Update on GE Initiative

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Introduction

The intent of this report is to update member councils on the Inter-council Working Party on GMO Risk Evaluation and Management Options as to progress on the work stream currently undertaken by the Working Party and on relevant developments regarding GMOs nationally and internationally. The participating members of the Working Party in this initiative include Far North District Council (FNDC), Whangarei District Council (WDC), Kaipara District Council (KDC) and Auckland Council (AC).

1. Progress on Work Stream

At its meeting on 10 February 2012 the Working Party passed the following resolutions:

(e) That the Working Party proceeds consistent with the resolutions of the participating Working Party councils, including:

(i) The preparation of a section 32 report including draft provisions for a possible joint district/unitary plan change.

(ii) That the cost of (i) be identified as a basis for joint funding provision by the participating councils prior to work commencing on (i).

(f) That funding of resolution (e) be implemented based on an equitable and practical model taking into account changes in council representation on the Working Party, noting that funding will be subject to the respective councils' LTP confirmation.

(g) That the section 32 report and draft plan provisions, once completed, be referred to the participating member councils on the Working Party for their determination of the next steps and, subject to that determination, a memorandum of understanding between the councils to jointly manage any further statutory process be prepared.

In accordance with these resolutions, a Proposal and Costing for Services has been obtained for the section 32 and draft plan provisions work stream and has been circulated to member councils. In addition, a funding model has been agreed to by councils on the Working Party and likewise circulated to member councils. FNDC, WDC and AC have all agreed to jointly fund this work based on the funding model. KDC has yet to agree to contribute funding. Given that KDC has called in commissioners to take over governance of the council due to financial difficulties, it appears unlikely KDC will be in a position to contribute funding at least in the short term.

The work stream is to be completed by December 2012. The completion date was set to ensure the section 32 and draft plan provisions could be used to inform the review of the Whangarei District Plan which is currently taking place and the formulation of the AC Unitary Plan of which a draft is expected in March 2013.

The Whangarei District Plan is currently subject to a statutory rolling review. All provisions in the plan are being reviewed and changes to the plan are being scheduled as a result of this review. It is considered efficient and useful by WDC to include the issue of GMO land uses as part of this review than to address it separately later as the insertion of new provisions relating specifically to GMOs (if supported by the section 32 analysis and a subsequent political decision) may affect other parts of the plan.

The partially completed review of the Auckland Regional Policy Statement had included the issue of genetically modified organisms (GMOS) and some consultation on this issue had taken place. In addition, the Auckland City District Plan (Islands Section) contains provisions regulating GMOs in the Hauraki Gulf Islands. These were reviewed relatively recently. As I understand it, the Islands Section of the Auckland City Plan is to remain in place and consistency with the rest of Auckland regarding GMOs may need to be considered during the formulation of the Unitary Plan.

When considering the time frame for including provisions in planning documents (if supported by the section 32 analysis and political decisions by councils on the Working Party) it is worth bearing in mind that much of the preparatory work will have been done by the Working Party, including draft plan provisions, section 32 analysis and preliminary consultation with the community, e.g. the Colmar Brunton survey which covered all of the Auckland/Northland regions. Further consultation could take place as part of the statutory process for producing planning documents and/or plan changes.

Lastly, to ensure this preparatory work remains relevant and up to date, a timely use of it is required. If the section 32 report supports district/unitary plan provisions regulating GMOs, and councils on the Working Party resolve to do so, then an efficient and timely process is likely to be beneficial to all councils. It may be desirable to carry out this process in a coordinated way with all councils on the Working Party cooperating as to timing and resourcing. If done in a coordinated manner and in a similar time frame any challenge to the provisions could be jointly responded to. This would present the opportunity to share the costs of potential court challenge amongst participating councils, thus lowering costs considerably to individual councils.

2. Risks of Inaction

At present there are no GMOs approved for general release to the environment in New Zealand. A GM equine influenza vaccine has been approved for conditional release during possible outbreaks of equine influenza. It has not yet been used. There have been over 20 field trials of GMOs since ERMA was established in 1996. Currently there are two major classes of GMOs that may be considered for release to the environment in New Zealand in the near to medium term. These are genetically engineered exotic trees, particularly pinus radiata, currently being trialled in Rotorua by Scion, and genetically engineered pastoral grasses, particularly rye grass and clover, being developed in Australia, USA and New Zealand by Pastural Genomics (a consortium of producer boards), AgResearch and a PGG Wrightson/ Gramina Joint Venture.

Scion obtained approval in 2010 to begin a new set of field trials involving two species of pine. These trials focus on herbicide tolerance, reproductive traits, and growth and quality traits. Scion is a Crown Research Institute (CRI) with linkages to several US companies and the US Department of Energy. AgResearch (another CRI) has received more than $40 million of government funding for research on pastoral grasses including GM clover and ryegrass. PGG Wrightson is in partnership with an Australian research centre and their Gramina venture is researching GM ryegrass and fescue in Australia. Pastoral Genomics is developing GM ryegrass and/or clover varieties. The consortium has links with the Noble Foundation in Oklahoma and the University of Florida. It is conducting field trials in Florida.

There are two other major classes of GMOs that have been trialled in New Zealand. These are transgenic livestock and GM horticultural crops. In 2010 AgResearch gained approval to continue and extend its transgenic livestock programme initiated in 2000. This involves research and development on a number of ruminant species, including cattle, sheep and goats – and to use genetic material from a range of donors, including human genes. The project is aimed at developing products from milk that contain a human protein that can be used in pharmaceuticals (biopharmaceuticals). AgResearch also gained approval to study, develop and commercialise a range of characteristics in transgenic animals, such as medical and/or nutritional proteins in milk, resistance to fungal and bacterial diseases and viruses and altered milk/ meat.

Trials of horticultural products have a relatively longer history in New Zealand. Most of these were carried out by CRIs Crop and Food Research and Hort Research (now Plant and Food Research). These products included potatoes, broccoli, onions, leek, and kale. Tamarillos were trialled in Northland. Most of these trials have now been shut down or suspended. A number of these trials breached their approval conditions and none have resulted in successful commercialisation.

In 2009, Pastoral Genomics and AgResearch were both poised to seek approval for conditional releases of two GM lines – a drought tolerant rye grass and a high energy pastoral grass. However, those plans were suspended apparently because further work was required to support the applications. These applications for conditional release could resurface in the near future (possibly within the next few years but most likely longer).

If either of these GMOs (or others) is approved for release, New Zealand will lose its GE free status. Given the nature of these two organisms (both produce pollen and/or seeds that are distributed widely) containment will be virtually impossible and contamination will be widespread. Pine pollen has been shown to travel hundreds of kilometres from its source. Grass pollen and seeds can travel similar distances. Government officials describe grass pollen as "notoriously difficult to contain and warn of GM grasses becoming "irreversibly established in the environment" and "permanent components of New Zealand's pasture and dairy production systems". The effects on New Zealand's GE free status, its associated marketing advantages, and its ability to access important markets for its primary produce will be profound and irreversible.

The effects on individual producers, rural communities, local and regional economies, regional and local authorities will likewise be profound. For example, it is likely many forms of organic production would become difficult, if not impossible, and export markets would certainly close to New Zealand honey (both of which happened in Canada after the introduction of GM crops). Other conventional non-GM primary producers would likely lose their price premiums, through contamination and potential contamination. This is particularly so for high value products aimed at top end markets such as wine, fruit and horticultural products. If GM pastoral grasses are released in New Zealand, the growing consumer resistance from top end markets to products from animals raised on GM feed would likely affect meat, wool and dairy prices, potentially significantly.

