Greenpeace Submission to ERMA on *BT* Brassica GMF 06001

To: ERMA New Zealand
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This submission concerns - Application number: **Genetically modified brassica - GMF 06001**

Application by New Zealand Institute for Crop & Food Research Ltd. **(applicant name)**

to To assess agronomic performance, in the Lincoln region, over 10 years of vegetable and forage brassicas, specifically cabbage, broccoli, cauliflower and kale, modified for resistance to caterpillar pests like cabbage white butterfly and diamond-back moth. **(application purpose)**

Decision sought: We ask that ERMA *decline* this application.

Our reasons are attached.

We DO wish to be heard in support of our submission.

Signature ______________________ **Date** ______________________

Post to: ERMA New Zealand Fax to: ERMA New Zealand, P O Box 131, Wellington (04) 916-2426

Greenpeace New Zealand, Inc.

Genetically modified brassica- GMF 06001

Reasons for Submission

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INTRODUCTION

Greenpeace opposes the release of genetically modified organisms (GMOs) into the environment due to the irreversible and unpredictable nature of GMOs which pose a variety of unknowable risks to the integrity of ecological systems and are known to contaminate conventional and organic production when released.

Case by case analysis is inherently flawed as, in this case, no full environmental impact assessment or health testing including on animals and humans have been carried out. Thus this application, like similar other applications, is being assessed in the absence of any full public environmental impact assessment. Problems may arise after the fact. For example, non target organisms, such as moths and butterflies may suffer from long term effects. Any such effects would not be detected by the environmental risk assessment.

These GE field trials have no credible benefits and should not be approved. Most New Zealanders and overseas markets have rejected GM foods. Better scientific information would be gained from contained experiments and research into long-term sustainability. The GM plants could never be used without contaminating GM-free production. Even trace-levels of contamination are a risk to farmers and the economy. The soil bacterium *Bacillus thuringiensis* (*Bt*) has shown to cause insects to develop resistance and become even more of a problem, so the very basis of the application is flawed. The target insects will quickly evolve resistance to the continually expressed *Bt* in the GM plant. Diamondback moth has developed resistance in cabbage production systems that use frequent *Bt* sprays over the crop cycle. Organic farmers in particular risk losing the use of *Bt* as a pesticide.

Surveys shown that of New Zealanders do not want GE food. International market demand is for GE-free produce, and in response to customer preference, most New Zealand food companies have non-GE ingredient policies[1]. GE brassica would therefore not be in demand locally or internationally. Any application for the environmental release of GE crops (including field testing) in New Zealand could undermine our current GE-free status and our export markets. In the long term it could also threaten the livelihoods of organic and conventional farmers as has already happened in North America through loss of markets[2] and contamination of GE free production[3]. *Bt* brassica would bring no benefits to the consumer, but will instead expose the environment to needless risk. The argument that the field trial should be approved because it will benefit the scientists does not stack up. The funds should be spent on products and production methods the consumers and the public want and that will lead to technologies with realizable benefits that can be commercialised.

Reasons for Rejection of this Application

Controls and Methodology

The methodology of the proposed experiment is flawed. For instance, contrary to statements made in the application,[4] the toxicity of the protein is not fully understood.

Key non-target species have not been identified for New Zealand. This is especially important for moths and butterflies and other important agro-ecosystem species such bees and earthworms.[5] Long-term exposure studies (i.e. of months rather than days) to non-target organisms are essential for determining the toxicity of *Bt* crops to non-target organisms.[6]

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1 Greenpeace, GE Free Food Guide online, www.gefreefood.org.nz.

2 International Trade, Seeds of Doubt, North American farmers' experiences of GM crops, UK Soil Assn, Sept 2002, Pg. 43, 10.1.

3 'GM pollution now pervasive', www.theage.com.au/news/2001/04/30/FFXGG3PO3MC.html, 30 April 2001. 'GM volunteer canola causes havoc', *The Western Producer*, 6 September 2001.

4 See the claim made on page 41 that "when susceptible insects ingest this crystalline protein it is cleaved and converted into an active toxin that kills the insect by binding to receptors on the midgut microvillar membrane and causing disruption of the midgut cells (Federici, 2003). Broderick, N. A., Raffa, K. F. and Handelsman, J. (2006). Midgut bacteria required for Bacillus thuringiensis insecticidal activity. Proc. Natl. Acad. Sci. USA 103, 15196-15199.

5 See Huffman, D. L., Bischof, L. J., Griffitts, J. S. and Aroian, R. V. (2004). Pore worms: using Caenorhabditis elegans to study how bacterial toxins interact with their target host. Int. J. Med. Microbiol. 293, 599-607.

6 Andow, D.A. and A. Hilbeck. 2004. Science-based risk assessment for non-target effects of transgenic crops. *Bioscience*, 54: 637-649. Ecological Society of America (ESA) 2004. Genetically engineered organisms and the environment: Current status and recommendations. ESA Position Paper http://www.esa.org/pao/esaPositions/Papers/geo_position.htm. Marvier, M. 2002. Improving risk assessment for nontarget safety of transgenic crops. *Ecological Applications* 12: 1119-1124.

The applicants claim that the use of genetic material from native flora and fauna is explicitly excluded (page 41), but *Bacillus thuringiensis* is indigenous to New Zealand,[7] although the genetic material proposed to be used may not be.

Errors and uncertainties give no confidence that this proposed field trial will enable the environment to be protected or the adverse effects of new organisms prevented or managed, as is required in section 4 of the Act. The description that "the genetic material may also contain any of a number of other standard and commercially available regulatory elements derived from vertebrates, invertebrates, plants, fungi, bacteria and viruses" (page 41) is unacceptably vague. Activity of regulatory elements depends on their context, which would vary between organisms.[8] For example, a strong promoter from one genome may be a weak, moderate or strong promoter in another. The evaluation of the constructs was not adequate for determining the number and structure of insertions nor for evaluating the number and structure of RNA products that might arise from various insertions or unanticipated processing of transcripts derived from the novel DNA.

