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**From:** Denise Snyder [mailto:scott101@hawaii.rr.com]**Sent:** Monday, April 23, 2012 2:46 PM**Subject:** Testimony in SUPPORT of Resolution 12-57, to be heard at Kapolei Hale on April 25, 2012

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CITY CLERK  
HONOLULU, HAWAII**Chair and Councilmembers,**

**Please support Resolution 12-57. We need our government to require labeling of genetically modified food.**

**GMO food is labeled in 50 countries and over forty percent of the world's population has GMO food labeling. But those of us living in the United States of America, the world's richest and most powerful nation, are told by the GMO seed industry that it is too costly to label GMO food here.**

The consumer has received no direct benefit from GMO food – it is not more nutritious or flavorful.

**Only two forms of genetically engineered plants are being commercially grown, those that enable plants to be sprayed with huge quantities of toxic poison or those that produce poison (the latter are regulated by the EPA as a pesticide). Some plants have both traits ('stacked'). Biotech companies sell the seed and herbicide as a package deal, and **US farmers use hundreds of millions of pounds more toxic herbicide because of these types of GE (genetically engineered) crops.** These chemicals pollute our water, land, air and bodies.**

**FDA (U.S. Food and Drug Administration) scientists recommended against the release of GE food into our food supply. Scientific consensus at the FDA was that GE foods were inherently dangerous and might create hard-to-detect allergies, poisons, new "super" diseases, and nutritional problems. They urged their superiors at the FDA to require rigorous long-term tests. However, politics trumped science and GE seeds were allowed, with no labeling.**

**There were no human trials before GE foods were released into the U.S. food system. After the public rejected the first GE tomato, Flavr Savr, all future GE food releases were done without any labeling or notice (beginning around 1996). **Every effort was made to keep the U.S. public unaware that we had, without our knowledge, become participants in unsupervised and undocumented food testing trials.****

**The AAEM (American Academy of Environmental Medicine) position paper, reflects, based on established scientific criteria, 'there is causation' between GE foods and 'adverse health effects.'**

Animal studies that have been done reveal problems. **GE food is linked to the increase in chronic health problems. Genes inserted into GE crops can transfer into the DNA of bacteria living inside our intestines and continue to function.** Several years ago, GE tryptophan sickened hundreds and caused the deaths of dozens of people in the U.S. and our federal government covered up the fact that the tryptophan was genetically modified.

**GE crops were widely introduced in 1996. Within nine years, the incidence of people in the US with three or more chronic diseases nearly doubled—from 7% to 13%. Visits to the emergency room due to allergies doubled from 1997 to 2002. And overall food related illnesses doubled from 1994 to 2001, according to the Centers for Disease Control.**

**Open-air field trials and other practices of the GMO seed industry have resulted in horrific contamination of our food supply BEFORE approval of their seed:** flax seed in Canada, rice in California, and corn on the mainland to name just a few instances of their reckless disregard for the rights of others. It would be interesting to know how the GMO industry explains these incidents (and others) given all their alleged regulation and safeguards.

**Please read the attached documents that give additional health and scientific information, including scientific evidence from 114 research studies and other authoritative papers documenting some of the limitations and risks of GM crops.**

**Given the facts, I am asking you to please support Resolution 12-57.**

Thank you,  
Denise Snyder  
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## **GMO Industry Arguments and Fact-based Rebuttals**

### **Argument 1: GMO mutations are “natural”**

- Have been going on since “time began”, i.e. crossing different varieties in the same plant families

#### ***Rebuttal 1.1: There is nothing natural about it.***

- Forcing gene families to cross when they never would in nature is not “natural” in the sense of naturally occurring**

#### ***Rebuttal 1.2: Even if GMO mutations were a natural process, “natural” does not make something safe***

- Hepatitis B is natural, would you like to die from that?
- Water is natural, would you like to drown?
- Safety or non-safety is not intrinsic to being natural

### **Argument 2: GMO’s are safe for human consumption**

- They claim GMO’s are safe because: “We have seen nothing after over a trillion meals” & “We saw nothing compared to a control group”

#### ***Rebuttal 2: There has not been enough time or proper control groups to adequately claim that GMO’s are safe for human consumption.***

There are 3 categories of time for effects to be revealed:

- o Acute, within 2 weeks
- o Subacute, within 6 months
- o long term, 6 months plus
- 

It took millions of cigarettes smoked before we recognized cancer and another 20 years to prove that 2nd hand smoke is hazardous to health.

- To track long term effects requires long term testing which is dependent on having control groups**

- No long term studies have been created in the lab, and with no labeling, no long term studies can be done in the populace**

- It is inaccurate to say there has been no effect because there has been no way to track the increase of incidents**

- o Chronic health conditions like diabetes, obesity, and heart disease are on the rise according to the CDS which reports that one in two Americans now have such conditions, and that seven of every 10 deaths in the US can be attributed to them.

- o According to a 2010 study in the Journal of the American Medical Association (summarized here), the rate of chronic conditions among US children jumped from 12.8 percent in 1994 to 26.6 percent in 2006, with asthma, obesity, and behavior/learning disorders leading the way.

(<http://motherjones.com/tom-philpott/2011/09/gmos-safe-eat>)

- Also, claiming “we have seen nothing” suggesting perfect health is misleading and inaccurate, because even within a control group no one has perfect health.

### **Argument 3: The method of GMO production is safe**

- “We haven’t seen a problem so far, so there must not be a problem with the genetic modification process.”

**Rebuttal 3: Genetic Modification is the method. Genetic modification as a method produces a wide range of inconsistent results even within the same crop type, and each mutation is its own unique life form.**

- Each genetically modification within a single crop type is a unique mutation and therefore must be tested on a case by case basis
- Suggesting that because problems have not been tracked in one GM crop type, i.e. corn, that it will not be found in another type of GM crop, i.e. alfalfa, is misleading
- **Every genetic modification even within a single crop type is a unique creation with a unique set of unknown potential hazards**

**Argument 4: GMO's are safe because "we have done animal studies."**

**Rebuttal 4.1: Published industry short term animal studies (90 days or less) suggest safety, but independent studies do not support the safety of industry's animal studies.**

**Rebuttal 4.2: Testing for safety is not even possible because the product is not consistent enough to be tested. (see rebuttal 3)**

**Argument 5: "Customers have the freedom of choice to not plant GMO's"**

**Rebuttal 5: Your rights end when they infringe upon my rights. The freedom of choice is not the freedom to contaminate**

**Argument 6: "Co-existence is possible between GMO and non-GMO crops"**

**Rebuttal 6: These GMO crops cannot grow side by side and not have crossover, it is the nature of the system to cross pollinate.**

□ In April 2011, a jury in the US has awarded Riceland Foods Inc. US\$ 136.8 million after court action over the 2006 contamination of **long grain rice stocks** in the USA with **Bayer's unapproved experimental GM rice LL601**, GM Freeze reports. This award follows several others in courts in the USA where the German-based ag-biotech company has repeatedly been found negligent for allowing a GM long grain rice strain, which had not received any safety approvals anywhere, to **contaminate supplies, forcing recalls and halting exports** for several years. The GM rice *had only been grown on experimental plots in the USA between 1998 and 2001, yet its presence was detected in imported rice in at least 24 countries.* [http://www.organic-market.info/web/News\\_in\\_brief/Genetic\\_Engineering/USA/176/188/0/9897.html](http://www.organic-market.info/web/News_in_brief/Genetic_Engineering/USA/176/188/0/9897.html)

- Co-existence is not possible

**Argument 7: "Regulatory agencies say GMO products are OK"**

**Rebuttal 7.1: Regulatory agencies are in fact saying that there are harmful aspects of GMO's:**

- **Horizontal gene transfer** (previously denied)
- **Development of need for increased use of herbicide known to cause birth defects**
  - The agency's vast environmental impact statement for GMO alfalfa (PDF)—was blunt on two points: 1) **"gene flow" between GM and non-GM alfalfa is "probable,"** and threatens organic dairy producers and other users of non-GMO alfalfa; and 2) there is strong potential for the creation of Roundup-resistant "superweeds" that require ever-higher doses of Roundup and application of ever-more toxic herbicides. The report noted that **2 million acres of US farmland already harbor Roundup-resistant weeds caused by other Roundup Ready crops.** (<http://motherjones.com/tom-philpott/2011/07/welcome-age-gmo-industry-self-regulation>)
  - **Horizontal gene transfer** is the transfer of DNA between two organisms; for example, **eating GMO corn and the resistant engineered genes transferring to humans through saliva and the gut**
  - **By transferring this DNA, there is a high probability that the engineered aspects of resistance will be transferred to the host, resulting in unintended consequences, such as resistance to antibiotics**

**Argument 8: “We’ve been doing GMO’s for 16 years, and there haven’t been any new health developments.”**

***Rebuttal 8: There are large trends of increasing disease incidents.***

□ See argument 3 for health statistics.

**Argument 9: “We already have been chemically altering our food with radiation, and there hasn’t been a problem.”**

***Rebuttal 9.1: Irradiating foods was approved by the FDA based on 7 studies which were subsequently discredited. Additionally:***

□ A compilation of 12 studies carried out in 1984 for the US government examined feeding irradiated chicken to several different animal species. The studies indicated the possibility of chromosome damage, immunotoxicity, greater incidence of kidney disease, and heart attacks.

□ Studies of rats fed irradiated food also indicate possible kidney and testicular tumors

□ One landmark study in India found 4 out of 5 children fed irradiated wheat developed polyploidy, a chromosomal abnormality that is a good indication of future cancer development (source: <http://www.sustainable-city.org/articles/irradiat.htm>)

***Rebuttal 9.2: Irradiation is a different technology to genetic modification with different potential unintended consequences.***

□ Radiating the food mutates the genome through deleting chromosomal information, whereas GMO’s insert genes and markers from completely different species

□ Examples of why food is radiated include stopping fruit from ripening, food from sprouting such as potatoes, and killing some forms of microorganisms

□ To compare irradiating food to creating a new life form through combining genes from two different species is misleading

**Argument 10: “GMO’s are saving industry through technology.”**

***Rebuttal 10: GMO’s may save a crop from one particular threat in the short term, but it is highly likely to not work in the long term and makes it very vulnerable to other threats***

□ The beauty and functionality of the immune system is its flexibility. It will turn on a functionality when it is needed, and turn it off if not

□ When GMO’s are modified to produce a certain response against a specific pathogen, this response is permanently turned on. “Always on” means that the immune system is going in one direction, which makes it difficult if not unable to respond to what needs to happen when other pathogens attack

□ Pathogens adapt – today’s fix may not work tomorrow.