Given the above, a number of risks of inaction become apparent for individual producers, communities, local and regional economies, and local government in New Zealand. A summary of these risks are:

Environmental risks including:

- Adverse effects on non-target species, including indigenous flora and fauna;
- GM plants becoming invasive and disrupting ecosystems;
- Altered genes transferring to other organisms; and
- Development of herbicide or pesticide resistance creating 'super-weeds' or 'super-pests'.

Economic risks including:

- Loss of income (and/or legal action) through contamination (or even perceived contamination) of non-GMO food products triggering market rejection of produce;
- Negative effects on marketing and branding opportunities based on a "Clean Green" image, including damage to regional marketing initiatives such as the 'Naturally Northland' brand, and damage to the tourism industry;
- Costs associated with environmental damage, such as cleanup costs for invasive weeds and pests in reserves, parks, and open space.

Socio-cultural risks including:

- Effects on Maori cultural beliefs (the concepts of whakapapa, mauri, tikanga, and kaitiakitanga);
- Ethical concerns, such as mixing genes from different species and use of human genes;
- Possible effects on human health of food derived from GMOs (including toxicity and allergy risks).

Of particular importance to all of the risks outlined above is the irreversibility of the effects from releasing GMOs into the environment. Once in the environment it would be almost impossible to remove GMOs, much like all new organism introduced to New Zealand that have become pests and weeds. The effects would therefore, in the main, be on-going and the costs of mitigating adverse effects continuous into the future.

Against these risks, important deficiencies in the national level regulation of GMOs have been identified. A key gap is that there is no liability under HSNO for damage arising as a result of an activity carried out in accordance with an approval from the national regulatory body, the Environmental Protection Agency (EPA), or from a general release. Common law actions will very rarely be an effective remedy so affected parties will tend to bear any losses arising from unexpected events and ineffective regulation of GMOs. While economic damage resulting from GM contamination will in the first instance fall on individual constituents, such damage can occur across wide groupings of producers and thus become a community concern. Councils may also be exposed to damage and financial costs associated with feral GMOs in the environment.

Further, there is no requirement under HSNO for applicants to prove financial fitness and no requirement for bonds to be posted in order to recover costs should damage occur. In consequence, parties who may cause damage but do not have sufficient resources to cover resulting costs are not held financially accountable and, once again, costs will tend to fall on affected parties (private producers, communities and local authorities).

Another important deficiency is that HSNO makes the exercise of precaution a matter for the EPA's discretion. Precaution is an option, not a requirement. This results in a lack of surety of outcome for local government on two levels:

- Whether the EPA will agree with and act at all on specific concerns that may be held by a council and its community; and
- Whether, for the risks the EPA concurs need addressing, it will exercise the same degree of caution as would a council and its community.

3. Local Government Initiatives

There have been a number of recent initiatives in New Zealand local government that have some relevance to the work of the Northland/Auckland Inter-council Working Party on GMOs. Two are summarized below:

Hawke's Bay

Local government in the Hawke's Bay is currently being lobbied by the community to declare Hawke's Bay a GE free region and prohibit the release of GMOs into the environment. A group of local food producers committed to building the region's reputation as a region known throughout the world for safe, sustainable, high quality food production (Pure Hawke's Bay) have been making submissions on planning documents and lobbying councils in the Hawke's Bay, including Hastings District Council, Napier City Council, and Hawke's Bay Regional Council. Napier City Council has previously declared itself GE free, while Hastings District Council recently voted unanimously to do likewise. Hawke's Bay Regional Council is considering its response. Hastings District Council is also considering the option of regulating GMOs in its district plan.

The Pure Hawke's Bay Vision Statement calls for the prohibition of GM trials and food production in the Hawke's Bay for the next ten years and for this to be ratified in the district plans of the five territorial authorities in the region along with the regional policy statement for the Hawke's Bay Regional Council. The main argument for this moratorium on GMOs is to build a marketing advantage for the region based upon clean, green, sustainable, and safe food production. John Bostock, one of the largest producers and international exporters in Hawke's Bay, stated:

"We have a market advantage now in being GE free. All our markets are clearly telling us they don't want to eat genetically modified foods. We need to listen very carefully to that and simply pick up the benefit by celebrating our GE- free status. This has to be the lowest cost best opportunity right in front of our eyes to create value for every Hawke's Bay producer, business and the whole community. We will all benefit from Hawke's Bay being positioned at the top end. We need to secure and promote our regional brand of sustainable, highest quality, GE free produce".

In its submission to the Hastings District Council Long Term Plan, Pure Hawke's Bay argued that keeping Hawke's Bay GE free was a "golden opportunity" for the region. It stated:

"*More than 40% of Hawke's Bay's GDP is tied to the primary and related sectors. The Hastings district is the largest producer of apples, pears and peaches in the country, and second only to Marlborough in grape and wine production…Market resistance to GM food production creates an opportunity for Hastings district and Hawke's Bay to build a regional brand that aligns with consumers and buyers domestically and abroad, and guarantees them that our food products are grown in a GM free region…While the region's food producers would be the primary beneficiaries from declaring the region a GM free food producing region, we believe that there would also be spin-off benefits for the tourism industry, as any such steps cement the region's commitment to environmental integrity… Under the status quo, the region is now open for commercial GM food production as there is nothing to stop a developer applying to field trial or release a GM food or feed crop at any time. Nor is there any mechanism to stop Central Government approving outdoor GM releases when Hawke's Bay councils or food producers oppose such activities."*

There appears to be considerable support in the Hawke's Bay community for keeping food production in the region GE free. According to a Colmar Brunton poll commissioned by Pure Hawke's Bay, 84 per cent of respondents thought Hawke's Bay should remain a GE free food producing region. Ninety per cent believed that retaining that status would be good for the region's reputation as a food producer, 84 per cent that it would give Hawke's Bay food exports a competitive advantage, and 82 per cent that it would have a positive economic impact on Hawke's Bay (the results of the poll, can be accessed on Pure Hawke's Bay website).

Bay of Plenty

Bay of Plenty Regional Council released the Bay of Plenty Proposed Regional Policy Statement (as amended by Council decisions) in August 2012. The policy statement retains the provisions relating to GMOs that were included in the original version released for public submissions in 2010. In Part One (Promoting Sustainable Management of the Bay of Plenty Region) there is a section on adopting a precautionary approach to the release, control and use of GMOs in the region. This is reproduced below:

1.7 Precautionary approach

The ability to manage activities can be hindered by a lack of understanding about environmental processes and the effects of activities. Therefore, an approach which is precautionary but responsive to increased knowledge is required. Although those intending to undertake activities seek certainty about what will be required of them, when there is little information as to the likely effects of those activities, public authorities are obliged to consider such activities on a case-by-case basis. In regional and district plans, such activities should generally be provided for as discretionary or non-complying. Any resource consent granted in such circumstances should be subject to whatever terms and conditions are necessary to avoid significant adverse effects on the environment.

The existence of genetically modified organisms in the environment has generated community concern. Of particular concern is the placement and location of trial and containment facilities. The Bay of Plenty Regional Council promotes a precautionary approach to the release, control and use of genetically modified organisms within the region. The precautionary approach is a necessary response to unresolved issues of potential liability, environmental risks, economic costs, and cultural and social effects. The Hazardous Substances and New Organisms Act 1996 contains specific legislation for managing genetically modified *organisms. These legislative functions are carried out by the Environmental Protection Authority. Current legislation may be inadequate to manage potential adverse effects from the use of genetically modified organisms in the region.*

In Part Three (Policies and Methods), there is a specific policy requiring a precautionary approach to managing natural and physical resources. This is reproduced below:

Policy IR 1B: Applying a precautionary approach to managing natural and physical resources

Apply a precautionary approach to the management of natural and physical resources, where there is scientific uncertainty and/or a threat of serious or irreversible adverse effects on the resource and the built environment. Such activities should be classified as discretionary or non-complying activities in regional and district plans.

