PSGR

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New Zealand Charitable Trust

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The Right Hon Bill English Prime Minister
Government House
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cc to all MPs; Members of Federated Farmers, Rural Women NZ and Young Farmers; NZ Ministries; NZ Councils and DHBs; and other relevant parties

Genetic engineering and New Zealand

NB Genetic engineering (GE), genetic modification (GM) and transgenic are synonymous

PSGR is a not-for-profit, non-aligned charitable trust whose members are science and medical professionals. Since the recommendations of the Royal Commission on Genetic Modification (RCGM) "to proceed with caution" we have maintained a watching brief on the scientific developments in genetic engineering (also referred to as genetic modification).

We congratulate those people and groups involved in advocating the removal of amendment s360D from the Resource Legislation Amendment Act and for the Maori Party for insisting it be withdrawn.

There was wide public concern that the Bill, once approved as it stood, would deny public the right of choice about genetically engineered organisms. Since the Royal Commission on Genetic Modification many New Zealanders have worked hard to retain their right to chose in the interests of their family, business and region.

The proposed changes, if allowing the release of transgenic crops and the inevitable increase of pesticide use, would have arguably violated several human rights; e.g. the right to adequate food - food contaminated by pesticides cannot be considered as adequate food - and the right to the highest attainable level of health. These points can be seen in the recent United Nations Report of the Special Rapporteur on the right to food; see http://www.ohchr.org/EN/Issues/Food/Pages/FoodIndex.aspx.[1]

Allowing for the genetic engineering of animals is unacceptable. Field trials have shown that transgenic manipulations are costly with no usable end product, and cause suffering to the animals.[2]

1 Report of the Special Rapporteur on the right to food, United Nations A/HRC/34/48 24 January 2017
2 GE Animals in New Zealand: the first 15 years http://www.gefree.org.nz/assets/pdf/GE-Animals-in-New-Zealand.pdf and]http://www.dairyreporter.com/Ingredients/Fonterra-s-NZMP-non-GMO-ingredients-launch?utm_source=newsletter_daily&utm_medium=email&utm_campaign=18-Apr-2017&c=HwF7FPiM4jr82Hmba%2BQsQm4L0s3IosFU&p2

Public concern is not with transgenic organisms in containment. It is with the release of genetically engineered organisms into the environment, leading to contamination of that environment and the food chain. The following serious considerations highlight why:

Herbicide use - especially of glyphosate

Herbicide tolerant crops are designed to tolerate specific broad-spectrum herbicides to kill weeds while leaving the cultivated crop intact. Over two decades the increase in the dominant genetically engineered glyphosate-resistant crops has led to an overall increase in the use of that herbicide. This has given rise to herbicide-resistant 'super' weeds that are harder to control chemically, significantly in North America and Australia. Weeds are generally hardy. Super weeds require even more toxic herbicides to control (e.g. Paraquat), because of their resistance to glyphosate.

The huge increase in glyphosate use has also impacted negatively on the environment.[3] This herbicide, its residues and its metabolites remain active and accumulate and persist in soils with adverse effects on soil microbes and other soil organisms. It kills beneficial soil microbes and other soil organisms, e.g. worms. Glyphosate use impacts animal biodiversity and health either directly or indirectly through destruction of habitats. An example of this in the US is the decline in monarch butterfly populations, due to the destruction of their food source, the milkweed plant.

Transgenic crops engineered to tolerate glyphosate, the active ingredient in Roundup herbicide, were developed by Monsanto Company. Monsanto held the patent for glyphosate outside the US until it expired in 1991. In the US, the patent on isopropylamine salt, the most widely used salt form for glyphosate, continued until 2000. Glyphosate brands are also marketed by Bayer, Dow, Zeneca and others multinationals.

Based on US Department of Agriculture (USDA) survey data, the percentage of herbicide tolerant crops grown in the US in 2016 were: soybeans 94%; cotton 89%; corn 89%. The adoption of 'stacked' varieties of cotton and corn means some have both herbicide tolerance and insecticide-producing Bt traits (engineered with transgenic *Bacillius thuringiensis* DNA).[4] 'Roundup Ready' seed crops also include canola, alfalfa, and sugar beets.

The first case of evolved resistance to glyphosate was confirmed in rigid ryegrass in 1996 in Australia. Resistance has now been confirmed in 35+ weed species worldwide, some 16 in North America. Weeds with mutations conferring resistance to glyphosate are listed on http://www.weedscience.org/Mutations/MutationDisplayAll.aspx?MOAID=12.