**Argument 11: “The precautionary principle unnecessarily undermines industry’s ability to be competitive.”**

***Rebuttal 11: This principle allows policy makers to make discretionary decisions in situations where there is the possibility of harm from taking a particular course or making a certain decision when extensive scientific knowledge on the matter is lacking. The principle implies that there is a social responsibility to protect the public from exposure to harm, when scientific investigation has found a plausible risk. These protections can be relaxed only if further scientific findings emerge that provide sound evidence that no harm will result.***

□ GMO’s have been put on the market with little to no testing, with no long term tests of over 90 days and significant reason to believe there are hazards to health, environment, and industry

□ Elevating economic interests over the health of the country is irresponsible both to individual consumers and the economy as a whole

□ **GMO’s** are a classic example of when the precautionary principle should have been used and was not. **But we don’t have to continue to make the same mistake with further GM varieties.**

# GM CROPS – JUST THE SCIENCE

## research documenting the limitations, risks, and alternatives

Proponents claim that genetically modified (GM) crops:

- are safe to eat and more nutritious
- benefit the environment
- reduce use of herbicides and insecticides
- increase crop yields, thereby helping farmers and solving the food crisis
- create a more affluent, stable economy
- are just an extension of natural breeding, and have no risks different from naturally bred crops.

However, a large and growing body of scientific research and on-the-ground experience indicate that GMOs fail to live up to these claims. Instead, GM crops:

- can be toxic, allergenic or less nutritious than their natural counterparts
- can disrupt the ecosystem, damage vulnerable wild plant and animal populations and harm biodiversity
- increase chemical inputs (pesticides, herbicides) over the long term
- deliver yields that are no better, and often worse, than conventional crops
- cause or exacerbate a range of social and economic problems
- are laboratory-made and, once released, harmful GMOs cannot be recalled from the environment.

The scientifically demonstrated risks and clear absence of real benefits have led experts to see GM as a clumsy, outdated technology. They present risks that we need not incur, given the availability of effective, scientifically proven, energy-efficient and safe ways of meeting current and future global food needs.

This paper presents the key scientific evidence – 114 research studies and other authoritative documents – documenting the limitations and risks of GM crops and the many safer, more effective alternatives available today.

## Is GM an extension of natural plant breeding?

Natural reproduction or breeding can only occur between closely related forms of life (cats with cats, not cats with dogs; wheat with wheat, not wheat with tomatoes or fish). In this way, the genes that offspring inherit from parents, which carry information for all parts of the body, are passed down the generations in an orderly way.

GM is not like natural plant breeding. GM uses laboratory techniques to insert artificial gene units to re-programme the DNA blueprint of the plant with completely new properties. This process would never happen in nature. The artificial gene units are created in the laboratory by joining fragments of DNA, usually derived from multiple organisms, including viruses, bacteria, plants and animals. For example, the GM gene in the most common herbicide resistant soya beans was pieced together from a plant virus, a soil bacterium and a petunia plant.

The GM transformation process of plants is crude, imprecise, and causes widespread mutations, resulting

in major changes to the plant's DNA blueprint<sup>1</sup>. These mutations unnaturally alter the genes' functioning in unpredictable and potentially harmful ways<sup>2</sup>, as detailed below. Adverse effects include poorer crop performance, toxic effects, allergic reactions, and damage to the environment.

## Are GM foods safe to eat?

Contrary to industry claims, GM foods are not properly tested for human safety before they are released for sale<sup>3,4</sup>. In fact, the only published study directly testing the safety of a GM food on humans found potential problems<sup>5</sup>. To date, this study has not been followed up.

Typically the response to the safety question is that people have been eating GM foods in the United States and elsewhere for more than ten years without ill effects and that this proves that the products are safe. But GM foods are not labelled in the US and other nations where they are widely eaten and consumers are not monitored for health effects.

Because of this, any health effects from a GM food would have to meet unusual conditions before they would be noticed. The health effects would have to:

- occur immediately after eating a food that was known to be GM (in spite of its not being labeled). This kind of response is called acute toxicity.
- cause symptoms that are completely different from common diseases. If GM foods caused a rise in common or slow-onset diseases like allergies or cancer, nobody would know what caused the rise.
- be dramatic and obvious to the naked eye. Nobody examines a person's body tissues with a microscope for harm after they eat a GM food. But just this type of examination is needed to give early warning of problems such as pre-cancerous changes.

To detect important but more subtle effects on health, or effects that take time to appear (chronic effects), long-term controlled studies on larger populations are required.

Under current conditions, moderate or slow-onset health effects of GM foods could take decades to become known, just as it took decades for the damaging effects of trans-fats (another type of artificial food) to be recognized. 'Slow poison' effects from trans-fats have caused millions of premature deaths across the world<sup>6</sup>.

Another reason why any harmful effects of GM foods will be slow to surface and less obvious is because, even in the United States, which has the longest history of GM crop consumption, GM foods account for only a small part of the US diet (maize is less than 15% and soya bean products are less than 5%).

Nevertheless, there are signs that all is not well with the US food supply. A report by the US Centers for Disease Control shows that food-related illnesses increased 2- to 10-fold in the years between 1994 (just before GM food was commercialised) and 1999<sup>7</sup>. Is there a link with GM food? No one knows, because studies on humans have not been done.

## Animal studies on GM foods give cause for concern

Although studies on humans have not been done, scientists are reporting a growing number of studies that examine the effects of GM foods on laboratory animals. These studies, summarized below, raise serious concerns regarding the safety of GM foods for humans as well as animals.

### Small animal feeding studies

- Rats fed GM tomatoes developed stomach ulcerations<sup>8</sup>
- Liver, pancreas and testes function was disturbed in

mice fed GM soya<sup>9 10 11</sup>

- GM peas caused allergic reactions in mice<sup>12</sup>
- Rats fed GM oilseed rape developed enlarged livers, often a sign of toxicity<sup>13</sup>
- GM potatoes fed to rats caused excessive growth of the lining of the gut similar to a pre-cancerous condition<sup>14 15</sup>
- Rats fed insecticide-producing GM maize grew more slowly, suffered problems with liver and kidney function, and showed higher levels of certain fats in their blood<sup>16</sup>
- Rats fed GM insecticide-producing maize over three generations suffered damage to liver and kidneys and showed alterations in blood biochemistry<sup>17</sup>
- Old and young mice fed with GM insecticide-producing maize showed a marked disturbance in immune system cell populations and in biochemical activity<sup>18</sup>
- Mice fed GM insecticide-producing maize over four generations showed a buildup of abnormal structural changes in various organs (liver, spleen, pancreas), major changes in the pattern of gene function in the gut, reflecting disturbances in the chemistry of this organ system (e.g. in cholesterol production, protein production and breakdown), and, most significantly, reduced fertility<sup>19</sup>
- Mice fed GM soya over their entire lifetime (24 months) showed more acute signs of ageing in their liver<sup>20</sup>
- Rabbits fed GM soya showed enzyme function disturbances in kidney and heart<sup>21</sup>.

## Feeding studies with farm animals

Farm animals have been fed GM feed for many years. Does this mean that GM feed is safe for livestock? Certainly it means that effects are not acute and do not show up immediately. However, longer-term studies, designed to assess slow-onset and more subtle health effects of GM feed, indicate that GM feed does have adverse effects, confirming the results described above for laboratory animals.

The following problems have been found:

- Sheep fed Bt insecticide-producing GM maize over three generations showed disturbances in the functioning of the digestive system of ewes and in the liver and pancreas of their lambs<sup>22</sup>.
- GM DNA was found to survive processing and to be detectable in the digestive tract of sheep fed GM feed. This raises the possibility that antibiotic resistance and Bt insecticide genes can move into gut bacteria<sup>23</sup>, a process known as horizontal gene transfer. Horizontal gene transfer can lead to antibiotic resistant disease-causing bacteria ("superbugs") and may lead to Bt insecticide being produced in the gut with potentially

harmful consequences. For years, regulators and the biotech industry claimed that horizontal gene transfer would not occur with GM DNA, but this research challenges this claim

- GM DNA in feed is taken up by the animal's organs. Small amounts of GM DNA appear in the milk and meat that people eat<sup>24 25 26</sup>. The effects on the health of the animals and the people who eat them have not been researched.

Do animal feeding studies highlight potential health problems for people?

Before food additives and new medicines can be tested on human subjects, they have to be tested on mice or rats. If harmful effects were to be found in these initial animal experiments, then the drug would likely be disqualified for human use. Only if animal studies reveal no harmful effects can the drug be further tested on human volunteers.

But GM crops that caused ill effects in experimental animals have been approved for commercialization in many countries. This suggests that less rigorous standards are being used to evaluate the safety of GM crops than for new medicines.

In fact, in at least one country – the United States – safety assessment of GMOs is voluntary and not required by law, although, to date, all GMOs have undergone voluntary review. In virtually all countries, safety assessment is not scientifically rigorous. For instance, the animal feeding studies that GM crop developers routinely conduct to demonstrate the safety of their products are too short in duration and use too few subjects to reliably detect important harmful effects.<sup>27</sup>

While industry conducts less than rigorous studies on its own GM products,<sup>28</sup> it has, in parallel, systematically and persistently interfered with the ability of independent scientists to conduct more rigorous and incisive independent research on GMOs. Comparative and basic agronomic studies on GMOs, assessments of safety and composition, and assessments of environmental impact have all been restricted and suppressed by the biotechnology industry.<sup>29 30</sup>

Patent rights linked with contracts are used to restrict access of independent researchers to commercialized GM seed. Permission to study patented GM crops is either withheld or made so difficult to obtain that research is effectively blocked. In cases where permission is finally given, biotech companies keep the right to block publication, resulting in much significant research never being published.<sup>31 32</sup>

The industry and its allies also use a range of public relations strategies to discredit and/or muzzle scientists who do publish research that is critical of GM crops.<sup>33</sup>

## Are GM foods more nutritious?

There are no commercially available GM foods with improved nutritional value. Currently available GM foods are no better and in some cases are less nutritious than natural foods. Some have been proven in tests to be toxic or allergenic.