Explanation

There is a lack of complete information and understanding about some natural and physical resources, and their use and development. A precautionary approach requires that any adverse effects can be identified and understood and any activity is carried out at a level or rate that adequately considers the risk of operating with imperfect information. Where appropriate, the precautionary approach may include an adaptive management approach.

If there are no successful appeals, these provisions will remain in the Bay of Plenty Regional Policy Statement. The practical effect of them (if any) will only become apparent over time. Without specific rules in regional or district plans they are unlikely to have significant practical effect. However, these provisions do indicate a growing concern amongst local authorities over the risks posed to local and regional communities and businesses from GMO releases to the environment.

4. Conclusions

From the growing international literature on the safety and efficacy of GMOs it is apparent that there are many unresolved risks associated with releasing GMOs into the environment. These include environmental risks, economic risks (including issues over liability), and socio-cultural risks (including the safety of GMO food products). Given New Zealand's dependence on primary produce and tourism to provide overseas exchange and maintain its standard of living, it would be unwise to ignore these risks or fail to give them adequate credence. At the very least, a highly precautionary approach to the release of GMOs to the environment is warranted. An appropriate response would be for Central Government to impose a national moratorium on the release of GMOs to the environment and on field trials posing a significant threat of contamination until the benefits to the nation and to regions from GMO production clearly outweigh the risks.

Failing this, districts and regions in New Zealand that wish to remain GM free must be able, and should be assisted, to do so. Central Government, both the present Government and previous Government, have been asked by the Inter-council Working Party in Northland/Auckland to consider various ways of addressing the risks to local government and its constituents. Both Governments have refused to do so. However, both Governments have stated that local government had jurisdiction to regulate GMOs in the environment through their planning documents under the RMA, if supported by a section 32 analysis.

The Working Party and its constituent councils have resolved to undertake such a task and produce draft unitary/district plan provisions and a section 32 analysis of those provisions. Should the section 32 report support the regulation of GMOs through RMA planning documents, and if member councils on the Working Party resolve to do so, it is important to initiate the statutory process of incorporating provisions in planning documents expediently and preferably jointly. This would ensure a consistent, efficient, and cost effective response to the existing inadequacies in the national legislation for managing GMOs in New Zealand, provide for the level of risk communities in Auckland and Northland have indicated they wish to carry, and allow for the Auckland/Northland region to take full advantage of the economic gains associated with remaining GM free - for primary producers, food manufacturers, exporters, the tourism industry, other businesses, and the community at large.

The collaborative approach to the GE issue undertaken by local authorities in the Northland and Auckland regions has been a cautious yet responsible way to proceed with this highly contentious issue. It is an excellent example of local government working together to address common concerns raised by their respective communities. It has also been a fiscally responsible approach to adopt. By sharing the costs of research and possible regulation amongst all local authorities in the Northland/Auckland region, the cost to individual councils and to ratepayers has been minimised.

The rationale for the collaborative approach was three-fold. Firstly, a collaborative approach would assist in lobbying Central Government to amend the HSNO Act. Secondly, it would lower costs, both for research and for future plan changes if that was the course of action agreed to. Lastly, to ensure regulation by local authorities under the RMA and LGA was most effective it would be best coordinated and implemented on a regional basis. Individual district or city councils could regulate unilaterally on aspects dealing with liability, such as compensation requirements, posting bonds for GMO releases, etc., but would have difficulty enforcing GMO exclusion zones, for example.

On a regional basis, however, there is a realistic possibility of setting in place a comprehensive system of management under the RMA and LGA if that system is agreed to by all (or most) local authorities in the region. Due to its unique geography, the Northland/Auckland region is especially well placed to undertake such a regional approach. Agreement by all (or most) local authorities in the Auckland/Northland region on a common regulatory approach would provide a workable basis for implementation, administration, and enforcement of a robust regional management system for GMO land uses.

Addendum: International Findings on Safety and Efficacy of GMOs

There is a growing international literature assessing the benefits and costs of GMOs in the environment and the safety of genetically engineered food. Hundreds of independently reviewed scientific papers are becoming available and a number of collations of this literature have appeared and are useful for assessing the effects of GMOs in the environment since commercial production began in 1996. The following are a selection of the collations readily available: *Failure to Yield: Evaluating the Performance of Genetically Engineered Crops*, 2009, Union of Concerned Scientists, Cambridge, USA; *Agriculture and Food: Who Benefits from GM Crops*, 2007, Friends of the Earth International, Amsterdam, Netherlands; *The Case for a GM Free Sustainable World*, 2003, Independent Science Panel, Institute of Science in Society, London, UK; *Seeds of Doubt: North American farmers experiences of GM crops,* 2002, Soil Association, Bristol, UK.

One of the latest reports (*GMO Myths and Truths: An evidence-based examination of the claims made for the safety and efficacy of genetically modified crops*, 2012, Antoniou, M., *et al,* Earth Open Source, London, UK) presents a large body of peer reviewed scientific and authoritative evidence on the benefits and risks of GMOs in the environment and in the food chain. The authors of the report are scientists and experts on genetics who believe there are good scientific reasons to be cautious of GMOs in the environment.

The report gives a broad overview of the scientific literature on the benefits and risks of GMOs in the environment in an easy to read format with comprehensive referencing of data sources. This is a useful source of information for local government staff and decision makers and is available on request.

From the growing international literature on the use of GMOs it is possible to discern a number of findings supported by authoritative research on the safety and efficacy of GMOs that have emerged since they were released commercially 16 years ago. A summary, based on the above reports (particularly Antoniou, M. *et al.* 2012) is outlined below. Original sources of data are referenced in the reports listed in the bibliography to this addendum. The present author claims no original contribution to these findings and offers no opinion of his own. He simply reproduces the findings of independent scientists presented by other authors in readily available documents. Rather than provide references in the text below I refer readers to those reports.

1. GMO use in primary production is not widespread. Globally, less than 10 per cent of cultivated land is dedicated to GMO uses. Production is concentrated in just a few countries: 90 per cent in five countries - USA, Argentina, Brazil, India and Canada. The bulk of production outside the Americas is cotton rather than food. Of the crops grown, soy, canola, maize and cotton constitute 99 per cent of production. The food crops are mainly used for animal feed and biofuel production, with some used for cooking oil and in processed food. The bulk of the crops produced are genetically engineered to be herbicide and/or pest resistant.

   Four companies produced almost all of these crops. The US company Monsanto dominates the market: In 2000 they accounted for 91 per cent of the total GM area. Syngenta (formerlyNovartis/AstraZeneca), Aventis CropScience (formerly AgrEvo, now acquired by Bayer) and Dupont account for virtually all the remaining commercial plantings of GM crops. Thus, after 16 years of commercialisation, only four commodity crops have resulted in significant production, all engineered to be herbicide or pest resistant and (apart from cotton) used mainly as animal feed and biofuel production. Despite the claims from the biotech companies, GM crops have not assisted in feeding an increasingly populous world. Farming of feed for animals and crops for biofuel production do not help feed hungry people.

2. No GM crops have increased yield potential (intrinsic yield) and in many cases have decreased it. Few have increased operational yield. The definitive study to date on GM crops and yield is *Failure to Yield,* by Dr Doug Gurian-Sherman, senior scientist at the Union of Concerned Scientists and former biotech adviser to the US Environmental Protection Agency. The study, which is based on peer-reviewed research and official US Department of Agriculture (USDA) data, was the first to tease out the contribution of genetic engineering to yield performance from the gains made through conventional breeding. The study found that GM technology has not raised the intrinsic yield of any crop. The intrinsic yields of corn and soybeans did rise during the twentieth century, but this was not as a result of GM traits, but due to improvements brought about through traditional breeding.