As farmers know, a weed is any plant or vegetation that interferes with farming or forestry activities. Some may directly harm livestock by poisoning (e.g. ragwort). Aquatic weeds like *Egeria* and *Hydrilla* form dense floating mats which block pump- and power-station intakes, clog drains and irrigation races, and impair water flow in rivers and streams. Transgenic organisms have been found to survive in waste water and sludge, soils and aquatic ecosystems (river, lake, and especially particles at the bottom of lakes).[5]. So-called "crippled" micro-organisms have evidently managed to survive and compete with indigenous micro-organisms.[6]

Contaminated weed management

In 1984, Monsanto Company estimated the overall cost of weeds in New Zealand at $393 million, equivalent to $1.03 billion in 2007 terms. Californian thistle was calculated in 1999 at costing about $10 million/pa. In 2003, giant buttercup did cost the dairy industry NZ$156 million in one year in lost production.[4]

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[3] http://www.ucsusa.org/sites/default/files/legacy/assets/documents/food_and_agriculture/rise-of-superweeds.pdf
[4] https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx
[5] http://www.teara.govt.nz/en/weeds-of-agriculture
[6] Bauda P, Lallement C, Manem J (1995) Plasmid content evaluation of activated sludge. Water Research 29, 371-374 http://www.sciencedirect.com/science/article/pii/0043135494E0088N

A 2013 report said weeds cost Australia over AUD$4 billion annually in control and lost production.[7] Wild Radish alone costs its grain industry AUD$140 million/pa.[8]

Britain's advisory committee on releases to the environment (ACRE) identified wild radish, wild turnip, hoary mustard, brown mustard and wild cabbage as species from which hybrids could be formed with transgenic canola / rapeseed varieties. In one field trial plot, 46% of seeds in a wild turnip plant were contaminated with transgenic DNA.[9] Wild radish, wild turnip and wild cabbage grow in New Zealand.

A report on 'Coexistence of genetically modified and non-genetically modified crops', prepared for the New Zealand Ministry for the Environment, said: "… concerns regarding herbicide tolerant GM crops relate mainly to the release of herbicide tolerant rapeseed and its potential to become an agricultural weed. In addition, there are concerns that genes conferring herbicide tolerance will be transferred to non-GM Brassica crops and to wild brassicas. Wild turnip (B. rapa var. slyvestris) is a potential risk for accidental escape of transgenes in New Zealand because it is one of the few naturalised or native species in this country that is closely related to a crop."[10]

Planting of transgenic crops on a commercial basis began in the 1995/1996 Northern Hemisphere season. The speed at which contamination occurred is illustrated by canola volunteers growing in Alberta, Canada, in 2000. Chemical and DNA tests found the volunteers resistant to three herbicides: Monsanto's Roundup, in which the active ingredient is glyphosate, Liberty (glufosinate ammonium) produced by Bayer CropScience, and BASF's Pursuit (ammonium salt of imazethapyr).[11] In 2005, a Greenpeace report[12] stated that by that time it had become virtually impossible for Canadian farmers to grow canola that was not genetically engineered,[13] [14] thus potentially eliminating exports to countries wanting "GE-Free" products.

The 2016 University of Illinois Plant Clinic herbicide resistance report[15] indicated that "glyphosate herbicide resistance and PPO Inhibitor herbicide resistance" was found in weed samples taken across 10 States. The tests used qPCR protocols to determine if the most common site of action for resistance to these two groups of herbicide is present in the plants. Reports say many farmers plan to return to conventional crops rather than spend more and more money on herbicides to control the superweeds.

As long ago as 2010, Professor David Mortensen, a weed ecologist in the College of Agricultural Sciences, Penn State University, said resistant weeds infested about 11 million acres, a fivefold increase from 2007. Industry's suggested remedy was to use the more toxic herbicides such as 2,4-D or similar.

Currently, the USDA is processing the deregulation of other new crop varieties that are resistant to Dicamba, 2,4-D and other herbicides. Scientists predict that Dicamba and 2,4-D use in new herbicide-resistant crops would ultimately give the same contamination results, and the use of multiple herbicides would speed up the evolution of weeds that have multiple resistances.[16]