One area of particular risk is the proposed transfer of plants to a greenhouse for flowering (page 4). This represents an opportunity for heritable genetic material loss from the greenhouse, either through human error or through breakage of the greenhouse or another cause.

Another source of risk is the proposal to leave 'a small amount' of plant material on site page 18. Horizontal gene transfer (HGT) is one mechanism by which genetic material may be lost due to this proposed practice. While the applicant states that in the field, detection of such an event is improbable (page 27), this of course does not mean the event is itself improbable. No material should be allowed to remain in the soil.

The applicant acknowledges (page 21) that the *Bt* endotoxin can enter the soil from root exudates and from the post harvest decomposition of plant material. That there may already be non-GM *Bt* in the soil is not the point. The risk is of the introduction of foreign genetic material and expressed proteins to the soil, which must be taken into account under section 44A(2)(c) of the Act, as well as the adverse effects on ecosystems and their constituent parts under section 44A(2)(a).

The effects of *Bt* brassicas on soil decomposers and other beneficial arthropods have not been assessed. Such soil organisms play a crucial role in soil health.

The answer of the applicant to the assessment of potentially significant adverse effects is simply that "[i]f any such effects were subsequently identified the consequences and impact would be minimal as the plants could easily be destroyed."[9] This is no answer to the possibility that genetic material may escape by flowering or otherwise, or from material left in the soil, or that proteins exuded by the plants will endure and/or have impacts on the soil ecosystem.

The Research Objective and Scope of Assessment of the Proposal

The identification of the research objective is important, since under section 44A(2)(b) of the Act, ERMA must take into account any alternative method of achieving the research objective that has fewer adverse effects on the matters referred to in paragraph (a), being adverse effects on health and safety and the environment, than the field test.

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7 Martin, P. A. W. and Travers, R. S. (1989). Worldwide abundance and distribution of Bacillus thuringiensis isolates. Appl. Envir. Microbiol. 55, 2437-2442.

8 Rigoutsos, I., Huynh, T., Miranda, K., Tsirigos, A., McHardy, A. and Platt, D. (2006). Short blocks from the noncoding parts of the human genome have instances within nearly all known genes and relate to biological processes. Proc. Natl. Acad. Sci. USA 103, 6605-6610.

9 Application, Page 29-30, paras. A, B, and C.

The purpose of the proposal is said to be "[t]o assess agronomic performance, in the Lincoln region, over 10 years of vegetable and forage brassicas, specifically cabbage, broccoli, cauliflower and kale, modified for resistance to caterpillar pests like cabbage white butterfly and diamond-back moth." (page 3). This is the stated purpose that has been notified. It is not stated to be to benefit the wider scientific community, or the researcher. The proposal should be assessed on the basis of the stated purpose.

However, the applicant states that "[t]o fully assess the insect resistance, environmental impact and phenotype of these plants field testing is required. There is no alternative method for achieving *these research objectives*". (page 34) (emphasis added). The stated research objective must presumably therefore be expanded to include 'To fully assess the insect resistance, environmental impact and phenotype of the stated brassicas,' as well as their agronomic performance.

However, the applicant has stated that "the potential for future reduced environmental exposure to pesticides is a benefit of this field test." (page 31) This claimed potential benefit is clearly a downstream potential benefit of the field trial. This claim means that the risks, as well as the claimed benefits, of GM *Bt* brassica must be assessed. The applicant compares its proposal with toxic sprays such as Decid Forte, toxic to bees, humans and aquatic organisms. However the applicant must also compare their proposal with other control methods, including organic methods, which have no synthetic chemical toxicity.

Likewise, the applicant claims beneficial effects on human health and safety (page 31) through reduced exposure to pesticides. This is another claimed downstream benefit. There is no human testing involved and no possible benefits on human health and safety from the field trial. In order for this claim to be assessed, ERMA must also assess not only the beneficial effects of organic agriculture on health and safety, but the potentially harmful effects of *Bt* crops differentiating between *Bt* used on crops, common in the crops and insects they are targeting, and *Bt* integrated into the crop itself, on human health and safety. This will require extensive testing and monitoring that has not to date occurred.[10]

The applicants cite Romeis *et al*[11] for the proposition that in the US, the average number of insecticide applications for cotton has decreased from 4.6 to 0.8 owing to the introduction of *Bt* cotton. This immediately raises a number of questions which must now be answered in order to assess this alleged beneficial effect:

- did the resistance to *Bt* cotton increase in the areas that *Bt* cotton was grown?[12]
- Is *Bt* introduced in a truncated, preactivated, non-selective form harmful to beneficial insects such as bees? What are the effects on non-target organisms such as butterflies? What other effects are there on biodiversity?[13]

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[10] See Jack A. Heinemann, Ashley D. Sparrow and Terje Traaavik, 2005. Is confidence in the monitoring of GE foods justified. 22 *Biotechnology* 331-336.

[11] Presumably J Romeis, M Meissle, F Bigler. 2006. Transgenic crops expressing Bacillus thuringiensis toxins and biological control. Nature Biotechnology 24: 63-71. That article in turn references the FAO, FAO, the State of Food and Agriculture, FAO, Rome, 2004.

[12] Up to half of approximately two million acres of Bt cotton planted in the southern United States suffered a heavy infestation and growers were advised to salvage the crop with emergency spraying. In spite of claims that the Bt cotton would be 90 to 95% effective, some cotton consultants reported that the product was only 60% effective.

[13] See comments on page 10.

- What is the incidence of *Bt* crop failure[14] and what damage was caused by *Bt* resistant pests?[15]
- What are the allergenic effects of *Bt* toxins?

