PSGR

Physicians and Scientists for Global Responsibility

New Zealand Charitable Trust

Formerly Physicians and Scientists for Responsible Genetics New Zealand

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Food Standards Australia New Zealand
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Application A1106 to allow food derived from corn line 4114 genetically engineered to provide tolerance to the herbicide glufosinate ammonium and protection against lepidopteran and coleopteran corn pests using strains of *Bacillus thuringiensis* (Bt).

PSGR recommends Food Standards Australia New Zealand (FSANZ) reject Application A1106. The food regulation review process of FSANZ has a legislated mandate to protect public health and safety. In approving this Application, FSANZ would not be meeting this duty of care.

There are three main areas of concern:

1. Risks associated with ingestion of a pesticide and/or insecticide

Transgenes express in the xylem of plants: leaves, fruit, flowers, pollen, nectar, and guttation fluid. Whatever part of a transgenic plant is used as a food or food ingredient, consumers will ingest transgenes, even if as minute fragments, from whatever part/s of the plant they consume.

Consumers will also ingest residues from the increased use of chemical sprays on transgenic herbicide-resistant crops and the increased potential uptake by plants of those sprays.

1.1 Glufosinate ammonium

Tolerance to glufosinate ammonium is achieved through expression of the enzyme phosphinothricin acetyltransferase derived from the soil bacterium *Streptomyces* viridochromogenes.

Glufosinate ammonium inhibits the enzyme glutamine synthetase, necessary for the human production of glutamine and for ammonia detoxification. It inhibits the same enzyme in animals. Glufosinate ammonium structurally resembles the natural amino acid, glutamic acid. It can stimulate the central nervous system and it is recognised that excess release of glutamic acid results in the death of nerve cells in the brain.[1]

[1] Fujii, T., Transgenerational effects of maternal exposure to chemicals on the functional development of the brain in the offspring. Cancer Causes and Control, 1997, Vol. 8, No. 3, pp. 524-528.

Glufosinate ammonium is used as a pre-emergence spray and as a pre-harvest desiccant on a variety of crops. Residues in food are of concern, especially when it is used as a pre-harvest desiccant.[2]

Agricultural sprays also include adjuvants and surfactants, which ingredients have frequently been proven more toxic than the pesticide itself. For example, the surfactant used in formulations, AES, has caused toxic effects. The metabolite, MPPA-3, is, like glufosinate, a neurotoxin. The US EPA reported that MPPA-3 injected into the brain of rats caused severe convulsions.[3]

Glufosinate has been found to cause a number of neurological symptoms in laboratory animals following both oral and dermal exposure. A study found that low doses of glufosinate affected central nervous system development in young rats, that exposure to even low doses of glufosinate in the infantile period causes changes in the kainic acid receptor in the brain.[4] Studies on sub-lethal doses of glufosinate ammonium caused abnormalities in the development of embryos in mammals both in vitro and in vivo, and deformities in the brain.[5] The World Health Organisation classifies glufosinate in toxicity Class III: "harmful if swallowed".

Farmers are spraying more frequently and more heavily simply because they can without harming their herbicide-resistant crops. This process of over spraying leaves standing crops contaminated with increased residual spray and these same plants then grow in ground retaining above-the-norm residues of the chemical spray/s, residues they can uptake.

Spraying close to harvest to suggest uniform maturity and facilitate easy lifting of the yield, desiccation, also leaves significant residual chemical/s on the crops close to harvesting. MAFF UK states that when used as a desiccant, glufosinate ammonium residues are detectable in dried peas, field beans, wheat, barley, oilseed rape, and linseed; all of which are used as food or feed ingredients. Wheat grain containing residues ground into flour retained 10-100% of the residue; bran residue levels 10-600% of those in grain. Such residues or a significant portion would be ingested.[6]

A 2010 study found pesticide exposure in general resulted in reduced fertility in males, genetic alterations in sperm, a reduced number of sperm, damage to germinal epithelium and altered hormone function. Some of the potential reproductive health effects of pesticides include reduced fertility, early and late pregnancy loss, premature birth and reproductive system effects, reduced fertility, genetic alterations in sperm, reduced number of sperm, damage to germinal epithelium, altered hormone function, low birth weight/small for gestational age and developmental defects.[7]

In a study published in December 2013, researchers tested the toxicity of nine pesticides involving the active ingredient and the added ingredients. Their results “challenge the relevance of the Acceptable Daily Intake for pesticides because this norm is calculated from the toxicity of the active principle alone. ... Chronic tests on pesticides may not reflect relevant environmental exposures if only one ingredient of these mixtures is tested alone.”