Examples include:

- GM soya had 12–14% lower amounts of cancer-fighting isoflavones than non-GM soya<sup>34</sup>
- Oilseed rape engineered to have vitamin A in its oil had much reduced vitamin E and altered oil-fat composition<sup>35</sup>
- Human volunteers fed a single GM soya bean meal showed that GM DNA can survive processing and is detectable in the digestive tract. There was evidence of horizontal gene transfer to gut bacteria<sup>36 37</sup>. Horizontal gene transfer of antibiotic resistance and Bt insecticide genes from GM foods into gut bacteria is an extremely serious issue. This is because the modified gut bacteria could become resistant to antibiotics or become factories for Bt insecticide. While Bt in its natural form has been safely used for years as an insecticide in farming, Bt toxin genetically engineered into plant crops has been found to have potential ill health effects on laboratory animals<sup>38 39 40</sup>
- In the late 1980s, a food supplement produced using GM bacteria was toxic<sup>41</sup>, initially killing 37 Americans and making more than 5,000 others seriously ill.
- Several experimental GM food products (not commercialised) were found to be harmful:
- People allergic to Brazil nuts had allergic reactions to soya beans modified with a Brazil nut gene<sup>42</sup>
- The GM process itself can cause harmful effects. GM potatoes caused toxic reactions in multiple organ systems<sup>43 44</sup>. GM peas caused a 2-fold allergic reaction – the GM protein was allergenic and stimulated an allergic reaction to other food components<sup>45</sup>. This raises the question of whether GM foods cause an increase in allergies to other substances.

## Can GM foods help alleviate the world food crisis?

The root cause of hunger is not a lack of food, but a lack of access to food. The poor have no money to buy food and increasingly, no land on which to grow it. Hunger is fundamentally a social, political, and economic problem, which GM technology cannot address.

Recent reports from the World Bank and the United Nations Food and Agriculture Organisation have identified the biofuels boom as the main cause of the current food crisis<sup>46 47</sup>. But GM crop producers and distributors continue to promote the expansion of biofuels. This

*“The climate crisis was used to boost biofuels, helping to create the food crisis; and now the food crisis is being used to revive the fortunes of the GM industry.” Daniel Howden, Africa correspondent, The Independent (London), 2008<sup>53</sup>*

suggests that their priority is to make a profit, not to feed the world.

GM companies focus on producing cash crops for animal feed and biofuels for affluent countries, not food for people.

GM crops contribute to the expansion of industrial agriculture and the decline of the small farmer around the world. This is a serious development as there is abundant evidence that small farms are more efficient than large ones, producing more crops per hectare of land<sup>48 49 50 51 52</sup>.

## Do GM crops increase yield potential?

At best, GM crops have performed no better than their non-GM counterparts, with GM soya beans giving consistently lower yields for over a decade<sup>54</sup>. Controlled comparative field trials of GM/non-GM soya suggest that 50% of the drop in yield is due to the genetic disruptive effect of the GM transformation process<sup>55</sup>. Similarly, field tests of Bt insecticide-producing maize hybrids showed that they took longer to reach maturity and produced up to 12% lower yields than their non-GM counterpart<sup>56</sup>.

A US Department of Agriculture report confirms the poor yield performance of GM crops, saying, “GE crops available for commercial use do not increase the yield potential of a variety. In fact, yield may even decrease.... Perhaps the biggest issue raised by these results is how to explain the rapid adoption of GE crops when farm financial impacts appear to be mixed or even negative<sup>57</sup>.”

The failure of GM to increase yield potential was emphasised in 2008 by the United Nations International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) report<sup>58</sup>. This report on the future of farming, authored by 400 scientists and backed by 58 governments, stated that yields of GM crops were “highly variable” and in some cases, “yields declined”. The report noted, “Assessment of the technology lags behind its development, information is anecdotal and contradictory, and uncertainty about possible benefits and damage is unavoidable.”

### Failure to Yield

The definitive study to date on GM crops and yield is “Failure to Yield: Evaluating the Performance of Genetically Engineered Crops”. Published in 2009, the study is authored by former US EPA and Center for Food

Safety scientist, Dr Doug Gurian-Sherman. It is based on published, peer-reviewed studies conducted by academic scientists and using adequate experimental controls.

In the study, Dr Gurian-Sherman distinguishes between intrinsic yield (also called potential yield), defined as the highest yield which can be achieved under ideal conditions, with operational yield, the yield achieved under normal field conditions when the farmer factors in crop reductions due to pests, drought, or other environmental stresses.

The study also distinguishes between effects on yield caused by conventional breeding methods and those caused by GM traits. It has become common for biotech companies to use conventional breeding and marker assisted breeding to produce higher-yielding crops and then finally to engineer in a gene for herbicide tolerance or insect resistance. In such cases, higher yields are not due to genetic engineering but to conventional breeding. “Failure to Yield” teases out these distinctions and analyses what contributions genetic engineering and conventional breeding make to increasing yield.

Based on studies on corn and soybeans, the two most commonly grown GM crops in the United States, the study concludes that genetically engineering herbicide-tolerant soybeans and herbicide-tolerant corn has not increased yields. Insect-resistant corn, meanwhile, has improved yields only marginally. The increase in yields for both crops over the last 13 years, the report finds, was largely due to traditional breeding or improvements in agricultural practices.

The author concludes: “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.”<sup>59</sup>

Critics of the study have objected that it does not use data from developing countries. The Union of Concerned Scientists responds that there are few peer-reviewed papers evaluating the yield contribution of GM crops in developing countries – not enough to draw clear and reliable conclusions. However, the most widely grown food/feed crop in developing countries, herbicide-tolerant soybeans, offers some hints. Data from Argentina, which has grown more GM soybeans than any other developing country, suggest that yields for GM varieties are the same or lower than for conventional non-GE soybeans.<sup>60</sup>

“If we are going to make headway in combating hunger due to overpopulation and climate change, we will need to increase crop yields,” says Dr Gurian-Sherman. “Traditional breeding outperforms genetic engineering hands down.”<sup>61</sup>

If GM cannot improve intrinsic (potential) yield even in the affluent United States, where high-input, irrigated, heavily subsidized farming is the norm, it would seem

irresponsible to assume that it would improve yields in the developing world, where increased food production is most needed. Initiatives promoting GM crops for the developing world are experimental and appear to be founded on expectations that are not consistent with data obtained in the West.

In the West, crop failure is often underwritten by governments, which bail out farmers with compensation. Such support systems are rare in the developing world. There, farmers may literally bet their farms and their entire livelihoods on a crop. Failure can have severe consequences.

## Three GM crops for Africa

### GM sweet potato

The virus-resistant sweet potato has been the ultimate GM showcase project for Africa, generating a vast amount of global media coverage. Florence Wambugu, the Monsanto-trained scientist fronting the project, has been proclaimed an African heroine and the saviour of millions, based on her claims about the GM sweet potato doubling output in Kenya. Forbes magazine even declared her one of a tiny handful of people around the globe who would “reinvent the future”.<sup>62</sup> It eventually emerged, however, that the claims being made for the GM sweet potato were untrue, with field trial results showing the GM crop to be a failure.<sup>63 64</sup>

In contrast with the unproven GM sweet potato variety, a successful conventional breeding programme in Uganda had produced a new high-yielding variety which is virus-resistant and has “raised yields by roughly 100%”. The Ugandan project achieved success at a small cost and in just a few years. The GM sweet potato, in contrast, in over 12 years in the making, consumed funding from Monsanto, the World Bank, and USAID to the tune of \$6 million.<sup>65</sup>

### GM cassava

The potential of genetic engineering to massively boost the production of cassava – one of Africa’s most important foods – by defeating a devastating virus has been heavily promoted since the mid-1990s. There has even been talk of GM solving hunger in Africa by increasing cassava yields as much as tenfold.<sup>66</sup> But almost nothing appears to have been achieved. Even after it became clear that the GM cassava had suffered a major technical failure<sup>67</sup>, media stories continued to appear about its curing hunger in Africa.<sup>68 69</sup> Meanwhile, conventional (non-GM) plant breeding has quietly produced virus resistant cassavas that are already making a remarkable difference in farmers’ fields, even under drought conditions.<sup>70</sup>

### Bt cotton

In Makhathini, South Africa, often cited as the showcase Bt cotton project for small farmers, 100,000 hectares were planted with Bt cotton in 1998. By 2002, that had crashed

to 22,500 hectares, an 80% reduction in 4 years. By 2004, 85% of farmers who used to grow Bt cotton had given up. The farmers found pest problems and no increase in yield. Those farmers who still grew the crop did so at a loss, continuing only because the South African government subsidized the project and there was a guaranteed market for the cotton.<sup>71</sup>

A study published in *Crop Protection* journal concluded, “cropping Bt cotton in Makhathini Flats did not generate sufficient income to expect a tangible and sustainable socioeconomic improvement due to the way the crop is currently managed. Adoption of an innovation like Bt cotton seems to pay only in an agro-system with a sufficient level of intensification.”<sup>72</sup>

## How will climate change impact agriculture?

Industrial agriculture is a major contributor to global warming, producing up to 20 per cent of greenhouse gas emissions, and some methods of increasing yield can exacerbate this negative impact. For example, crops that achieve higher intrinsic yield often need more fossil fuel-based nitrogen fertilizer, some of which is converted by soil microbes into nitrous oxide, a greenhouse gas nearly 300 times more potent than carbon dioxide. Minimizing global agriculture’s future climate impact will require investment in systems of agriculture less dependent on industrial fertilizers and agroecological methods of improving soil water-holding capacity and resilience.

GM seeds are created by agrochemical companies and are heavily dependent on costly external inputs such as synthetic fertilizer, herbicides, and pesticides. It would seem risky to promote such crops in the face of climate change.

### Peak oil and agriculture

According to some analysts, peak oil, when the maximum rate of global petroleum extraction is reached, has already arrived. This will have drastic effects on the type of agriculture we practise. GM crops are designed to be used with synthetic herbicides and fertilizers. But synthetic pesticides are made from oil and synthetic fertilizer from natural gas. Both these fossil fuels are running out fast, as are phosphates, a major ingredient of synthetic fertilizers.

Farming based on the current US GM and chemical model that depends on these fossil fuel-based inputs will become increasingly expensive and unsustainable. The statistics tell the story:

In the US food system, 10 kcal of fossil energy is required for every kcal of food consumed.<sup>73</sup>

- Approximately 7.2 quads of fossil energy are consumed in the production of crops and livestock in the U.S. each year.<sup>74 75</sup>

- Approximately 8 million kcal/ha are required to produce an average corn crop and other similar crops.<sup>76</sup>
- Two-thirds of the energy used in crop production is for fertilizers and mechanization.<sup>77</sup>

Proven technologies that can reduce the amount of fossil energy used in farming include reducing fertilizer applications, selecting farm machinery appropriate for each task, managing soil for conservation, limiting irrigation, and organic farming techniques.<sup>78</sup>

In the Rodale Institute Farming Systems Trial (FST), a comparative analysis of energy inputs conducted by Dr David Pimentel of Cornell University found that organic farming systems use just 63% of the energy required by conventional farming systems, largely because of the massive amounts of energy required to synthesize nitrogen fertilizer, followed by herbicide production.<sup>79</sup>

Studies show that the low-input organic model of farming works well in African countries. The Tigray project in Ethiopia, part-funded by the UN Food and Agriculture Organisation (FAO), compared yields from the application of compost and chemical fertilizer in farmers' fields over six years. The results showed that compost can replace chemical fertilizers and that it increased yields by more than 30 percent on average. As side-benefits to using compost, the farmers noticed that the crops had better resistance to pests and disease and that there was a reduction in "difficult weeds".<sup>80</sup>

## GM crops and climate change

Climate change brings sudden, extreme, and unpredictable changes in weather. If we are to survive, the crop base needs to be as flexible, resilient and diverse as possible. GM technology offers just the opposite – a narrowing of crop diversity and an inflexible technology that requires years and millions of dollars in investment for each new variety.