Increases in secondary pests also cause additional pesticide to be sprayed. After 7 years of growing GE *Bt* cotton in China, farmers are losing money and having to spray as much insecticide as conventional cotton.[16] These pests were secondary but, because of initial reductions in pesticide associated with the cultivation of *Bt* cotton, have been able to grow in number to the stage where they are an important pest. As some researchers found:[17]

> Though *Bt* farmers save a lot on primary pesticides, they have to spend more to suppress the outbreak of the secondary pests, leading to total pesticide expenditures between these two groups of farmers that are almost identical. In addition, the price for *Bt* seeds are 2 to 3 times higher than conventional seed in China. The extra cost of *Bt* seed must make the net revenue of *Bt* farmers lower than that of non-*Bt* farmers.

There are reports that *Bt* cotton is not fully insect resistant, especially later in the season. The pest insects that GE *Bt* cotton is supposed to kill has been seen feeding on the cotton leaves in the late growth stages (boll development) of cotton. There are suggestions that low concentrations of *Bt* in the leaves are because the *Bt* protein is degraded, linked to heat stress.[18] Interactions between the *Bt* toxin and the plant's own defence compounds may also reduce the insecticidal activity of *Bt.*[19] In India, researchers found a highly variable expression of *Bt* between different varieties of GE *Bt*

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14 E.g. see the reports of crop failure in India. See A Qayum and K Sakkhari, Bt Cotton in Andrha Pradesh,: a Three Year Assessment, at http://www.ddsindia.com/www/PDF/BT_Cotton_-_A_three_year_report.pdf.

15 See Scientists Confirm Failures of Bt-Crops, http://www.i-sis.org.uk/SCFOBTC.php .

16 Wang, S., Just, D.R. & Pinstrup-Andersen, P. 2006. Tarnishing silver bullets: Bt technology adoption, bounded rationality and the outbreak of secondary pest infestations in China. Presentation at the American Agricultural Economics Association Annual Meeting Long Beach, CA, July 22-26, 2006. Available at: http://www.grain.org/research/btcotton.cfm?links. See also: http://www.news.cornell.edu/stories/July06/Bt.cotton.China.ssl.html

17 Wang, S., Just, D.R. & Pinstrup-Andersen, P. 2006. Tarnishing silver bullets: Bt technology adoption, bounded rationality and the outbreak of secondary pest infestations in China. Presentation at the American Agricultural Economics Association Annual Meeting Long Beach, CA, July 22-26, 2006. Available at: http://www.grain.org/research/btcotton.cfm?links. See also: http://www.news.cornell.edu/stories/July06/Bt.cotton.China.ssl.html

18 Chen, D., Ye, G., Yang, C., Chen, Y. & Wu, Y. 2005. The effect of high temperature on the insecticidal properties of *Bt* Cotton. Environmental and Experimental Botany 53: 333–342.

19 Olsen, K.M., Daly, J.C., Holt, H.E. & Finnegan, E.J.. 2005. Season-long variation in expression of Cry1Ac gene and efficacy of *Bacillus thuringiensis* toxin in transgenic cotton against Helicoverpa armigera (Lepidoptera: Noctuidae). J. Economic Entomology 98: 1007-1017.

cotton and between plant parts.[20] There are even reports of farmers in India committing suicide because of the debts they have incurred by cultivating GE *Bt* cotton.[21]

Lower activity of the *Bt* toxin on cotton bollworm in the GE cotton plant late in the season has several implications, including that farmers will lose money because their plants are still being attacked by pest insects, lowering yields, farmers will have already spent extra money on *Bt* cotton seeds, as they are more expensive than conventional cotton seeds, and farmers will have to use extra insecticide to spray the pest that the expensive *Bt* cotton seeds are supposed to be resistant to: an unforeseen additional cost and damaging to ecosystems. Therefore, the envisaged pesticides reductions gained by the use of GE brassicas may never be achieved or, if achieved, may only last for a few short years.

The applicants also claim that

> This field test will hopefully show that use of GM crops can lead to reduced pesticide input on vegetable and forage brassicas. It will enhance our knowledge and understanding of the use of GM crops for reduced insecticide use and possibly as part of an IPM regime. In addition, this field test will provide more information to the public about the potential beneficial effects of transgenic brassicas and enable more informed debate about the use of transgenic crop plants. This field test will also provide an opportunity to conduct impacts research to assess the environmental effect of such a field test. The increased scientific knowledge in these areas will be made available to the wider scientific community through published papers and conference presentations. This field test will enhance the international reputation of NZ agricultural research and demonstrate to the international science community that NZ are at the fore front of GM research. This will enhance our ability to attract and retain scientists and to attract research funds, both from NZ and possibly overseas.

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20 Kranthi, K.R., Naidu, S., Dhawad, C.S., Tatwawadi, A., Mate, K., Patil, E., Bharose, A.A., Behere, G.T., Wadaskar, R.M. & S. Kranthi. 2005. Temporal and intra-plant variability of Cry1Ac expression in *Bt*-cotton and its influence on the survival of the cotton bollworm Helicoverpa armigera (Hübner) (Noctuidae: Lepidoptera). Current Science 89: 291-298.

21 *The Times of India*, "All in a day: Six farmers commit suicide," 30 September 2006, at http://timesofindia.indiatimes.com/articleshow/2047898.cms, reports that "[m]ost suicide cases relate to those farming families which have run up huge debts because of the high cost in using the expensive genetically-modified cotton seeds, which have to be bought every year. Crop failures in this situation, therefore, leave farmers with debts they are unable to pay and are then hounded by loan sharks."

The claims of scientific knowledge and funding were the core of the claimed benefits that impressed ERMA when assessing the GMF03001 GMO onion ("GM onion") application. These are addressed elsewhere in this submission, but each claimed benefit must be assessed together with the accompanying cost. The following table may assist.

