Witness Brief Form 2

Royal Commission on Genetic Modification

(For Publication)

1. Name of Witness

Dr Elaine R. Ingham

2. Name of "Interested Person" (on behalf of whom the Witness will appear)

Green Party of Aotearoa/New Zealand

3. Witness Brief Executive Summary

Executive Summary

Provide an overarching summary of the evidence and recommendations made [in respect of items (1) and (2) of the Warrant]. The Executive Summary should be no more than **3** pages in length

Please note that individual section summaries will be required and therefore the Executive Summary should focus on summarising the issues addressed in the brief and provide cross references to the sections in which the issues are covered rather than summarising the substantive content

1. Genetically engineered organisms have not been adequately assessed for their environmental or human health effects. It is inadequate to subject ORGANISMS to the tested required for non-living chemical pesticides, and conclude that there will be no adverse or risky effects from release of those organisms based on that testing.

2. A graduate student of mine, no longer working in the field of engineered organisms, and I did some research on a particular engineered bacterium that had been approved by the USEPA for field testing. No environmental effects were detected during pesticide or toxicity testing with this organism. However, Michael Holmes discovered that the engineered bacterium, Klebsiella planticola with a additional alcohol gene, killed all the wheat plants in microcosms into which the engineered organisms was added[1]. None of the wheat plants were killed in microcosms into which the not-engineered parent organism or just water were added.

3. This bacterium was engineered to produce alcohol from plant debris, so alcohol could be produced after raking up grass straw residues instead of burning fields. This organism would have been released to the real world by placing the residue left at the bottom of the fermentation container following grass straw alcohol production on fields as fertilizer. With a single release, we know that bacteria can spread over large distances, probably world-wide.

4. These bacteria would therefore get into the root systems of all terrestrial plants and begin to produce alcohol. The engineered bacterium produces far beyond the required amount of alcohol per gram soil than required to kill any terrestrial plant. This would result in the death of all terrestrial plants, because the parent bacterium has been found in the root systems of all plants

[1] Holmes, M. and E.R. Ingham. (1999) Ecological effects of genetically engineered Klebsiella planticola released into agricultural soil with varying clay content. Appl. Soil Ecol. 3:394-399.

where anyone has looked for its presence. This could have been the single most devastating impact on human beings since we would likely have lost corn, wheat, barley, vegetable crops, trees, bushes, etc, conceivably all terrestrial plants.

5. It is clear, therefore, that current testing procedures required by US regulatory agencies are completely inadequate in assessing the potential risks involved with genetically engineered organisms. Until such time as adequate testing procedures are instigated and carried out, engineered organisms should not be considered to have acceptable risks.

4. Evidence by Section (as specified in the matters set out in the Warrant)

Evidence by Section

Witness briefs are to be structured in line with the matters specified in the Warrant and the sections numbered accordingly

Each section should stand alone, and include a section summary, identifying the issues addressed in the section

Witness briefs may address **all** or only **some** of the sections (as specified in the Warrant). However section numbers should be retained, for example, if a brief addresses matters (a), (c) and (e), the sections shall be numbered (a), (c), and (e), rather than a, b, and c

Witness briefs may, within each section, adopt a sub-section approach using different headings; however, each paragraph should be consecutively numbered

Section A Recommendations

The Warrant has set the Commission the task of receiving representations upon, inquiring into, investigating, and reporting on the items set out in Section A (1) and (2) below

Section A (1)

A (1) the strategic options available to enable New Zealand to address, now and in the future, genetic modification, genetically modified organisms, and products

Section A (1) Summary

6. They should not be used in New Zealand, since they have not been adequately tested anywhere in the world to determine their complete environmental or human health risks.

A (1)

7. They should not be used in New Zealand, since they have not been adequately tested anywhere in the world to determine their complete environmental or human health risks.

Section A (2)

A (2) any changes considered desirable to the current legislative, regulatory, policy, or institutional arrangements for addressing, in New Zealand, genetic modification, genetically modified organisms, and products

Section A (2) Summary

8. Require full and complete biosafety testing before any engineered organisms is allowed to be released, in line with the Precautionary Principle. Appropriate assays to determine the effect of GEOs on soil are set out below. A worksheet setting out an example of how to assess the effects of a GE bacteria on release, taken from the biosafety manual, follows.