Each GM crop is tailor-made to fit a particular niche. With climate change, no one knows what kind of niches will exist and where. The best way to insure against the destructive effects of climate change is to plant a wide variety of high-performing crops that are genetically diverse.

GM companies have patented plant genes that they believe are involved in tolerance to drought, heat, flooding, and salinity – but have not succeeded in using these genes to produce a single new crop with these properties. This is because these functions are highly complex and involve many different genes working together in a precisely regulated way. It is beyond existing GM technology to engineer crops with these sophisticated, delicately regulated gene networks for improved tolerance traits.

Conventional natural cross-breeding, which works holistically, is much better adapted to achieving this aim, using the many varieties of virtually every common crop

that tolerate drought, heat, flooding, and salinity.

In addition, advances in plant breeding have been made using marker-assisted selection (MAS), a largely uncontroversial branch of biotechnology that can speed up the natural breeding process by identifying important genes. MAS does not involve the risks and uncertainties of genetic engineering.

The controversies that exist around MAS relate to gene patenting issues. It is important for developing countries to consider the implications of patent ownership relating to such crops.

## Non-GM successes for niche crops

If it is accepted that niche speciality crops may be useful in helping adaptation to climate change, there are better ways of creating them than genetic engineering. Conventional breeding and marker-assisted selection have produced many advances in breeding speciality crops, though these have garnered only a fraction of the publicity given to often speculative claims of GM miracles.

An example of such a non-GM success is the "Snorkel" rice that adapts to flooding by growing longer stems, preventing the crop from drowning.<sup>81</sup> While genetic engineering was used as a research tool to identify the desirable genes, only conventional breeding – guided by Marker Assisted Selection – was used to generate the Snorkel rice line. Snorkel rice is entirely non-GM. This is an excellent example of how the whole range of biotechnology tools, including GM, can be used most effectively to work with the natural breeding process to develop new crops that meet the critical needs of today.

## Are GM crops environmentally friendly?

Two kinds of GM crops dominate the marketplace:

- Crops that resist broad-spectrum (kill-all) herbicides such as Roundup. These are claimed to enable farmers to spray herbicide less frequently to kill weeds but without killing the crop
- Crops that produce the insecticide Bt toxin. These are claimed to reduce farmers' need for chemical insecticide sprays.

Both claims require further analysis.

## GM crops and herbicide use

The most commonly grown herbicide-resistant GM crops are engineered to be resistant to Roundup. But the increasing use of Roundup has led to the appearance of numerous weeds resistant to this herbicide<sup>82</sup>. Roundup resistant weeds are now common and include pigweed<sup>83</sup>, ryegrass<sup>84</sup>, and marestail<sup>85</sup>. As a result, in the US, an initial

drop in average herbicide use after GM crops were introduced has been followed by a large increase as farmers were forced to change their farming practices to kill weeds that had developed resistance to Roundup<sup>86 87</sup>. Farmers have increased radically the amounts of Roundup applied to their fields and are being advised to use increasingly powerful mixtures of multiple herbicides and not Roundup alone<sup>88 89</sup>.

All of these chemicals are toxic and a threat to both the farmers who apply them and the people and livestock that eat the produce. This is the case even for Roundup, which has been shown to have a range of damaging cellular effects indicating toxicity at levels similar to those found on crops engineered to be resistant to the herbicide<sup>90</sup>.

A Canadian government study in 2001 showed that after just 4-5 years of commercial growing, herbicide-resistant GM oilseed rape (canola) had cross-pollinated to create "superweeds" resistant to up to three different broad-spectrum herbicides. These superweeds have become a serious problem for farmers both within<sup>91 92</sup> and outside their fields<sup>93</sup>.

In addition, GM oilseed rape has also been found to cross-pollinate with and pass on its herbicide resistant genes to related wild plants, for example, charlock and wild radish/turnip. This raises the possibility that these too may become superweeds and difficult for farmers to control<sup>94</sup>. The industry's response has been to recommend use of higher amounts and complex mixtures of herbicides<sup>95 96</sup> and to start developing crops resistant to additional or multiple herbicides. These developments are clearly creating a chemical treadmill that would be especially undesirable for farmers in developing countries.

## Insecticide-producing GM crops

Bt insecticide-producing GM crops have led to resistance in pests, resulting in rising chemical applications<sup>97 98 99</sup>.

In China and India, Bt cotton was initially effective in suppressing the boll weevil. But secondary pests, especially mirids and mealy bugs, that are highly resistant to Bt toxin, soon took its place. The farmers suffered massive crop losses and had to apply costly pesticides, wiping out their profit margins<sup>100 101 102 103</sup>. Such developments are likely to be more damaging to farmers in developing countries, who cannot afford expensive inputs.

The claim that Bt GM crops reduce pesticide use is disingenuous, since Bt crops are in themselves pesticides. Prof Gilles-Eric Seralini of the University of Caen, France states: "Bt plants, in fact, are designed to produce toxins to repel pests. Bt brinjal (eggplant/aubergine) produces a very high quantity of 16-17mg toxin per kg. They affect animals. Unfortunately, tests to ascertain their effect on humans have not been conducted."<sup>104</sup>

## GM crops and wildlife

Farm-scale trials sponsored by the UK government showed that the growing of herbicide-resistant GM crops (sugar beet, oilseed rape) can reduce wildlife populations<sup>105 106</sup>.

## The case of Argentina

In Argentina, the massive conversion of agriculture to GM soya production has had disastrous effects on rural social and economic structures. It has damaged food security and caused a range of environmental problems, including the spread of herbicide-resistant weeds, soil depletion, and increased pests and diseases<sup>107 108</sup>.

## GM crops and non-target insects and organisms

Bt insecticide-producing GM crops harm non-target insect populations, including butterflies<sup>109 110 111</sup> and beneficial pest predators<sup>112</sup>. Bt insecticide released from GM crops can also be toxic to water life<sup>113</sup> and soil organisms<sup>114</sup>. One study reveals more negative than positive impacts on beneficial insects from GM Bt insecticide-producing crops.<sup>115</sup>

## Can GM and non-GM crops co-exist?

The biotech industry argues that farmers should be able to choose to plant GM crops if they wish. It says GM and non-GM crops can peacefully "co-exist". But experience in North America has shown that "coexistence" of GM and non-GM crops rapidly results in widespread contamination of non-GM crops.

This not only has significant agroecological effects, but also serious economic effects, damaging the ability of organic farmers to receive premiums, and blocking export markets to countries that have strict regulations regarding GM contamination.

Contamination occurs through cross-pollination, spread of GM seed by farm machinery, and inadvertent mixing during storage. The entry of GM crops into a country removes choice – everyone is gradually forced to grow GM crops or to have their non-GM crop contaminated.

Here are a few examples of GM contamination incidents:

- In 2006 GM rice grown for only one year in field trials was found to have widely contaminated the US rice supply and seed stocks<sup>116</sup>. Contaminated rice was found as far away as Africa, Europe, and Central America. In March 2007 Reuters reported that US rice export sales were down by around 20 percent from those of the previous year as a result of the GM contamination<sup>117</sup>.
- In Canada, contamination from GM oilseed rape has made it virtually impossible to cultivate organic, non-GM oilseed rape<sup>118</sup>.

- US courts reversed the approval of GM alfalfa because it threatened the existence of non-GM alfalfa through cross-pollination<sup>119</sup>
- Organic maize production in Spain has dropped significantly as the acreage of GM maize production has increased, because of cross-pollination problems<sup>120</sup>
- In 2009, the Canadian flax seed export market to Europe collapsed following the discovery of widespread contamination with an unauthorized GM variety<sup>121</sup>.
- In 2007 alone, there were 39 new instances of GM contamination in 23 countries, and 216 incidents have been reported since 2005<sup>122</sup>.

## Alternatives to GM

Many authoritative sources, including the IAASTD report on the future of agriculture<sup>123</sup>, have found that GM crops have little to offer global agriculture and the challenges of poverty, hunger and climate change, because better alternatives are available. These go by many names, including integrated pest management (IPM), organic, sustainable, low-input, non-chemical pest management (NPM) and agroecological farming, but extend beyond the boundaries of any particular category. Projects employing these sustainable strategies in the developing world have produced dramatic increases in yields and food security<sup>124 125 126 127 128 129</sup>.

Strategies employed include:

- Sustainable, low-input, energy-saving practices that conserve and build soil, conserve water, and enhance natural pest resistance and resilience in crops
- Innovative farming methods that minimise or eliminate costly chemical pesticides and fertilizers
- Use of thousands of traditional varieties of each major food crop, which are naturally adapted to stresses such as drought, heat, harsh weather conditions, flooding, salinity, poor soil, and pests and diseases<sup>130</sup>
- Use of existing crops and their wild relatives in traditional breeding programmes to develop varieties with useful traits
- Programmes that enable farmers to cooperatively preserve and improve traditional seeds
- Use of beneficial and holistic aspects of modern biotechnology, such as Marker Assisted Selection (MAS), which uses the latest genetic knowledge to speed up traditional breeding<sup>131</sup>. Unlike GM technology, MAS can safely produce new varieties of crops with valuable, genetically complex properties such as enhanced nutrition, taste, yield potential, resistance to pests and diseases, and tolerance to drought, heat, salinity, and flooding<sup>132</sup>.

## Organic and low-input methods improve yields in Africa

There seems little reason to gamble with the livelihoods of poor farmers by persuading them to grow experimental GM crops when tried-and-tested, inexpensive methods of increasing food production are readily available. Several recent studies have shown that low-input methods such as organic can dramatically improve yields in African countries, along with other benefits. Such methods have the advantage of being knowledge-based rather than costly input-based. As a result they are more accessible to poor farmers than the more expensive technologies (which often have not helped in the past).

