European Citizens to the Environment. See http://ec.europa.eu/public_opinion/archives/ebs/ebs_295_en.pdf

FoEE (2009). 'False industry claims of increased biotech crop cultivation in Europe', Friends of the Earth Europe Briefing, 2008, http://www.foeeurope.org/GMOs/Who_Benefits/EU_briefing_2009.pdf

Gaskill G *et al*, 2006) Gaskill G *et al* (2006). Europeans and Biotechnology: patterns and trends. Eurobarometer 64.3. See http://ec.europa.eu/research/press/2006/pdf/pr1906_eb_64_3_final_report-may2006_en.pdf
GM-Free Ireland (2009). 'GM-Free Irish Label Good For Business', GM-Free Ireland press release (2009), www.gmfreeireland.org/press/GMFI46.pdf

GMO Compass (2009) 'Application for authorization to place on the market MON 87460 maize in the European Union, according to Regulation (EC) No 1829/2003 on genetically modified food and feed Part II' http://www.gmo-compass.org/pdf/regulation/maize/MON87460_maize_application.pdf

GMO Database (2010). GMO Database, Genetically Modified Food and Feed: Authorization in the EU. http://www.gmo-compass.org/eng/gmo/db/

GMO Database (2010a) GMO Database, Genetically Modified Food and Feed: Authorization in the EU. See http://www.gmo-compass.org/pdf/regulation/maize/MON87460_maize_application.pdf
GMO-Free Regions (2009). List of GMO-Free regions, GMO-Free regions website, 2009, http://www.gmo-free-regions.org/gmo-free-regions/list.html

Greenpeace (2010). Data held at Greenpeace website as at 22 February 2010. http://www.greenpeace.org/raw/content/czech/media/press-release/Seznam_pestitelu_geneticky_modifikovane_kukurice_v_CR/GMO_v_CR-2009.pdf

[3] For more information on this see 'Promises, promises – the claims of the biotechnology industry' chapter.

Guardian (2009). Germany deals blow to GM crops, The Guardian, http://www.guardian.co.uk/environment/2009/apr/14/germany-gm-crops

INFOMG (2010). OMG in Romania, INFOMG, as at 22 February 2010, http://www.infomg.ro/web/ro/Home/OMG_in_Romania/

ISAAA (2008). ISAAA Brief 39-2008: Executive Summary, Global Status of Commercialized Biotech/GM Crops: 2008 The First Thirteen Years, 1996 to 2008, http://www.isaaa.org/RESOURCES/PUBLICATIONS/BRIEFS/39/executivesummary/default.html

ISSA (2009). 'France adopts gm-free label for meat, poultry, and dairy produce', Irish Seed Savers Association, 2009, https://secure43.websitewelcome.com/~misc0001/article.php?artid=677

Polonoinfo.sk (2010) http://www.polnoinfo.sk/clanok/918/z-domova/rastlinna-vyroba/gmo-kukurica-sa-na-slovensku-pestuje-na-ploche-o-55--mensej-ako-vlani/

Spain (2009). Superficie en hectareas de variedades maiz g.m. que se encuentran incluidas en el registro de variedades comerciales, Ministry Of Agriculture Spain (2009), http://www.mapa.es/agricultura/pags/semillas/estadisticas/serie_maizgm98_06.pdf

Spiroux de Vendômois et al (2009). A Comparison of the Effects of Three GM Corn Varieties on Mammalian Health Int J Biol Sci 2009; 5:pp 706-726, http://www.biolsci.org/v05p0706.htm

Unian (2009). Are Ukrainians willing to buy genetically modified products - results of telephone survey. See http://unian.net/eng/news/news-347306.html

GMOs in the Southern Cone

Introduction

The Southern Cone of America[4] is a region of prime importance for global food production, and has been specifically targeted by transnational agribusiness for the commercial production of GM crops. Along with the US, the Southern Cone is now responsible for more than 80% of the total area planted with GMOs worldwide.

Genetically modified organisms are now a key element of agribusiness development, particularly in this region. Technological 'packages' have been developed, based on the use of agricultural machinery, genetically modified seeds and biocides, which enable a quick return on invested capital. These packages require little manual labor and externalize associated environmental and social costs. As a result, agribusiness has become particularly attractive to investors and speculative capital. In recent years there has been a significant flow of capital from various financial sectors towards GM agriculture.

However, the rapid advance of agribusiness and genetic engineering in the Southern Cone has brought with it serious social and environmental impacts that are not being adequately dealt with by governments. Booming agribusiness is displacing peasant and indigenous communities; pushing the agricultural frontier deeper into the forests; increasing pollution and health problems because of the increased use of biocides; accelerating the erosion of natural resources and destroying peoples' knowledge and food sovereignty.

As a result of all this, farmers and social organizations are actively resisting the advance of agribusiness. Soy especially has seen spectacular growth in the last decade, and battles over soy expansion illustrate the social tensions created by the rapid concentration of land, wealth and power. In Paraguay, for example, displacements and the indiscriminate use of herbicides on soy plantations has led to serious conflicts and the murder of Paraguayan peasants (Zibechi, 2005). In Brazil, a demonstration organized by the landless workers' movement – 'Movimento dos Trabalhadores Rurais sem Terra (MST) against an experimental area managed by Syngenta, ended with a peasant being shot dead by security guards hired by the company (La Jornada, 2007). In Uruguay, the expansion of soy agribusiness has displaced family agriculture, because the increase in agribusiness has increased land rental rates; and thus the main organization of family farmers (Comisión Nacional de Fomento Rural) has asked the Uruguayan government to limit the expansion of agribusiness in order to prevent the complete disappearance of family farming (CNFR, 2009).

Agribusiness interests in the region also exert considerable influence and can be difficult for governments to resist. In Bolivia, for example, one of the main leaders of the Media Luna (the richest region of the country), and President of the Pro-Santa Cruz Civic Committee, Branco Marinkovic, is also one of the main soy producers in the region (El Deber, 2007). This Committee promoted the creation of an autonomist movement in defense of the interests of the powerful local elite and opposed to recognizing the rights of the original peoples. This posed a serious problem for the administration of Bolivian President Evo Morales (Bolpress, 2008) (TeleSUR, 2010), and several indigenous people were murdered as a consequence of this conflict (BIC, 2008).

Similarly there was a sharp conflict between the 'campo' (the countryside) and the Argentinean government in 2008, when soy industrialists opposed the government's restrictions on commodity exports (Página 12, 2008) (Programa de las Américas, 2009).

[4] The geographic region composed of the southernmost areas of South America, south of the Tropic of Capricorn

The advance of GM crops in the Southern Cone

At present, GM crops occupy around 37 million ha in the Southern Cone, which represents one third of the surface area dedicated to GM crops around the world. The main GM crop is soy, but GM maize and cotton are also being cultivated. Apart from the United States, Argentina and Brazil are the world's two main producers of GM crops. Within the region, Argentina has the largest surface area of GM crops (19 million ha), followed by Brazil (with 14.5 million ha) (See Table 4).

Table 4: Surface Area of GM Crops in thousands of ha (season 2008/09)

	Soy	Corn	Cotton	Canola / oilseed rape	Total
Argentina	16,800	1,910	280	----	18,990
Brazil	13,000	1,300	250	----	14,550
Paraguay	2,000	----	---	----	2,000
Uruguay	580	72	----	----	652
Bolivia	650	----	----	----	650
Chile*	0.2	11.6	----	4.1	15.9

The data for this table was collected from several sources because there is no official data available corresponding to each country. Sources (see below for details): Argentina: MAGyP Argentina, ArgenBio; Brasil: CONAB, Report from an EU mission in Brasil, RPC, CIB; Paraguay: MAG; Uruguay: MGAP; Bolivia: ANAPO; Chile: SAG. * For Chile the data relate to surface dedicated to seed plots.

Agribusiness's intense drive to find countries willing to cultivate genetically engineered crops on a commercial scale has given a new momentum to the expansion of intensive industrial agriculture in the Southern Cone region, undoing much that had previously been done to develop agri-ecological farming in the area. This is most marked in terms of the expansion of GM soy.

In the season 2008/2009 some 21.7 million ha of soybean were sown in Brazil, and for 2009/2010 around 23 million ha of soy are expected to be sown, generating a record crop of 64 million tons (CONAB, 2009). According to estimates from the private sector, around 60% of the area (around 13 million ha) is genetically modified Roundup Ready (RR) soy (EU mission in Brazil, 2009) (RPC, 2009/2010).

In Argentina, soy crops covered around 18 million ha (equivalent to more than 75 % of the area occupied by summer crops) but as a result of the drought of the summer 2008/2009, only 16.8 million (MAGyP, 2009) were harvested. Almost 100 % of this was RR soy (ArgenBio, 2010).

In Paraguay, according to the National Agricultural Survey (CNA, using its Spanish acronym) (MAG, 2008), 2.5 million ha of soy were sown in 2008/2009 (near 60 % of the total agricultural area of the country) of which 80 % was RR soy (RAP-AL, 2010).

In Uruguay, soy occupied 580,000 ha in the season 2008/2009 representing 75% of the surface sown with summer crops (MGAP-DIEA, 2009), and nearly 100 % of this was RR soy. In Bolivia, 50% of the agricultural land (around 940,000 ha) was sown with soy in 2009; and 70 % of this, according to ANAPO, was RR soy (IFPRI).

As a whole, soy crops in the region occupied 42.5 million ha (425,000 km^2), of which 33 million were RR soy; the overall production of soybean was 97 million tons.

In relation to corn, some 14 million ha were sown in Brazil in the 2008/2009 season (IFPRI). The Council on Information on Biotechnologies (CIB), an organization that promotes GM technology in Brazil, estimates that 1.3 million ha of this was GM corn. CIB (2009) In Argentina, for the same season, nearly 3.5 million ha were sown with corn although only 2.3 million CIB (2009) were actually harvested due to drought. Of this, 83% was GM corn according to ArgenBio CIB (2009), an organization that brings together GM seed multinationals operating in Argentina. In Uruguay, although there is no data for the total area sown with GM corn, 82% of the seed imported in 2008 was GM (INASE, 2009). It is thus possible to calculate that around 80% of the area cultivated in Uruguay in the 2008/2009 season (over a total sown area of 87,500 ha (MGAP-DIEA, 2009)) was planted with GM corn.