Claimed Benefit	**Some accompanying Costs and Risks**
This field test will hopefully show that use of GM crops can lead to reduced pesticide input on vegetable and forage brassicas.	What would the efficacy of the *Bt* crops be? What would the effects on the environment, including insect resistance, effects on non-target organisms? What has caused *Bt* crop failures worldwide and what have the effects been? Could this answer be given by studying other research reports?
It will enhance our knowledge and understanding of the use of GM crops for reduced insecticide use and possibly as part of an IPM regime.	What is the efficacy of non-GM IPM regimes? How are GM crops meant to be part of an IPM regime? What are the ways that GM crops can undermine an IPM regime? Could this answer be given by studying other research reports?|
In addition, this field test will provide more information to the public about the potential beneficial effects of transgenic brassicas and enable more informed debate about the use of transgenic crop plants.	What are the potential detrimental effects of transgenic brassicas? Could this answer be given by studying other research reports? Is it the role of these scientists to provide information to the public and enable a more informed debate? Can that information be better collected and transmitted by others better trained and skilled in communication? Will the information be bias-free?
This field test will also provide an opportunity to conduct impacts research to assess the environmental effect of such a field test.	How much of this research can be carried out without a field test? What are the opportunity costs of not funding such non-field test research? Is researching a field trial a sufficient justification for conducting the field trial in the first place?
The increased scientific knowledge in these areas will be made available to the wider scientific community through published papers and conference presentations.	What is the opportunity cost for non-GM research? What studies have they already made of published papers and conference presentation? Why were they not included in

	this application?
This field test will enhance the international reputation of NZ agricultural research and demonstrate to the international science community that NZ are at the fore front of GM research. This will enhance our ability to attract and retain scientists and to attract research funds, both from NZ and possibly overseas.	What is the opportunity cost for non-GM research and scientists? Why would New Zealand wish to accept environmental risks in order to allegedly enhance the reputation of New Zealand's scientists? What damage will it do to the international reputation of non-GM farmers, researchers and exporters for New Zealand to be seen as being at the forefront of GM research? What other forms of research could Crop and Food carry out that would be better suited to current and realistically anticipated New Zealand agriculture and that would benefit New Zealand science?

It is impermissible to weigh the claimed negligible effects of the field trial itself against claimed beneficial effects beyond the field trial. The applicants make this error in stating that "[t]he beneficial effects of this field test in terms of the potential for reduced exposure of humans, beneficial organisms and the environment to toxic insecticides outweigh any potential adverse effects. In addition, this field test will address important questions regarding the impact of GM plants on the environment."

The applicant is attempting to weigh potential future applications of *Bt* technology against the potential adverse effects of the field trial itself. The Act and Methodology do not allow that. The claimed benefits of potential future applications of *Bt* technology must be weighed against the risks and costs of the potential future applications. Likewise, the claimed benefits for scientists must be weighed against the opportunity costs for other scientists. In addition, we can reduce toxic insecticides right now by spraying *Bt* instead of insecticides on these pests.

Costs and economics: no credible benefits

These GM field trials have no credible benefits and should not be approved. In terms of ERMA's assessments of the GM onion proposal, the benefits of the field tests benefits are negligible, and the costs and risks are significant. This is particularly the case with any application of GM brassica. Most New Zealanders and overseas markets have rejected GM foods.

The resulting *Bt* brassica is very unlikely to be commercially viable, given the strong opposition to GM crops by New Zealand's brassica markets. The field test could well damage New Zealand's reputation as a GM free producer. Such is the market rejection of GM crops that even if this field test is scientifically successful, GM brassica will be not be of commercial value. So the experiment poses known and unknown environmental, social and economic risks with little or no prospect of an economic benefit to New Zealand.

Claimed Benefits to the Scientific Community are Misplaced

The Committee hearing the application into GM onions found that the principal benefit to be derived from the field trial was the scientific knowledge expected to be gained[22] and concluded that this benefit was at least moderate.[23] But in doing so, they did not consider the cost. They purported to apply the Methodology, including Clause 13(a) and (b), but that clause requires that the Authority takes into account the costs and the benefits. The Committee assessing the GM Onions did not do that on the basis of any evidence. It is worth noting that the Annotated Methodology explicitly lists opportunity cost as something that should be taken into account under Clause 13. So while the Committee assessing that application said they took into account the opportunity cost of not funding more beneficial research,[24] they did so without assessing evidence as to what that research might be and what its costs and benefits may be. The Committee said that "the risk is assessed as low because of uncertainty about the relative value of alternative research programmes in advance of their implementation." What the Committee really meant is that either they had no evidence about them and therefore could not assess them, or did not accept the evidence that was before them – yet that did not prevent them from finding that the benefits outweighed the costs and risks. Reference is made to paragraph 32 of the methodology. So when the final weighing was made under clause 27 of the Methodology, to take into account the extent to which the risks and any costs may be outweighed by benefits, the Committee failed properly to assess the social and economic costs, being the potential costs to the country, of lost markets, the social and potential environmental cost of having GM field trials, the opportunity cost to other researchers and other costs, all to be weighed against the very marginal benefits of the field trial.

Better scientific information would be gained from contained experiments and research into long-term sustainability. The funds should be spent on sustainable agriculture and on products and production methods the consumers and the public want.

Research carried out by New Zealand government institutes should be ethical, socially and environmentally responsible and should respect standards established by New Zealand society and consumer markets.

The GE crop trial risks undermining public confidence in the direction of agricultural science and expectations that research in New Zealand should be as focused on long-term sustainability, and respect community values. Claimed benefits are misdirected and misplaced.

Any conclusion that the proposed field trial should go ahead because of benefits to the scientific community would be misinformed speculation and based on no evidence. The opportunity cost of the funds spent on this project is real and must be assessed, if the Committee intends to conclude that there is a net benefit to the scientific community. In fact the scientific community is much larger than the GE researchers, and this committee is in no position to assess whether the funds are better spent on this project or another. The costs and benefits of the field trial should be assessed on their own basis, and weighed against the costs and benefits to the scientific community in a systematic manner.

In short, if alleged benefits outside the confines of the field trial are to be taken into account, then the costs outside the confines of the field trial must also be taken into account. Opportunity cost is one such cost. If downstream benefits are to be assessed then downstream costs must be as well.

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22 Para. 2.7.2.1.