A 2008 United Nations report, "Organic Agriculture and Food Security in Africa", looked at 114 farming projects in 24 African countries and found that organic or near-organic practices resulted in a yield increase of more than 100 percent. In East Africa, a yield increase of 128 percent was found.<sup>133</sup> The Foreword to the study states: "The evidence presented in this study supports the argument that organic agriculture can be more conducive to food security in Africa than most conventional production systems, and that it is more likely to be sustainable in the long term."<sup>134</sup>

## Organic and low-input methods improve farmer incomes in developing countries

Poverty is a major contributory factor to food insecurity. According to the 2008 United Nations report, "Organic Agriculture and Food Security in Africa", organic farming has a positive impact on poverty in a variety of ways. Farmers benefit from:

- cash savings, as organic farming does not require costly pesticides and fertilizers;
- extra incomes gained by selling the surplus produce (resulting from the change to organic);
- premium prices for certified organic produce, obtained primarily in Africa for export but also for domestic markets; and
- added value to organic products through processing activities.

These findings are backed up by studies from Asia and Latin America that concluded that organic farming can reduce poverty in an environmentally friendly way.<sup>135</sup>

A recent study found that certified organic farms involved in production for export were significantly more profitable than those involved in conventional production (in terms of net farm income earnings).<sup>136</sup> Of these cases, 87 per cent showed increases in farmer and household incomes as a result of becoming organic, which contributed to reducing poverty levels and to increasing regional food security.

## Who owns the technology?

In considering which agricultural technologies will most benefit the developing world, it is crucial to ask who owns those technologies. The “Gene Revolution” that is proposed for Africa will be rolled out via public-private partnerships. The public side of such partnerships will be provided by Africa, whereas the private side will be provided by biotechnology companies based in the United States and Europe.

The transgenes used in creating GM crops are patented and owned by biotech companies. In the United States and Canada, companies have launched lawsuits against farmers whose crops were alleged to contain a company's patented GM genes. Farmers' claims that they have not intentionally planted GM crops have proved no defence in court against large fines being imposed.

When farmers buy GM seed, they sign a technology agreement promising not to save and replant seed. They have to buy new seed each year from the biotech company, thus transferring control of food production

from farmers to seed companies. Consolidation of the seed industry increasingly means that farmers have little choice but to buy GM seed. Centuries of farmer knowledge that went into creating locally adapted and varied seed stocks are wiped out.

In contrast, low-input and organic farming methods do not involve patented technologies. Control of food production remains in the hands of farmers, keeping farmer skills alive and favouring food security.

## Conclusion

GM crop technologies do not offer significant benefits. On the contrary, they present risks to human and animal health, the environment, farmers, food security, and export markets. There is no convincing reason to take such risks with the livelihoods of farmers when proven successful and widely acceptable alternatives are readily and cheaply available. These alternatives will maintain the independence of the food supply from foreign multinational control and offer the best insurance against the challenges of climate change.

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## Review of Roundup Herbicide Health Effects as reported by Antoniou et al., (2011)

*A list of potential health impacts as documented in the report:  
"Roundup and birth defects Is the public being kept in the dark?"*

Link to this document:

[https://docs.google.com/document/d/1FpOjzD\\_5UoPM9-ozbY8lyxGAQQkBTM8LEFzx4KZijng/edit?hl=en\\_US](https://docs.google.com/document/d/1FpOjzD_5UoPM9-ozbY8lyxGAQQkBTM8LEFzx4KZijng/edit?hl=en_US)

Below is a list of the potential health disorders that have been observed from exposure to the herbicide glyphosate as documented by the report of Antoniou et al., 2011. Below, each potential health disorder is presented separately, along with "quotes" extracted from their report and with the respective citations of refereed publications provided by the authors.

Citation of the report by Antoniou et al.:

Antoniou, M., M.E.E. Mostafa. H.C. Vyvyan, HC. Jennings, C. Leifert Rubens, O. Nodari, C. Robinson, and J. Fagan. 2001. Roundup and birth defects Is the public being kept in the dark? Earth Open Source. June 2011. 52 pp.

Available at: <http://www.scribd.com/doc/57277946/RoundupandBirthDefectsv5>

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## 1.0. Summary assessment

“Taken together, the industry studies and regulatory documents on which the current approval of glyphosate rests reveal that:

- Industry (including Monsanto) has known since the 1980s that glyphosate causes malformations in experimental animals at high doses
- Industry has known since 1993 that these effects could also occur at lower and mid doses
- The German government has known since at least 1998 that glyphosate causes malformations
- The EU Commission’s expert scientific review panel knew in 1999 that glyphosate causes malformations
- The EU Commission has known since 2002 that glyphosate causes malformations. This was the year its DG SANCO division published its final review report, laying out the basis for the current approval of glyphosate.

The public, in contrast, has been kept in the dark by industry and regulators about the ability of glyphosate and Roundup to cause malformations. In addition, the work of independent scientists who have drawn attention to the herbicide’s teratogenic effects has been ignored, denigrated, or dismissed. These actions on the part of industry and regulators have endangered public health. They have also contributed to the growing division between independent and industry science, which in turn erodes public trust in the regulatory process.”

## 2.0. Birth defects

“Research published in August 2010 showed that the best-selling herbicide Roundup<sup>1</sup> causes malformations in frog and chicken embryos at doses much lower than those used in agricultural spraying.<sup>2</sup> The malformations found were mostly of the craniofacial and neural crest type, which affect the skull, face, midline, and developing brain and spinal cord.

The research team was led by Professor Andrés Carrasco, lead researcher of the Argentine government research body CONICET. Carrasco was prompted to carry out the study by reports of high rates of birth defects in areas of Argentina dedicated to growing genetically modified Roundup Ready (GM RR) soy.<sup>3</sup> The birth defects seen in humans were of a similar type to those found in Carrasco’s study.”

2. Paganelli, A., Gnazzo, V. et al. 2010. Glyphosate-based herbicides produce teratogenic effects on vertebrates by impairing retinoic acid signaling. *Chem Res Toxicol* 23(10): 1586–1595.

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Monsanto and Dow refuted the research from Argentina:

“BVL’s response to Carrasco was followed by a response from industry. Employees of Monsanto and Dow, two major manufacturers of glyphosate herbicides, published a letter in the same journal that published Carrasco’s original study.<sup>47</sup> The Monsanto/Dow letter was published back-to-back with Carrasco’s response.<sup>48</sup> Monsanto/Dow take the same line as BVL, claiming:

Glyphosate does not cause adverse reproductive effects in adult animals or birth defects in offspring of these adults exposed to glyphosate, even at very high doses.<sup>49</sup> But both BVL’s and Monsanto/Dow’s claims are misleading, as we show below.

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## 3.0. Birth defects, mechanism of action

### “5.1. How Carrasco’s findings built on previous studies

Carrasco built on the findings of Dallegrave in that he identified the mechanism for the teratogenic activity of Roundup/glyphosate. Such malformations in humans and animals are known to be linked with an excess of retinoic acid (RA), an oxidized form of vitamin A.169 170 171 172 173 174 175 176 The link between RA and malformations is the reason why pregnant women are advised not to take vitamin A supplements. Carrasco found that glyphosate increased RA activity in frog embryos and that this was the mechanism through which the malformations occurred.177

Carrasco says that the malformations of the vertebrae found by Dallegrave may represent teratogenic effects on late embryonic development. His experiments did not extend the observations to the same late stage of development as Dallegrave’s. However, the malformations he found are compatible with those found by Dallegrave.178”

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177. Paganelli, A., Gnazzo, V. et al. 2010. Glyphosate-based herbicides produce teratogenic effects on vertebrates by impairing retinoic acid signaling. *Chem Res Toxicol* 23(10): 1586–1595.
178. Carrasco, A. E. 2010–2011. Personal email communications with the authors.

## 4.0. Birth defects: Epidemiological evidence

### “5.2. Epidemiological evidence on glyphosate and birth defects

In response to Carrasco’s study, BVL claims: “There is no epidemiological evidence in humans that glyphosate (herbicides) might be teratogenic” and “There is no clear-cut link to a hypothetical increase in malformations in regions with extensive use of plant protection products [pesticides, including herbicides] in South America.”

It is true that the authorities in South America have not carried out systematic epidemiological studies in areas where glyphosate spraying is widespread. Even so, enough evidence exists to show that the rapid escalation in the rates of birth defects coinciding with the expansion of GM soy and glyphosate spraying is far from “hypothetic”:

- Amnesty International reported that since Carrasco’s research findings were announced, “Activists, lawyers and health workers ... have started to conduct their own studies, registering cases of foetal malformations and increased cancer rates in local hospitals.”<sup>179</sup>
- An epidemiological study in Paraguay found that women who were exposed during pregnancy to herbicides were more likely than unexposed women to deliver offspring with birth defects of a similar type to those that Carrasco found in his experiments.<sup>180</sup> BVL dismisses this study on the grounds that it is small and does not mention glyphosate. BVL fails to mention that the study was carried out in an area of Paraguay (Itapua) devoted to GM soy monocultures sprayed with glyphosate and agrochemical mixtures. Itapua was home to Silvino Talavera, an 11-year-old boy who died in 2003 from agrochemical poisoning after being sprayed. Glyphosate was one of three agrochemicals found in his blood.<sup>181</sup> These were the facts that gave rise to public demand for the epidemiological study that BVL so lightly dismisses.
- A report commissioned by the provincial government of Chaco, Argentina, analyzed health statistics in the town of La Leonesa and other areas where soy and rice crops are heavily sprayed. The report found that the rate of birth defects increased nearly fourfold over the entire state of Chaco in only a decade, coinciding with the expansion of the agricultural frontier into the province and the corresponding rise in agrochemical use. The report mentioned glyphosate as one of several agrochemicals that were causing problems. It noted that complaints from sprayed residents centred on “transgenic crops, which require aerial and ground spraying (dusting) with agrochemicals”.<sup>182</sup>
- BVL dismisses newspaper reports of birth defects and other severe health problems in sprayed areas by saying “To our knowledge, there is no scientific confirmation of these reports so far”. BVL fails to mention that some of these newspaper reports mention local epidemiological studies conducted by doctors and scientists showing an escalation in birth defects.<sup>183 184</sup> Carrasco also refers to clinical observations in his study.<sup>185</sup> The fact that these small studies have not been translated into English or published in a scientific journal is no excuse for BVL to pretend that they do not exist. This is

- particularly true as BVL's report on Carrasco's study relies for its assurances of glyphosate's safety on unpublished, non-peer-reviewed industry studies.
- In March 2010, just months after the release of Carrasco's findings, a court in Santa Fe province in Argentina banned the spraying of glyphosate and other agrochemicals near populated areas. The court found that farmers "have been indiscriminately using agrochemicals such as glyphosate, applied in open violation of existing laws [causing] severe damage to the environment and to the health and quality of life of the residents". While the decision is limited to the area around San Jorge, other courts are likely to follow suit if residents seek similar court action.186
  - An epidemiological study in Ontario, Canada found high levels of premature births and miscarriages in female members of farming families that used pesticides, including glyphosate.187

None of these cases provides unequivocal evidence that glyphosate is the culprit in causing the harm, since other agrochemicals are used in the areas concerned. This is especially so since the spread of glyphosate-resistant weeds accompanying the spread of GM Roundup Ready crops has forced farmers to use other agrochemicals, such as 2,4-D, in addition to glyphosate.188 189 190 191 192 193

However, this type of uncertainty is true of all epidemiological studies, which do not show causation but only point to an association. That is why epidemiological studies need to be supported with toxicological studies on a single substance, such as Carrasco's research. His work, along with that of other independent researchers, confirms that Roundup/glyphosate is a reproductive and developmental toxin."