For cotton, Brazil planted 840,000 ha in 2008/2009 (CONAB, 2009), of which 250,000 ha was GM cotton according to CIB (CIB, 2009). In Argentina, 94% (ArgenBio, 2010) of the total of almost 300,000 ha of cotton (MAGyP, 2009) was sown with GM seeds.

In Chile, GM seeds are only allowed to be used for the production of seeds for export (at present they are discussing a future biosafety law and whether or not they should authorize the commercial release of GMOs). The main GM crop grown is corn, at 11,850 ha, followed by canola at 4,054 ha and soy at 204 ha (SAG, 2010).

The Commercial release of GMOs in the Southern Cone – questionable authorizations

In the Southern Cone, the introduction of genetically modified crops started in 1996, when Argentina and Uruguay authorized the cultivation of Monsanto RR soy. Neither country conducted an environmental impact study, and no assessments were made of the likely social and economic impacts.

GM soy was then transferred illegally from Argentina and Uruguay into Brazil, Paraguay and Bolivia. Seed companies subsequently chose to develop and promote their products in these countries on the basis of a *fait accomplis strategy* – it is already there, and it is unalterable. In Brazil, two other Monsanto GM products (AS-PTA, 2009), Bollgard cotton and GA21 corn, also entered the country illegally (in 2004 and 2005 respectively).

In Paraguay, the NGO Alter Vida estimates that around 8,000 ha are currently being cultivated with GM cotton, even though the approval process has not passed the evaluation stage yet (RAP-AL, 2010). Similarly, most of the GM cotton sown in Argentina seems to be a cultivar with two stacked GM traits that has not yet been authorized for planting (RIAN, 2009). The governments have responded to this strategy with a policy that essentially enshrines impunity. Instead of issuing and enforcing sanctions to control the illegal introduction of these crops in their countries, they have adapted their country's regulations to allow for GM crops. In Brazil they have even used the fact that they are already being grown as an argument for authorizing GM crops (RIAN, 2009).

During 2009, several new GM varieties were approved in the region. Three GM varieties of cotton, five of corn and one of soy (CTNBio, 2009) were released in Brazil. The latter is the first GM variety released that was also developed in Brazil, as a result of an agreement between BASF and Embrapa Soja (a part-public Brazilian firm dedicated to agricultural research). This GM variety is tolerant to herbicides of the imidazolinone group and is presented as an alternative to RR soy to fight those weeds that have already developed a resistance to glyphosate (BLT, 2009).

In Argentina, a new GM cotton variety has also been released and several licenses have been granted to produce GM corn seeds for export (even those these do not yet have a commercial release approval) on the condition that they have been approved at the destination country (CONABIA, 2009). In 2008 (no update is available for 2009), 49 licenses were granted to produce GM corn seeds, including 13 to Monsanto and 8 to Syngenta. 180 experimental releases were also authorized including for soy, maize, wheat, sugar cane, cotton, rice, safflower, orange, potato and alfalfa (CONABIA, 2009a).

In Uruguay, after lifting the moratorium on new GM releases (in place from January 2007 to July 2008), the evaluation of five new GM traits in maize was approved; and the production of two new types of GM soy was also authorized, although only for export (which conveniently allows producers to skip the two-year evaluation process required for any GM crop to be commercially released within the country) (GNBio, 2009).

All new GM releases consist of GM traits related to herbicide tolerance (glyphosate or glufosinate ammonium) and/or lepidoptera resistance, either individually or stacked together.

Table 5: Authorizations granted to GM crops. Commercial release year per country.

Species	Development	Applicant	Trait*	Argentina	Brazil	Uruguay	Paraguay	Bolivia
Soy	GTS 40-3-2	Monsanto	TH(G)	1996	(1998)** 2005	1996	2004	2005
Soy	BPS-CV127-9	BASF-Embrapa	TH(I)		2009			
Maize	176	Ciba-Geigy (Syngenta)	RL	1998				
Maize	T25	Bayer	TH(GA)	1998	2007			
Maize	MON810	Monsanto	RL	1998	2007	2003		
Maize	Bt11	Syngenta	RL+TH(GA)	2001	2007	2004		
Maize	NK603	Monsanto	TH(G)	2004	2008			
Maize	TC 1507	Dow - Pionner	RL+TH(GA)	2005	2008			
Maize	GA21	Syngenta	TH(G)	2005	2008			
Maize	MIR 162	Syngenta	RL		2009			
Maize	MON810 x NK603	Monsanto	RL x TH(G)	2007	2009			
Maize	Bt11 x GA21	Syngenta	RL+TH(GA) x TH(G)		2009			
Maize	TC 1507 x NK603	Dow - Pionner	RL+TH(GA) x TH(G)	2008	2009			
Maize	MON 89034	Monsanto	RL		2009			
Cotton	MON 531	Monsanto	RL	1998	2005			
Cotton	LLCotton25	Bayer	TH(GA)		2008			
Cotton	MON1445	Monsanto	TH(G)	2001	2008			
Cotton	281-24-236/3006-210-23	Dow	RL+TH(GA)		2009			
Cotton	MON 15985	Monsanto	RL		2009			
Cotton	MON531 x MON1445	Monsanto	RL x TH(G)	2009	2009			

Sources: (CTNBio, 2009) (CONABIA, 2009) (GNBio, 2009) (Observatorio IICA, 2009) (Pardo, M y Gudynas, E. 2005)
*TH: Tolerance to herbicide, (G): Glyphosate, (I): Imidazolinonas, (GA): Glufosinate Ammonium.
RL: Resistance to Lepidoptera
(The table does not show those developments currently being assessed, or authorized only for seed production for export.)
**GTS 40-3-2 (RR) soy in Brazil was approved in 1998 and suspended by judicial decision favorable to the Brazilian Institute for the Defense of Consumers; in 2005, it was authorized as a consequence of the Biosafety law being approved (Fernandes, 2009).

Increased use of pesticides

The main environmental impacts related to the introduction of agri-biotechnology are associated with the expansion of soy monocultures. Each hectare cultivated with soy requires the use of approximately 4 liters of biocide and in the case of RR soy, plus around 10 liters of glyphosate. In the Southern Cone, during the last season, around 200 million liters of biocides were used on soy crops (including the highly toxic organochlorine endosulfan, which is banned in many countries around the world); and 350 million liters of glysophate were applied to the area cultivated with GM soy. This has had serious consequences on both the environment and human health, particularly for rural populations. The death of Silvino Talavera in 2003, a Paraguayan child who died after coming into contact with pesticides being used on GM soy close to his house, is emblematic of this. There have been many similar cases of pesticide poisoning, particularly in Paraguay (Palau, 2004).

As discussed elsewhere in this report, the massive application of glyphosate that has taken place is also beginning to show its effects in the development of glyphosate resistance in several weed species. In Argentina these include *Hybanthus parviflorus* (Violetilla), *Parietaria debilis* (Yerba Fresca), *Viola arvensis* (Violeta Silvestre), *Petunia axillaris* (Petunia), *Verbena litoralis* (Verbena), *Commelina erecta* (Flor de Santa Lucía), *Convulvulus arvensis* (Corrihuela, Slender dayflower), *Ipomoea purpurea* (Bejuco, Morning glory), *Iresine difusa* (Iresine) and recently the *Sorghum halepense* (Sorgo de alepo, Johnsongrass) (BSC, 2009). The latter is a particularly serious concern as it is especially difficult to control.

In Brazil, Embrapa researchers have also reported cases of glyphosate resistance in nine species, four of which are weeds that may cause serious problems to crops: *Conyza bonariensis, Conyza Canadensis* (buva, Canadian horseweed), *Lolium multiflorum* (azevem, Italian Ryegrass), and *Euphorbia heterophylla* (milkweed) (Cerdeira *et al*, 2007). The resistant Canadian horseweed has become a particularly severe problem in Brazil since these resistant plants have spread rapidly (Gazeta do Povo, 2009). Another widely distributed species in Brazil and Paraguay, *Digitaria insularis,* commonly known as sourgrass*,* is also reported to have developed herbicide resistance (Weedscience.org, 2010). Ironically, the biotech industry proposes to resolve this problem by developing yet more GM soybean varieties, that are resistant to other herbicides. For example, the CNTBio of Brazil is considering the authorization of a GM soy variety that is resistant to 2,4-D, a herbicide that is even more toxic than glyphosate, and forbidden in many countries (BLT, 2009b).

During 2009, another controversial issue arose following investigations into the impacts of glyphosate on embryo development. Andres Carrasco, an embryology professor of the School of Medicine of the University of Buenos Aires (also the main researcher of the National Council of Scientific and Technical Research (CONICET) and Director of the Molecular Embryology Laboratory) confirmed the lethal effect of glyphosate on amphibian embryos. As a consequence of an article in an Argentinean newspaper, where the scientist released the conclusions of his study, the Association of Environmental Lawyers filed a special injunction claim with the Supreme Court of Law, requesting a ban on the use and sale of glyphosate until its effects on health and the environment were assessed. Some days later, the Ministry of Defense also took the unusual step of forbidding the cultivation of soy on Ministry lands. The corporations and agribusiness lobby associations, along with others in the media and politics, were outraged and a formidable campaign was launched to defend agrichemicals and discredit the critics (Página12, 2009). The Chamber of Agricultural Health and Fertilizers (CASAFE, which is the lobby association for agrichemical companies in Argentina and also has two representatives on CONABIA, the Argentinean Biotechnology authority) even sent its lawyers to the laboratory where Carrasco worked in order to demand a copy of the scientific report. Months later, an interdisciplinary report by CONICET (a government body focusing on the promotion of science and technology) concluded that there was insufficient data available in Argentina on the effects of glyphosate on human health. In a further article, Carrasco branded the document *"institutionally outrageous"* because of its reference and links to studies commissioned by Monsanto. The debate goes on, but so does the use of glyphosate (Newsweek Argentina, 2009).

Land grabbing and deforestation

The impact that the expansion of soy production is having on forests in the Southern Cone is also extreme. In Argentina, for example, 200,000 ha of native forest disappear every year as a direct consequence of the advance of the agricultural frontier, and this is mainly driven by the expansion of soybean monocultures (Dirección Nacional de Ordenamiento Ambiental y Conservación de la Biodiversidad, 2008).