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[2] http://www.pananz.net/wp-content/uploads/2013/04/Glufosinate-monograph-12-Dec-2008.pdf
[3] Cox, C., Herbicide Fact Sheet: Glufosinate, Journal of Pesticide Reform, North West Coalition for Alternatives to Pesticides, Oregan, US, 1996.
[4] Fujii, T., T. Ohata, M. Horinaka, Alternations in the response to kainic acid in rats exposed to glufosinate-ammonium, a herbicide, during infantile period. Proc. Of the Japan Acad. Series B-Physical and Biological Sciences, 1996, Vol. 72, No. 1, pp. 7-10.
[5] Watanabe, T. , Apoptosis induced by glufosinate ammonium in the neuroepithelium of developing mouse embryos in culture. Neuroscientific Letters, 1997, Vol. 222, No. 1, pp.17-20. Watanabe, T. and T. Iwase, Development and dymorphogenic effects of glufosinate ammonium on mouse embryos in culture. Teratogenesis carcinogenesis and mutagenesis, 1996, Vol. 16, No. 6, pp. 287-299.
[6] http://www.ifrc.org/PageFiles/89755/Photos/307000-WDR-2011-FINAL-email-1.pdf.
www.gmo-compass.org/eng/agri_biotechnology/gmo_planting/257.global_gm_planting_2009.html
[7] de Vendômois JS, Roullier F, Cellier D, Séralini GE. A Comparison of the Effects of Three GM Corn Varieties on Mammalian Health. Int J Biol Sci 2009; 5(7):706-726. doi:10.7150/ijbs.5.706. Available from http://www.ijbs.com/v05p0706.htm

1.2 *Bacillus thuringiensis* (Bt)

Protection against lepidopteran insect pests is conferred by the *Bacillus thuringiensis cy1F* gene, which is a synthetic version of a gene from *Bacillus thuringiensis* var. *Aizawai* and encodes a truncated version of an insecticidal protecin Cry1F.

Protection against coleopteran insect pests if conferred by two genes, *cry34Ab1* and *cry35Ab1* both from *Bacillus thuringiensis* strain PS149B1 and enclosing the insecticidal proteins Cry34Ab1 and Cry35Ab1.

A study in 2013 examined the hematotoxicity and genotoxicity of four Bt spore-crystals, in this case engineered to express individually Cry1Aa, Cry1Ab, Cry1Ac or Cry2A. It demonstrated that Bt spore-crystals induced hematotoxicity, particularly to the erythroid lineage. This corroborated published literature demonstrating that alkali-solubilized Bt spore-crystals caused in vitro hemolysis in cell lines of laboratory subjects, including human erythrocytes. It suggested that the plasma membrane of susceptible cells (erythrocytes, in this case) may be the primary target for these toxins. The researchers concluded that the results showed that the Bt spore-crystals can cause hematological risks to vertebrates, increasing their toxic effects with long-term exposure.

With the advent of transgenic food plants expressing δ-endotoxins, the bioavailability of Cry proteins has increased.[8]

It is also known that synthetically produced Bt toxins can show much higher toxicity than native proteins and higher toxicity can give rise to unexpected risks. There have been no studies on potential health impacts due to combinations of the toxins or synergies with external factors such as protease inhibitors, or with residues from spraying. In general, the mode of action of Bt toxins is not fully understood and controversially debated.[9]

Developers of transgenic crops claim Bt has a history of safe use. They point to organic farmers and others who use Bt for natural insect control. However, with transgenic crops Bt genes are inserted into the plant and the Bt-toxin produced in transgenic plants is thousands of times more concentrated than natural Bt spray, In fact, it is designed to be more toxic.[10] It has properties of an allergen, and unlike the spray, cannot be washed off the plant.