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[7] http://www.csiro.au/en/Outcomes/Safeguarding-Australia/Aust-Weed-Management.aspx
[8] http://www.daff.gov.au/natural-resources/invasive/national_weeds_productivity_research_program
[9] www.guardian.co.uk/science/2003/jul/10/gm.sciencenews
[10] http://www.mfe.govt.nz/sites/default/files/coexistence-feb01.pdf
[11] www.gene.ch/genet/2000/Feb/msg00053.html
[12] http://www.greenpeace.org/international/Global/international/planet-2/report/2005/5/canola-report.pdf
[13] http://www.ucsusa.org/assets/documents/food_and_agriculture/seedreport_fullreport.pdf
[14] Evidence of seed contamination is also given in the Union of Concerned Scientists' Report, 'Gone to Seed - Transgenic Contaminants in the Traditional Seed Supply'. See also 'GM Canola: The Canadian Experience', Agriculture and Agri-Food Canada, Research Centre http://www.canolawatch.org/wp-content/uploads/2011/10/20110309_FPJ_Aut11_Beckie.et_.al_.pdf
[15] http://bulletin.ipm.illinois.edu/?p=3821
[16] Pest Manag Sci. 2008 Apr;64(4):377-87. doi: 10.1002/ps.1539. Weed species shifts in glyphosate-resistant crops. Owen MD

Potential for contamination of conventional crops and weed species with transgenes

In August 2012, Bob Mackley, a farmer of non-GE crops in Australia, spoke in New Zealand about transgenic crops and their effects in his native Australia. He reported that many Australian farmers have suffered significant losses as a result of GE contamination of their conventional crops, and that legislation favours seed companies, not farmers. Legally without the means to protect his livelihood, Mackley has, regardless of conditions, been forced to time his plantings to avoid contamination from transgenic crops grown by a neighbour. His is a critical balance between profit or contamination and loss. Contaminated volunteers infringe on his land.

There are a number of genetic barriers that could be used to isolate or minimise cross contamination of a transgenic and conventional plant due to pollen and seed dispersal; e.g. male sterility, chloroplast transformation, apomixis, ploidy level and control of flowering. However, that contamination can only be minimised, not eliminated.

Genetically engineered traits and seed may be transported by any of the following means:

- By horizontal gene transfer (HGT);
- Through stock into manure; on farm vehicles or human footwear;
- By being blown off trucks transporting seed; co-mingled with conventional seed in handling, transport or storage; in food and stock feed processing;
- By rain and floodwater; and as wind-borne pollen.

Researchers studying rain in Northwest India concluded that long distance dispersal could allow pollen grains to travel 600 km (Singh *et al*, 1993). A frontal storm can quickly lift air masses skywards several kilometres (Emberlin *et al* 1993, 1995, 1997) carrying pollen grains with the airflow (Faegri & Iverson 1989). In the upper atmosphere, pollen can travel for hundreds of kilometres at a range of 25-50 metres per second, before being deposited or captured by rain droplets (Mandrioli *et al* 1984). Pollen grains can also be re-suspended from surfaces and re-deposited at other locations (Erdtman 1969; Faegri and Iverson 1989).

A study surveyed pedigreed canola (*Brassica napus L.*) seedlots for contaminating herbicide resistance traits and found unexpected contamination (even at 0.25%) can cause problems for producers that practice direct seeding and depend on glyphosate for nonselective, broad-spectrum weed control.[17]

New Zealand's Crown Research Institute, Crop & Food Research, has developed transgenic potatoes since the 1980s. However, this research has now stopped because the transgenic potatoes did not perform well in the field and were not considered commercially viable. A report prepared for the Ministry for the Environment read: "True potato seeds can contribute to a significant weed problem in subsequent crops (Lawson, 1983). Up to 15-250 million true seeds per hectare can be produced depending on the cultivar, environmental conditions and insect activity. Seeds may remain dormant in soil for up to two years and have been reported to retain viability over a seven-year rotation to the next potato crop."[10] This could apply to transgenic potato crops as readily as non-GE crops.

No genetically engineered organisms have been approved for commercial release in New Zealand. Despite strict import controls designed to minimise the chances of contamination from accidental mixing and cross pollination at all stages from planting to point of sale, New Zealand has imported seed found to be contaminated and some plantings have had to be destroyed. Traces of transgenic material involving seed imports were found 2001 through to 2005. Any further subsequent lapses have not been made public.[18]

[17] Evidence of Contamination of Pedigreed Canola (Brassica Napus) Seedlots in Western Canada with GE Herbicide Resistance Traits https://www.researchgate.net/publication/228539903_Evidence_of_Contamination_of_Pedigreed_Canola_Brassica_Napus_Seedlots_in_Western_Canada_with_Genetically_Engineered_Herbicide_Resistance_Traits [accessed Apr 29, 2017].