Thousands of farmers are also evicted violently from their lands. The MOCASE (Peasant Movement of Santiago del Estero) and MNCI (National Indigenous-Peasant Movement), members of La Via Campesina Argentina, are continuously denouncing the persecution suffered by peasants when they resist eviction by force. In the northwest region of the country, the peasant and indigenous communities' struggle against these displacements and forest clearance has even been criminalized: an example is the Cacique Cavana of the Wichi Community in the basin of the river Itiyuro (in the province of Salta), who has been accused in more than sixty criminal lawsuits. The situation is similar in Paraguay where several peasants have been murdered for resisting the advance of soy monocultures.

Contamination

In the case of maize, genetic contamination from GM releases has also become a serious concern. During 2009, studies carried out in Brazil (Silva, 2009), Chile (FSS, 2010) and Uruguay (P.Galeano *et al.,* 2009) showed the presence of genetically modified genes in conventional plants. These studies show that the isolation measures established in the various national regulations are not enough to avoid contamination by out-crossed pollination. The concept of 'regulated co-existence' between GM production and conventional crops is increasingly used in biosafety policies, but these studies show that co-existence is not possible in the case of maize. They also demonstrate the pervasive character of GM technologies.

Stakeholders

Agribusiness corporations have established a series of organizations in the Southern Cone dedicated to political lobbing and influencing public opinion. CropLife is a network of these organizations, and includes business chambers dealing with agri-biotechnology (CropLife, 2010). This network and others, together with ISAAA and organizations such as ArgenBio and the Council of Information on Biotechnologies of Brazil – which have been founded and are wholly or partly funded by biotechnology corporations – are the main source of information for the Technical Commissions in charge of risk assessments, research and development centers, and the media. The aims of ArgenBio make this point clear:

"ArgenBio was created with the mission of disseminating information on biotechnology, contributing to its understanding through education and promoting its development. ArgenBio arises from the commitment undertaken by its founding members to respond to the demand for clear and transparent information about biotechnology and its applications, its benefits and its safety. To such end, our priority is to develop activities in the following areas: qualification and training, dissemination, education, and general information. Thus, ArgenBio aims at reaching the following public audiences, providing them with adequate information according to their respective interests and needs: professionals and teachers, media, and the general public." (Argenbio, 2010b)

The founders of ArgenBio are: Bayer, Dow, Monsanto, Nidera, Syngenta and Pioneer.

On the other side, we find social movements and peasants' organizations struggling to challenge the dominance of this powerful industry. These organizations include peasant movements, umbrella organizations like La Via Campesina, the network for a GMO-free Latin America (*Red* *por una America Latina libre de Transgénicos*), and academic associations like SOCLA (the Latin American Scientific Society of Agroecology). These organizations need to build and maintain alliances representing popular sectors, to challenge the advance of agribusiness and biotechnology effectively.

Following the VI Brazilian Congress on Agri-ecology and the II Latin American Congress on Agri-ecology held in Curitiba in November of 2009, more than 3,800 participants signed the Agri-ecological Letter of Curitiba (Carta agro-ecológica de Curitiba) 2009. This letter sums up the threats that agribusiness and biotechnology pose to society, our natural resources and the environment in general, as the following translated extract demonstrates:

"It is essential for human kind to keep the centers of origin of cultivated species free from GMOs, and to prevent the patenting of genetic resources thereby allowing us to freely exchange seeds;

We are against agricultural practices, technologies, public policies and agricultural and food business corporations that threaten environmental protection, increase socio-economic inequity, and endanger food safety and food sovereignty, human health and life; especially with respect to genetically modified organisms and agritoxics." (Carta Agroecológica de Curitiba 2009)

References

ArgenBio (2010). Cultivos aprobados y adopción, ArgenBio, as at 23 February 2010, ArgenBio, http://www.argenbio.org/index.php?action=cultivos&opt=5

Argenbio (2010b). See: http://www.argenbio.org/index.php?action=acerca&opt=2&id=1 consulted February 2010.

AS-PTA (2009) Transgênicos no Brasil: un resumo. Gabriel Bianconi Fernandes, AS-PTA. November 2009.

BIC (2008). Masacre de 30 campesinos a manos de civicos en Pando, Bolivia. BIC, 17/09/2008. Disponible en: http://www.bicusa.org/en/Article.3898.aspx

BLT (2009). Boletim 471 Por un Brasil libre de transgénicos, Dec. 18 2009.

BLT (2009b). Boletim 444 Por un Brasil libre de transgénicos, 5 de junio 2009. http://www.aspta.org.br/por-um-brasil-livre-de-transgenicos/boletim/boletim-444-05-de-junho-de-2009

Bolpress (2008). Acusan a cívico cruceño Branko Marinkovic de racismo. Nota de Bolpress, 15/02/2008. Disponible en: http://boliviateamo.blogspot.com/2008/02/acusan-civico-cruceo-branco-marinkovic.html

BSC (2009). Argentina: las consecuencias inevitables de un modelo genocida y ecocida. Magazine: Biodiversidad sustento y culturas, August 2009. Available in: http://www.biodiversidadla.org/content/view/full/50874

Carta Agroecológica de Curitiba (2009). Avaliable in: http://todoganado.com/blogs/2009/12/carta-de-los-participantes-en-el-vi-congreso-brasilerio-de-agroecologia-y-ii-congreso-latino-americano/

Cerdeira et al (2007) Review of potential environmental impacts of transgenic glyphosate-resistant soybean in Brazil. Cerdeira et al, 2007 Available in: http://www.informaworld.com/smpp/content~content=a779480992

CIB (2009). CIB, http://www.cib.org.br/pdf/ISAAA_stats_2009.pdf

CNFR (2009). Propuestas de Políticas Públicas Para el Desarrollo de la Agricultura Familiar, CNFR, octubre 2009. Disponible en: http://www.cnfr.org.uy/uploads/files/propuesta_2.pdf

CONAB (2009). http://www.conab.gov.br/conabweb, consulted in December 2009

CONABIA (2009). CONABIA, http://www.minagri.gob.ar/SAGPyA/areas/biotecnologia/50-Evaluaciones/_archivo2/000200-Eventos%20con%20evaluaci%C3%B3n%20favorable%20de%20la%20CONABIA%20y%20permiso%20de%20comercializaci%C3%B3n.php, consulted Dec. 2009.

CONABIA (2009a). CONABIA, http://www.minagri.gob.ar/SAGPyA/areas/biotecnologia/50-Evaluaciones/docs/liberaciones_ogm_2008.pdf, consulted Dec. 2009.

CropLife (2010). See http://www.croplifela.org/cms2/index.php?option=com_content&view=article&id=3&Itemid=6&lang=es consulted February 2010.
CTNBio, 2009. CTNBio, http://www.ctnbio.gov.br/index.php/content/view/12482.html, consulted Dec. 2009.

Dirección Nacional de Ordenamiento Ambiental y Conservación de la Biodiversidad (2008). El avance de la frontera agropecuaria y sus consecuencias. Subsecretaría de Planificación y Política Ambiental, Secretaria de ambiente y desarrollo sustentable de la nación, Jefatura de gabinete de Ministros, República Argentina. Marzo. Available in: : http://www.ambiente.gov.ar/archivos/web/File/032808_avance_soja.pdf

El Deber (2007). Branko Marinkovic es nuevo presidente cívico cruceño. Nota de prensa de El Deber, Santa Cruz, 11/02/2007. Disponible en: http://www.laprensa.com.bo/noticias/11-02-07/11_02_07_poli1.php

EU mission in Brazil, report, April 2009, http://ec.europa.eu/food/fvo/rep_details_en.cfm?rep_id=2271

Fernandes (2009) La situación de los Transgénicos en Brasil. Gabriel Bianconi Fernandes, AS-PTA. August 2009.

FSS (2010) Study by the Fundación Sociedades Sustentables funded by the Heinrich Boell Foundation through the Program Cono Sur Sustentable. See note in: http://www.rebelion.org/noticia.php?id=75176 consulted February 2010.

Gazeta do Povo (2009). Buva "transgênica" resiste ao glifosato. Gazeta do Povo, 1/12/2009. http://portal.rpc.com.br/jm/online/conteudo.phtml?tl%3D1%26id%3D950000%26tit%3DBuva-transgenica-resiste-ao-glifosato

GNBio (2009). GNBio, http://www.mgap.gub.uy/portal/hgxpp001.aspx?7,1,144,O,S,0,MNU;E;2;2;12;5;MNU;, , consulted Dec. 2009.

IFPRI. GM soybeans in Bolivia, International Food Policy Research Institute.

INASE (2009) INASE, http://www.inase.org.uy/, consulta diciembre 2009

La Jorn. da (2007). Syngenta: milicias privadas y asesinatos. Nota de Silvia Riveiro en la Jornada, México, 27/10/2007. Disponible en: http://www.viacampesina.org/main_sp/index2.php?option=com_content&do_pdf=1&id=414

MAG (2008). MAG, Censo Nacional Agropecuario 2008, http://www.mag.gov.py/PresentacionCAN2008.pdf.

MAGyP (2009), http://190.220.136.179/sst_pcias/consultaA_pcia.php?codigo=C00896&pcia, consulted in December 2009

MGAP-DIEA (2009). Encuesta Agrícola 'Invierno 2009'.

Newsweek Argentina (2009). El otro caso Carrsco. Nota de Matías Loewy en Newsweek Argentina, 25/11/2009. Disponible en: http://www.radiocultural.com.ar/index.php/noticias/266-el-otro-caso-carrasco.html

Observatorio IICA (2009). Cultivares de soja con solicitudes aprobadas por SENAVE, Observatorio IICA Paraguay. Disponible en: http://www.iica.org.py/observatorio/producto_paraguay_soja_variedades.htm, accessed in December 2009

P Galeano et al. (2009). Technical Report of the Study: Interpolonización entre cultivos de maíz transgénico y no transgénico comerciales en Uruguay P.Galeano et al., 2009. A sttudy of the Universidad de la República, funded by Heinrich Boell Foundation through the program Uruguay Sustentable a REDES-AT. Available in: http://www.redes.org.uy/wp-content/uploads/2009/10/Estudio-final.pdf.