Moreover, studies confirm that even the less toxic natural bacterial spray is harmful. When dispersed by plane to kill gypsy moths in the Pacific Northwest, about 500 people reported allergy or flu-like symptoms.[11] [12] Similar symptoms are reported by farm workers in India, caused by handling Bt cotton.[13] [14]

More significant is the incidence of animals dying when grazed on Bt cotton stubble.

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[8] 'Hematotoxicity of Bacillus thuringiensis as Spore-crystal Strains Cry1Aa, Cry1Ab, Cry1Ac or Cry2Aa in Swiss Albino Mice', Mezzomo et al., J Hematol Thromb Dis 2013, 1:1, http://dx.doi.org/10.4172/jhtd.1000104; http://foodrecap.net/wp-content/uploads/2013/05/nailing-cry-toxin-harmful-to-mice.pdf

[9] https://www.testbiotech.org/sites/default/files/SmartStax_Bt_Synergies_Testbiotech.pdf

[10] See for example, Dutton et al, 'Uptake of Bt-toxin by herbivores feeding on transgenic maize and consequences for the predator Chrysoperia carnea,' Eco Entomology 27 (2002): 441–7; and Romeis et al, 'Bacillus thuringiensis toxin (Cry1Ab) has no direct effect on larvae of the green lacewing Chrysoperla carnea (Stephens) (Neuroptera: Chrysopidae),' J Insect Physiology 50, no. 2–3 (2004): 175–183.

[11] Report of health surveillance activities: Asian gypsy moth control program, Olympia, WA: Washington State Dept. of Health, 1993).

[12] M Green et al., 'Public health implications of the microbial pesticide Bacillus thuringiensis: An epidemiological study, Oregon, 1985-86,' Amer. J. Public Health 80, no. 7(1990): 848–852.

[13] Ashish Gupta et al, 'Impact of Bt Cotton on Farmers' Health (in Barwani and Dhar District of Madhya Pradesh),' Report, Oct–Dec 2005.

[14] Sunday India, 26 October 2008

Post mortems showed severe irritation and black patches in both intestines and liver (as well as enlarged bile ducts).[15] In feeding study by the Deccan Development Society, all sheep fed Bt cotton plants died within 30 days; those that grazed on natural cotton plants remained healthy. Of 13 buffalo grazed on Bt cotton plants all became sick the next day and all died within three days.[16]

There is support for the specificity of the association of transgenic foods and specific disease processes. Multiple animal studies show significant immune dysregulation, including upregulation of cytokines associated with asthma, allergy, and inflammation.[17] [18] [19]

1.3 Transgene ingestion and effects on human health

While DNA is claimed to be mostly degraded during the industrial process and in the digestive tract, small fragments were detected in body tissues such as leukocytes, liver, spleen and gut bacteria.[20] Fragments of orally administered phage M13 and plant DNA were found to be taken up by phagocytes as part of their normal function as immune system cells.[21] Fragments could pass into other organs, including the foetus.

Animal studies reveal the potential for conditions presenting now and in the short- and long-term future. As shown above, transgenes have proven fatal in the field.

Ingestion effects may not be as immediate as the effects from direct spraying. However, with multiple daily helpings of transgenes, cumulative effects will stack up, particularly as other transgenic crops form part of the human diet. The effects over long periods are uncertain simply because no one is looking, or dare not risk using human guinea pigs in trials, or risk their careers by suggesting this is crucial research. Instead, industry and regulatory agencies have given transgenes a tick of approval without initiating independent long-term studies and without monitoring consumers.

In 2004, Netherwood et al[22] proved transgenes move from ingested food to bacteria in the human gut. In an earlier, four-year study, Professor Dr Han-Hinrich Kaatz found the transgene conferring resistance to glufosinate ammonium had transferred in bees' guts to microbes.[23] Since the pat gene can transfer to gut bacteria in bees, and since genetic material from transgenic soy can transfer to human gut bacteria, it is likely that the pat gene can also transfer from any transgene to human intestinal flora.