23 Para. 2.7.2.6.

24 Paras.. 2.10.1.2 and 2.10.1.3.

Alternatives

As noted, ERMA must take into account any alternative method of achieving the research objective that has fewer adverse effects on health and safety and the environment than the field test.

There are many worthy alternative research and development investments to achieve the claimed outcome of improving environmental impacts. There are alternative approaches to genetic engineering for pest, pathogen and weed control that not only increase yields and reduce costs, but also have significant health and environmental benefits. Alternatives include increasing the diversity of crops in the field and the diversity of the surrounding areas, integrated pest management, and altered cultivation practices. Indications are that pest control benefits are profound, including far greater benefits for health, local economies, and preservation and enhancement of the agricultural and natural ecosystems. These methods are often low or no cost, and increased labour costs are quite frequently substituted for the purchase of imported chemicals, with the result that more of the revenue remains in the locality. There is already a successful, commercially viable and growing organic brassica industry in New Zealand.

Crop and Food should be investing in methods to improve the efficiency and ease of organic brassica production and suggest targets for increased conversion to organic production. So claimed scientific benefits such as scientific knowledge and funding must be weighted against these other, more useful and deployable, objects of scientific knowledge and funding.

The applicant fails to state whether there have been field trials of *Bt* brassica elsewhere in the world. This makes it impossible to assess whether there are alternative ways of accomplishing the research objectives. The specific question was asked: "Have any of the new organism(s) in this application previously been considered in New Zealand or elsewhere?" the applicant answered that "[n]o other countries' regulatory bodies have assessed these organisms for approval." This does not answer the question.[25] The applicant should be required to answer the question.

Risks

Contamination

The GM plants could never be used without the risk of contaminating GE-free production. Even trace-levels of contamination are a risk to farmers, particularly organic and GE-free farmers, and the economy.

Effect on Non-target Organisms

In its natural form, *Bt* has been used by farmers practising organic and other sustainable growing methods since the 1950s as a spray to kill pests without damaging non-targeted insects or other wildlife. Natural *Bt* sprays have little effect on non-target organisms because the bacterial "pro-toxin" is in an inactived state and only becomes toxic when processed in the gut of certain (targeted) species of insect larvae.

In contrast, many insect resistant plants contain an artificial, truncated *Bt* gene and less processing is required to generate the toxin. It is therefore less selective, and may harm

[25] For instance, See M.C. Christey, R.H. Braun, E.L. Conner, J.K. Reader, D.W.R. White, C.R. Voisey , "Cabbage White Butterfly and Diamond-Back Moth Resistant Brassica Oleracea Plants Transgenic for Cry1ba1 Or Cry1ca5," Acta Hort. (ISHS) 706:247-254 http://www.actahort.org/books/706/706_29.htm and see Jin R.-G., Liu Y.-B. , Tabashnik B. E. ,Borthakur D. 2000. Development of transgenic cabbage (Brassica Oleracea var. Capitata) for insect resistance by Agrobacterium Tumefaciens-mediated transformation. In Vitro Cellular and Developmental Biology Plant 36(4): 231-237, and Jun Cao1, Anthony M. Shelton and Elizabeth D. Earle. 2001. Gene expression and insect resistance in transgenic broccoli containing a *Bacillus thuringiensis* cry1Ab gene with the chemically inducible PR-1a promoter. 8 Molecular breeding 8*:* 207-216.

non-target insects that do not have the enzymes to process the pro-toxin, as well as the pests for which it is intended. Genetically engineered *Bt* plants could be harmful to non-target organisms if they either consume the toxin directly in pollen or plant debris, or indirectly by feeding on pests that have ingested the toxin. This could cause harm to ecosystems by reducing the numbers of important species, or reduce the numbers of beneficial organisms that would naturally help control the pest species.

Most of the current *Bt* crops (containing the Cry1Ab or Cry1Ac gene) are toxic to certain species of moths and butterflies (Lepidoptera). Larvae of non-target moths and butterflies may inadvertently ingest the *Bt* toxin whilst feeding on plants growing nearby *Bt* crops. The impact of pollen from *Bt* maize on larvae of the monarch butterfly (*Danaus plexippus*) in North America is the most well-known example of this phenomenon.[26]

Exposure to *Bt* pollen from *Bt* maize was found to cause adverse effects on larvae of the non-target monarch butterfly in North America. Although no short-term effects (4-5 days) were noted,[27] longer-term studies (2 years) found over 20 % fewer monarch larvae reached the adult butterfly stage when exposed to naturally deposited *Bt* pollen.[28] Many species of butterflies and other insects are already under threat[29] from factors such as climate change and loss of habitat. Increased stress from exposure to *Bt* pollen could further threaten certain species.

Bt toxins from GE plants can kill non-target species and be passed higher up the food chain, an effect that has never been observed with the *Bt* toxin in its natural form. Green lacewings (*Chrysoperla carnea)* have been shown to be affected by *Bt* crops in the laboratory.[30] Lacewings are beneficial insects that play an important role in the natural

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26 Losey, J.E., L.S. Raynor and M.E. Carter. 1999. Transgenic pollen harms monarch larvae. Nature 399: 214; Hanson-Jesse, L.C. and J.J. Obrycki. 2000. Field deposition of *Bt* transgenic corn pollen: lethal effects on the monarch butterfly. Oecologia 125: 241 -248; Sears, M.K., R.L. Hellmich, D.E. Stanley-Horn, KS. Oberhauser, J.M. Pleasants, H.R. Mattila, B.D. Siegfried, and G.P. Dively. 2001. Impact of *Bt* corn pollen on monarch butterfly populations: A risk assessment. Proceedings of the National Academy of Sciences 98: 11937-11942.