Página 12 (2008). El Frankestein sojero contra su creador, entrevista de Javier Lorca a Norma Giarraca en Página 12, 31/03/2008. Disponible en: http://www.pagina12.com.ar/diario/elpais/subnotas/101594-32008-2008-03-31.htmlç

Página12 (2009). Lo que sucede en Argentina es casi un experimento masivo. Interview by Darío Aranda to Andrés Carrasco in Página12, published on 3/05/2009. Available in: http://www.pagina12.com.ar/diario/elpais/1-124288-2009-05-03.html

Palau (2004). Capitalismo agrario y expulsión campesina – Avance del monocultivo de soja transgénica en Paraguay. T. Palau. CEIDRA, 2004.

Pardo, M y Gudynas, E (2005). SOJA EN BOLIVIA. La encrucijada entre mercados, tecnologías e impactos. Observatorio del Desarrollo, Diciembre.

Programa de las Américas (2009). El corazón sojero de la guerra gaucha, nota de Lucía Alvarez en la página web Programa de las Américas, 24/04/2009. Disponible en: http://www.ircamericas.org/esp/6077

RAP-AL (2010) http://www.rap-al.org/articulos_files/Transgenicos_en%20Paraguay_%20Hebe_%20Gonzalez(Altervida).pdf

RIAN (2009) Informe Cultivo de Algodón. Año agrícola 2008 /2009. Red de Información Agropecuaria Nacional. August 2009.

RPC (2009/2010). RPC, Expedição Safra 2009/2010, http://portal.rpc.com.br/gazetadopovo/blog/expedicaosafra/?id=950193

SAG (2010), consulted 2010, http://www.sag.cl/opendocs/asp/pagDefault.asp?boton=Doc52&argInstanciaId=52&argCarpetaId=1762

Silva (2009). Study performed by experts from the Agricultural Secretary of the State of Parana. Presentación de Marcelo Silva en Seminário sobre proteção da agrobiodiversidade e direitos dos agricultores, August 25, 2009, Curitiba.

TeleSUR (2010). Fiscal boliviano imputa a Branco Marinkovic por terrorismo y alzamiento armado. Nota de TeleSUR, 2/02/2010. Disponible en: http://www.telesurtv.net/noticias/secciones/nota/66221/fiscal-boliviano-imputa-a-branco-marinkovic-por-terrorismo-y-alzamiento-armado/

Weedscience.org (2010). See, http://www.weedscience.org/Case/Case.asp?ResistID=5351, consulted February 2010

Zibechi (2005). Paraguay: La guerra de la soja. Raúl Zibechi, Servicio Informativo "Alai-amlatina", 10/05/05. Disponible en: http://www.rebelion.org/noticias/2005/5/14952.pdf

The New Promise: GM Crops and Climate Change

Even though claims that GM crops can solve hunger and poverty remain unproven, a new claim has recently emerged: that GM crops will be one of the solutions to combating climate change.

This claim is based on a range of arguments, including a rehashing of older declarations that GM crops reduce pesticide use and increase yields, meaning that they will be useful in both mitigating and adapting to climate change. An additional new argument is that GM crops will reduce the loss of carbon from soil by reducing tillage. It is also being claimed that new drought-resistance crops are about to be commercialized. Biotech companies are lobbying hard (EuropaBio 2008) at the UN's climate change negotiations for GM crops and industrial farming methods, which are responsible for up to 50% of global emissions of nitrous oxide, to be recognized as mitigation techniques in agriculture (Europa Bio 2008).

As a result, governments and private funders such as the Gates Foundation are ramping up their investments in GM research. In the UK, for example, the government spent £49 million on biotechnology in 2006/2007, compared to just £1.6 million on organic farming. (Friends of the Earth 2007) In October 2009, the Gates Foundation announced a further US$120 million grant for agriculture in Africa. At the press launch Bill Gates said *"Biotechnology has a critical role to play in increasing agricultural productivity, particularly in light of climate change."* (America.gov 2009)

The solution is not more of the same

GM crops have been developed as part of the intensive model of agriculture that has dominated farming over the last 60 years. Intensive crop and livestock farming methods require large inputs of oil, artificial fertilizers, pesticides and the use of hybrid seeds. Collectively these are major contributors to climate change, since they lead to increases in greenhouse gas emissions, reductions in soil carbon, soil erosion and habitat destruction. The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD), which has an intergovernmental governance structure, has concluded that *"business as usual is not an option*"(IAASTD, 2008*)* and that farming practices will have to change radically to meet the challenges of climate change. These will include feeding a growing population, protecting and restoring biodiversity and ecosystems services, and producing fuel and raw materials for industry.

The GM industry has also failed to gain acceptance for GM plant varieties as food crops in important markets especially in Europe, Africa, Japan and, most recently, India (MOEF, 2009). This is primarily due to public and political concern about the potential socio-economic, environmental and health impacts of GM crops (Mmegi, 2009) (Biosafety Africa, 2009) (Friends of the Earth Europe, 2008).

Many of the industry's claims about GM technology turn out to be exaggerations or entirely premature. In addition, the model of GM farming, like other forms of intensive agriculture, is reliant on highly expensive technology and energy-intensive inputs. To rely on such uncertain claims would be very foolish given the urgent need to tackle the causes and effects of climate change.

GM is a false solution to climate change. It is also highly expensive to develop and thus suppresses the development of other approaches. Meanwhile the value of local agricultural knowledge and agro-ecology continues to be recognized in recent reports (APPG, 2010) (UNEP, 2008) (IAASTD, 2008) But, agro-ecological alternatives receive little attention and even less funding from governments and, private charities such as Gates, when compared to investments in GM and biotechnology (GM Freeze, 2008).

Examining the evidence on GM and climate change

Claim # 1: GM farming increases carbon retention in soils

'Soil carbon' refers to the organic matter present in most soils, which can be released as carbon dioxide if soils are disturbed; such disturbances are common in industrial agricultural and logging, and contribute to climate change. A technique known as 'conservation tillage', which leaves some of the crop residues or stubble on the surface rather than plowing it back into the ground, is used to minimize the disturbance of the soil and soil erosion.

The claim that GM technology can increase the relative retention of carbon stored in soil comes from the use of such zero or minimum tillage cultivation techniques with GM crops. However, 'conservation tillage' was developed well before the first GM crops appeared and is in no way specific to GM crops. It was originally intended to enhance soil and water conservation.

Furthermore, the introduction of GM herbicide tolerant crops (GMHT) is undermining the sustainability of these earlier conservation tillage systems, by increasing the quantity of herbicides used and because of soil compaction by repeated use of heavy machinery, for example in the central Pampas region of Paraguay (Gerster *et al*, 2008). Indeed some reports suggest that a reduction in overall emissions of greenhouse gases from zero tillage systems is not proven (Paul H *et al*, 2009) because of increased carbon dioxide and nitrous oxide emissions. In addition, recent studies suggest that 'no-till', one particular form of conservation tillage, has environmental benefits such as reducing soil erosion, but may not sequester more carbon than conventional tillage (plowing) (UCS, 2009).

Importantly, the overall claim is also based on the promise that GM herbicide tolerant crops will lead to a reduction in the quantity of herbicide used because of the use of just one herbicide, the elimination of pre-sowing applications of herbicides and fewer applications on the growing crop. However, after more than a decade cultivating GMHT in North and South America, evidence from both governmental agencies and academics confirms that the crops actually *in*crease herbicide use. A recent review found that in the 13 years since GMHT crops were introduced in the US, the amount of herbicide applied had increased by around 144,000 tonnes (Benbrook C., 2009).

It is also notable that the claims made about GM crops' relative ability to sequester carbon in soil are based on comparisons with other forms of intensive agricultural production. They tend to overlook agricultural practices based on agro-ecological principles in which carbon rich materials, such as manure and compost, are systematically returned to the soil to improve it. There are also other types of conservation tillage, including methods suitable for organic farming systems, in which the use of chemical herbicides is not permitted.

In fact many recent studies demonstrate that a number of agronomic practices employed in integrated agricultural systems have great potential to build-up soil carbon content over time. These techniques combine crop rotation, recycling organic materials and low or no inputs of pesticides, herbicides, and industrial fertilizers. For example, studies that compare carbon accumulation in organic (plowed) and conventional (plowed) systems demonstrate that organic systems sequester more carbon than conventional chemical-intensive systems (Drinkwater, 1998) (Pimental, 2005) (Wander, 2006).

Systems that integrate livestock and crops, employ perennial pastures, and adopt many of the practices used in organic production (eg long crop rotations, leguminous crops and cover crops, manure produced by livestock as fertilizer) also have potential for improved greenhouse gas balance, as well as reduced pollution (Smith P. *et al*, 2007).

In spite of these concerns though, GM no-till is currently being considered for carbon finance funding by the UNFCCC climate change negotiations (Paul H. *et al*, 2008).

Claim # 2: GM crops reduce greenhouse gas emissions from farm operations

This claim is based on the idea that herbicide tolerant GM crops require fewer herbicide applications, thus saving fuel by reducing the number of tractor passes across the field (PG Economics, 2009). This claim is closely connected to that of zero tillage as the two systems go hand in hand. These promises initially encouraged farmers to buy GMHT seeds: they expected improved weed control and reduced fuel and labor costs. However, after a brief 'honeymoon period' when GMHT crops were first introduced in 1996, problems began to emerge.

GMHT crops and herbicide resistant weeds
In the US, Argentina and Brazil, where the majority GMHT crops are grown, the promise of reduced herbicide use has been seriously undermined by the development of weeds with strong resistance to herbicides such as Roundup (GM Freeze, 2010). This means other or additional chemical herbicides have to be used.

The majority of GM crops have been designed to be tolerant of either Monsanto's Roundup (glyphosate) or Bayer's Liberty (glufosinate ammonium). Crops tolerant to Roundup (known as RR or Roundup Ready) are the most prevalent in all the GM crops growing countries. In the US, for example, 100% of the GM soya produced is RR, GM maize is about 95% RR and GM cotton about 97% RR. In Brazil and Argentina 100% of the GM soya crops has been Roundup Ready over the last 12 years.