[18] https://www.mpi.govt.nz/news-and-resources/resources/official-information-act-responses/historic-genetically-modified-seed-import-incidents/

Liability for contamination

While detection systems are capable of detecting low levels of transgenic contamination, the Crop & Food Research Report mentioned earlier states[10]: "Such levels of contamination could not be detected previously in organic crops concerned about contamination from non-organic sources." Obviously, continuous improvements in detection systems are needed.

Insurance companies will not insure against any adverse effects of growing transgenic crops. When Minister for the Environment, David Benson-Pope confirmed in writing that if transgenic contamination occurs in New Zealand it will be the person or persons affected by the contamination who will pay, i.e., local councils and growers, not the polluter.[19]

Once released, transgenic organisms will remain in the environment and replicate.

Of particular concern for New Zealand is the development of transgenic ryegrass

Field trials of transgenic ryegrass, developed in Australia and funded by the New Zealand taxpayer, are expected to begin in the US this year. AgResearch's High Metabolisable Energy ryegrass is claimed to have proven in the laboratory to reduce methane and nitrous oxide emissions and nitrogen leaching while improving productivity. The HSNO Act may allow restricted release of this ryegrass in New Zealand.

When considering transgenic ryegrass we must be sensitive to New Zealand's valuable overseas markets for ryegrass seed which are based on quality and purity. Our markets would not tolerate transgenic contamination. In February 2014, it was reported that seed exports rose in value to NZ$192 million. Radish, ryegrass and white and red clover are export seed crops and exported to over 60 world markets. Their total value was up NZ$24m / 14% from the previous year according to Statistics New Zealand data. Herbage seed from rye grass, clover and other grasses accounted for 53% of total seed exports by value; Australia buying 16%.[20]

Release of transgenic ryegrass could seriously threaten New Zealand agriculture and exports.[21]

Ryegrass (*Lolium rigidum*) is a problematic weed in Australia. Victoria's Department of Primary Industries has published an overview of baseline biological information relevant to the risk assessment of transgenic forms of ryegrass species that may be released in Australia. It states that Italian ryegrass, perennial ryegrass and tall fescue are a "highly outcrossing, wind pollinated species". Extensive gene flow can occur of viable and non-viable material, and dispersal of pollen can be "forward, backward and upward".[22] Recent, recurrent selection studies have revealed that phenotypic variation in response to low herbicide rates is heritable and can result in rapid evolution of herbicide resistance in genetically variable cross-pollinated rigid ryegrass.[23]

Pollen can rise high into the atmosphere, move with wind patterns and be re-deposited in calm weather. Pollen could move significant distances from its source. Studies have shown that the amount of pollen dispersed / deposited does not always decrease with increasing distance from a source.[21] How far pollen can travel is defined in the report, 'Pollen-Rain from Vegetation of Northwest India'.[24]

Grass seeds are capable of germination after passing through animals' digestive systems, with viable seeds being recovered from faeces 12-24 hours after feeding, and seeds can be transported in sheep wool. Viable Italian ryegrass seeds have been found in European hares' faeces showing wild animals assist in seed

[19] https://www.nzgeo.com/stories/whos-paying/
[20] http://www.stuff.co.nz/business/farming/cropping/9695230/Seed-exports-rise-in-value
[21] https://farmersweekly.co.nz/topic/genetics-and-science/genetic-modification/kiwi-grass-ready-for-us-trial
[22] 'The Biology of Lolium multiflorum Lam. (Italian ryegrass), Lolium perenne L. (perennial ryegrass) and Lolium arundinaceum (Schreb.) Darbysh (tall fescue)', #AG1241; 1 May 2008 Version. Australian Government Office of the Gene Technology Regulator http://www.ogtr.gov.au.
[23] Herbicide-Susceptible Rigid Ryegrass (Lolium rigidum) Population Made Even More Susceptible [2012] Manalil, et al.
[24] Singh G et al, Pollen-rain from vegetation of Northwest India, New Physiologist, 1993, 72: 191-206. www.wrm.org.uy/actors/BDC/COP8.pdf

dispersal, as well as birds, water and humans.[21] Perennial ryegrass seed persists in soil. A study in New South Wales of tall fescue and perennial ryegrass indicated 14 months after seed production that the seed bank contained 14% of perennial ryegrass and 10% of tall fescue seed released. Under controlled conditions, seeds maintained germination ability for at least 12 months.[21]

Researchers found the likelihood of weediness is increased by the intentional introduction of plants. *Lolium* species have many weedy characteristics and are capable of adapting rapidly to their environment, producing large amounts of seed which are easily dispersed.[21]

Gene flow is a natural phenomenon not unique to transgenic crops. When a weed crossbreeds with a farm-cultivated relative and acquires new genetic traits – including engineered DNA that make it more hardy – the hybrid weed can pass the traits on to future generations. The result may be very hardy, hard-to-kill weeds.