Pollen from *Bt* maize (Syngenta's Bt176) caused the monarch butterfly controversy. This strain of *Bt* maize, Bt176 has been or is being phased out. Long-term exposure to *Bt* pollen from two *Bt* maize types, MON81O and Bt11, has recently been found to cause adverse effects on larvae of the monarch butterfly, even though these strains of *Bt* maize contain less *Bt* in their pollen than Bt176. Studies over 2 years have found over 20 % fewer monarch larvae reached the adult butterfly stage when exposed to naturally deposited Bt pollen. Dively, G.P., R. Rose, M.K. Sears, R.L. Hellmich, D.E. Stanley-Horn, D.D. Calvin, J.M. Russo and P.L. Anderson. 2004. Effects on monarch butterfly larvae (Lepidoptera: Danaidae) after continuous exposure to CrylAb expressing corn during anthesis. Environmental Entomology 33: 1116-1125.

27 Stanley-Horn, D.E., G.P. Dively, R.L. Hellmich, H.R. Mattila, M.K. Sears, R. Rose, L.C.H. Jesse, J.E. Losey, J.J. Obrycki and L. Lewis. 2001. Assessing the impact of Cry1Ab-expressing corn pollen on monarch butterfly larvae in field studies. Proceedings of the National Academy of Sciences 98: 11931-11936.

28 Dively, G.P., R. Rose, M.K. Sears, R.L. Hellmich, D.E. Stanley-Horn, D.D. Calvin, J.M. Russo and P.L. Anderson. 2004. Effects on monarch butterfly larvae (Lepidoptera: Danaidae) after continuous exposure to Cry1Ab expressing corn during anthesis. Environmental Entomology 33: 1116-1125.

29 Thomas, J.A., M.G. Telfer, D.B. Roy, C.D. Preston, J.J.D. Greenwood, J. Asher, R. Fox, R.T. Clarke and J.H. Lawton. 2004. Comparative losses of British butterflies, birds and plants and the global extinction crisis. Science 303: 1879-1881.

30 Hilbeck, A., W.J. Moar, M. Pusztai-Carey, A. Filippini, and F. Bigler. 1999. Prey-mediated effects of Cry1Ab toxin and protoxin and Cry2A protoxin on the predator *Chrysoperla carnea*. Entomologia Experimentalis et Applicata 91: 305-316. Dutton A., H. Klein, J. Romeis and F. Bigler. 2002. Uptake of *Bt* toxin by herbivores feeding on transgenic maize and consequences for the predator Chrysoperla carnea. Ecological Entomology 27: 441-447.

control of crop pests. The toxic effects of *Bt* crops on lacewings are via the prey that they ate, which in turn had been ingesting the *Bt* crop. This illustrates that the *Bt* toxin can affect organisms higher up the food chain. However, the environmental risk assessments for *Bt* crops include only single species studies, which would not detect any effects on organisms higher up the food web. This approach has been highly criticised and scientists have suggested that the effects of *Bt* crops need to be studied at multiple levels of the food web.[31]

Impact on Soil Health

Soil organisms play a crucial role in soil health. Therefore, it is necessary to understand how different agricultural practices affect them. *Bt* crops may be problematic for long-term soil health, as they express proteins that are known to be toxic to certain insects and are suspected of being toxic to a range of non-target organisms as well, including earthworms.[32] An unknown number of species make up the soil food web and could be affected by *Bt* - yet tests have been conducted on very few, in very few soil types and ecosystems. If, under field conditions, the *Bt* deposited in the soil by these crops has an impact on soil organisms — such as bacteria, fungi, insects, and worms — there will be downstream effects. If *Bt* crops kill or otherwise reduce the activity of any of these soil organisms, they will disturb the web of relationships necessary for carrying out essential ecosystem functions, such as decomposition and nutrient cycling.

Bt crops secrete the toxin from the root into the soil[33] and *Bt* crop residues left in the field contain the *Bt* toxin. The *Bt* toxin can persist in soils for over 200 days, particularly if there is a cold winter period.[34] Therefore, *Bt* proteins are likely to be present in the soil, not only throughout the growth of the crop, but also long after the crop is harvested. This raises the possibility of the accumulation of *Bt* toxins in the soil.[35] The persistence of *Bt* could cause problems for non-target organisms and the health of the soil ecosystem.

Resistance

Constant exposure to the *Bt* toxin produced by these plants encourages the survival of individual pests which have a genetic immunity to *Bt*. Over time, this could lead to the

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31 Knols, B.G.J. and M. Dicke. 2003. *Bt* crop assessment in the Netherlands. Nature Biotechnology 21: 973-974. Andow, D.A. & A. Hilbeck. 2004. Science-based risk assessment for non-target effects of transgenic crops. Bioscience, 54: 637-649. Ecological Society of America (ESA) 2004. Genetically engineered organisms and the environment: Current status and recommendations. ESA Position Paper http://www.esa.org/pao/esaPositions/Papers/geo_position.htm.

32 Marvier, M. 2001. Ecology of transgenic crops. American Scientist 89: 160-167. Zwahlen, C. A. Hilbeck, R. Howald and W.Nentwig. 2003. Effects of transgenic *Bt* corn litter on the earthworm Lumbiicus terrestiis. Molecular Ecology 12:1077 - 1086.

33 Saxena, D., S. Flores and G. Stotzky. 1999. Transgenic plants: Insecticidal toxin in root exudates from *Bt* corn. Nature 402: 480; Saxena, D., S. Flores, and G.Stotzky, 2002. *Bt* toxin is released in root exudates from 12 transgenic corn hybrids representing three transformation events. Soil Biology & Biochemistry 34: 133-137.

34 Tapp, H. and G. Stotzky. 1998. Persistence of the insecticidal toxin from *Bacillus thuringiensis* subsp. kurstaki in soil. Soil Biology & Biochemistry 30: 471-476. Zwahlen, C. A. Hilbeck, P. Gugerli & W. Nentwig. 2003. Degradation of the Cryl Ab protein within transgenic *Bacillus thuringiensis* corn tissue in the field. Molecular Ecology 12: 765-775.

35 Venkateswerlu G. and G. Stotzky. 1992. Binding of the protoxin and toxin proteins of *Bacillus thuringiensis* subsp. kurstaki on clay minerals. *Current Microbiology* 25: 225-233.

proliferation of resistant individuals to the extent that *Bt* would no longer be effective against the majority of the targeted pest population.