The evolution of weeds that are resistant to Roundup has clearly accelerated since the introduction of GMHT crops, undermining the whole zero tillage approach. In Argentina, one of the countries used as the perfect example of no-till farming, the spread of glyphosate resistant (GR) Johnsongrass (*Sorghum halepense*) has been very rapid. By 2007, all Argentinean provinces growing GM soya were infested with GR Johnsongrass; and it is known to have covered 10,000 ha in Northern Argentina, although throughout the country the area may be as high as 100,000ha. It has been observed that *"…the evolution of glyphosate-resistance in* S,halepense *is a major threat to glyphosate-resistant soybean productivity in northern fields of Argentina."* (Vila Auid *et al*, 2008)

The impact of resistance is also being felt in the US where an analysis of pesticide usage based on official data showed that GM crops have actually resulted in a net increase in pesticide use – compared with pre-GM figures an additional 0.11kg of pesticide was applied per acre in 2008 (Benbrook C., 2008). GM crops are generally pushing pesticide use upward in the US. In 2008, for example, GM crop acres required over 26% more pesticide per acre in the US than conventional varieties (Benbrook C., 2008). This trend is projected to continue as a result of the rapid spread of glyphosate-resistant weeds.

Perhaps unsurprisingly, the agro-chemical industry's solution to weed resistance is to use yet more herbicide, by recommending the use of Roundup in combination with other herbicides with higher toxicity such as 2,4 D (2,4-Dichlorophenoxyacetic acid, a component of Agent Orange used during the Vietnam War). GMHT crops with several HT traits relating to different herbicides are also being developed, so that a range of products can be used on glyphosate-resistant weeds. But this will only serve to increase dependency on fossil-fuel based chemical weed control (Monsanto, 2006).

In addition, farmers are also resorting to tillage in order to control weeds, which again undermines the no-till promotion of GM crops.

In conclusion, claims that GMHT crops would lead to lower labor costs and reduced herbicide applications, and that they are climate friendly because of reduced tillage, are increasingly found to be wanting.

GMHT crops damage soils

Zero tillage also depends on the use of heavy equipment and tractors to carry out field operations, but prolonged use can cause soil compaction. This is a well-documented problem common to all forms of cultivation that rely on heavy machinery for field operations (Pen State University, 1996). The use of zero tillage on monocultures of the same crop year after year – which is the basis of GMHT crop cultivation in North and Latin America – is a sure way to develop soil compaction. Compaction can reduce root penetration and water logging and can eventually reduce yields. Furthermore, any remedial action is also like to depend on the use of fossil fuel intensive machinery.

Overall, some of the energy saved from reducing the number of field operations is immediately lost by using more power per operation. Alternative approaches to crop production based on agro-ecological principles use nitrogen fixing plants, composts and manures together with crop rotation. This builds soil fertility, including by increasing the organic matter/carbon in the soil and increase its moisture-holding capacity. These improvements in soil structure help reduce soil erosion and increase penetration of rainfall. Biodiversity also increases over time, which improves nutrient cycling and increases numbers of pest predators.

Claim # 3: GM crops will feed us in a warming world

GM crops do not produce higher yields

It is frequently claimed that GM crops produce higher yields than conventional crops, meaning that more food should be produced from the same area of land. The argument is that this would alleviate the need for increased land for agriculture, which currently leads to the destruction of forests and other carbon-rich ecosystems. But none of the GM crops so far developed for commercial cultivation has been yield enhancing, and there is no evidence to support this claim. Rather than increasing yield, the focus has been on agronomic traits and over 99% of commercial GM crops are modified to create herbicide tolerance or insect resistance (or both) (ISAAA, 2009).

The largest and most comprehensive assessment of agricultural science, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) examined the evidence for GM and found no definite evidence that GM crops were yield-enhancing:

"Assessment of modern biotechnology is lagging behind development; information can be anecdotal and contradictory, and uncertainty on benefits and harms is unavoidable. There is a wide range of perspectives on the environmental, human health and economic risks and benefits of modern biotechnology, many of which are as yet unknown….The application of modern biotechnology outside containment, such as the use of genetically modified (GM) crops is much more contentious. For example, data based on some years and some GM crops indicate highly variable 10-33% yield gains in some places and yield declines in others." (IAASTD, 2008)

Yield is a complex phenomenon that depends on numerous factors, including weather, the availability of irrigation and fertilizers, soil quality, farmers' management skills, and levels of pest infestation. Genetic improvements achieved through conventional (ie non-biotechnological) breeding are also important. Indeed, traditional plant breeding has continued since GM crops were first introduced and hence the steady rise in overall yields since 1996 can be attributed to this general trend, which started in the 1930s.

A recently published review, which closely evaluated the overall effect that genetic engineering has had on crop yields in relation to other agricultural technologies, observes that GM technology has had little or no overall impacts on crop yields:

“Overall, corn and soybean yields have risen substantially over the last 15 years, but largely not as result of the GE traits. Most of the gains are due to traditional breeding or improvement of other agricultural practices.”(Gurian-Sherman, 2009)

Several other studies have reported similar findings (Jost P *et al*, 2008) (Elmore R *et al*, 2001) (Ma *et al*, 2005). Studies also show that Roundup Ready soya suffers from ‘yield drag’ with on average 5-10% lower yields than conventional soya, as well as reduced uptake of essential nutrients (Elmore R *et al*, 2001).

Most GM crops are not produced for food

As explained previously, the overall contribution of GM crops to global food supply remains small in comparison to other crops bred in a conventional manner. There is no commercial production of most of the world’s staple crops – wheat, barley, oats, potatoes, rice, sorghum, cassava, and millet. With the exceptions of small areas of papaya and squashes in the USA and tomatoes and sweet pepper in China, no GM fruit and vegetables have been developed to the point of commercial cultivation either.

GM production is largely confined to four crops: soya, maize, oilseed rape and cotton are grown on over 99% of the total area under GM cultivation. And 95% of the area grown is in just six countries: the US, Brazil, Argentina, Canada, China and India. In 2008 industry sources (ISAAA, 2009) reported that 125 million ha of GM crops were being grown in the world: this amounts to just 2.6% of farmed land (GM Freeze, 2009). The proportion of the world’s farmers actively growing GM crops – 13.3 million according to the industry – is around 1% of the total 1.3 billion farmers (GM Freeze 2009). It is important that the claims being made for GM crops’ ability to contribute to alleviating the impacts of climate change-induced hunger are assessed in the light of this data.

In addition, between 66% and 90% (DSC, 2008) of all soya production is fed to animals, mainly in very inefficient intensive production systems (the ratio of plant protein needed to produce one unit of animal protein varies between 5 and 9 depending on the system being employed). The GM crop industry is thus contributing directly to industrial livestock production, which is also a major producer of greenhouse gases through land clearance (6%) and methane emissions (6%) (Garnett, 2007).

‘Marginal land’ cannot be used for GM miracle crops

The idea that there are vast areas of ‘marginal land’ ready to grow GM crops for food and agrofuels – which has been widely promoted since the first GM crops appeared in the 1990s – is increasingly recognized as spurious. ’Marginal’ or ‘waste’ land seldom exists.

A recent review of this important issue (Econexus *et al*, 2008), found that that land is rarely idle. Rather it is more likely to be used by pastoralists, smallholders, Indigenous Peoples and women who utilize the land in a sustainable low impact way for hunting, and gathering food, fuel and building materials. These uses of land often have no visible impact and are often unrecognized. In addition, land may also be important for biodiversity including rare or important species, and for protecting water resources. Maintaining forests and other ecosystems is also critical in mitigating climate change, since they store vast quantities of carbon and also play a vital part in the world’s hydrological cycle.

The Food and Agriculture Organization (FAO) has also recognized the importance of so-called ‘marginal land’ to local people, and acknowledges that without rights or access to these lands rights they can be left destitute:

“For local farmers and pastoralists, however, access to this land may be their most valuable asset. When the land is expropriated, it can be difficult for local users, especially if they hold no

formally recognized tenure rights, to negotiate sufficient compensation to ensure a sustainable livelihood." (FAO, Undated)

"While there is a perception that land is abundant in certain countries, these claims need to be treated with caution. In many cases land is already being used or claimed – yet existing land uses and claims go unrecognized because land users are marginalized from formal land rights and access to the law and institutions." (Cotula *et al*, 2009)

Claim # 4: 'miracle' new GM crops will produce food during drought and stress

'Miracle GM crops' are not currently available for commercial cultivation
There is much made of 'miracle' GM crops, that would be capable of growing in 'marginal lands' or dealing with environmental extremes. Crops might, for example, be modified to cope with abiotic stresses such as salinity (Mollor IS *et al*, 2009) high levels of aluminum in soils (Magalhaes, 2007) or drought (EuropaBio, 2009). But these crops are nowhere near commercial cultivation at the moment. Claims made about such crops tend to be highly theoretical and speculative, as clearly illustrated in the discourse around drought-tolerant GM crops, for example:

"If the right genes <u>could be</u> transferred to food crops, losses to drought <u>might be</u> significantly reduced and more organic matter <u>could be</u> returned to the soil. Interestingly, many proteins that confer tolerance to drought also confer tolerance to other stresses such as high and low temperature and salinity. The genes of the resurrection plant <u>could</u> offer multiple benefits. (New Agricultarist, undated) " (emphasis added)

Genetic engineers have been trying to convert plants so that they make more efficient use or carbon dioxide and water. This means converting plants with Carbon 3 metabolism (C3) which include most plants e.g. trees, wheat and oilseed rape, to Carbon 4 metabolism (C4) plants. C4 plants include maize and sugar cane, which make more efficient use of carbon dioxide and water. Successful genetic modification conferring drought tolerance has so far proved impossible because this requires major changes to the metabolism of the plant. It is also worth pointing out that no seed will germinate and flourish in the absence of any moisture, which is so often the case in prolonged periods of drought in Africa, Australia and Europe.
Notably, Monsanto recently applied for an EU marketing consent for drought tolerant maize known as MON87460 and make the same point in their application:

"Under water-limited conditions, grain yield loss is reduced compared to conventional maize. However, like conventional maize, MON 87460 is still subject to yield loss under water-limited conditions, particularly during flowering and grainfill periods when maize yield potential is most sensitive to stress, by disrupting kernel development. Under severe water deficit, maize grain yield for MON 87460, as well as conventional maize, can be reduced to zero.(Monsanto application, undated)"

What is important to note is that the information so far available from Monsanto does not include evidence that the GM maize will actually function even the limited water-stress circumstance outlined above (Monsanto application, undated).