Neither the foregoing event nor its effects have been further studied.

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[15] 'Mortality in Sheep Flocks after Grazing on Bt Cotton Fields—Warangal District, Andhra Pradesh', Report of the Preliminary Assessment, April 2006, http://www.gmwatch.org/archive2.asp

[16] http://www.responsibletechnology.org/doctors-warn

[17] Finamore et al, 'Intestinal and peripheral immune response to MON 810 maize ingestion in weaning and old mice'. J Agric. Food Chem. 2008; 56(23):11533-11539. Kroghsbo et a;. 'Immunotoxicological studies of genetically modified rice expression PHA-E lectin or Bt toxin in Wistar rats', Toxicology. 2008; 245:24-34.

[18] Malatesta M, Boraldi F, Annovi G, et al. 'A long-term study on female mice fed on a genetically modified soybean: effects on liver ageing. Histochem Cell Biol. 2008; 130:967-977. Velimirov et al, 'Biological effects of transgenic maize NK603xMON810 fed in long term reproduction studies in mice', Report-Federal Ministry of Health, Family and Youth. 2008.

[19] Kilic A, Aday M. A three generational study with genetically modified Bt corn in rats: biochemical and histopathological investigation. Food Chem. Toxicol. 2008; 46(3):1164-1170.

[20] 'Foreign (M13) DNA ingested by mice reaches peripheral leukocytes, spleen, and liver via the intestinal wall mucosa and can be covalently linked to mouse DNA', Schubbert et al, Proc. Natl. Acad. Sci. USA Vol. 94, pp. 961–966, February 1997 Medical Sciences, http://www.pnas.org/content/94/3/961.full.pdf

[21] On the fate of orally ingested foreign DNA in mice: chromosomal association and placental transmission to the fetus. Schubbert et al, Mol Gen Genet. 1998 Oct;259(6):569-76. http://www.ncbi.nlm.nih.gov/pubmed/9819049

[22] 'Assessing the survival of transgenic plant DNA in the human gastrointestinal tract', Netherwood et al., Nat Biotechnol. 2004 Feb;22(2):204-9. Epub 2004 Jan 18. http://www.ncbi.nlm.nih.gov/pubmed/14730317.

[23] Antony Barnett, New Research Shows Genetically Modified Genes Are Jumping Species Barrier, London Observer, May 28, 2000.

2 Bioaccumulation and potential health results associated with residues

Bioaccumulation is a normal process of growth and nurturing of organisms. All animals - including humans - bioaccumulate ingested material and can bioaccumulate substances in the body to levels that can cause harm. A typical food chain bioaccumulation process is plant uptake from soil or spray, animal eating plant, human eating animal. Each step can result in increased bioaccumulation including toxins where absorption of a substance is at a rate greater than that at which the substance is lost or eliminated.

While official bodies accept the word of developers and those with vested interest continue to deny the possibility of adverse effects, this does not mean there are none. Animal studies reveal the potential for conditions presenting now and in the short- and long-term future.

For example, in one study, mouse embryos exposed to glufosinate in vitro developed apoptosis (fragmentation of the cells leading to cell death) in the neuroepithelium of the brain.[24] An earlier study found all embryos in treated groups had specific defects including overall growth retardation, increased death of embryos, hypoplasia (incomplete g/ml, and cleft lips at 20µ development) of the forebrain at 10g/ml.

Described as a "crisis" the number of US citizens with chronic health conditions is rapidly increasing: rising from 44.7% (118 million people) in 1995 – the year the first large scale planting of transgenic crops occurred - to 47.7% (149 million) in 2015. The rate is predicted to rise to 49.2% (149 million) in 2030.[25] In a 2012 study based on official statistics, researchers found approximately half (117 million) of US adults have at least one of the 10 chronic conditions examined (hypertension, coronary heart disease, stroke, diabetes, cancer, arthritis, hepatitis, weak or failing kidneys, current asthma, or chronic obstructive pulmonary disease [COPD]). One in four adults has multiple chronic conditions.