A (2)

9. Biosafety testing should follow the guidelines in the biosafety manual published by the Edmonds Institute. http://www.edmonds-institute.org/manual.html

10. Very few adequate soil tests have been carried out before the release of GEOs in North America. In the case of a release being considered, the following tests should be carried out to determine the effects of GEOs on soil organisms.

Active Bacteria/Active Fungi:

11. These tests measure the presence (numbers, biomass) of bacteria and fungi that are actively feeding and reproducing. Active bacteria and fungi rapidly enhance soil structure, nutrient retention, disease suppression and residue/pollutant decomposition.

12. This test is used to determine:

- Is nitrogen being retained against loss at this time?
- Is this soil dominated by the influence of fungi or bacteria at this time? Is there a decent food supply to support other types of microbes in the foodweb that feed upon bacteria or fungi?
- Did a product cause a bloom of bacteria or fungal activity that is useful and worthwhile?
- Did an application of a herbicide or other pesticide to soil stimulate or kill either bacteria or fungi?

Total Bacteria/Total Fungi:

13. This test measures the total amount of bacteria and fungi, including the active fraction. These tests do not distinguish active from inactive or dead cells, but give the long-term amount of carbon or nitrogen held in these organisms, assess disease suppressiveness, benefits to soil aggregation, and relate to decomposition rates.

14. This test is used to determine:

- Has the soil been dominated by fungi or bacteria or both in the recent past? Is there a pool of retained nitrogen in the form of protein that can be released to plants later?
- What is the size or capacity of the food supply to support higher forms of organisms in the soil foodweb that graze on bacteria and fungi. These higher forms balance the population levels of bacteria and fungi and excrete nitrogen into the soil in the form of ammonium for plants.

Nematode Numbers and Community Structure:

15. This tests extracts all the living nematodes from 50 to 100 grams of soil and reports numbers as numbers per gram dry soil. Nematodes are identified to genus and placed in one of four functional group classes according to what they eat. The report differentiates root-feeding nematodes to genus, but NOT to species. Reports list the beneficial bacterial-feeders, fungal-feeders and predatory nematodes, if any. Discovering total population levels, and the number of

each of the four groups is very informative about the health of the soil in general and the beneficial or negative impact of management practices.

16. This test is used to determine:

17. Are any pest nematodes present? Are they at economic threshold? Are any beneficial nematodes present? What ratio of beneficial nematodes that consume bacteria or fungi. Bacteria feeders help balance total bacteria populations and release nitrogen back to the plant. Fungal feeders balance total fungal levels, including root rot fungi, and also help release the nitrogen locked up inside fungi back to the plant. Predatory nematodes are higher-order predators that help balance all other nematodes. It is desirable to have some of these around but they are especially delicate and easily hurt by tillage.

Protozoa:

18. Protozoa are single celled critters that mostly eat bacteria. As such they are very important as a way to recycle the nitrogen and other nutrients locked up inside the bacteria. Some protozoa also attack nematodes and some will attack fungi. All in all, having good populations of the right kinds of protozoa makes for a balanced soil. Protozoa come in three major groups, the ciliates, flagellates, and the amoebae. We can tell important things about soil by looking at which of these three types ate high or low.Protozoa come in three main groups, the ciliates, flagellates and amoebae. The relative numbers of these groups assess whether the sample is aerobic, or anaerobic.

Mycorrhizal fungi (VAM):

19. This test determines the kind and amount of beneficial mycorrhizal colonization on the roots. These are extremely important fungi for plants that require colonization, such as most crop, vegetable, orchard and landscape trees and shrubs. This test measures:

- Is enough of the root system protected by mycorrhizal]fungi from disease-causing organisms?
- Is the root system colonized enough to supply nutrients at the rate the plant requires?
- Could the plant benefit from improved colonization?

Microarthropods:

20. This test provides information on the numbers and identification to major group of the visible soil critters. The important groups are the fungal-feeding, herbivore, and predatory microarthropods.

21. Roughly speaking there are two distinct aspects to studying arthropods in the soil. The first, and most fundamental, is the interrelationship between the most abundant and diverse elements within the soil itself. Since these are true soil-dwellers, they are usually small and inconvenient to see with the naked eye. The principal role of these creatures, (to make a long story short), is to recycle nutrients and make them available for plants. These micro-arthropods may be extracted from a soil core.