In contrast, traditional breeding has produced varieties that mature quickly increasing the chances of achieving a harvestable crop in some dry years. In other words, solutions already exist or are seriously viable, and it is these that need to be further researched in the interest of mitigating the impacts of climate change (Jane Ininda, 2006).

GM crops do not fare well under other stress conditions
Many soils around the world have been rendered unusable by desertification and/or the over use of irrigation, which produces toxic levels of salt in the top layers of the soil. So far no commercial

crops have been developed, although genes occurring naturally in wheat have been identified in Australia, suggesting that marker-assisted breeding (traditional plant breeding assisted by identifying the desired gene in the parent plants first) may provide a more likely route to success.

Professor Tim Flowers of the School of Biological Sciences at the University of Sussex has stated:

"Evaluation of claims that biotechnology can produce salt-tolerant crops reveals that, after ten years of research using transgenic plants to alter salt tolerance, the value of this approach has yet to be established in the field. Biotechnologists have reasons for exaggerating their abilities to manipulate plants. If 'biotechnology' is to contribute tolerant crops, these crops may still be decades from commercial availability. The generation of drought tolerant crops is likely to have a similar period of development." (FAO, 2010)

A focus on single varieties will reduce our ability to deal with climate change
Some plant breeders recognize that the stresses crops will be subject to in the future will be highly variable and unpredictable, because of climate change. Any one crop, for example, might be subject to drought or abnormally high rainfall or new pests and diseases. Growing monocultures based on single varieties will thus limit a crop's ability to respond to changing conditions.

Instead, it has been proposed that mixed variety seed lots with a far broader genetic base should be sown. This would allow the crop to cope with different stresses in the way that natural ecosystems with their large gene pools can (Wolfe M., undated). Research from field-scale trials and laboratory studies confirm that biodiverse agriculture conserves the environment and delivers high and dependable yields. Monoculture yields may appear large when measured for a particular crop per hectare, yet on mixed farms the whole farm output per year is greater, less dependant on favorable weather conditions and more sustainable in the long term (Alteri M. A, 2005) (FAO, 2004).

Claim # 5: crops can be genetically modified to provide fuels

A member of the European biofuels industry commented that, "*In many ways, genetically modified (GM) crops and biofuels are made for each other. The enhanced yields available from the current generation of GM crops such as corn and soybeans can help farmers meet the growing feedstock demand for biofuels while still producing sufficient quantities of food and animal feed. In the future, GM crops with even higher yields and entirely novel GM varieties of grasses and trees should make biofuels production even more efficient and inexpensive (*Evans J, 2008*).*

In reality, however, the potential to increase yields from GM crops to supply demand for agrofuel feedstocks is far from proven. Improving the efficiency of some crops by genetically modifying them from C3 carbon metabolism to C4 carbon metabolism has not been achieved (as described above). This would require genetic changes that would fundamentally alter the metabolism of the plant and there is no certainty that the resulting plant will be able to thrive in the environment and produce high yields because successful crop plants are the sum of genetics, interaction between different genes, and interaction between genes and the environment. Introducing or changing a gene(s) is thus no guarantee of success. Agrofuels production is also constrained by the limited efficiency of photosynthesis in converting solar energy into biomass (in practice only about 3-6% of total solar radiation is converted into biomass (FAO, 1997)); and by the availability of productive land that is not being used for other purposes.
The GM crop most widely used for agrofuels is soya: 70% of the global crop is GM Roundup Ready soya. A recently published analysis of greenhouse gas emissions of bio-diesel production based on soya, which included land clearance, concluded:

"Our analysis provides a useful range of estimates. Our results indicate that soybean biodiesel production, despite its high savings from a pure engineering perspective dramatically increases greenhouse gas emissions compared to conventional diesel when factoring in emissions from land use change across a broad range of assumptions. (Searchinger *et al*, undated)"
The claims about the role of GM crops and trees in replacing fossil fuels is based on very limited evidence and poor analysis of the environmental and socioeconomic impacts that such a major shift in land use would have (see Claim 7 below for more on GM trees). Several detailed critiques have also been published exposing the threat of uncontrolled expansion of agrofuel production in general (Robertson GP, 2008), (Searchinger TC *et al*, 2009) which could lead to:

- Loss of land previous used for food production.
- Displacement of farmers and Indigenous Peoples.
- Damage to biodiversity.
- Increased agrochemical use (pesticides and fertilizers) and pollution from intensively management plantations.
- Poor working conditions.
- Human rights abuses.
- Substantial increases in GHG emissions.

Claim # 6: GM crops could mean the end of reliance on nitrogen fertilizers

The 'holy grail' for genetic engineers is to be able to genetically modify nitrogen fixation into non-leguminous plants such as wheat and barley. There are already a large number of crop plants (eg peas, beans and clover) that have a symbiotic relationship with soil bacteria, which form nitrogen-fixing nodules on their roots. Sustainable farming systems already use these crops as part of rotation or sown under non-nitrogen fixing crops.

GM proponents claim that nitrogen-fixing crops could reduce the need for artificial nitrogen (N) fertilizers, thereby reducing the use of fossil fuels to manufacture, pack, transport and broadcast the fertilizers, as well as reducing the use of the fertilizers themselves. This could reduce emissions of both CO_2 and N_2O emissions.

However, despite these claims, there has been very little progress in terms of developing GM nitrogen-fixing crops. It may be that it simply proves to be too difficult to achieve this objective, because of the complexity of the nitrogen (N) fixation process, especially since it involves symbiotic relationships between two organisms: the genetic transformations required to achieve this are far more complex than the simple single gene modifications associated with GM herbicide tolerance. Nitrogen fixing is also a highly energy intensive process which can impact negatively on yields. As one scientist observed: *"Nitrogen fixation in wheat was not considered a realistic prospect in the short term*", for this reason (APPG, 2008).

An FAO report in 2005 also explains why genetic modification for nitrogen fixation is so difficult:

"Nitrogen-fixation has long been a desired yet elusive 'green' biotechnology. However, the objective of improving-plant-Rhizobium symbiosis or other associations is not easy to achieve due to the complexities of the relationships, the multiplicity of factors involved, the specificity of the interaction between the two organisms, the influence of the environment on the system of expression and the possible competition between beneficial and other soil microflora". (FAO, 2005)

In addition, high levels of nitrate can accumulate in the foliage of some leafy vegetables, e.g. lettuce and spinach, to the point where 'Acceptable Daily Intakes' could be exceeded (EFSA, 2008). Nitrate can be converted into nitrites and thence nitrosamines in the body, and these have been linked to cancer.

Claim # 7: GM trees can sequester carbon

GM trees (often also referred to as GE or genetically engineered trees) are already being developed for a range of uses, although China is the only country where they are currently being grown on a commercial scale. In China, Poplar (*Populous spp.)* species have been genetically engineered, cloned and planted to prevent erosion. Elsewhere GM tree planting has been confined to a small number of test sites.

In the context of climate change, fast growing trees which fix more CO_2 than conventional trees would be superficially attractive as carbon sinks, and if the process was energy efficient, as sources of cellulose to produce ethanol for agrofuels. However the risks associated with GM trees are far more complex to assess than those associated with annual or biennial crops species. Trees differ in a number of important characteristics. A review of the scientific literature shows that due to the complexity of trees – which are organisms with large habitats and numerous interactions – it is not currently possible to undertake meaningful and adequate risk assessments of GM trees. Furthermore, trait-specific risk assessments are not appropriate.

In addition, both scientific literature and in-field experience show that contamination by and dispersal of GM trees will take place. Transgenic sterility is not a viable option because many species are capable of spreading by vegetative means and there is presently no transgenic sterility method that could be relied upon throughout the long life of a tree. Regulation of trees at the national level is also insufficient due to the large-scale dispersion of reproductive plant material by trees, much of which will be likely to cross national borders. All this makes GM trees a particularly compelling case for the application of the precautionary principle.

In China, GM trees are reproduced by taking cuttings (cloning) meaning the population has a very narrow genetic base. This approach makes GM trees especially vulnerable to serious disease and insect attacks, which would be difficult to control. In contrast, the regeneration of native forests through community-based tree planting has been demonstrated as a practical solution to stabilizing soils and preventing erosion, by The Green Belt Movement in Kenya (The Green Belt Movement, undated).

GM threatens real solutions to climate change

Patenting natural climate genes
Patents are used by large transnational corporations, to protect markets and prevent farmers saving seeds from one crop to sow the next year. The enforcement of such patents has been applied to control farming and ensure that biotechnology companies retain seed sales. The same companies (Monsanto, Bayer, Syngenta, BASF and Dupont) are systematically patenting any natural genes which could at some point be included in crops modified to mitigate and adapt to the changing conditions associated with climate change: drought, salinity, floods, high and low temperatures, and other abiotic stresses, as well as chemical loads in water and general stress. So far they have filed 532 patent documents covering 55 patent families (ETC, 2009).
The privatization of genetic resources in this way restricts farmers' and researchers' access to seeds and knowledge, and fuels the development of powerful monopolies (Tansey G., 2008). The top ten seed companies in the world already control 57% of seed sales (ETC, 2008). But restricting farmers' access to seeds, which they traditionally rely on from one year to the next by saving seed from each crop, is a threat to their food sovereignty (ETC, 2008). In addition, there is a serious and worrying overlap between food crops and those earmarked for GM biofuels: soya, maize, sugar beet, wheat, canola/oilseed rape and potatoes.

What is Food Sovereignty?

Food Sovereignty is the right of peoples, communities, and countries to control their own seeds, lands, water and food production through just and ecological systems; which ensures enough, diverse, nutritious, locally produced and culturally appropriate food for all.

In the urban context this means the ability to produce or buy such food sourced locally and regionally from a network of diverse retail outlets and markets, which means building bridges between those who produce and consume food (People's Food Sovereignty Forum, 2007).