While there are multiple reasons for this rise in chronic diseases, professional medical bodies point to the evidence accumulating that consuming transgenes has adverse effects on human health. Medical professionals and veterinarians in the US are advising patients, pet owners and farmers not to eat transgenic foods or feed them to pets or livestock. The results of not doing so are reported to be substantial improvements in health and well-being.[26]

The International Assessment of Agricultural Knowledge Science and Technology for Development (IAASTD), part of the United Nations Environment Programme, issued a report co-authored by over 400 international experts and sponsored by the UN and the World Bank. It concluded: "The safety of GMO foods and feed is controversial due to limited available data, particularly for long-term nutritional consumption and chronic exposure" and "the approval process of GM crops is considered inadequate."[27]

The Australian Medical Association has said, "Genetically modified foods have been developed and introduced without regard for full and independent safety evaluation, or full and adequate public consultation or rigorous assessment of health impacts."[28]

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[24] 'Foreign (M13) DNA ingested by mice reaches peripheral leukocytes, spleen, and liver via the intestinal wall mucosa and can be covalently linked to mouse DNA', Schubbert (TWO BBs) R, et al, Proc. Natl. Acad. Sci. USA, Vol. 94, pp. 961–966, February 1997, Medical Sciences, http://www.pnas.org/content/94/3/961.full.pdf
[25] http://www.fightchronicdisease.org/sites/fightchronicdisease.org/files/docs/GrowingCrisisofChronicDiseaseintheUSfactsheet_81009.pdf
[26] http://www.cdc.gov/pcd/issues/2014/13_0389.htm
[27] http://www.unep.org/
[28] https://ama.com.au/

A British Medical Association report concluded that with regard to the long-term effects of GE foods on human health and the environment, "many unanswered questions remain" and that "safety concerns cannot, as yet, be dismissed completely on the basis of information currently available".[29]

The American Academy of Environmental Medicine[30] (AAEM) has stated, "GM foods pose a serious health risk in the areas of toxicology, allergy and immune function, reproductive health, and metabolic, physiologic and genetic health, and are without benefit. There is more than a casual association between GM foods and adverse health effects. There is causation as defined by Hill's Criteria[31] in the areas of strength of association, consistency, specificity, biological gradient and biological plausibility. The strength of association and consistency between GM foods and disease is confirmed in several animal studies."

It further states, "Multiple animal studies show significant immune dysregulation," including increase in cytokines, which are "associated with asthma, allergy, and inflammation." All are on the rise in the US. The AAEM highlights animal studies showing altered structure and function of the liver, including altered lipid and carbohydrate metabolism as well as cellular changes that could lead to accelerated aging and possibly lead to the accumulation of reactive oxygen species (ROS).[32] Kidney, pancreas and spleen changes have been documented.[28] [33]

The cumulative effects of ingesting growing quantities of multiple and substantially different sequences of transgenes on a daily basis, potentially for a lifetime has not been pursued officially. Effectively, populations, especially in the US, and especially the most vulnerable of society – foetuses, infants and children, the elderly, and those with challenged immune systems - have unknowingly acted as guinea pigs for an ongoing experiment, the results of which no official body is monitoring or evaluating.

There is also an absence of independent substantive data on the potential interactions of chemicals that a transgenic product has been designed to resist and an absence of data to assess potential health risks to humans through unique combinations of chemicals in food that are accepted as probable or feasible. This is an unmanaged risk.

3 The premises on which evaluations are based

It is safe to say transgenic food crops have been evaluated mainly by US regulatory bodies which authorities declared them safe for human consumption. It is also a fact that almost all of the 'safety' testing has been carried out by the company developing the novel DNA, not by independent scientists.

In Alliance for Bio-Integrity et al v Shalala (1998) over 44,000 pages of files produced by the US Food and Drug Administration (FDA) at the behest of the Court revealed it had declared genetically engineered foods to be safe despite disagreement from its own experts, and that it falsely claimed a broad scientific consensus supported its stance.