   The study found that GM soybeans did not increase operational yields either. GM soybeans mostly decreased yield. GM maize increased operational yields only slightly, mostly in cases of heavy infestation with European corn borer. Bt maize offered little or no advantage when infestation with European corn borer was low to moderate, even when compared with conventional maize that was not treated with insecticides. The study concluded, “Commercial GE crops have made no inroads so far into raising the intrinsic or potential yield of any crop. By contrast, traditional breeding has been spectacularly successful in this regard; it can be solely credited with the intrinsic yield increases in the United States and other parts of the world that characterized the agriculture of the twentieth century.”

3. No GM crop that has been commercialised is more nutritious than its non-GM counterpart and some are less nutritious. GM proponents have long claimed that genetic engineering will deliver healthier and more nutritious “biofortified” crops. However, no such nutritionally enhanced GM foods are available in the marketplace. In some cases, GM foods have been found to be less nutritious than their non-GM counterparts, due to unexpected effects of the genetic engineering process. Examples include: GM soy had 12–14 per cent lower levels of cancer-fighting isoflavones than non-GM soy. Canola (oilseed rape) engineered to contain vitamin A in its oil had much reduced vitamin E and an altered oil-fat composition, compared with the non-GM control.

   Experimental GM rice varieties had unintended major nutritional disturbances compared with non-GM counterparts. The structure and texture of the GM rice grain was affected and its nutritional content and value were dramatically altered. The variation ranged from 20 to 74 per cent for amino acids, from 19 to 38 per cent for fatty acids, from 25 to 57 per cent for vitamins, from 20 to 50 per cent for nutritionally important trace elements, and 25 per cent for protein. GM rice varieties variously showed markedly decreased levels of vitamin E, protein, and amino acids. The most widely publicised example of a GM nutritionally enhanced food, beta-carotene-enriched ‘Golden Rice’, has not undergone proper toxicological testing and, after more than a decade, is still not ready for the market.

4. GM crops in the main increase pesticide use rather than decrease it. GM crops are claimed by proponents to reduce pesticide use (the term “pesticide” includes herbicides, which technically are pesticides). But this has proved untrue. Herbicide-tolerant crops have been developed by agrochemical firms specifically to depend upon agrochemicals and have extended the market for these chemicals. Far from weaning agriculture away from environmentally damaging chemicals, GM technology has prolonged and extended the use of chemicals. The adoption of GM Roundup Ready crops, especially soy, has caused massive increases in the use of glyphosate worldwide.

   A report by agronomist Dr Charles Benbrook using official US department of Agriculture data looked at the effects on pesticide use during the first thirteen years of GM crop cultivation in the United States, from 1996 to 2008. Crops taken into account were GM herbicide-tolerant and GM Bt maize varieties, GM Roundup Ready soy, and GM herbicide-tolerant and GM Bt cotton varieties. The report found that Bt maize and cotton delivered reductions in chemical insecticide use totalling 64.2 million pounds (29.2 million kg) over the thirteen years – though even the sustainability of this trend is questionable, given the emergence of Bt-resistant pests and the changes in insecticide use patterns. But herbicide-tolerant maize, soy, and cotton caused farmers to spray 383 million more pounds (174 million kg) of herbicides than they would have done in the absence of herbicide-tolerant seeds. This massive increase in herbicide use swamped the modest 64.2 million pound reduction in chemical insecticide use attributed to Bt maize and cotton.

   The report showed that recently, herbicide use on GM fields has veered sharply upward. Crop years 2007 and 2008 accounted for 46 per cent of the increase in herbicide use over thirteen years across the three herbicide-tolerant crops. Herbicide use on GM herbicide-tolerant crops rose 31.4 per cent from 2007 to 2008. The report concluded that farmers applied 318 million more pounds of pesticides as a result of planting GM seeds over the first thirteen years of commercial use. In 2008, GM crop fields required over 26 per cent more pounds of pesticides per acre (1 acre = 0.4 hectares) than fields planted to non-GM varieties.

   The report identified the main cause of the increase in herbicide use as the spread of glyphosate-resistant weeds. The widespread use of Roundup Ready crops has led to over-reliance on a single herbicide – glyphosate, commonly sold as Roundup. This has resulted in the rapid spread of glyphosate-resistant weeds in countries where GM crops are planted. Resistant weeds include pigweed, ryegrass, and marestail. The Herbicide Resistance Action Committee (HRAC), financed by the pesticide industry, lists 21 glyphosate-resistant weeds around the world. In the United States, glyphosate-resistant weeds have been identified in 22 states. When resistant weeds first appear, farmers often use more glyphosate herbicide to try to control them. But as time passes, no amount of glyphosate herbicide is effective and farmers are forced to resort to potentially even more toxic herbicides, such as paraquat, 2,4-D, and mixtures of herbicides.

   This has led to the development of ‘stacked trait GM crops’, crops engineered to be resistant to a number of herbicides. These stacked trait crops enable farmers to spray mixtures of weedkillers. Dow has applied to release a multi-herbicide-tolerant soybean, engineered to tolerate being sprayed with glyphosate, glufosinate, and 2,4-D34 – an ingredient of the defoliant Agent Orange. In 2012 Dow sparked public outrage when it applied to the US Department of Agriculture to commercialise its 2,4-D-tolerant corn. Weed scientists warn that such multi-herbicide-tolerant crops will cause an increase in 2,4-D use, trigger an outbreak of still more intractable weeds resistant to both glyphosate and 2,4-D, and undermine sustainable approaches to weed management.

In regard to insecticide use, even the modest reduction in chemical insecticides attributed to GM Bt crops is proving unsustainable, due to the emergence of pests resistant to Bt toxin and secondary pests. GM Bt insecticidal crops express the Bt toxin in every cell for their entire lifetime, constantly exposing pests to the toxin. Exposing pests to a pesticide for long periods of time inevitably speeds up the emergence of resistant pests, since selective pressure eliminates all but the most resistant pests, which then reproduce and pass on their genes. For this reason, Bt crop technology sometimes enjoys short-term success in controlling pests but is soon undermined by the emergence of pests resistant to the toxin. By 2009, the western corn rootworm had evolved resistance to a Bt maize specifically engineered to target the pest that was first commercialised only six years previously. Bt-resistant rootworm populations have now been reported in several states in the US..

Even when Bt toxin succeeds in controlling a primary pest, secondary pests move into the ecological niche. For instance, in the United States, the Western bean cutworm has increased significantly in Bt maize fields. In China and India, Bt cotton was initially effective in suppressing the target pest, the boll weevil. But secondary pests that are resistant to Bt toxin, especially mirids and mealy bugs, soon took its place. Moreover, mirid bug infestation of other food crops (Chinese dates, grapes, apples, peaches, and pears) increased in proportion to the regional planting area of Bt cotton.

5. GM crops have caused widespread contamination of non-GM farming, both conventional and organic and co-existence is in many instances impossible. The GM industry used to claim that GM contamination of non-GM crops could not occur. After it became clear that this was false, it shifted the argument to lobbying for “co-existence” of GM, non-GM, and organic crops. The industry now argues that farmers should be able to choose to plant GM crops if they wish and says that no serious problems are caused for non-GM and organic farmers. But experience has shown that the arrival of GM crops in a region removes choice for farmers. “Coexistence” rapidly results in widespread contamination of non-GM crops, resulting in lost markets, reduced income, litigation over liability and patent infringements. Contamination occurs through seed contamination, cross-pollination, spread of GM seed by farm machinery, and inadvertent mixing during storage and food production. Farmers are gradually forced to grow GM crops or have their non-GM crops contaminated. GM contamination of crops has had severe economic consequences, threatening the livelihoods of farmers who receive premiums for growing organic and non-GM crops and blocking export markets to countries with strict regulations on GM food products.