The field trial could therefore cause insects to develop resistance and become even more of a problem. Its claimed benefits are in reality additional risks. Any benefits from *Bt* that did eventuate would only be effective short-term and are thus not sustainable. As insects become resistant, they will be even more of a problem for farmers, resulting in the loss of a safe and important tool for many farmers, and careful use has maintained its benefit without pest resistance. Resistance to GE *Bt* cotton is inevitable.[36] There are suggestions that a monoculture of *Bt* cotton is speeding up resistance in India.[37] Build up of insect resistance will mean that more and more insecticide will have to be applied. This will increase farmer's debts and damage the environment.

Attempts to combat resistance through the use of refugia (planted areas of non-*Bt* crops) to slow down the build up of insect resistance to *Bt* are unlikely to be fully effective. GE contamination of non-*Bt* maize refugia, caused by cross pollination, could undermine refugia, as pest insects will still be exposed to *Bt* in the refugia.

Increased resistance would pose a serious threat to sustainable and environmentally friendly agricultural methods and the use of natural *Bt* by organic and other farmers.

Antibiotic-resistant marker genes

ERMA should not approve GE plants containing antibiotic-resistant marker genes which can add to existing problems in controlling disease. Other evidence of health impacts from *Bt* crops on people and animals must also be properly studied before the application is considered.

Risks to Sustainable Agriculture

Because of its effectiveness and safety compared to the pesticides it displaces, *Bt* is probably the single most important insecticide ever discovered. Organic and other environmentally conscious farmers have been using naturally occurring *Bt* toxins in foliar sprays against harmful pests for several decades. *Bt* pesticides kill targeted pests without harming beneficial predator insects and the toxins have no known detrimental effect on mammals or birds.

If pests develop resistance to its effects, these farmers will be deprived of a powerful pest control mechanism and other users may switch to more environmentally damaging pesticides. Organic pest control methods could also be jeopardised by the destruction of beneficial predator insects, such as the green lacewing, which are essential to environmentally friendly pest management.

Health Impacts

The trial should not be approved until evidence of health impacts on people and animals linked to *Bt* brassica are properly investigated. *Bt* toxins occur in may forms and some have been identified as potential allergens in humans. Starlink Corn was one such variant.

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36 Gunning, R.V., Dang, Ho T., Kemp, F.C., Nicholson, I.C. & Moores, G.D, "New resistance mechanism in Helicoverpa armigera threatens transgenic crops expressing *Bacillus thuringiensis* Cry1Ac toxin," *Applied and Environmental Microbiology* 71: 2558–2563.

37 Kranthi, S., Kranthi, K.R, Siddhabhatti, P.M. & Dhepe, V.R. 2004, "Baseline toxicity of Cry1Ac toxin against spotted bollworm Earias vittella (Fab) using a diet-based bioassay," *Current Science* 87: 1593-1597.

The health risks of GM Brassica have not been investigated in previous trials, nor would they be in this one.

Economic Matters: Insurance and liability

No insurance companies will cover the risks of GE crops. These risks will be carried by the taxpayer since Crop & Food are a Crown Research Institute. Therefore the public will be paying for the research, the application, ERMA process, the growing, the security and any mitigation or economic losses that result.

There is no strict liability regime to ensure that those that wish to experiment with GMOs will be held financially accountable for any unintended or unforeseen adverse impacts on other farmers, consumers or the environment.

While at first sight various common law torts may be applicable, the difficulties of causation, remoteness of damages and foreseeability, burden of proof and liability, mean that even proving the elements of the various torts may be very problematic. In the context of GMOs, as a new technology, many types of damage may not be foreseeable. Exemptions, including statutory authorisation, Act of God and intervention of third parties, may be applicable. Statutory authorisation in New Zealand could prove a bar to recovery in nuisance or *Rylands v Fletcher* and a problem in negligence. If a defendant has complied with HSNO and controls, particularly if the kind of damage that eventuated was addressed in the consent by conditions, a defence of statutory authorisation may succeed, even if other requirements in nuisance or *Rylands v Fletcher* are satisfied. The provisions in HSNO, which require a breach of the Act or controls, are subject to exceptions and still may present difficulties of causation. Where there was no breach of the Act or controls, such as when controls proved inadequate, or when situations which were not addressed in controls cause damage, GM-free growers and others may be left without an effective remedy.

Insufficient Information

There are no details about the precise combination of genes from various bacteria, viruses and their arrangement in each plant. Different re-combinations of gene elements may present different levels of risk and should be considered carefully. The gene profile of the GE plants created is important for proper risk assessment and risk management.

LEGAL CONSIDERATIONS

The application is lodged pursuant to section 40 of the Hazardous Substances and New Organisms Act 1996 (the "Act"), and is to be determined in accordance with matters set out in Part II of the Act (sections 5, 6, 7, 8, and 9) and in accordance with s 9, the relevant provisions of the Hazardous Substances and New Organisms (Methodology) Order 1998 (the *Methodology*), and with sections 44, 44A, 45 and 45A, the additional matters contained in sections 37.

Part II

ERMA must bear in mind that under section 4 of HSNO, the purpose of the Act is to protect the environment, and the health and safety of people and communities, by preventing or managing the adverse effects of hazardous substances and new organisms. This is an overriding purpose of the Act which colours all other provisions. Where ERMA can prevent adverse effects, in order to protect the environment, it should. The environment is best protected with this application by declining the application. This is particularly so with such a misconceived and misguided application. The adverse effects identified by Greenpeace and other submitters can and should be prevented by declining the application. This would best prevent the adverse effects of GE organisms in the New Zealand environment, as well as specific adverse effects identified in this and other submissions.

Under section 5(a) of the Act, ERMA must recognise and provide for the safeguarding of the life-supporting capacity of air, water, soil and ecosystems. This is a higher duty than taking into account. ERMA must provide for that safeguarding, and particular in this case the life supporting capacity of the soil and ecosystems. That includes protecting the soil from DNA from the proposed experiment and the ecosystem from adverse effects.