Section B Relevant Matters

The Warrant has set the Commission the task of receiving representations upon, inquiring into, and investigating, the matters set out in Section B (a) – (n) below

Section B (a)

B (a) where, how, and for what purpose genetic modification, genetically modified organisms, and products are being used in New Zealand at present
Section B (a) Summary
B (a)

Section B (b)

B (b) the evidence (including the scientific evidence), and the level of uncertainty, about the present and possible future use, in New Zealand, of genetic modification, genetically modified organisms, and products
Section B (b) Summary

22. Soil organisms are extremely sensitive to the use of genetically engineered organisms. Research into the effects of GEOs on soil is scanty. In the few cases where impacts have been assessed, it is usual to find that nearly every engineered plant will have unpredicted and unexpected effects on beneficial organisms in the soil. For example, Bt corn reduces the beneficial funghi around the root system, which reduces the corn plant's ability to take up nutrients reduced, and diminishes soil aggregate structure. This in turn leads to increased irrigation needs, and increased leaching of nutrients from the soil.

B (b)

23. Soil organisms are extremely sensitive to the use of genetically engineered organisms, and in those few cases where impacts have been assessed, it is quite likely that nearly every engineered plant will have unpredicted and unexpected effects on beneficial organisms in the soil. For example, we have worked this summer with growers on the effects of Bt corn on the beneficial fungi in soil. Bt clearly reduces colonization of corn roots by mycorrhizal fungi. These fungi are REQUIRED by corn to obtain nutrients from soil. Only if corn is grown with excessive fertilizer can corn do as well without mycorrhizal fungi as with these fungi.

24. Thus, use of Bt corn will harm grower's abilities to grow corn in the future without significant expenditures for nutrient inputs. Not only is the corn plant's ability to take up nutrients reduced, but soil aggregate structure is lost as well. Bt corn requires more water during the summer, because when soil aggregate structure is reduced, soil water-holding capacity is lost. More water resources must be used to maintain crop production compared to before the use of Bt plants.

25. Ability to hold nutrients in the soil is reduced when mycorrhizal fungi are lost, and thus, greater amounts of nutrients leach from the soil and end up in groundwater and drinking water, which taxpayers must then pay to clean up before that water can be safely consumed.

26. Round-up ready plants result in the use of more round-up, which selects for more and more bacterial dominance in soil, reducing the numbers and kinds of beneficial, disease-suppressive fungi. Thus, continued use of round-up ready plants changes the dominance of fungi versus bacteria in the soil, altering many nutrient cycling processes, nutrient retention abilities, and the ability of the soil to suppress disease.

27. Why aren't these effects known? Because regulatory agencies are not aware of the importance of soil organisms and their benefits to plant production. We have only recently begun to understand how important these organisms are to human health, to the level of nutrients in our foods. Without these organisms, disease suppression is severely curtailed, nutrient retention in soil is reduced, nutrient cycling is lost and fertilizers must be added in ever-increasing amounts in order to make up for this lack of in-soil availability of nutrients.

28. Soil structure will not be maintained without life in the soil, and compaction becomes ever more a factor. Root diseases abound, and plants cannot maintain production levels. All the ills of modern agriculture are intensified, and magnified. In order to understand the importance that effects on soil could have to agriculture and ecosystems, I have set out the functions of soil below.

29. **Decomposition of crop residues, manure and other organic material:** These materials will only decompose if certain species of fungi and bacteria, the "decomposers", decay them and allow recycling processes to occur. The ideal process forms large amounts of humus. The decay function gets rid of crop residues, but what it really does is convert the food energy in fresh organic matter to a form that feeds other soil organisms that do different indispensable functions, as described below.

30. **Retention of nutrients:** Nitrate and some other nutrients can leach out and be lost unless they can be banked in soils until the plant needs them. The function of nutrient retention occurs when bacteria and fungi multiply and increase their populations in the soil. Bacteria and fungi are extremely rich in protein that is made from nitrogen. When bacteria and fungi multiply they gather up free nitrogen from the soil and convert it to protein in their bodies. Nitrogen in this form is a bank account of convertible nitrogen that will not leach away or be lost as a gas. Products and cultural practices that stimulate a "bloom" of bacteria or fungi reproductive growth can be used as tools to achieve nutrient retention. When this function is working in your soil you can begin to apply lower rates of N and P with no reduction in crop yield.