Among the new set of problems that GM crops have brought, the arrival of herbicide tolerant (HT) volunteers and ‘superweeds’ emerges as a serious problem for farmers. For example, GM herbicide-tolerant oilseed rape (canola) seed can persist and remain viable in soil for years. GM herbicide resistant “volunteers” – plants that were not deliberately planted but are the result of germination of residual GM seeds from crops previously grown in the field – were found growing ten years after the GM oilseed rape crop had been planted. GM herbicide-resistant oilseed rape was found to be thriving in the wild in North Dakota, often far from areas of agricultural production through seed dispersal, cross pollination, and transport of harvested produce. GM genes were present in 80% of the wild canola plants found. The presence of volunteers requires repeated application of herbicides, often far more toxic weedkillers such as paraquat and 2,4-D. Even so persistent volunteers can still result in contamination of future crops.

There are now GM herbicide tolerant canola varieties which are separately resistant to three different herbicides, being grown commercially in North America. One of the early scares about GM crops was the potential that they might create ‘superweeds’. The fear was that through cross pollination, the trait for herbicide tolerance would either move into populations of related weed plants, making them harder to control, or that through successive generations herbicide tolerance traits from different GM varieties would combine, ‘stacking’ the genes for tolerance to a number of different herbicides in one plant.

The biotechnology industry had repeatedly dismissed such concerns. When asked about superweeds, Monsanto directed enquiries to The Council for Biotechnology Information, a GM industry funded organisation. In February 2001, the council stated that new research findings “dispel fears that biotech plants will become superweeds, either in their own right or by breeding with unmodified plants.” But evidence shows that gene-stacking was already a problem in 1998, two years after GM HT canola was first grown in Canada. In 1999, Agriculture Canada, part of the Department of Agriculture and Agri-food, found gene stacking in all of the 11 locations it investigated where Roundup Ready and Liberty Link crops were growing in adjoining fields. Weed scientists now know that the occurrence of volunteers with ‘stacked’ herbicide tolerant genes is common in the Canadian prairies.

In field trials, University of Idaho researchers have confirmed that multiple resistance develops at a very fast rate. Through field trials they found that canola plants can acquire three herbicide tolerance genes – for glyphosate, glufosinate and the imidazolinones – in just two years. They also identified hybrids of canola and weed species containing two herbicide tolerant transgenes.

6. GM contamination of both conventional and organic primary produce has had serious adverse economic effects on producers, communities, local, regional and national economies. There has been a significant and continuing consumer resistance to GM food products and as a consequence significant market rejection of GM produce, particularly in Europe and Asia. The major food retailers and manufacturers in Europe and Asia have responded by adopting GM free sourcing policies. All of the major UK food retailers have GM free policies for their own brand products. The Co-op, Iceland, Marks and Spencer, Safeway, Sainsbury, Tesco and Waitrose have all made statements confirming this position. They are also considering introducing GM free animal feed policies for their meat and dairy products. Sainsbury, Marks and Spencer (UK), Carrefour (France) and Switzerland's main supermarket chains have either fully eliminated products from animals reared on GM feed, or offer customers a choice.

   Similar market resistance has occurred in Japan and is increasing in China as concerns over food safety increase. There are a growing number of countries with laws in place that impose special labelling or import rules on foods with GM ingredients. In total more than half the world's population is covered by restrictions on the use and sale of GM crops. Most of these countries have adopted GM labelling rules. The EU's labelling rules cover food containing GM material, and there are proposals to extend them to also cover food derived from GMOs and GM animal feed sold to livestock producers. Several countries have banned the import of specific GM varieties; some have imposed total bans on all GMOs.

   The results of this have been dramatic. Within a few years of the introduction of GM crops, almost the entire $300 million annual US maize exports to the EU and the $300 million annual Canadian rape exports to the EU had disappeared. From 1996 to 2001, according to USDA data, the value of US maize exports to the EU dropped 99.4 per cent from US$305 million (2.8 million tonnes) to US$1.8 million (6,300 tonnes). Canadian oilseed rape (canola) suffered a similar fate. Canada was the world's largest exporter of canola. GM canola was introduced in 1996 and just two years later almost the entire C$300-400 million of annual sales to Europe had ceased. In 2009, an unauthorised GM flax called CDC Triffid contaminated Canadian flax seed supplies, resulting in the collapse of Canada's flax export market to Europe. GM contamination of pollen has resulted in the loss of export markets for Canadian honey. Contamination has caused the loss of nearly the whole organic oilseed rape (canola) sector in the province of Saskatchewan, at a potential cost of millions of dollars. Organic maize production in Spain has dropped as the acreage of GM maize production has increased, due to contamination by cross-pollination with GM maize.

   Asian countries have also rejected GM imports. After the StarLink maize incident in 2000, Japan and South Korea, the biggest foreign buyers of US maize, rejected US maize over contamination concerns. US maize exports to Japan dropped 1.3 million tonnes in 2001. China has also become reluctant to accept GM food crops. In 2000, the state of Saskatchewan exported C$123 million of oilseed rape to China, but new regulations requiring proof that GMOs are safe has put this trade in doubt. Animal feed is the main market supporting the remaining trade in GM crops, but even this large outlet is now becoming more difficult. In May 2001, the USDA announced: "Over the last 12 months, demand for certified biotech-free soybean meal has grown from near zero to 20–25 per cent of the EU market according to officials in the compound feed industry." The importing countries have turned elsewhere for GM free supplies. Europe is still importing very large quantities of maize but non-GM producing countries are becoming increasingly sought after.

Organic farmers are struggling practically and economically; many have been unable to sell their produce as organic due to contamination. All non-GM farmers are finding it very hard or impossible to grow GM-free crops. Seeds have become contaminated with GMOs, good non-GM varieties have become hard to buy, and there is a high risk of crop contamination. Because of the lack of segregation, the whole food processing and distribution system has become vulnerable to costly and disruptive contamination incidents. In September 2000, just one per cent of unapproved GM maize contaminated almost half the national maize supply and cost the company, Aventis, up to $1 billion.

In 2000 GM StarLink maize, produced by Aventis (now Bayer CropScience), was found to have contaminated the US maize supply. StarLink had been approved for animal feed but not for human consumption. The discovery led to recalls of StarLink-contaminated food products across the US, spreading to Europe, Japan, Canada, and other countries. Costs to the food industry are estimated to have been around US$1 billion. In addition, the US government bore indirect costs of between US$172 and US$776 million through the USDA's Loan Deficiency Payments Program, which offers producers short-term loans and direct payments if the price of a commodity crop falls below the loan rate. Aventis paid out US$110 million to farmers who brought a class action suit against the company and spent another US$110 million buying back StarLink-contaminated maize.

In 2006, an unapproved experimental GM rice, grown only for one year in experimental plots, was found to have contaminated the US rice supply and seed stocks. Contaminated rice was found as far away as Africa, Europe, and Central America. In 2007 US rice exports were down 20 per cent from the previous year as a result of the GM contamination. In 2011 the company that developed the GM rice, Bayer, agreed to pay US$750 million to settle lawsuits brought by 11,000 US farmers whose rice crops were contaminated. A court ordered Bayer to pay US$137 million in damages to Riceland, a rice export company, for loss of sales to the EU. In 2011 an unauthorized GM Bt pesticidall rice, Bt63, was found in baby formula and rice noodles on sale in China. Contaminated rice products were also found in Germany and Sweden. The same rice was found in rice products in New Zealand in 2008, leading to product recalls. GM Bt rice has not been shown to be safe for human consumption. Periodic recalls of products contaminated with Bt63 rice continue to be reported even today in Europe.