Non-target effects on pollinator food and habitats, conventional crops, air, rain and groundwater

The increase in the use of multiple herbicides has reduced the occurrence of wild flowers and food sources for pollinators, and their habitats, and it has damaged soil. Pesticide residues in soil leach out into bodies of water. There is concern for non-target effects on soil microbial communities that can potentially negatively affect soil functions, plant health, and crop productivity. In one study, rhizosphere soil was sampled over four growth periods and the bacterial community composition compared between glyphosate treated and untreated rhizospheres using next-generation barcoded sequencing. "In the presence or absence of glyphosate, corn and soybean rhizospheres were dominated by members of the phyla Proteobacteria, Acidobacteria, and Actinobacteria. Proteobacteria (particularly gammaproteobacteria) increased in relative abundance for both crops following glyphosate exposure, and the relative abundance of Acidobacteria decreased in response to glyphosate exposure." Some Acidobacteria are involved in biogeochemical processes; a decrease in abundance affecting significant changes in nutrient status of the rhizosphere."[25]

Earthworms shred plant litter, mineralising it and soil organic matter in their guts, and produce casts that enhance soil nutrient availability and promote plant productivity. Burrowing aids soil root penetration and water infiltration. Another study found "the earthworm *Eisenia fetida* avoids soil contaminated by the glyphosate based herbicide Groundclear, and this impact on locomotor activity could compromise the survival of the worms." Yet a further study found the number of hatched *Eisenia fetida* Andrei cocoons was significantly reduced in earthworms exposed to Roundup treated soils, and the number of juveniles was also significantly lower, indicating that glyphosate has a deleterious effect on the viability of cocoons. This study also found that the earthworms avoid soil treated with glyphosate. Earthworms have chemoreceptors and sensory turbercles and present a high sensitivity to chemicals in the soil.[26]

A 2011 study, 'Occurrence and fate of the herbicide glyphosate and its degradate aminomethylphosphonic acid in the atmosphere', conducted by the US Geological Survey (USGS) monitored glyphosate content in air and water samples in Iowa and Mississippi across two growing seasons. Results showed that glyphosate is detected 60-100% of the time in both air and rain samples. Its concentration in rainfall is found to be at higher levels than for any other previously monitored pesticide.

A second USGS 2011 study, 'Fate and transport of glyphosate and aminomethylphosphonic acid in surface waters of agricultural basins' monitored water concentrations of glyphosate. It found glyphosate persists in streams throughout the growing season of transgenic crops in Iowa and Mississippi, but is generally not observed during other times of the year. The degradation product of glyphosate, aminomethylphosphonic acid (AMPA), which has a longer environmental lifetime, is also frequently detected in streams and rain.

25 Science of The Total Environment, Volume 543, Part A, 1 February 2016, Glyphosate effects on soil rhizosphere-associated bacterial communities, Newmana et al, https://doi.org/10.1016/j.scitotenv.2015.11.008. http://www.sciencedirect.com/science/article/pii/S004896971530989X
26 The impact of glyphosate on soil health, The evidence to date www.soilassociation.org/media/7202/glyphosate-and-soil-health-full-report.pdf

Growing transgenic crops close to organic and conventional produce increases the risk of genetic cross-contamination, as pollen from genetically engineered crops has the potential to drift onto conventional crops and produce offspring. With transgenic crops prohibited under organic standards organic farmers suffer significant financial losses if this occurs. A survey by Food & Water Watch, found over half of the surveyed organic farmers had grain rejected because of transgene contamination. The value of the New Zealand domestic market for organics is an estimated NZ$217 million for certified products and exports were between NZ$240m and and NZ$250m in value in 2015. The value of organic pastoral exports has grown 45% since 2009.[27]

Transgene contamination affects exports. When Canadian honey was found contaminated with novel DNA, exports to Europe dropped dramatically. In May 2013, when the USDA revealed that unapproved transgenic wheat was growing in an Oregon wheat field, Japan cancelled its order to buy US western white wheat. A Japanese pizza maker rejected corn from a Gisborne firm when it was found to contain transgenic material. In Europe 'GM Free' labelling is increasing; consumers do not want to ingest transgenic foodstuffs or additives.