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## 5.0. Embryonic deaths, death of fetus

With respect to a study on increased embryonic deaths, the authors quote what German regulators found from a Monsanto study, and provide their own analysis:

### ***“Brooker et al., 1991***

Submitter companies: Monsanto/Cheminova65

*Germany's summary:* This study looked at the effects of glyphosate on pregnancy in rabbits, at doses of 50, 150, and 450 mg/kg bw/d. It found a significant increase in embryonic deaths in all the glyphosate-treated groups compared with controls. However, a comparison with historical control data showed that the incidence in the control group was untypically low. Also, a clear dose-response relationship was not shown. On the other hand, an increase in late embryonic deaths at the top dose level (450 mg/kg bw/day) was also found in another study on rabbits. There was concern about the more frequent occurrence of foetuses with heart malformations in the high dose group, but the incidence was in the range of historical background data. However, anomalies of the heart have been described in other rabbit teratogenicity studies with glyphosate, too. Thus, a possible effect on the occurrence of visceral anomalies remains equivocal.66

*UK's comment:* “The increased levels of embryonic death/post-implantational loss at all dose levels are of concern, as are the reports of heart defects... a more robust argument should be presented before these findings can be dismissed.”67

*Our comment:* Again, Germany uses historical control data and an inappropriate model for toxicity dose-response to explain away malformations of the heart in a glyphosate-exposed

group. Again, by taking this position, Germany appears to be acting against the public interest by ignoring or dismissing findings of glyphosate-induced teratogenicity and foetotoxicity.”

Reference cited:

65. Rapporteur member state, Germany. 1998. Monograph on Glyphosate. Annex B–5: Toxicology and Metabolism. In: Glyphosate DAR, released by German government agency BVL on CD, Volume 3-1\_Glyphosat\_05.pdf: p. 45 of the pdf.

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## 6.0. Embryonic deaths, death of fetus

Another EU/German regulatory review of a study showing deaths of embryos:

**“Anonym. (1981)**

Submitter company: Alkaloida73

*Germany’s summary:* This oral feeding study examined teratological effects of glyphosate in rats and rabbits. Vital details were either not recorded or poorly described, so the study was only considered as supplementary information. No malformations were recorded, but there were more foetal deaths at the two upper dose levels (50.7 and 255.3 mg/kg bw/d).<sup>74</sup> It is difficult to understand why an increase in foetal deaths would occur at doses far below those at which foetal effects were found in the gavage [force-feeding via stomach tube] studies. Thus it is doubtful whether this effect is related to glyphosate.<sup>75</sup>

*UK’s comment:* “Though this study is questioned [by the rapporteur, Germany] for showing evidence of fetotoxicity at lower doses than other studies, the study by Brooker (see above) may also indicate fetotoxicity at 50 mg/kg bw/d.”<sup>76</sup>

*Our comment:* Germany here again appears to show a bias towards considering low-dose findings as non-treatment-related and irrelevant – seemingly because it cannot accept that oral feeding may result in different exposures and effects than gavage. But the UK’s PSD points out that another study supports this study’s findings.”

References cited:

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FullReport\_Glyphosat\_05.pdf: p. 26 of the pdf.

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## 7.0. Lung, kidney, heart, and skeletal malformations

Comments by German, UK regulators and by the independent scientists:

### ***“Bhide and Patil (1989)***

Submitter companies: Barclay/Luxan68

*Germany’s summary:* This study examined teratological effects of glyphosate in rabbits at doses of 125, 250, and 500 mg/kg bw/d. At the high dose, two females aborted. There was no evidence of foetotoxic and teratogenic effects up to and including the mid-dose group. But the high-dose group had a decreased number of viable foetuses per litter and the number of non-viable implants (non-development and death of embryo) increased. The number of visceral and skeletal malformations was increased in the high-dose group.<sup>69</sup>

The study’s authors do not mention whether a statistical analysis was performed.

*UK’s comment:* “Another study with equivocal evidence of heart defects.”<sup>70</sup>

*Our comment:* The data shows that dose-dependent increases in lung and kidney malformations were found *across all glyphosate-exposed groups*. Increased heart malformations were found in all exposed groups. Increased skeletal (rudimentary 14th rib) malformations were found in the mid-dose and high-dose groups.

Germany incorrectly claims that the teratogenic NOAEL is the mid dose of 250 mg/kg bw/d. In reality, there are evident increases in most of the defects, even at the lowest dose of 125 mg/kg bw/d. The authors of this study do not provide an analysis of statistical significance and groups of only 15 animals were used, making statistical significance difficult to establish. But it is more accurate to say the mid dose, possibly even the low 125 mg/kg dose, is the LOAEL. Testing the effects of lower, realistic doses requires far larger animal groups if an increase in toxicity compared with the unexposed control group is to be reliably detected.<sup>71 72</sup>

At the very least, this study should have been repeated with a larger sample size and lower doses. Effects should have been examined thoroughly by allowing full gestation and pup development. “

References cited (EU regulator papers, analysis of industry studies):

69. Rapporteur member state, Germany. 1998. Monograph on Glyphosate. Annex B–5: Toxicology and Metabolism. In: Glyphosate DAR, released by German government agency BVL on CD, Volume 3-1\_Glyphosat\_05.pdf: p. 19 of the pdf.

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## 8.0. Skeletal malformations

*“Tasker, E.J. and Rodwell, D.E. (1980)*

Submitter companies: Monsanto and Cheminova<sup>77</sup>

*Germany’s summary:* This teratogenicity study in rats found a higher number of foetuses with malformations at the highest dose level (3500 mg/kg bw/d), but this was within the range of historical control data and was not considered to be due to glyphosate treatment. Specifically, there were more foetuses with unossified sternebrae (bones of the sternum/breastbone) in the high-dose group. While this effect was considered to be due to the glyphosate treatment, it is “rather a developmental variation than a malformation.”<sup>78</sup>

*UK’s comment:* The UK PSD does not comment on this study.

*Our comments:* Germany once again resorts to historical control data in order to conclude that there is lack of evidence of teratogenicity. Given the findings of malformations from glyphosate treatment in several other studies, this is unjustifiable.

Germany’s decision to redefine unossified sternebrae as a “variation” rather than a malformation is scientifically unjustifiable and at odds with other authorities. Unossified sternebrae in the rat are clearly defined as a skeletal deformity in *The Handbook of Skeletal Toxicology*.<sup>79</sup>

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## 9.0. Teratogenic effects: skeletal malformations; craniofacial and mouth deformities, eye abnormalities and bent, curved tails in tadpoles

Note, teratogenic= ability to cause malformations/birth defects.

EU regulators indicate there is no evidence of birth-defects but the researchers provide evidence to the contrary:

“In its response to Carrasco’s findings of malformations in frog and chicken embryos exposed to glyphosate and Roundup, the German government agency BVL says: “There is a huge and reliable database for developmental toxicity of glyphosate and no evidence of teratogenicity has been obtained.”<sup>165</sup> It is fair to assume that BVL’s “huge and reliable database” stretches beyond the industry studies to include the independent scientific literature. This interpretation is confirmed by the fact that BVL cites Dallegrave’s studies (2003, 2007) on the reproductive and developmental toxicity of Roundup on rats, which BVL claims showed “no craniofacial [of the skull and face] malformations”.

But this is untrue. The 2003 Dallegrave study cited by BVL does show craniofacial malformations from Roundup. Dallegrave found that sublethal oral doses of Roundup cause craniofacial ossification defects, loss of caudal vertebrae, and misshapen atlas and other cervical and thoracic vertebrae in rats. The author did not use the word “craniofacial” but described the nature of the malformations, which included the craniofacial type: “incomplete skull ossification and enlarged fontanel”. The effects were statistically significant and dose-dependent, strengthening the conclusion that they were caused by the glyphosate formulations.<sup>166</sup>

Another study, not cited by BVL, found that glyphosate formulations cause craniofacial and mouth deformities, eye abnormalities and bent, curved tails in tadpoles.<sup>167</sup>

Both these studies are part of what BVL calls the “huge and reliable database” on glyphosate. Both show evidence of teratogenicity.<sup>168</sup> Therefore, BVL must publicly retract its claims of “no craniofacial malformations” in Dallegrave’s 2003 study and of “no evidence of teratogenicity” in the scientific literature. In dismissing these findings, BVL and the EU Commission are ignoring data that is publicly available in the peer-reviewed literature.”

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## 10.0. Endocrine Disruption: Powerful endocrine disruptor and reproductive abnormalities

“A study on rats showed that a Roundup formulation was a potent endocrine disruptor and caused disturbances in reproductive development when the exposure was performed during the puberty period. Adverse effects, including delayed puberty and reduced testosterone production, were found at all dose levels, including the LOAEL of 5 mg/kg. The dose-response relationship was clear.<sup>99</sup> One of the critical failures of regulatory toxicity tests is to ignore important developmental windows such as puberty. This study helps to fill that knowledge gap.”

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# 11.0 Endocrine Disruption: Reproductive, developmental, and endocrine disruption effects

## *“Reproductive and developmental toxicity and endocrine disruption*

The 2002 review notes that studies on glyphosate and glyphosate trimesium found reduced pup weight and decrease in litter size and pup body weight gain, but says these effects are confined to high, “parentally toxic doses”. The review adds that effects include lower number of viable foetuses and reduced foetal weight, retarded ossification (bone formation), and higher incidence of skeletal and/or visceral (internal organ) anomalies. Effects of glyphosate trimesium include increased post-implantation losses (miscarriage), reduced foetal weight, and increased incidence of rib “variations” at maternally toxic doses.