In Africa there is also growing concern that the patenting of climate genes will undermine local initiatives for dealing with the huge challenge of climate change:

"Patent monopolies undermine and stymie climate adaptation by African farmers because it constrains the free exchange of and experimentation with crop germplasm – critical activities for the development of African solutions". (African Centre for Biosafety, 2009)

The importance that the industry places on securing intellectual property rights was also highlighted in a leaked strategy document produced by US lobby group, the Biotechnology Industries Organization (BIO), in the run up to in the 2009 climate change negotiations in Copenhagen:

"Biotechnology provides key solutions to mitigating climate change. This is our opportunity to make those solutions more widely known, while protecting the ability of innovators to maintain intellectual property rights." (Bio, undated)

Genuine solutions are threatened
Genetically modifying crops to allow agriculture to adapt to and mitigate climate change is a high-risk strategy. Few of the supposed 'savior' crops have actually been demonstrated to work in the field, and their ability to meet much publicized expectations remains unknown. None have yet been commercialized. Davinder Sharma, an Indian commentator on agriculture and GM crops, succinctly sums up why such claims are being made:

"These assertions are not amusing, and can no longer be taken lightly. I am not only shocked but also disgusted at the way corporations try to fabricate and distort the scientific facts, and dress them up in such a manner that the so-called 'educated' of today will accept them without asking any questions." (Sharma D., 2009)

This focus on GM technology diverts attention away from another successful approach to agriculture that already has a proven track record when it comes to addressing some of the challenges linked to climate change: agro-ecology. This system of food production is championed by Via Campesina, the global network of peasant farmers, who observe that:

"Agro-ecology and other sustainable food production systems are preserving biodiversity and increasing food productivity. These systems have in practice shown alternatives to the high-tech, expensive and unsustainable model of the 'green revolution'."(IAASTD, 2008)

In April 2008, the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) published its report based on four years of deliberation looking into the scientific, social science and economic aspects of the genetic modification of crops. The report included 20 key findings, amongst which was a call for far greater emphasis on agro-ecological approaches to land management and the need to develop agricultural knowledge, science and technology (AKST) to this end. (GM Freeze, 2008)

"*An increase and strengthening of AKST towards agroecological sciences will contribute to addressing environmental issues while maintaining and increasing productivity. Formal, traditional and community-based AKST need to respond to increasing pressures on natural resources, such as reduced availability and worsening quality of water, degraded soils and landscapes, loss of biodiversity and agroecosystem function, degradation and loss of forest cover and degraded marine and inshore fisheries*." (IAASTD, 2008)

The overriding message of the report was summed up thus:

"Agriculture has a footprint on all of the big environmental issues, so as the world considers climate change, biodiversity, land degradation, water quality, etc. they must also consider agriculture which lies at the centre of these issues and poses some uncomfortable challenges that need to be faced. We've got to make sure the footprint of agriculture on climate change is lessened; we have to make sure that we don't degrade our soil, we don't degrade the water, and we don't have adverse effects on biodiversity. There are some major challenges, but we believe that by combining local and traditional knowledge with formal knowledge these challenges can be met." (Professor Robert Watson, Director IAASTD & Chief Scientist DEFRA UK) (IAASTD press release, 2008)

The IAASTD did not endorse GM crops as the solution, much to the annoyance of the biotechnology industry and the USA, Australia and Canada, all of whom provided amended text to the final report to record their disquiet. (IAASTD draft report, 2008) However, 58 counties have endorsed the IAASTD findings without such reservations.

In October 2008, the UNEP-UNCTAD Capacity-building Task Force on Trade, Environment and Development also published a report on "Organic Agriculture and Food Security in Africa," which supported the IAASTD's finding that agro-ecological approaches to land management provide the best options for dealing with the many tasks being asked of farmers. It concluded that:

"Organic agriculture can increase agricultural productivity and can raise incomes with low-cost, locally available and appropriate technologies, without causing environmental damage. Furthermore, evidence shows that organic agriculture can build up natural resources, strengthen communities and improve human capacity, thus improving food security by addressing many different causal factors simultaneously." (UNEP, 2008)

However, many agro-ecological solutions to the major problems of drought and saline soils (which often result from the use of ecologically inappropriate crops and the overuse of irrigation on hybrid crops) remain unavailable to many farmers. A failure to make money available to fund extension services and infrastructure is a serious impediment. In some countries land tenure for farmers, and especially women, also makes the adoption of agro-ecological practices more difficult.

Agro-ecological systems can tackle climate change

Agro-ecological systems have been identified as key to facing the challenges to feeding a growing population in a warming world. They respect the multi-functionality of agriculture, which is especially important for resource poor farmers in the developing world. Agro-ecological practices can reduce greenhouse gas emissions from agriculture in a variety of ways:

(1) Increasing soil organic matter

- Practicing crop rotations.
- Including grass/legume crops to improve soil structure.
- Adopting mixed cropping, crop rotation and crops breaks.

- Avoiding excessive cultivation to reduce carbon losses.
- Avoiding the excessive use of fertilizers, which reduces natural nutrient cycles and emits greenhouse gases.
- Recycling organic matter (such as animal manure and crop waste) back into the soil to increase soil fertility and water holding capacity, and to improve the soil structure for better root growth and to prevent soil erosion.
- Avoiding the excessive use of irrigation, which can cause salt to build up in top soil to toxic levels

(2) Agro-forestry
Agro-forestry is *"a collective name for land-use systems and practices where woody perennials are deliberately integrated with crops and/or animals on the same land management unit.*" (FAO 1993) Agro-forestry systems set out to create diverse cropping systems with many layers of productive crops from the ground to the upper canopy of the trees. In many areas of the world where farmers have to deal with intermittent and unreliable circumstances, agro-forestry can provide a more sustainable form of land management than large-scale crop monocultures.

(3) Water harvesting
There are several techniques for harvesting seasonal rainfall (Practical Action undated) to make it available for crops during dry seasons, including the diversion of water using check dams; small-scale reservoirs, and contour plowing to capture run-off more effectively.

(4) Drip Irrigation
Drip or trickle irrigation systems are a water-efficient alternative to spray irrigation: water is delivered to plants in the correct amounts close to their roots.

(5) Expanding techniques to cope with salinity
- Use of water efficient irrigation so that water is applied at rates crops can cope with.
- Regulation of ground water abstraction to prevent over pumping and the intrusion of saline waters from the sea.
- Building dykes and levees to prevent sea water inundating farm land in tropical storms (this also helps to protect communities living near coastlines).
- Leaching (flushing) of soils using 'clean' water to wash salt out of the root zone.
- Leaching using natural rainfall often using a salt tolerant crop such as millet (Primefacts 2006) to produce food whilst this takes place.
- Planting deep-rooted trees and shrubs to lower water tables beneath crops.
- Improved drainage of irrigated land.
- Improved infiltration of irrigation water using cultivation techniques, such as contour plowing (for example furrowing the soil to increase the rate at which water enters the soil)
- Incorporation of organic matter to improve infiltration.
- Use of mulches to reduce evaporation losses.
- Incorporation of crop residues into the soil which would be lost if these were diverted into secondary biofuel production.
- Using conventional breeding (with marker-assisted selection) to develop saline tolerant varieties based on local gene pools.
- Support research in to seed priming – a technique that allows crops to grow under saline conditions (Iqbal M *et al*, 2006)

References

African Centre for Biosafety, (2009) Patents, Climate Change and African Agriculture: Dire Predictions. See http://www.biosafetyafrica.org.za/images/stories/dmdocuments/ACB-Brief_Patent_Climate_African_Agric_Sep-2009.pdf

Altieri, M.A. and C.I. Nicholls (2005) Agroecology and the Search for a Truly Sustainable Agriculture UNEP, Mexico

America. Gov (2009) 'Gates Foundation Announces $120 Million in Grants for Agriculture' www.america.gov/st/.../20091019152444akllennoccm0.3777277.html

Benbrook, C, 2009. Impacts of Genetically Engineered Crops on Pesticide Use: The First Thirteen Years, The Organic Center, November 2009, See http://www.organiccenter.org/science.latest.php?action=view&report_id=159

Benbrook, C. M. (2009) 'Impacts of Genetically Engineered Crops on Pesticide Use: The first Thirteen Years' http://www.organic-center.org/reportfiles/13Years20091126_FullReport.pdf

Bio, (undated) United Nations Framework Convention on Climate Change (UNFCCC): Bio Action Plan

Biosafety Africa (2009) Press release 'South African Govt rejects GM potato' http://www.biosafetyafrica.net/index.html/index.php/20100207281/South-African-Govt-rejects-GM-potato/menu-id-100023.html

Cotula, L., Vermeulen, S., Leonard, R. and Keeley, J., (2009), Land Grab or Development Opportunity? Agricultural Investment and International Land Deals in Africa, IIED/FAO/IFAD, London/Rome (p6)

Drinkwater, L., et al. (1998). Legume-based cropping systems have reduced carbon and nitrogen losses. Nature 396:262–265;

Econexus et al, (2008). Agrofuels and the Myth of Marginal Land http://www.econexus.info/pdf/Agrofuels_&_Marginal-Land-Myth.pdf

Elmore R et al, (2001) Glyphosate-Resistant Soybean Cultivar Yields Compared with Sister Lines, Agron J 2001 93: 408-412, http://agron.scijournals.org/cgi/content/abstract/93/2/408 also quoted in the University of Nebraska press release announcing this study: "Research Shows Roundup Ready Soybeans Yield Less," May 16, 2000, http://ianrnews.unl.edu/static/0005161.shtml.