31. **Nutrient Recycling:** Once nutrients have been retained, other kinds of soil organisms can be encouraged that feed on the bacteria and fungi. The rich meal of protein is metabolized and released back into the soil as ammonium that is quickly converted to nitrate for use by crops. The organisms that perform this function are beneficial nematodes that only feed on bacteria or fungi, the protozoa that feed on bacteria, and beneficial soil mites that feed on fungi. As these species go about their work they cause nitrogen especially, but also phosphorus and other nutrients, to be released at a gradual rate that supplies crops with a steady diet all season long.

32. **Biological control of root rot and parasitic nematodes:** A healthy soil that contains a broad diversity of microbial types most often contains species that kill, inhibit or suppress the kinds of fungi that cause root rots and the kinds of nematodes that attack roots. There is plenty of

research and on-farm experience to show that these economic threats can be controlled very well without the need for applied fungicides and nematicides. What it takes for this to happen is good soil health in the form of an active, intact soil foodweb.

33. **Production of plant growth regulators:** All plants depend on the presence of certain species of soil microorganisms in the root zone to produce various hormones and other chemical "signals" that stimulate growth and development. Two plants from the same seed, one in a dead soil and the other in a living soil, both with the same nutrients, will show different rates of growth, final size and value. The plant growing in healthy soil will have found the partnership it expects with beneficial microbes that produce growth hormones not made by the plant itself. The plant in healthy soil will be the better plant.

34. **Soil structure and tilth:** Enjoying the very best tilth depends on maintaining an aggregated or crumb soil structure. This is the ideal soil structure that allows for the optimum infiltration of air, water and roots systems. The formation of soil aggregates is mostly a biological process under the control of certain types of organisms in the soil foodweb. Aggregates will not form unless many sand, silt and clay particles are "glued" together by the gums and gels that only certain species of soil bacteria can produce. These aggregates are further strengthened against melting or collapse by certain species of beneficial fungi that grow throughout the aggregate and physically bind it. It is impossible for a soil to maintain the ideal crumb structure in the absence of the particular species of bacteria and fungi that perform the gluing and binding functions.

35. **Clean up of herbicide or pesticide carry over:** Most herbicide and pesticide molecules can be "eaten" or degraded by certain kinds of microbes in the soil, if those species are present. A healthy soil will tend to rid itself of ag chemical carry over and other forms of pollution.

Section B (c)

B (c) the risks of, and the benefits to be derived from, the use or avoidance of genetic modification, genetically modified organisms, and products in New Zealand, including: **(i)** the groups of persons who are likely to be advantaged by each of those benefits **(ii)** the groups of persons who are likely to be disadvantaged by each of those risks
Section B (c) Summary

36. These cannot be known without adequate testing, which has not yet occurred. The risks of each engineered organisms must be determined on a case-by-case basis. There is no way to determine who will be at risk, or who will benefit, except those selling the engineered organisms for immediate, monetary gain.

B (c)(i)

Response

B (c)(ii)

Response

Section B (d)

B (d) the international legal obligations of New Zealand in relation to genetic modification, genetically modified organisms, and products
Section B (d) Summary

Response

B (d)

Response

Section B (e)

B (e) the liability issues involved, or likely to be involved, now or in the future, in relation to the use, in New Zealand, of genetic modification, genetically modified organisms, and products
Section B (e) Summary

B (e)

Response

Section B (f)

B (f) the intellectual property issues involved, or likely to be involved, now or in the future, in relation to the use in New Zealand of genetic modification, genetically modified organisms, and products
Section B (f) Summary

Response

B (f)

Response

Section B (g)

B (g) the Crown's responsibilities under the Treaty of Waitangi in relation to genetic modification, genetically modified organisms, and products
Section B (g) Summary

Response

B (g)

Response

Section B (h)

B (h) the global developments and issues that may influence the manner in which New Zealand may use, or limit the use of, genetic modification, genetically modified organisms, and products
Section B (h) Summary

Response

B (h)

Response

Section B (i)

B (i) the opportunities that may be open to New Zealand from the use or avoidance of genetic modification, genetically modified organisms, and products
Section B (i) Summary

37. New Zealand can maintain the reputation of being unsullied by inappropriate use of engineered organisms, and could become a haven for those seeking to escape unpredicted and unexpected effects of those organisms once released into the environment.