- The 2002 review gives a developmental NOAEL (the highest level at which the effect being looked for is not found) of 300 mg/kg bw/d for glyphosate and 40 mg/kg bw/d for glyphosate trimesium. However, studies from the open literature have found adverse reproductive and developmental effects, in some cases at much lower levels. While we have discussed some of these studies in the above sections, we provide a comprehensive summary as follows:
- Glyphosate herbicide alters hormone levels in female catfish and decreases egg viability. The study concludes that the presence of glyphosate in water is harmful to catfish reproduction.<sup>296</sup>
- Roundup disrupts production of the steroid hormone progesterone in mouse cells by disrupting expression of a regulatory protein.<sup>297</sup>
- Roundup causes decreased sperm numbers and increased abnormal sperms in rats.<sup>298</sup>
- A commercial formulation of glyphosate was found to be a potent endocrine disruptor in rats, causing disturbances in their reproductive development after they were exposed during puberty.<sup>299</sup>
- In human cells, glyphosate-based herbicides prevent the action of androgens, the masculinising hormones, at levels up to 800 times lower than glyphosate residue levels allowed in some GM crops used for animal feed in the United States. DNA damage is found in human cells treated with glyphosate-based herbicides at these levels. Glyphosate-based herbicides also disrupt the action and formation of estrogens, the feminizing hormones.<sup>300</sup> This in vitro study found the first toxic effects of glyphosate-based herbicide at 5 ppm, and the first endocrine disrupting actions at 0.5 ppm – 800 times less than the 400 ppm level authorized by the US Environmental Protection Agency (EPA) in some animal feeds.<sup>301 302</sup>
- Glyphosate acts synergistically with estrogen, disrupting estrogen-regulated gene expression in human cells.<sup>303</sup>

- \_ Glyphosate is toxic to human placental cells and this effect increases in the presence of Roundup adjuvants. Roundup acts as an endocrine disruptor, inhibiting an enzyme responsible for estrogen production. The authors conclude that Roundup could cause reproductive problems in humans at levels below those used in agriculture.<sup>304</sup> The authors suggest that their results could explain epidemiological findings of increased premature births and miscarriages in female members of farming families using glyphosate.<sup>305 306</sup>
- \_ Glyphosate and Roundup damage human embryonic cells and placental cells, in concentrations well below those recommended for agricultural use. The study's authors conclude that Roundup may interfere with human reproduction and embryonic development.<sup>307</sup>
- \_ The fetuses of rats fed orally with high doses of Roundup had increased incidence of skeletal malformations.<sup>308</sup>
- \_ Roundup causes malformations in frog and chicken embryos at doses much lower than those used in agricultural spraying.<sup>309</sup> Malformations were of the craniofacial and neural tube type (of the skull, face, and developing brain and spinal cord)."

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## 12.0. Endocrine disruption

### *“Failure to consider endocrine disruption*

The ECCO Panel says, “Various literature references suggest that glyphosate is an endocrine disruptor.” Again, the panel has no idea what to make of these findings: “The group recognised that there was no guidance available regarding how such information should be used so it was agreed that the rapporteur should consult the Chairperson of the mammalian toxicology meeting at the BBA [German Federal Ministry for Food, Agriculture and Consumer Protection] to see if this is a concern.”<sup>314</sup> The final review report of 2002 does not mention endocrine disruption – sufficient reason in itself why the current approval of glyphosate is inadequate. However, independent studies show that glyphosate herbicides are endocrine disruptors.<sup>315 316 317</sup>”

### References cited:

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## 13.0. Irreversible damage to liver cells

“A 75-day study on rats showed that Glyphosate-Biocarb (a Brazilian formulation) caused damage to liver cells in a dose-response manner, including at the LOAEL of 4.87 mg/kg. According to the authors, the findings suggest that the damage to liver cells was “irreversible”.<sup>100</sup>”

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## 14.0. Human cell death

The authors make reference to a review by German regulators (BVL), in reference to research done in Argentina by Carrasco:

“BVL’s response to Carrasco’s study was not a one-off. In 2009, BVL issued a similarly dismissive response<sup>237</sup> to a study by Benachour and Séralini, which found that Roundup caused total cell death in human umbilical, embryonic, and placental cells within 24 hours.<sup>238</sup> In these experiments, Roundup obtained from the market was diluted by 100,000 times – far below the concentrations used when the chemical is sprayed on GM RR crops.

The researchers tested Roundup formulations, as well as pure glyphosate, AMPA (glyphosate’s main breakdown product), and the adjuvant POEA. They concluded that the presence of adjuvants increases the permeability of human cells to Roundup and amplifies the toxicity of glyphosate:

‘The proprietary mixtures available on the market could cause cell damage and even death around residual levels to be expected, especially in food and feed derived from R (Roundup) formulation-treated crops’.<sup>239</sup>

BVL’s response to this complex and worrying study was as brief as it was inadequate. Passing over the findings on the toxicity of glyphosate and AMPA, BVL only admitted that POEA (“tallow amines”) was a problem. It said it had asked manufacturers of glyphosate herbicides to replace tallow amines with less problematic ingredients within two years. That was the sum of BVL’s recommendations.

In choosing to focus solely on the adjuvant POEA, BVL simply ignored all the harmful effects that the researchers found with the Roundup formulations as a whole, their active ingredient glyphosate, and glyphosate’s main breakdown product, AMPA. So Roundup continues to be marketed without restriction and people continue to be put at risk.”

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## 15.0. DNA damage: Roundup causes genotoxic (DNA damage) effects

"The 2002 review flatly states that glyphosate and glyphosate trimesium are "not genotoxic" (causing damage to DNA). It is difficult to understand how this conclusion could be reached, given that even industry studies from the 1980s found that Roundup caused chromosome aberrations and gene mutations in mice lymphoid cells.<sup>253 254</sup>

In addition, a number of studies showing that glyphosate and Roundup are genotoxic existed in the peer reviewed literature even at the time of the 2002 review. Findings include:

- Roundup increases the frequency of gender-linked lethal recessive mutations in fruit flies (these mutations are normally only seen in males).<sup>255</sup>
- Roundup increases the frequency of DNA adducts (the binding to genetic material of reactive molecules that lead to mutations) in the liver and kidneys of mice at all three doses tested. The response was dose-dependent.<sup>256</sup>
- Roundup causes increased frequency of sister chromatid exchanges in human lymphocytes (white blood cells), even at the lowest dose tested.<sup>257</sup>
- Mice injected with glyphosate and Roundup show increased frequency of chromosome damage and increased DNA damage in bone marrow, liver, and kidney.<sup>258</sup>
- Numerous additional recent studies confirm genotoxicity:
- Roundup damages the DNA in the blood cells of European eels at environmentally relevant concentrations.<sup>259</sup>
- Roundup has adverse effects on the cells of various organs in fish exposed at sublethal concentrations of 5–15 ppm (a typical concentration in a post-application site). Effects include hyperplasia (increased proliferation of cells) and increased activity of metabolic enzymes.<sup>260</sup>
- Glyphosate-based herbicides cause increased frequency of DNA strand breaks and cell nucleus abnormalities indicative of mutagenic stress in goldfish at low doses (5–15 ppm).<sup>261</sup>
- Glyphosate-based herbicides cause DNA damage and endocrine disruption in human cells at levels up to 800 times lower than glyphosate residue levels allowed in some GM crops used for animal feed in the United States.<sup>262</sup>

- \_ Glyphosate-based herbicides inhibit RNA transcription and delay hatching in sea urchin embryos at a concentration well below that recommended for commercial spray application. The Roundup surfactant polyoxyethylene amine (POEA) is highly toxic to the embryos when tested alone and so could contribute to the inhibition of hatching.<sup>263</sup>
- \_ Glyphosate-based herbicides and glyphosate's main metabolite (environmental breakdown product), AMPA, alter cell cycle checkpoints in sea urchin embryos by interfering with the physiological DNA repair machinery. Such cell cycle dysfunction is seen from the first cell division in the sea urchin embryos.<sup>264 265 266 267</sup> The failure of cell cycle checkpoints is known to lead to genomic instability and the possible development of cancer in humans. Studies on glyphosate and AMPA suggest that the irreversible damage that they cause to DNA may increase the risk of cancer.<sup>268 269</sup>
- \_ An epidemiological study in Ecuador found a higher degree of DNA damage in people living in an area that was aerielly sprayed with glyphosate compared with those living 80 kilometres away.<sup>270</sup>

AMPA, glyphosate's main breakdown product (metabolite), is also genotoxic in isolation. The 2002 review, on the basis of the industry studies, calls AMPA "less toxic than the parent compound".<sup>271</sup> The ECCO Panel states, "AMPA is not of toxicological significance."<sup>272</sup> However, an independent study found that AMPA is genotoxic, damaging DNA in human cells at very low doses and in mice at a dose of 200–400mg/kg.<sup>273</sup>

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## 16.0. Cancer: Roundup carcinogenic effects

“The 2002 review claims “no evidence” of carcinogenicity for glyphosate and glyphosate trimesium. But glyphosate was known to have carcinogenic effects long before the 2002 review. Two long-term studies on rats were conducted in 1979–1981 and 1988–1990.<sup>274</sup> The rats received 3, 10 and 32 mg/kg of glyphosate per day in the first study and 100, 410 and 1060 mg/kg per day in the second. The first study found a significant increase in tumours in the testes of rats fed glyphosate, but the same effect was not found in the second test using the higher doses. On this basis, glyphosate was excluded from the carcinogenic category.<sup>275 276</sup> This move was based on outdated and incorrect assumptions about toxicology. It used to be thought that toxic effects increased in proportion to dose, and that there is a safe level of a chemical, below which toxic effects are not found. But toxicologists now know that these assumptions are not always true. Some chemicals have more potent effects (notably endocrine effects) at low doses than higher doses.<sup>277</sup> In some cases, no safe threshold can be found.<sup>278 279</sup> However, regulators have not revised their conclusions on glyphosate based on up-to-date scientific knowledge.

Studies from the independent literature also show that Roundup and glyphosate have carcinogenic effects:

- Glyphosate induces cancer in mouse skin<sup>280</sup>
- Epidemiological studies show a link between Roundup/glyphosate exposure and two types of cancer: multiple myeloma<sup>281</sup> and non-Hodgkin’s lymphoma.<sup>282 283 284</sup>
- Other studies (mentioned under Genotoxicity, above) show that Roundup, glyphosate, and its metabolite AMPA cause changes to cells and DNA that are known to lead to cancer.<sup>285 286 287 288 289 290”</sup>

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## 17.0. Cancer: Observed salivary gland lesions, carcinogenic?