Across the North American prairies, wheat is the most important crop. Nearly 70 per cent of Canadian wheat and more than 50 per cent of US wheat is exported. It would be devastating if the wheat industry were to suffer similar losses as the maize and oilseed rape sectors. If some of the wheat crop was GM, it would be extremely difficult for the industry to manage adequate segregation before and after harvest. For organic farmers, wheat is a major crop and essential for organic crop rotations. Losing wheat to GM contamination could signal the collapse of North American organic farming. It seems that the market will not accept contaminated or GM wheat. According to Canadian Wheat Board estimates, two-thirds of international buyers do not want to buy genetically modified wheat. A survey of the US customer base for hard spring wheat indicated that 65 per cent are opposed to GM wheat. According to the American Corn Growers Association, European millers have described GM wheat as a 'market destructor' for the US. Agricultural economist Hartley Furtan has made an assessment of the likely impacts of growing GM wheat. He concluded that while there might be a small direct economic benefit, this would be swamped by the loss of premiums, costs of testing and segregation and having to rely on lower market prices.

The North American farming community is now strongly opposing the planned introduction of GM wheat More than 200 Canadian groups, including the National Farmers Union, Wheat Board and organic farming bodies are seeking a halt to the approval of GM wheat. In the US, the National Farming Union supports a moratorium on GM wheat and legislation banning GM wheat has been sought in some states. GM wheat has not yet been approved for commercial production and Monsanto has now pushed back its planned introduction of GM wheat, although it still advocates for its release.

7. GM contamination has resulted in widespread litigation and ill feeling amongst the farming community. Farmers have been particularly badly affected, financially and emotionally. The extensive contamination of non-GM primary producers (both conventional and organic) has led to on-going litigation affecting all levels of the industry - farmers, seed suppliers, manufacturers, exporters, retailers, consumers, and the major biotech companies over liability and compensation for loss of income, loss of markets premiums, and patent infringements. The legal issues include problems connected with alleged patent infringement, with Monsanto demanding money from farmers for the presence of unlicensed GM plants found on their land. It also includes lawsuits following the loss of farmers' sales and concerns over farmers' exposure to liability risks following from contamination.

   A legal quagmire for farmers has developed over patent infringement. If a farmer grows a GM crop without paying a technology fee to the biotechnology company that developed and patented it, they can be accused of stealing the intellectual property of that company. The farmer is infringing the company's patent. On the same grounds, farmers growing GM crops are prohibited, by the technology agreements they sign with the companies, from saving GM seed from the harvest for the following year. They have to buy new seed each year. No doubt some farmers have saved GM seed illegally; saving seed has been a traditional practice in farming for a long time. However, farmers have been successfully sued and forced to make payments to biotech companies for patent infringement resulting from contamination of their crops from neighbouring properties, or contaminated seed, or volunteers from previous plantings. For example, Percy Schmeister, a Canadian farmer was successfully sued by Monsanto in 1998 for patent infringement for growing GM canola without a licence even though the GM canola in his crops was the result of contamination from a neighbouring property. The court ruled this irrelevant and ruled in favour of Monsanto. The cost to the farmer was $600,000 which included direct costs to Monsanto and legal costs.

   The Schmeiser case raises serious problems for farmers. If the way the seed arrives is deemed immaterial, then farmers in North America can be held accountable for the air or insect-borne transfer of patented varieties. Though they are not intentionally growing the GM crop, they can still be held responsible for GM plants appearing on their land. A non-GM farmer has few means of preventing contamination if he is in a GM growing area. The strategies that he could employ to mitigate the risk, such as planting hedges and changing his rotation, are not foolproof and would be at a cost to him. Indeed, the affected farmers feel that they are the injured party if their land has been contaminated, particularly if they are trying to supply the GM free or organic markets or control GM volunteers. Contamination has very serious implications, for farmers growing GM crops and those trying to avoid them. Two examples illustrate the complexity of the legal disputes over contamination from GMOs.

The Saskatchewan Organic Directorate (SOD) is one of Canada's leading organic sector groups. On 10 January 2002 two SOD members, Larry Hoffman and Dale Beaudoin, launched a class action against Monsanto and Aventis on behalf of all certified organic grain farmers in Saskatchewan. They were seeking compensation for damages for financial loss from the destruction of the province's organic rape market that resulted from the spread of GM canola into organic varieties. They were also seeking an injunction to prevent Monsanto from introducing GM wheat into the state. Also on the table was the possibility of including the federal government in the suit because of its role in allowing the introduction of transgenic crops. Their claim alleged that GM canola has "spread across the prairies and contaminated conventional crops so extensively that most certified organic grain farmers no longer attempt to grow canola." It went on to say "when Monsanto and Aventis introduced their GE canolas they knew, or ought to have known, that the genetically engineered canola would spread and contaminate the environment. The companies had no regard for the damage these crops would cause to organic agriculture. The claim alleged that the loss of canola as an organic crop had robbed organic farmers of a high paying and growing market." The suit sought to hold Monsanto and Aventis responsible for the economic damages of GM contamination on multiple grounds including negligence, nuisance, trespass, pollution and failure to conduct an environmental assessment.

The legal fall out from the StarLink contamination crisis in September 2000 has affected farmers, the food industry, consumers and Aventis, the biotechnology company which developed the maize. By November 2001, nine class actions had been filed against Aventis, as individuals and companies tried to recover millions of dollars in losses and costs. Farmers in Wisconsin who lost money due to the fall in maize prices following the crisis filed a class action (Southview Farms vs Aventis). In another class action (Mulholland vs Aventis), farmers sued for the domestic and foreign markets that they claim were lost because Aventis failed to prevent StarLink maize from entering the food supply. They alleged public nuisance, consumer fraud, deceptive business practices, and negligence. Consumers brought a class action against Aventis and several food companies, based on the allergic reactions that have been suffered by consuming contaminated food products. In an initial settlement the companies agreed to pay $9 million. Companies involved in the lawsuit included Kraft Foods, Azteca Foods and AstraZeneca affiliate Garst Seed. Thousands of Taco Bell restaurant franchises and other Mexican food companies filed another class action against Aventis. They claimed that the discovery of StarLink in their products resulted in the company becoming the "Poster child for concerns about GMOs."

However, liability was unclear in the StarLink case and farmers could have found themselves held liable for damages. Aventis had meant to get farmers to sign a grower agreement requiring them to plant 660 foot buffer strips of non-StarLink maize around the fields and explaining that the maize was not approved for human consumption. However, many farmers claim that they were unaware of a marketing restriction and many agreements were not signed before planting. Also, StarLink maize was in many cases planted directly next to a neighbour's non-StarLink maize. Many of these then tested positive for the StarLink Cry9C protein. Just one per cent of the national corn harvest contaminated almost half the total US maize supply, which led to some difficult legal questions. Who is liable for contaminated maize 'infecting' entire shipments of maize? Who is liable for the contamination not being picked up until the maize had been processed into a wide range of products? Who is liable for StarLink crops contaminating neighbouring crops of non-StarLink maize?

8. GMOs have adverse effects on the environment including biodiversity. A number of studies have shown that GMOs have had detrimental effects on the environment. GM proponents claim that Bt crops only affect target pests and their close relatives. Regulators have uncritically accepted this claim and allowed the commercialisation of Bt crops with a minimum of oversight. But research studies show that this assumption is false. Mycorrhizal fungi benefit plants by colonising their roots, helping them take up nutrients, resist disease, and tolerate drought. A study comparing Bt and non-Bt maize found a lower level of mycorrhizal colonisation in the roots of Bt maize plants. Residues of Bt maize plants, ploughed under at harvest and kept mixed with soil for up to four months, suppressed soil respiration (carbon dioxide production), markedly altered bacterial communities, and reduced mycorrhizal colonisation. A separate field study on Bt

maize residues ploughed into soil after harvest confirmed that Bt toxin resisted breakdown and persisted in soil for months.