ETC group, (2008) Patenting the climate genes and capturing the climate agenda ETC communiqué May/June 2008 Issue 99. http://www.etcgroup.org/en/node/687

Europa Bio (2008) Open letter from EuropaBio to President Barroso:Priorities for the 7 December Copenhagen Climate Change Summit. See http://pr.euractiv.com/press-release/open-letter-europabio-president-barrosopriorities-7-december-copenhagen-climate-change

EuropaBio (2009) Frequently asked questions - How does biotechnology address current human & environmental challenges? http://www.europabio.org/green_biotech/GBE_FAQ-challenges.htm#09

European Food Safety Agency, (2008) Nitrates in Vegetables: Scientific Opinion of the Panel on Contaminants in the Food Chain. NoEFSA _Q_2006-071

Evans J, (2008) GM crops and Biofuels. Ethanol Producer Magazine August 2008 available at http://www.ethanolproducer.com/article.jsp?article_id=4462

FAO (1993) Report of the First External Programme and Management Review of the International Centre for Research in Agroforestry http://www.fao.org/wairdocs/TAC/X5812E/x5812e08.htm

FAO (1997). Renewable biological systems for alternative sustainable energy production (FAO Agricultural Services Bulletin - 128) Chapter 1 Biological energy production http://www.fao.org/docrep/w7241e/w7241e05.htm

FAO (2004) What is agrobiodiversity? http://www.fao.org/docrep/007/y5609e/y5609e01.htm

FAO (2005). Status of Research and Application of Crop Biotechnologies in Developing Countries. Preliminary Assessment. FAO Rome ftp://ftp.fao.org/docrep/fao/008/y5800e/y5800e00.pdf

FAO (2010) FAO International Technical Conference Agricultural biotechnologies in developing countries: Options and opportunities in crops, forestry, livestock, fisheries and agro-industry to face the challenges of food insecurity and climate change (ABDC-10) http://www.fao.org/fileadmin/user_upload/abdc/documents/crop.pdf

FAO (undated). Climate Change, Biofuels and Land. See ftp://ftp.fao.org/nr/HLCinfo/Land-Infosheet-En.pdf

Friends of the Earth (2007). 'Planting Prejudice - How UK Government support for GM crops undermines sustainable farming policies.' http://www.foe.co.uk/resource/briefings/planting_prejudice.pdf

Friends of the Earth Europe (2008) 'False industry claims of increased biotech crop cultivation in Europe http://www.foeeurope.org/GMOs/Who_Benefits/EU_briefing_2009.pdf '

Garnett T, (2007) Food Climate Research Network, Meat and Dairy Production and Consumption http://www.fcrn.org.uk/frcnPubs/publications/PDFs/TG%20FCRN%20livestock%20final%206%20Nov%20.pdf

Gerster G *et al*, 2008. Distribución de la Compactación en el Perfil del Suelo utilizando diferentes Neumáticos. Consecuencias sobre el Enraizamiento del Cultivo de Soja. Instituto Nacional de Tecnologia Agropecuaria (INTA), 2008. Econoagro http://www.econoagro.com:80/verArticulo.php?contenidoID=646.

GM Freeze and Friends of the Earth Europe, (2009) Media Briefing 'Undoing the ISAAA Myths on GM Crops' http://www.gmfreeze.org/uploads/ISAAA_myths_briefing.pdf

GM Freeze (2009). Blind Alley, Is DFID's policy on agriculture failing to deliver food and environmental security? See http://www.gmfreeze.org/uploads/blind_alley_final.pdf

GM Freeze, Practical Action, and Friends of the Earth (2008) Special Briefing New Labour and the International Assessment of Agricultural Knowledge Science and Technology for Development (IAASTD) – Meeting the Challenge http://www.gmfreeze.org/uploads/special_IAASTD_brieifing.pdf

Gurian-Sherman, D. (2009) Failure to Yield: Evaluating the Performance of Genetically Engineered Crops. Union of Concerned Scientists, USA. http://www.ucsusa.org/food_and_agriculture/science_and_impacts/science/failure-to-yield.html

IAASTD, (2008) Agriculture at a Crossroads Key finding 7. See http://www.agassessment.org/reports/IAASTD/EN/Agriculture%20at%20a%20Crossroads_Global%20Summary%20for%20Decision%20Makers%20(English).pdf

IAASTD, (2008) Executive Summary Page 14. http://www.agassessment.org/docs/SR_Exec_Sum_280508_English.pdf

Igbal M and Asraf M, (2006) Wheat Seed Priming in Relation to Salt Tolerance; growth. yields and levels of free salicylic acid and polyamines Ann. Bot.Fennici, 43:250-259.

Indian Ministry of Environment and Forests (2009) Decision on commercialisation of Bt Brinjal http://moef.nic.in/downloads/public-information/minister_REPORT.pdf

International Assessment of Agricultural Science & Technology (IAASTD) (2008) Inter-governmental report aims to set new agenda for global food production "business as usual is not an option"-- Professor Robert Watson- Director IAASTD & Chief Scientist DEFRA www.agassessment.org/docs/IAASTD_backgroundpaper_280308.doc

International Assessment of Agricultural Science and Technology for Development (2008) Press release http://www.agassessment.org/index.cfm?Page=Press_Materials&ItemID=11

ISAAA, (2009) ISAAA Brief 39-2008: Executive Summary http://www.isaaa.org/resources/publications/briefs/39/executivesummary/default.html

Jane Inindia (2006) 'Public Breeding Produces New Maize Varieties for Kenyan Farmers' African Crops. Net http://www.africancrops.net/news/dec06/ininda.htm

Jost P et al, (2008) "Economic Comparison of Transgenic and Non-transgenic Cotton Production Systems in Georgia," Agronomy Journal, Volume 100, Issue 1, 2008. http://agron.scijournals.org/cgi/content/abstract/100/1/42
M.M. Wander (2006) Total and labile soil organic matter in organic and conventional farming systems. Soil Society of America Journal 70: 950–959.

Ma & Subedi, (2005) "Development, yield, grain moisture and nitrogen uptake of Bt corn hybrids and their conventional near-isolines," Field Crops Research 93 (2-3): 199-211, http://cat.inist.fr/?aModele=afficheN&cpsidt=16911550

Magalhaes JV, (2007) A gene in the multidrug and toxic compound extrusion (MATE) family confers aluminium tolerance in sorghum. Nature Genetics 39 pp 1156-1161
Minutes of the UK inaugural meeting of the all-party parliamentary group on science & technology in agriculture (2008) http://66.102.9.132/search?q=cache:fgWEi4IJZwcJ:www.appg-agscience.org.uk/linkedfiles/FINALMINUTES_APPG%2520INAUGURALMEETING_11.03.08.doc+Nitrogen+fixation+in+wheat+was+not+considered+a+realistic+prospect+in+the+short+term&cd=1&hl=en&ct=clnk

Mmegi online (2008) 'GM crops no panacea to food insecurity – expert' http://www.mmegi.bw/index.php?sid=1&aid=87&dir=2009/October/Thursday29

Møllor IS et al, (2009) Shoot Na^+ Exclusionand Increased salinity Tolerance Engineered by Cell Type – Specific Alterantionof Na^+ transport in Arabidopsis Plant Cell published on line http://www.plantcell.org/cgi/rapidpdf/tpc.108.064568v1

Monsanto News release (2006) 'Monsanto Sales Representatives And Agronomists Prepared To Address Grower Concerns About Glyphosate-Resistant Giant Ragweed' http://monsanto.mediaroom.com/index.php?s=43&item=448

Monsanto, (ndated) Application for authorization to place on ther market MON87460 maize in European Union, according to regulation (EC) No 1829/2003 on genetically modified food and feed. See http://www.gmo-compass.org/pdf/regulation/maize/MON87460_maize_application.pdf

Paul H et al, 2009. Agriculture and Climate Change: Real Problems, False Solutions See http://www.econexus.info/pdf/agriculture-climate-change-june-2009.pdf

Pennysylvania State University, (1996) Soil compaction and Conservation Tillage Conservation Tillage series No.3. http://cropsoil.psu.edu/extension/ct/uc125.pdf

People's Food Soverignity Forum (2009) Terra Preta: Forum on the Food Crisis, Climate Change, Agrofuels and Food Sovereignty, http://www.foodsovereignty.org/new/
PG Economics (2009) 'Biotech crops making important contributions to sustainable farming' http://www.pgeconomics.co.uk/Biotech%20crops%20making%20important%20contributions%20to%20sustainable%20farming.htm

Pimentel, D. (2005). Environmental, energetic and economic comparisons of organic and conventional farming systems. BioScience 55:573–582; Marriott, E.E., and

Practical Action, (undated). Water Harvesting in Sudan. http://practicalaction.org/practicalanswers/product_info.php?products_id=66

Prime facts (2006) Millet for reclaiming irrigated saline soilsan http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/86965/pf242-millet-for-reclaiming-irrigated-saline-soils.pdf

Robertson GP, (2008) Sustainable Biofule Redux. Science 3 Oct 200 Vol 322 Nop 5898 pp49-50

Searchinger TD et al, (2009) Fixing Critical Climate Accounting Error Science 23 Oct 2009 Vol 326 No 5952 pp 527-528

Searchinger TD and Heimlkich R, (undated). Estimating Greenhouse Gas Emissions from Soy-based US Biodiesel hen Factoring in Emissions from Land Use Change See http://www.farmfoundation.org/news/articlefiles/371-4-Searchinger.pdf

Sharma D, (2009) 'Do GM crops increase yield? The answer is no. See http://www.countercurrents.org/sharma210309.htm

Smith P et al, (2007) Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. see http://www.ipcc.ch/publications_and_data/ar4/wg3/en/figure-8-4.html

Smith P et al, 2007. Agriculture. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Tansey G, 2008. Farming, Food and Global Rules in The Future Control of Food A Guide to International Negotiations and Rules on Intellectual property Biodiversity and Food Security Eds G Tansy and T Rajotte.

The All-Party Parliamentary Group on Agriculture and Food for Development, (2010), Why no food for thought? See http://www.agricultureandfoodfordevelopment.org/Why%20No%20Food%20for%20Thought%20-%20A%20Parliamentary%20Inquiry.pdf

The Dutch Soy Alliance, (2008) Soy- Big Business, Big Responsibility.

The Green Belt Movement (undated) Tree-Planting Program http://gbmna.org/w.php?id=13

Thompson J, (undated) GM crops – part of the solution for soils? See New Agriculturalist on line http://www.new-ag.info/01-6/focuson/focuson9.html

UNEP (2008) Organic Agriculture and Food Security in Africa. See http://www.unctad.org/en/docs/ditcted200715_en.pdf

Union of Concerned Scientists (2009) Agricultural Practices and Carbon Sequestration Fact Sheet http://www.ucsusa.org/food_and_agriculture/science_and_impacts/science/ag-carbon-sequest-fact-sheet.html

Vila Aiud, M, et al, (2008) "Glyphosate-resistant weeds of South American cropping systems: an overview". Martin Vila-Aib (University of Buenos Aires) and Maria Balbi (Monsanto Argentina) et al, Pest manag Sci 64: pp366

Wolfe M, (undated) Perspective Diversity within crops restricts disease See http://www.new-ag.info/01-1/perspect.html