### *“Unresolved concerns about salivary gland lesions*

Concerns about repeated findings of salivary gland lesions in experimental animals treated with glyphosate are expressed throughout the DAR materials and mentioned in the 2002 final review report. However, nobody seems to know what the lesions mean, and no attempt is made to find out. A comment by the ECCO Panel is typical:

Histological effects were observed in salivary glands in the 6 and 12 month dog study, however, since these lesions were considered without functional consequence or long term effects they were not considered to be adverse.<sup>313</sup>

The regulators should have insisted that these experiments be continued for a longer period, so that the true consequences of these lesions were revealed. Salivary gland lesions can be pre-cancerous.”

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## 18.0. Nervous system: Roundup causes neurotoxic effects

### *“Neurotoxicity*

The 2002 review of glyphosate claims “no relevant effects” in tests for delayed neurotoxicity. But glyphosate is an organophosphate, a class of chemicals known to have neurotoxic effects, so claims of “no relevant” neurotoxic effects demand a strong and transparent evidence base to back them up.

In fact, studies from the open literature have found neurotoxic effects of glyphosate:

- \_ An epidemiological study carried out in Minnesota, USA found that the children of pesticide applicators exposed to glyphosate had an increased incidence of neurobehavioral disorders.<sup>291</sup>
- \_ In an acute poisoning incident, a man who accidentally sprayed himself with glyphosate developed the neurological disorder Parkinsonism.<sup>292</sup>
- \_ A toxicological study on rats found that glyphosate depletes the neurotransmitters serotonin (serotonin is associated with feelings of well-being and is known as the “happiness hormone”) and dopamine.<sup>293</sup>

- \_ Glyphosate causes a loss of mitochondrial transmembrane potential (a hallmark of cellular injuries) in rat brain cells.<sup>294</sup>
- \_ Glyphosate and Roundup act synergistically with the organophosphate insecticide diazinon in neuroblastoma (nerve cancer) cells. Glyphosate and Roundup become more neurotoxic when the cells have been pre-exposed to diazinon. Roundup is more toxic than glyphosate and produces effects at a concentration as low as 10 ppb, which is equivalent to a glyphosate concentration of 0.5 nM. Unusual dose-response relationships are found with both glyphosate and Roundup, which the authors say merit further investigation as they indicate that the relationship between concentration and toxicity at low concentrations may not be entirely predictable.<sup>295</sup>

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## 19.0 Conflict of interest: Industry bias on safety studies conducted by their own scientists

Even if the industry tests had shown no malformations, this would not be proof of glyphosate's safety. Every time industry studies are compared with those from the independent scientific literature, the same verdict is reached: industry tests are biased towards conclusions of safety. The best known example is tobacco industry studies, which successfully delayed regulation for decades by manufacturing doubt and controversy about the effects of smoking and passive smoking.<sup>104</sup> More recently, studies sponsored by the pharmaceutical and mobile phone industry have been shown to be more likely to portray their products in a favourable light than non-industry-funded studies.<sup>105 106 107</sup> A review of studies on genetically modified crops and foods showed that the existence of either financial or professional conflict of interest was associated with study outcomes that cast products in a favorable light.<sup>108</sup>

Fewer comparisons of industry vs. independent studies have been performed for chemicals (including pesticides), but in four such reviews the same relationship is found: industry sponsorship is more likely to find favorable results, while the independent literature finds both safety and risk.<sup>109 110 111 112</sup>

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## 20.0. Conflict of interest: Monsanto, and bias in their response to health safety studies showing potential negative health effects from Roundup

“Even if the industry tests had shown no malformations, this would not be proof of glyphosate’s safety. Every time industry studies are compared with those from the independent scientific literature, the same verdict is reached: industry tests are biased towards conclusions of safety. The best known example is tobacco industry studies, which successfully delayed regulation for decades by manufacturing doubt and controversy about the effects of smoking and passive smoking.<sup>104</sup> More recently, studies sponsored by the pharmaceutical and mobile phone industry have been shown to be more likely to portray their products in a favourable light than non-industry-funded studies.<sup>105 106 107</sup> A review of studies on genetically modified crops and foods showed that the existence of either financial or professional conflict of interest was associated with study outcomes that cast products in a favorable light.<sup>108</sup>

Fewer comparisons of industry vs. independent studies have been performed for chemicals (including pesticides), but in four such reviews the same relationship is found: industry sponsorship is more likely to find favorable results, while the independent literature finds both safety and risk.<sup>109 110 111 112</sup>

The Monsanto/Dow employees follow BVL in defending industry studies. In their response to Carrasco, they write: “Multiple high quality toxicological studies and expert review panels consistently agree glyphosate is not a teratogen or reproductive toxicant.” They say the industry-funded studies that Carrasco calls untrustworthy “have been exhaustively reviewed by multiple government scientific regulators, often comprised of academic expert scientists and all of which have strongly supported the conclusions put forth in those studies.”<sup>113</sup> Monsanto/Dow names the “Regulatory authorities and independent experts who have documented this position” as WHO/FAO, US EPA, the European Commission, and Williams (2000).

- But Monsanto/Dow’s cited authorities for its position do not stand up to scrutiny:
- The European Commission’s 2002 review of glyphosate claims that developmental effects are confined to “maternally toxic doses”. But this claim is examined and discredited above.
- The WHO report on glyphosate (1994)<sup>114</sup> mainly cites industry studies. For example, 180 studies were generated by Monsanto, of which over 150 were not published or

subjected to peer review. Other unpublished technical reports provided as references in the same document include 17 reports from Agrichem, five from Luxan BV, and five from Rhone Poulenc – all producers and/or marketers of pesticides.<sup>115</sup>

- Williams co-authored his paper on glyphosate's safety with Ian C. Munro.<sup>116</sup> Munro is executive vice president of the chemical industry consulting firm Cantox,<sup>117</sup> which states that its mission is "protect client interests while helping our clients achieve milestones and bring products to market".<sup>118</sup> The Williams paper was published in the controversial chemical industry-sponsored journal Regulatory Toxicology and Pharmacology (RTP). RTP was one of several industry-linked organizations that were investigated by a US Congressional Committee in 2008 over their role in the FDA's decision allowing the toxic chemical bisphenol A in infant formula and other foods.<sup>119</sup>  
<sup>120</sup> <sup>121</sup> All this would matter less if Williams had cited credible sources in his claims for glyphosate's reproductive and developmental safety. But he cites unpublished industry studies, such as Schroeder (1981), Reyna (1990), and Tasker (1980). As these studies are from the industry dossier submitted for glyphosate's approval, it is strange that Williams fails to mention the other studies from the same dossier that we examine above – Suresh (1993), Brooker (1991), and Bhide and Patil (1989) – which found that glyphosate was teratogenic.

In sum, Monsanto/Dow relies for its claims of glyphosate's safety on carefully selected industry sources and cooperative regulators who only consider industry studies."

## 21.0 NY Courts: Monsanto can't make safety claims about Roundup

### "12.4. Industry tests are old and use outdated protocols

Anyone who is familiar with the rapid evolution of scientific knowledge relating to glyphosate over the past decade would be shocked to see that its current approval depends mostly on studies dating from the 1990s – some from as far back as the 1970s and 1980s.

In the 1990s glyphosate was still frequently claimed to be safe and environmentally friendly. Few independent studies were in existence to contradict these claims. Even so, by 1996, independent science had moved on to such an extent that a New York court ruled that Monsanto was no longer allowed to claim that Roundup was "safe, non-toxic, harmless or free from risk", or as biodegradable.<sup>354</sup> During the 2000s, a battery of independent scientific studies showed serious toxic effects from Roundup and glyphosate. None of this knowledge has made its way through to the regulatory system."

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Assurance of discontinuance pursuant to executive law § 63(15). New York, NY, Nov. False advertising by Monsanto regarding the safety of Roundup herbicide (glyphosate). <http://www.mindfully.org/Pesticide/Monsanto-v-AGNYnov96.htm>

## 22.0. Inert ingredients (adjuvants) increase toxicity of Roundup

12.6. The complete formulations as they are sold were not tested

The existing review of glyphosate fails to take into account the complete formulations as they are currently sold. Glyphosate herbicides contain adjuvants (added ingredients) which are themselves toxic and which can act synergistically with glyphosate to increase its toxicity. Studies show that Roundup is more toxic than glyphosate alone because the adjuvants enable the glyphosate to penetrate human cells more easily.<sup>355 356 357</sup> These problems are addressed in the new pesticides regulation 1107/2009, which takes into account the toxicity of the formulation as sold. This alone is reason enough to require that glyphosate herbicides be reviewed under the new regulation without delay.

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## 23.0. Roundup remains biologically active in the soil

**“Incorrect claim about biological availability of glyphosate**

The UK Pesticides Safety Directorate (PSD) notes that the issue of a waiting period between glyphosate spraying and re-entry into fields in order to protect humans, livestock, and plants, is not properly dealt with in Germany’s DAR. However, the PSD immediately dismisses this concern:

This should not be an issue for glyphosate as it is not usually biologically available once it contacts soil.<sup>349</sup>

But this claim was not true even at the time of the DAR. A 1983 study showed that glyphosate persists in sandy loam soil and is not inactivated in the 120 days prior to planting. Plants growing in the glyphosate-treated soil showed decreased nitrogen fixation, root nodule numbers and root weights – indicating that glyphosate was biologically available and toxic to plants 120 days after application.<sup>350</sup>

A new risk assessment should address the issue of the re-entry period.”

References cited:

349. EU Commission. 1999. Glyphosate: Comments from Pesticides Safety Directorate, York, UK, on the EC Monograph – ECCO 76. March 4. In: Glyphosate DAR, released by German government agency BVL on CD, FullReport\_Glyphosat\_04.pdf: p. 39 of the pdf.

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***“Incorrect claim about biological activity of AMPA***

Monsanto says AMPA’s long persistence in soil is of no “regulatory concern” because “AMPA is biologically inactive”.<sup>351</sup> But a 2004 study showed that AMPA causes injury to glyphosate-tolerant and non-glyphosate-tolerant soybeans. Findings are the same when the AMPA is deliberately applied and when it forms from the breakdown of applied glyphosate. The study concludes that soybean injury to glyphosate-tolerant soybeans from glyphosate is due to AMPA formed from glyphosate degradation.<sup>352</sup> Therefore AMPA is biologically active.

It is clear that the documents on which the existing approval of glyphosate is based are out of date and out of touch with current scientific knowledge and farmer experience.”

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351. EU Commission. 1999. Monsanto/Cheminova comments to Monograph (dated 11 Dec 1998). Feb 11. In: Glyphosate DAR, released by German government agency BVL on CD, FullReport\_Glyphosat\_04.pdf: p. 52 of the pdf.

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