ERMA must also under section 5(b) of the Act recognise and provide for the maintenance and enhancement of the capacity of people and communities to provide for their own economic, social, and cultural well-being and for the reasonably foreseeable needs of future generations. This includes providing for the needs of farmers and ordinary New Zealanders to be able to grow crops free of GE pollution and the need to safeguard New Zealand's economic security in a world that does not want GE produce. The development of GM brassica in no way meets these needs and endangers the GE-free status of New Zealand. Other methods better provide for New Zealand's economic and cultural well-being. Cultural well-being also includes local, regional and national opposition to GE cultivation.

Section 5(b) of the Act is also relevant to the account insect resistance to *Bt*. The claimed benefits are quite simply not sustainable, since insects will in time develop resistance to *Bt*. Insects will be more, not less, of a problem to brassica farmers, and this is also likely to lead to increased of costs for clean-up, compensation and dealing with insect pests that have become resistant to *Bt*

Under section 6(a) of the Act, ERMA just take into account the sustainability of all native and valued introduced flora and fauna. Sustainability is threatened by GE and its threat to biodiversity. GE is a highly unsustainable technology: it introduces a 'quick fix' to address problems that can be solved using sustainable methods, and introduces a whole new raft of potential problems. ERMA must under section 6(b) take into account the intrinsic value of ecosystems. Again, GE introduces foreign genetic material into ecosystems and this experiment can in no way be said to enhance ecosystems.

Under section 6(c) of the Act, ERMA must take public health into account. There have so far been virtually no independent studies of the health effects of GM and adequate experiments have not been conducted into the effect of GM brassica or other GM produce on human health.

ERMA must under section 6(e) take into account the economic and related benefits to be derived from the use of brassica. This must be read in light of section 5(b) which requires ERMA to recognise and provide for the maintenance and enhancement of the capacity of people and communities to provide for their own economic well-being. Where an application such as for the GM brassica threatens people and communities to provide for their own economic well-being, in its interference with their GE-free status and the ability of New Zealanders to sell into markets which demand GE-free produce, ERMA must recognise and provide for their capacity. Comments made above about the adverse economic aspects of GE, about risks to the economy, about the lack of insurance and transfer of risk to the community and other economic matters all show this application should be declined. The opportunity cost incurred due to research funds not being available to sustainable agricultural solutions such as alternative weed control methods including IPM and organic methods is relevant under this paragraph.

Under 6(f) ERMA must take into account New Zealand's international obligations. The Biosafety Protocol is in force. The obligations include in Art 2(2) the obligation to ensure that the development, handling, transport, use, transfer and release of any living modified organisms are undertaken in a manner that prevents or reduces the risks to biological diversity, taking also into account risks to human health, the provisions on risk assessment and ERMA should note the objective of the Protocol, being in accordance with the precautionary approach, to contribute to ensuring an adequate level of protection in the field of the safe transfer, handling and use of living modified organisms resulting from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity, taking also into account risks to human health, and specifically focusing on transboundary movements.

Under section 7, ERMA shall take into account the need for caution in managing adverse effects where there is scientific and technical uncertainty about those effects. This provision must in light of the entry into force of the Biosafety Protocol, be read in light of Principle 15 of the Rio Declaration on Environment and Development, which reads that "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

In *Bleakley v Environmental Risk Management* Authority (HC, AP177/00, 2001) ERMA had decided that the section 7 direction to "take into account the need for caution in managing adverse effects" was discharged by a cautious attitude towards containment involving strict controls. The Court considered section 7 in the context of section 45, and held that it required caution in management of effects if they occurred, a matter which went beyond mere caution over risk occurrence. The lack of knowledge about insect resistance, effects on non-target organisms and on the soil must be considered in this light.

Under section 44A(2)(a) of the Act, ERMA must take into account any adverse effects of field testing the organism on (i) human health and safety and (ii) the environment, in particular ecosystems and their constituent parts. The matters referred to earlier, and in particular potential effects of HGT, of hybridisation, of effects on local honey and other effects of the field test must be taken into account under this paragraph.

Under section 44A(2)(b) of the Act, ERMA must take into account any alternative method of achieving the research objective that has fewer adverse effects on the matters referred to in paragraph (a) than the field test. These have been set out here. Other methods of weed control such as organic methods to control weeds in brassica without the adverse effects of GM *Bt* brassica outlined here.

Under section 44A(2)(c) of the Act, ERMA must take into account any effects resulting from the transfer of any genetic elements to other organisms in or around the site of the development or field test. Any effects from HGT must be considered in this respect, as must the spread of GM material.

Under section 45 of the Act, ERMA may only approve the application if it is satisfied that the organism can be adequately contained and if the beneficial effects of having the organism in containment outweigh the adverse effects of the organism and any inseparable organism should the organism escape. This is not the case for the many reasons set out here. On this basis of this paragraph the application should be declined.

Under section 45A of the Act, an approval must include controls to ensure that, after the end of the field test, the organism and any heritable material from the organism is removed or destroyed, and may include controls to ensure that, after the end of the field test and after heritable material is removed or destroyed, some or all of the genetic elements remaining from the organism are removed or destroyed.

Under Clause 13 of the Methodology, when evaluating the assessments of costs and benefits associated with the organism, ERMA must take into account the costs and benefits associated with the application and whether the costs and benefits are monetary or non-monetary, and the magnitude or expected value of the costs and benefits and the uncertainty bounds on the expected value, and the distributional effects of the costs and benefits over time, space and groups in the community. Clause 14 makes it clear that the costs and benefits are those that relate to New Zealand and that would arise as a result of approving the application. These matters have been referred to above under economic matters. ERMA must under Clause 15 have regard to evidence in public submissions that is relevant to the assessment of the risks, costs and benefits of introducing the substance or organism.

For all these reasons, Greenpeace submits that this application should be declined.