Genetically engineered crops have been grown since the mid 1990s. In the subsequent two decades, despite claims to the contrary, evidence has accumulated "that several vertebrate pathways are likely targets of action, including hepatorenal damage, effects on nutrient balance through glyphosate chelating action and endocrine disruption. Other early assumptions about glyphosate, for example that it is not persistent in the environment, have also been called into question, depending upon soil type. In addition, the prediction that glyphosate would never be present widely in surface water, rainfall, or groundwater has been shown to be inaccurate."[28]

Human health, glyphosate and other agrichemicals

Glyphosate is widely used in agriculture, horticulture, viticulture, silviculture and forestry, in industrial and public sites, gardens, sports facilities, school grounds and aquatic environments. Regulatory bodies worldwide have approved many applications involving glyphosate and other herbicides, generally on the basis of decisions made by US regulatory authorities which largely rely on industry tests run for short periods, and without testing being carried out by independent scientists. With growing usage, concerns about its effects on human and environmental health are increasingly being raised. Also, increasingly, countries are pursuing tighter control to an outright ban on glyphosate.

The EU Commission claims glyphosate as safe. According to an investigation by EUObserver and Dutch magazine OneWorld, this conclusion was partially based on scientific evidence contained in internal Monsanto documents recently revealed in cancer litigation in the US. The documents suggest the scientific evidence was "written or influenced by Monsanto".[29] EU member states are putting bans and restrictions in force.[30]

The American Cancer Society has glyphosate on a list of "probable carcinogens."[31]

Canada's food regulator has found traces of glyphosate in nearly one-third of food products with residue levels above the acceptable limits in about four per cent of grain products.[32]

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[27] 2016 New Zealand Organic Market Report http://www.oanz.org/publications/reports.html
[28] Environ Health. 2016; 15: 19. 2016 Feb 17. doi: 10.1186/s12940-016-0117-0 PMCID: PMC4756530. Concerns over use of glyphosate-based herbicides and risks associated with exposures: a consensus statement, J P Myers et al, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4756530/
[29] EU weed-killer evidence "written by Monsanto" By Vincent Harmsen EUObserver, 2 May 2017 https://euobserver.com/environment/137741
[30] GMWatch Review 379, 4 May 2017
[31] http://www.cbc.ca/news/health/cfia-report-glyphosate-1.4070275
[32] Canadian Food Inspection Agency Safeguarding with Science: Glyphosate Testing in 2015-2016 http://static.producer.com/wp-content/uploads/2017/04/CFIA_ACIA-9123346-v1-FSSD-FSSS-Glyphosate-Final-Report-15-16_0184101.pdf#_ga=1.196489061.892407858.1492107204

Dr Warren Bell, president of the Canadian Association of Physicians for the Environment, is concerned about the long-term health effects of exposure to low levels of glyphosate. Speaking to CBC Nova Scotia in 2016, he said: "Glyphosate residues have been found in California wine, in menstrual pads, in German beer, in the urine of 99.6 per cent of Germans tested." He added that, once glyphosate is in a person's body, there is evidence to suggest it could mimic the naturally occurring amino acid, glycine, and prevent proteins in the body from working properly. It opens up the potential for "disturbances of biological function." Bell is also concerned about evidence that suggests glyphosate can create antibiotic resistance in humans.[31]

With changes in the usage of glyphosate based herbicides associated with transgenic, herbicide-tolerant crops, regulators have made dramatic increases in accepted tolerance levels in maize, oilseed (soybeans and canola), and alfalfa crops and related livestock feeds.

PSGR maintains there is a need for a reassessment of glyphosate toxicity by independent laboratories. Further, independent studies need to look at the cumulative effects of multi-herbicide ingestion.

These studies to be accompanied by systematic efforts by relevant agencies to monitor glyphosate based herbicide levels in people and the food supply, neither of which are happening currently anywhere worldwide.

Friends of the Earth Europe commissioned laboratory tests on urine samples from city-dwelling volunteers in 18 countries across Europe. On average 44% of samples contained glyphosate.[33]

PSGR also suggests that common commercial formulations of glyphosate based herbicides should be prioritized for inclusion in government toxicology testing programmes such as the Total Diet Study overseen by the Ministry for Primary Industries.