GM Bt insecticide producing crops have been found to have toxic effects on non-target insect populations, including butterflies, and beneficial pest predators such as ladybirds and lacewings. Bt crops have more negative than positive impacts on beneficial insects. Bt toxin impacts bee learning behaviour, interfering with bees' ability to find nectar sources for food. A study conducted in Indiana, USA found that Bt insecticide released from GM Bt maize was polluting 25 per cent of streams tested. Other studies have found that GM Bt maize biomass is toxic to aquatic and soil organisms. Water fleas (an organism often used as an indicator of environmental toxicity) fed GM Bt maize showed toxic effects including reduced fitness, higher mortality, and impaired reproduction.

Long-term exposure to pollen from GM maize that expresses the Bacillus thuringiensis (Bt) toxin has been found to cause adverse effects on the behaviour and survival of the monarch butterfly, the best-known of all North American butterflies. Effects on European butterflies are virtually unknown, as few studies have been conducted. Those few do, however, suggest cause for concern that European butterflies would suffer as a result of insect resistant GM crop being planted.

Manufacturers claim that Roundup, the glyphosate-based herbicide used on most GM crops, breaks down quickly and harmlessly in the environment. But research shows that this is untrue: In soil, glyphosate has a half-life (the length of time taken to lose half its biological activity) of between 3 and 215 days, depending on soil conditions. In water, glyphosate's half-life is 35–63 days. Glyphosate is toxic to earthworms and reduces bird populations due to habitat changes. Roundup is highly toxic to amphibians. A study in a natural setting found that Roundup application at the rate recommended by the manufacturer eliminated two species of tadpoles and nearly exterminated a third species, resulting in a 70 per cent decline in the species richness of tadpoles. Contrary to common belief, the presence of soil does not reduce the chemical's effects. Further experiments with lower concentrations, well within levels to be expected in the environment, still caused 40 per cent amphibian mortality.

A laboratory study in Germany showed that GM Bt toxins increased the mortality of ladybird larvae that fed on it, even at the lowest concentrations tested. The study showed that claims that Bt toxins are only harmful to a limited number of insect pests and their close relatives are shown to be false. Bt toxins were found to harm non-target organisms – ladybirds – that are highly beneficial to farmers. Ladybirds devour pests such as aphids and disease-causing fungi. Based on this study, and over 30 others, Germany banned the cultivation of Monsanto's Bt maize MON810, which contains one of the harmful toxins.

In 2007 Emma Rosi-Marshall's team published research showing that Bt maize material got into streams in the American Midwest and that when fed to non-target insects, it had harmful effects. In a laboratory feeding study, the researchers fed Bt maize material to the larvae of the caddis fly, an insect that lives near streams. The larvae that fed on the Bt maize debris grew half as fast as those that ate debris from non-GM maize. And caddis flies fed high concentrations of Bt maize pollen died at more than twice the rate of caddis flies fed non-Bt pollen.

In the early 2000s, the UK government conducted three-year farm-scale trials to examine the impacts of GM herbicide-tolerant crops (maize, sugar beet and canola) on farmland biodiversity. The trials looked at whether GM crops would reduce weed levels and have wider impacts on farmland biodiversity. The findings showed that the cultivation of GM herbicide-resistant crops reduces wildlife populations and damages biodiversity, due to the effects of the broad-spectrum herbicides applied to them. There were 24 per cent fewer butterflies in the margins of GM oil-seed rape (canola) fields, because there were fewer weed flowers (and hence nectar) for them to feed on. In addition, there were fewer seeds for birds from oil-seed rape and sugar beet. Many farmland birds rely on seeds from weeds for their survival and the trials showed that GM beet and GM canola reduced seed numbers by up to 80 per cent compared with conventional beet and canola.

There have been relatively few in-depth studies on the environmental effects of introducing GMOs into the environment and studies on ecological effects are not required in most countries prior to approving GMOs for release. Given the complexity of ecosystems and the irreversible nature of most GMO releases this is a serious deficiency in the regulatory regime and science associated with genetic engineering. This lack of scientific research needs to be urgently addressed before the long term ecological sustainability of GMOs can be properly assessed.

9. GM food crops have not been proven safe to eat, nor are they required to be tested for safety prior to being released on to the market. Nor are they strictly regulated for safety. Many studies have raised

concerns as to their safety yet there have been no long term studies on the safety of GM foods for human consumption (or for animal consumption).

GM foods were first commercialised in the US in the mid 1990s. The US food regulator, the Food and Drug Administration (FDA), allowed the first GM foods onto world markets in spite of its own scientists' warnings that genetic engineering is different from conventional breeding and poses special risks, including the production of new toxins or allergens. Government scientists in Canada issued similar warnings. In a review in 2001, the Royal Society of Canada called the approval regime for GMOs "scientifically unjustifiable". The FDA overruled its scientists in line with a US government decision to "foster" the growth of the GM industry. The FDA formed a policy for GM foods that did not require any safety tests or labelling. Contrary to popular belief, the FDA does not have a mandatory GM food safety assessment process and has never approved a GM food as safe. It does not carry out or commission safety tests on GM foods. Instead, the FDA operates a *voluntary* programme for pre-market review of GM foods. All GM food crops commercialised to date have gone through this review process, but there is no legal requirement for them to do so.

The outcome of the FDA's voluntary assessment is not a conclusion, underwritten by the FDA, that the GMO is safe. Instead, the FDA sends the company a letter to the effect that: the FDA acknowledges that the company has provided a summary of research that it has conducted assessing the GM crop's safety; the FDA states that, based on the results of the research done by the company, the company has concluded that the GMO is safe; the FDA reminds the company that it is responsible for placing only safe foods in the market; the FDA reminds the company that, if a product is found to be unsafe, the company may be held liable. Clearly, this process does not guarantee – or even attempt to investigate – the safety of GM foods.

The US FDA's approach to assessing the safety of GM crops and foods is based on the concept of "substantial equivalence". The European approval regime applies the same concept but terms it "comparative safety assessment". Substantial equivalence assumes that if a GMO contains similar amounts of a few basic components such as protein, fat, and carbohydrate as its non-GM counterpart, then the GMO is substantially equivalent to the non-GMO and no compulsory safety testing is required. Claims of substantial equivalence for GM foods are widely criticized as unscientific by independent researchers. When claims of substantial equivalence have been independently tested, they have been found to be untrue. Using the latest molecular analytical methods, GM crops have been shown to have a different composition to their non-GM counterparts. This is true even when the two crops are grown under the same conditions, at the same time and in the same location – meaning that the changes are not due to different environmental factors but to the genetic modification.

Many governments, including those of the EU, Japan, Australia, and New Zealand, have an agency that assesses the safety of GM crops. Based on its assessment, the agency recommends approval or rejection of the crop for use in food or animal feed. The final decision is made by the government. In Europe, the relevant agency is the European Food Safety Authority (EFSA). Typically the EU member states fail to agree on whether to approve a GM crop, with most voting not to approve it, but the vote does not achieve the "qualified majority" required to reject the GMO. The decision passes to the European Commission, which ignores the desires of the simple majority of the member states and approves the GMO. Worldwide, safety assessments of GMOs by government regulatory agencies are not scientifically rigorous. As in the US, they do not carry out or commission their own tests on the GM crop. Instead, they make decisions regarding the safety of the GMO based on studies commissioned by the very same companies that stand to profit from the crop's approval.