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[29] http://bma.org.uk/
[30] http://www.aaemonline.org/gmopost.html
[31] Hill, AB. The environment and disease: association or causation? Proceeding of the Royal Society of Medicine 1965; 58:295-300.
[32] Malatesta et al, 'A long-term study on female mice fed on a genetically modified soybean: effects on liver ageing. Histochem Cell Biol. 2008; 130:967-977. Velimirov et al, Biological effects of transgenic maize NK603xMON810 fed in long term reproduction studies in mice. Report-Federal Min Health, 2008. Kilic & Aday, 'A three generational study with genetically modified Bt corn in rats: biochemical and histopathological investigation. Food Chem. Toxicol. 2008; 46(3):1164-11707
[33] Finamore et al. Intestinal and peripheral immune response to MON 810 maize ingestion in weaning and old mice. J Agric. Food Chem. 2008; 56(23):11533-11539.

Internal reports and memoranda disclosed agency scientists repeatedly cautioned that foods produced through recombinant DNA technology - that is, genetically engineered organisms - entail different risks than do their conventionally produced counterparts and that this was consistently disregarded when FDA policy was written in treating transgenic foods the same as conventional ones.

In taking this stance, the agency violated the US Food, Drug and Cosmetic Act in allowing genetically engineered foods to be marketed without testing on the premise that they are 'generally recognized as safe' (GRAS) by qualified experts.

The consensus of scientists working for the FDA at that time was that transgenic foods were inherently risky, and might create hard-to-detect allergies, poisons, gene transfer to gut bacteria, new diseases, and nutritional problems. They urged rigorous long-term tests.

The 2014 'Hot Debate' at New Zealand's Lincoln University featured six experts discussing transgenic organisms. Dr Jon Hickford and Dr Tony Connor, proponents of genetic engineering technology, stated transgenic foods were safe to eat.

They were asked (a) if they could provide 10 human studies to support this statement, and (b) would they also advise where the diagnostic tools are available for health professionals to identify if GE foods in the human diet are contributing or not to illnesses. Drs Hickford and Conner admitted there are no safety studies nor are there any diagnostic tools for monitoring public health impacts of GE foods.[34]

After near two decades of commercial transgenic crops, the results to consumers unknowingly ingesting transgenes are being questioned.

PSGR urges FSANZ to give serious attention to how they assess risks and why they approve virtually every Application made using scientific analysis released by overseas regulators of questionable integrity. The US FDA has admitted it operates under a directive "to foster" the US biotech industry.[35] New Zealand and Australia should not follow suit.

4 Conclusion

There remains no official monitoring of effects on the human population and consumers have virtually no notification of the risks related to commercial transgenic crops via labelling or freedom of information.

With US consumers increasingly growing aware of the potential results of ingesting transgenic DNA, the fastest growing sector in its grocery industry is for foods free of transgenes, that sector now estimated to be at close to one third of the market. This is the result of consumer pressure, and from medical professionals recommending foods free of transgenes with consequent improved health for patients.[36]

New Zealand remains well positioned to help meet that demand for GE-free food and its population would benefit from such a stance.

[34] http://www.scoop.co.nz/stories/PO1404/S00063/myths-revealed-about-safety-of-ge-food.htm.
[35] Alliance for Bio-Integrity http://www.biointegrity.org/list.htm.
[36] http://www.aaemonline.org/gmopost.html.

PSGR urges FSANZ to:

- Undertake in-depth research using independent scientists to evaluate Applications with long term testing and not to take as an authority the questionable decisions of US regulators.

- Uphold public safety by banning transgenic foods from the New Zealand food supply, as there is no scientific proof that they are equivalent to non-transgenic foods or that they are safe.

If transgenic foods continue to be allowed into the New Zealand food supply FSANZ should insist on comprehensive mandatory labelling to identify them, to warn of potential health risks, and to give consumers a choice.

FSANZ should reject Application A1106. The food regulation review process of FSANZ has a legislated mandate to protect public health and safety. In approving this Application, FSANZ would not be meeting this duty of care.

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Ends