Glyphosate has been detected a number of items including honey and infant formula.[34]

Leading the way to reassessments is the World Health Organisation International Agency for Research on Cancer (IARC).[35] Seventeen experts from 11 countries met at IARC in Lyon, France to assess the carcinogenicity of the organophosphate pesticides tetrachlorvinphos, parathion, malathion, diazinon, and glyphosate. In March 2015 they classified glyphosate as "probably carcinogenic to humans" (Group 2A).[36] [37]

Among other effects, the group found:

• Glyphosate has been detected in the blood and urine of agricultural workers, indicating absorption;
• Soil microbes degrade glyphosate to aminomethylphosphoric acid (AMPA);
• Blood AMPA detection after poisonings suggests intestinal microbial metabolism in humans;
• Glyphosate and glyphosate formulations induced DNA and chromosomal damage in mammals, and in human and animal cells in vitro;
• One study reported increases in blood markers of chromosomal damage (micronuclei) in residents of several communities after spraying of glyphosate formulations;
• Glyphosate, glyphosate formulations, and AMPA induced oxidative stress in rodents and in vitro.

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[33] http://www.foeeurope.org/weed-killer-glyphosate-found-human-urine-across-Europe-130613
[34] http://www.ecowatch.com/toxic-weed-killer-glyphosate-found-in-breast-milk-infant-formula-1882030657.html
[35] http://monographs.iarc.fr/ IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. The IARC Monographs identify environmental factors that can increase the risk of human cancer. These include chemicals, complex mixtures, occupational exposures, physical agents, biological agents, and lifestyle factors
[36] 'Carcinogenicity of tetrachlorvinphos, parathion, malathion, diazinon, and glyphosate', Guyton et al, published online, 20 March 2015 DOI: http://dx.doi.org/10.1016/S1470-2045(15)70134-8. The assessments will be published as volume 112 of the IARC Monographs.
[37] (http://monographs.iarc.fr; monographs identifying environmental factors that can increase the risk of human cancer. National health agencies can use this information as scientific support for their actions to prevent exposure to potential carcinogens. Since 1971, more than 900 agents have been evaluated, of which more than 400 have been identified as carcinogenic, probably carcinogenic, or possibly carcinogenic to humans. https://www.iarc.fr/

Glyphosate-formulated herbicides have been linked to numerous health problems particularly non-Hodgkin's lymphoma, ADHD, rhinitis, and hormone disruption.[38] Short term health effects include lung congestion and increased breathing rates. Chronic exposures at levels above Maximum Contaminant Levels (MCL) are likely to produce kidney damage and reproductive effects.

There are calls for the deregulation of corn and soybeans engineered to be tolerant to the herbicide 2,4-D. As with glyphosate, these new engineered crops will increase 2,4-D usage. The main reason for the push is the failure and contamination effects of glyphosate-tolerant crops. Dow AgroSciences produces 2,4-D and the 2,4-D tolerant transgenic crops which can also be stacked with glyphosate resistance.

2,4-D's contamination with dioxins relates to Agent Orange (2,4-D and 2,4,5-T), much of which was heavily contaminated with 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD), the most potent dioxin and an acknowledged carcinogen, even up to 40 ppm. 2,4-D is contaminated with dioxins during manufacturing and the US Environmental Protection Agency says little to no information is available on the levels of dioxin contamination present in 2,4-D after synthesis.

Dioxins have very long half-lives, are bio-accumulative, and present significant health risks developmentally and postnatally, including increased risk of birth defects, cancer, heart disease and diabetes.[39] [40] 2,4-D is acknowledged as neurotoxic, genotoxic, and an endocrine disruptor.

2,4-D has a high potential to leach from soils and contaminate ground water. Environmental monitoring has detected the herbicide in streams, groundwater and drinking water. Studies document 2,4-D's negative impacts on a wide range of animals. In birds, 2,4-D exposure reduced hatching success and caused birth defects. Toxic to fish, 2,4-D can bio-accumulate inside the fish. 2,4-D also is toxic to honey bees and earthworms.

With human food crops developed to resist herbicides and insecticides, consumers ingest resistant transgene/s, even if as minute fragments, from whatever part of the plant they consume, and with sprayed chemicals will be exposed to ingesting residues of greater than average applications. The cumulative effects of multiple daily helpings will stack up, particularly because other transgenic crops already form part of the human diet. It seems there is no research into the cumulative effect of virtual daily ingestion of multiple sources of transgenic foods and food additives, and of multiple agrichemical residues.

The human immune system is a major component in the pathogenesis of chronic diseases such as cancer and cardio-vascular disease. Epidemiological studies consistently find an inverse relationship exists between intake of vegetables and fruit and the risk for these diseases. It is unacceptable and irresponsible to add to those risks by approving transgenic food and feed, especially as regulators continue to increase acceptable chemical residue levels to meet industry demands and field results.