Another problem is the frequently unpublished status of the studies that companies submit to regulatory agencies. The fact that they are not published means that they are not readily available for scrutiny by the public or independent scientists. The lack of availability of industry studies in the past has resulted in the public being deceived over the safety of GMOs. For example, the biotech industry's raw data on Monsanto's GM Bt maize variety MON863 (approved in the EU in 2005) were only forced into the open through court action by Greenpeace. Then independent scientists at the France-based research organisation CRIIGEN analysed the raw data and found that Monsanto's own feeding trial on rats revealed serious health effects – including liver and kidney toxicity – that had been hidden from the public. The CRIIGEN study showed that rats fed GM maize had reduced growth and produced signs of liver and kidney toxicity, and concluded that it could not be assumed that the maize was safe for human consumption.

Other peer reviewed studies by independent scientists have found harmful effects on the health of laboratory and livestock animals fed GMOs. Effects include toxic and allergenic effects and altered nutritional value. A few of them cited in *GMO Myths and Truths 2012* are presented below. Many more are available in that report and other publications.

A review of 19 studies (including the biotech industry's own studies submitted to regulators in support of applications to commercialise GM crops) on mammals fed with commercialised GM soy and maize that are already in our food and feed chain found consistent toxic effects on the liver and kidneys. Such effects may be markers of the onset of chronic disease, but long-term studies, in contrast to these reported short- and medium-term studies, would be required to assess this more thoroughly. Such long-term feeding trials on GMOs are not required by regulators anywhere in the world.

Internationally renowned scientist Dr Arpad Pusztai found that GM potatoes had harmed the health of laboratory rats. Rats fed GM potatoes showed excessive growth of the lining of the gut similar to a pre-cancerous condition and toxic reactions in multiple organ systems. Mice fed a diet of GM Bt potatoes or non-GM potatoes spiked with natural Bt toxin protein isolated from bacteria showed abnormalities in the cells and structures of the small intestine, compared with a control group of mice fed non-GM potatoes. The abnormalities were more marked in the Bt toxin-fed group. This study shows not only that the GM Bt potatoes caused mild damage to the intestines but also that Bt toxin protein is not harmlessly broken down in digestion, as GM proponents claim, but survives in a functionally active form in the small intestine and can cause damage to that organ.

Rats fed GM rice for 90 days had a higher water intake as compared with the control group fed the non-GM isogenic line of rice. The GM fed rats showed differences in blood biochemistry, immune response, and gut bacteria. Organ weights of female rats fed GM rice were different from those fed non-GM rice. The authors claimed that none of the differences were "adverse", but they did not define what they mean by "adverse". Even if they had defined it, the only way to know if such changes are adverse is to extend the length of the study, which was not done. The authors conceded that the study "did not enable us to conclude on the safety of the GM food". In another study rats fed GM Bt rice developed significant differences as compared with rats fed the non-GM isogenic line of rice. These included differences in the populations of gut bacteria – the GM-fed group had 23% higher levels of coliform bacteria. There were differences in organ weights between the two groups, namely in the adrenals, testis and uterus. The authors concluded that the findings were most likely due to "unintended changes introduced in the GM rice and not from toxicity of Bt toxin" in its natural, non-GM form.

Mice fed GM peas (not subsequently commercialized) engineered with an insecticidal protein (alpha-amylase inhibitor) from beans showed a strong, sustained immune reaction against the GM protein. Mice developed antibodies against the GM protein and an allergic-type inflammation response (delayed hypersensitivity reaction). Also, the mice fed on GM peas developed an immune reaction to chicken egg white protein. The mice did not show immune or allergic-type inflammation reactions to either non-GM beans naturally containing the insecticide protein, to egg white protein fed with the natural protein from the beans, or to egg white protein fed on its own. The findings showed that the GM insecticidal protein acted as a sensitizer, making the mice susceptible to developing immune reactions and allergies to normally non-allergenic foods. This is called immunological cross-priming. The fact that beans naturally containing the insecticidal protein did not cause the effects seen with the peas that expressed the transgenic insecticidal protein indicated that the immune responses of the mice to the GM peas were caused by changes in the peas brought about by the genetic engineering process. In other words, the insecticidal protein was changed by the GM process so that it behaved differently in the GM peas compared with its natural form in the non-GM beans – and the altered protein from the GM peas stimulated a potent immune response in the mice.

Rats fed insecticide-producing MON863 Bt maize grew more slowly and showed higher levels of certain fats (triglycerides) in their blood than rats fed the control diet. They also suffered problems with liver and kidney function. The authors stated that it could not be concluded that MON863 maize is safe and that long-term studies were needed to investigate the consequences of these effects. Female rats fed GM soy showed changes in uterus and ovaries compared with controls fed organic non-GM soy or a non-soy diet. Certain ill effects were found with organic soy as well as GM soy, showing the need for further investigation into the effects of soy-based diets (GM and non-GM) on reproductive health.

The main use of the GM crops which have been commercialised so far is for animal feed. Maize, canola and soya are basic components of the intensive meat production industry, so the effect on livestock of these crops is very important. However no, or almost no, animal feeding trials with pigs, cattle or other livestock were carried out before the crops went into commercial production. The GM industry and government regulators claim that meat, eggs, and dairy products from GM fed animals do not need to carry a GM label because GM molecules – DNA and protein – are broken down in the animals' digestive tracts and are not detectable in the final food product. But this assumption is false.

GM DNA present in animal feed has been detected in milk sold on the Italian market, though the authors of the study said it was unclear whether the source of the GM DNA was ingestion by the animal or external contamination. Other studies show that GM DNA in feed was taken up by the animal's organs and detected in the meat and fish that people eat. In another, GM feed was found to affect the health of animals that ate it. GM DNA from soy was detected in the blood, organs, and milk of goats. An enzyme, lactic dehydrogenate, was found at significantly raised levels in the heart, muscle, and kidneys of young goats fed GM soy. This enzyme leaks from damaged cells during immune reactions or injury, so high levels may indicate such problems.

GM foods are not tested on humans before they are released for sale. The only published studies that have directly tested the safety of GM foods for human consumption found potential problems but were not followed up. In a study on human volunteers fed a single GM soybean meal, GM DNA survived processing and was detected in the digestive tract. There was evidence of horizontal gene transfer to gut bacteria. Horizontal gene transfer is a process by which DNA is transferred from one organism to another through mechanisms other than reproductive mechanisms. In a study on humans, one of the experimental subjects showed an immune response to GM soy but not to non-GM soy. GM soy was found to contain a protein that was different from the protein in non-GM soy. This shows that GM foods could cause new allergies.

A study conducted in Canada detected significant levels of the insecticidal protein, Cry1Ab, which is present in GM Bt crops, circulating in the blood of pregnant women and in the blood supply of their foetuses, as well as in the blood of non-pregnant women. How the Bt toxin protein got into the blood (whether through food or another exposure route) is unclear and the detection method used has been disputed by defenders of GM crops. Nevertheless, this study raises questions as to why GM Bt crops are being commercialised widely, when existing research raises serious concerns about their safety and yet no systematic effort is under way to replicate and thereby assess the validity of that research. Independent scientists argue that these studies should be followed up with controlled long-term studies and GM foods and crops should not be commercialised in the absence of such testing.

GM proponents claim that people have been eating GM foods in the United States for 16 years without ill effects. But this is an anecdotal, scientifically untenable assertion, as no epidemiological studies to look at GM food effects on the general population have ever been conducted. Furthermore, there are signs that all is not well with the US food supply. Reports show that food-related illnesses increased two- to ten-fold in the years between 1994 (just before GM food was commercialised) and 1999. No one knows if there is a link with GM foods because they are not labelled in the US and consumers are not monitored for health effects. Moderate or slow-onset health effects of GM foods could take decades to become apparent through epidemiological studies, just as it took decades for the damaging effects of trans fats (another type of artificial food) to be recognised. To detect important but subtle effects on health, or effects that take time to appear (chronic effects), long-term controlled studies on large populations would be needed.

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