B (i)

Response

Section B (j)

B (j) the main areas of public interest in genetic modification, genetically modified organisms, and products, including those related to:
(i) human health (including biomedical, food safety, and consumer choice)
(ii) environmental matters (including biodiversity, biosecurity issues, and the health of ecosystems)
(iii) economic matters (including research and innovation, business development, primary production, and exports)
(iv) cultural and ethical concerns
Section B (j) Summary

38. At several United Nations meetings, Monsanto scientists said that Bt protein in the leaf material of these plants would be decomposed within 15 minutes of reaching the soil. However leaf proteins, sugars and carbohydrates be found months after leaf fall in the soil.

39. The unpredictability of GEO's means that their release should be more strictly controlled than the release of any ordinary new species into a different environment. Years of research must take place prior to any release going ahead.

B (j)(i)

40. Human health issues with respect to genetically engineered organisms must be considered in a much more realistic light. For example, with Bt potato, or corn, Monsanto scientists stated that

because Bt is a protein, it would be denatured rapidly in the stomach, which has a pH of 1 or 2. Proteins, they say, are rapidly digested in the intestines.

41. This is true of any protein, and yet how many of us suffer from allergic reactions to peanuts, or brazil nuts, or milk, or any number of proteins? Those proteins were denatured in the stomach, but can nonetheless kill people. Just because a protein will be denatured in the stomach does not mean there is no risk.

42. What is the effect of consuming large numbers of french-fries with Bt toxin in it? What if this protein is not decomposed in the stomach, or even if denatured, still affects human health?

43. At several United Nations meetings, Monsanto scientists said that Bt protein in the leaf material of these plants would be decomposed within 15 minutes of reaching the soil. If this is true, why can leaf proteins, sugars and carbohydrates be found months after leaf fall in the soil? These materials can accumulate, especially in systems where the soil foodweb has been de-pauperized or destroyed through excessive use of pesticides and fertilizers. Thus, there is a risk from accumulation of these protein materials in soil.

44. If the Biosafety Manual is used, then the risk of unexpected or unpredicted effects can be REDUCED, not removed completely. A number of years of work should be required before a new organisms is released. Think about bringing a new animal to New Zealand, and the usually stringent rules that must apply to the possible escape of that animal, and the potential destructive effects it could have on New Zealand's wildlife.

45. Even more stringent rules should apply to genetically engineered organisms, because at least with existing animals, we know a great deal about their behavior in their normal habitats. We know how that behavior can be modified and be completely surprising when they are released into a new habitat. But with genetically engineered organisms, we cannot predict exactly how they will behave, even in the original habitat, much less in a new and unusual, and unique, set of habitats such as exist in New Zealand.

46. It is dangerous to thing that everything can be known about how an organisms will react in a new environment. Predicting the behavior of something novel, that has never before existed, is extremely risky.

B (j)(ii)

Response

B (j)(iii)

Response

B (j)(iv)

Response

Section B (k)

B (k) the key strategic issues drawing on ethical, cultural, environmental, social, and economic risks and benefits arising from the use of genetic modification, genetically modified organisms, and products

Section B (k) Summary

Response

B (k)

Response

Section B (l)

B (l) the international implications, in relation to both New Zealand's binding international obligations and New Zealand's foreign and trade policy, of any measures that New Zealand might take with regard to genetic modification, genetically modified organisms, and products, including the costs and risks associated with particular options
Section B (l) Summary

Response

B (l)

Response

Section B (m)

B (m) the range of strategic outcomes for the future application or avoidance of genetic modification, genetically modified organisms, and products in New Zealand
Section B (m) Summary

Response

B (m)

Response

Section B (n)

B (n) whether the statutory and regulatory processes controlling genetic modification, genetically modified organisms, and products in New Zealand are adequate to address the strategic outcomes that, in your opinion, are desirable, and whether any legislative, regulatory, policy, or other changes are needed to enable New Zealand to achieve these outcomes
Section B (n) Summary

Response

B (n)

Response