Claims that US citizens have eaten transgenic foods - without identifying labels - for two decades with no ill effects is seriously misleading. There has been no substantive independent epidemiological studies on human subjects to see if there are any negative affects to health and without mandated registering of potential adverse effects. It is scientifically impossible to trace, let alone study, patterns of consumption and their impacts based on the US experience and that claims that transgenic are safe for human health based on the experience of North American populations have no scientific basis.

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[38] http://cdn.intechopen.com/pdfs-wm/48553.pdf

[39] *Walters, J. Environmental Fate of 2,4-Dichlorophenoxyacetic Acid. Environmental Monitoring and Pest Management. California Department of Pesticide Regulation. Sacramento, CA. *US EPA. Appendix E. Review of Dioxin contamination. Available at http://www.epa.gov/espp/litstatus/effects/redleg-frog/2-4-d/appendix-e.pdf. *US EPA. Appendix E. Review of Dioxin contamination. Available at http://www.epa.gov/espp/litstatus/effects/redleg-frog/2-4-d/appendix-e.pdf

[40] http://www.toxipedia.org/display/toxipedia/2%2C4-D

What can be seen from US statistics is that: *the rate of chronic health conditions in US children increased from 12.8% in 1994 to 26.6% in 2006[41]; *a 2012 JAMA paper says the most common chronic condition experienced by adults is multimorbidity, the coexistence of multiple chronic diseases or conditions[42]; *as of 2012, about half of all adults, 117 million people, had one or more chronic health conditions and one of four adults two or more chronic health conditions.[43]

Allergic disease is the fifth leading chronic disease in the US among all ages, and the third most common chronic disease among children under 18 years old. Following the introduction of transgenic food crops, from 1997 to 2007, the prevalence of reported food allergy increased 18% among US children under age 18 years; almost one in five children. Children with food allergy are two to four times more likely to have other related conditions such as asthma and other allergies, compared with children without food allergies.[44] We know an allergic reaction occurs when ingestion exposes a consumer to a new protein. In the case of transgenic food crops, this can be a novel protein that does not occur in nature and has not been ingested previously. Reactions by an allergic person can range from a tingling sensation around the mouth and lips to death. It took decades to appreciate that trans-fats have caused millions of premature deaths; that DDT was harmful to humans[45]. Lessons must be learned. Apply the precautionary principle to transgenic food crops.

In 2011, doctors at Sherbrooke University Hospital in Quebec, Canada, found Bt-toxin[46] from transgenic corn accumulates in the human body. In 93% of the pregnant women tested, they found significant levels of the insecticidal protein CrylAb in the blood, in 80% of umbilical blood in their babies, and in 67% of non-pregnant women tested.[47]

From the womb to old age, human ingestion of genetically engineered organisms can pose health risks.

For more detailed information, see also

Glyphosate - PAN Mongraph http://www.pan-germany.org/download/PAN_HHP_List_150602_F.pdf

Glyphosate – calling for a ban http://www.psgr.org.nz/glyphosate/viewdownload/10-glyphosate/25-glyphosate-calling-for-a-ban

Glyphosate - N-(phosphonomethyl)glycine the active ingredient in many herbicides, an overview http://www.psgr.org.nz/glyphosate

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www.psgr.org.nz

[41] Dynamics of obesity and chronic health conditions among children and youth. Van Cleave et al AMA303p623-30(2010 Feb 17)
[42] Designing health care for the most common chronic condition--multimorbidity. Tinetti et al JAMA307p2493-4(2012 Jun 20)
[43] https://www.cdc.gov/chronicdisease/overview/
[44] http://www.responsibletechnology.org/gmo-dangers/health-risks/articles-about-risks-by-jeffrey-smith/Genetically-Engineered-Foods-May-Cause-Rising-Food-Allergies-Genetically-Engineered-Soybeans-May-2007
[45] DDT is a persistent organic pollutant (POP) with a half life of 2–15 years. Concerns were raised about its use in the 1940s. It was used extensively for agricultural use in the 1950s and 1960s. New Zealand finally banned DDT in 1989. https://en.wikipedia.org/wiki/DDT_in_New_Zealand
[46] The adoption of HT corn reached 89% of US corn acreage in 2014, 2015, and 2016. Insect-resistant crops contain the gene from the soil bacterium Bt (Bacillus thuringiensis) planted since 1996.
[47] Reprod Toxicol. 2011 May;31(4):528-33. doi: 10.1016/j.reprotox.2011.02.004. 18 February 2011, Maternal and foetal exposure to pesticides associated to genetically modified foods in Eastern Townships of Quebec, Canada, Aris and Leblanc. https://www.ncbi.nlm.nih.gov/pubmed/21338670