BEFORE THE WHANGAREI AND FAR NORTH DISTRICT COUNCILS JOINT HEARINGS PANEL

IN THE MATTER	of the Resource Management Act 1991 **AND**
IN THE MATTER	of Plan Change 131 and Plan Change 18 - Genetically Modified Organisms
AND	
IN THE MATTER	of the submissions and further submissions on the above two plan changes

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STATEMENT OF PRIMARY EVIDENCE OF JOHN SMALL ON BEHALF OF WHANGAREI AND FAR NORTH DISTRICT COUNCILS

20 APRIL 2016

Contents

1. Summary of Evidence

1. This evidence analyses the economic aspects of proposed measures that prohibit the outdoor release of genetically modified organisms (GMOs) and assign discretionary status to GMO field trials along with provisions for strict liability conditions. The measures are being promulgated by a group of councils and are intended to cover the area from Auckland region to the top of the North Island.

2. My analysis is heavily influenced by several facts.

    a. There is considerable scientific uncertainty over the costs and benefits arising from outdoor cultivation of GMOs. Professor Heinemann's evidence shows this to be the case. Uncertainty has two dimensions: frequency and scale. The ability of GMOs to reproduce means that the scale of unintended cost is unlimited.

    b. At this point there are no GMOs that are both ready for commercial release and experiencing demand from growers in this part of New Zealand. There are a small number of major crops worldwide that have been genetically modified but none of these are large crops in the relevant region.

    c. Major exporters of primary products in New Zealand perceive a market benefit from this country's GM-free status and are opposed to outdoor release. This includes Horticulture New Zealand and Fonterra despite Fonterra having been an investor in gene science research through the Pastoral Genomics consortium.

    d. The proposed measures are time-limited and can be changed in the event that a cost-benefit analysis supports change. Plans have a ten year life but the Resource Management Act 1991 includes a mechanism for plan changes on the application of any party, including councils.

3. These facts indicate that there is currently a benefit being realised from not having outdoor releases of GMOs. The proposed measures protect that benefit in a way that my analysis finds is complementary to the provisions of the Hazardous Substances and New Organisms Act 1996. The benefits arise from consumer preferences and are revealed by consumer-facing business people who, in my opinion have both a commercial imperative to understand consumer views and an incentive to represent them accurately on this topic.

4. The same facts indicate that any costs of the proposal are modest in scale, well understood, and unlikely to arise for several years at least. The main costs of concern are opportunity costs: foregoing net benefits that could be realised if not for the proposed measures. These will only arise if supply and demand for a particular outdoor GMO crop eventually emerges in the region. That event is unlikely to occur for several years at least. Moreover, the well-established plan change process is grounded in cost-benefit analysis and has modest costs relative to the major benefits that GMO developers hope to produce.

5. My analysis also relies on the modern economic theory of investment under uncertainty, which has been adopted for decision-making by many large corporations. The precautionary principle which underpins the proposed measures is consistent with this theory and there is solid academic support for its application to GMO policy.

6. In my opinion, this analysis is supportive of the recently reported statements by the Environment Minister, Dr Nick Smith, who refused to relax New Zealand's GMO rules because of the "*marketplace impact if NZ was seen as too relaxed towards GM*".[1] Productivity gains are an illusion if consumers are unwilling to pay for them.

7. In conclusion, for the reasons described in this evidence I support the measures proposed by the Auckland Council and Whangarei and Far North District Councils to regulate the outdoor use of GMOs.

[1] NZ Farmers Weekly, "*Market reaction trumps GM gains*", April 18 2016, page 17.

2. Introduction

8. A group of councils covering the northern part of New Zealand, from the southern boundary of Auckland region to the tip of the North Island, has been collaborating for over a decade on the development of local level regulation of genetically modified organisms (GMOs). The collaborating councils are Whangarei District Council, Auckland Council, Far North District Council, Kaipara District Council and Northland Regional Council. This group formed an Inter-council Working Party on GMO Risk Evaluation and Management Options in 2003.

9. Analysis undertaken for the Working Party indicated that community concerns over the outdoor release of GMOs have a basis in fact and the risks are not adequately managed through legal provisions and agencies at the national level. As a consequence, the Working Party developed draft district and unitary plan provisions and an associated cost benefit analysis. These provisions are now under consideration by Auckland Council and Whangarei and Far North District Councils.

10. The provisions proposed by the Auckland Council and Whangarei and Far North District Councils are to prohibit the release of GMOs to the environment and make outdoor field trials a discretionary activity requiring consent with conditions attached to address liability, financial fitness and a requirement for bonds. However, there is also the ability to change the prohibited status of a GMO or class of GMOs if it can be shown to provide net benefits to the Auckland/Northland region at acceptable risk by way of a plan change initiated by council or the public. I have been asked to provide expert economic evidence that examines the proposed provisions in the Proposed Auckland Unitary Plan (PAUP) and those of the other two councils undertaking concurrent plan changes, Whangarei and Far North District Councils ('the Proposal') and responds to the views of submitters.

2.1 Code of Conduct

11. I have read Practice Note 2014 of the Environment Court of New Zealand and in particular section 7 of that note dealing with expert witnesses. I agree to be bound by the code of conduct and have been bound by it in preparing this evidence.

2.2 Qualifications and Experience

12. My skills and experience for this task are evidenced in my Curriculum Vitae which is attached to this evidence. I hold a PhD in economics from the University of Canterbury and was an academic economist for eleven years, primarily at the University of Auckland where I directed research centres and served as head of economics, but also through visiting positions at universities in Australia, the USA, Canada and the UK. My academic specialities were in econometrics and micro-economics, particularly industrial organisation. I developed and taught courses in these areas, published research in international peer-reviewed journals and supervised graduate students.

13. I have been undertaking economics consulting projects for 25 years and founded Covec, an Auckland-based consultancy, in 2001. I have given expert evidence to

many courts, tribunals and commissions in New Zealand, Australia and the Asia-Pacific region and have twice been appointed as a Lay Member of the High Court of New Zealand. Most of my consulting work has concerned competition and regulatory economics as applied to the development and enforcement of public policy in respect of particular industries including telecommunications, energy (gas and electricity) waste, aviation, rail, agriculture, payment systems and logistics. I also teach short courses on these topics and recent clients include the Treasury, the Commerce Commission and the regulators of the gas and electricity industries.

14. In respect of cost-benefit analysis, my most recent assignments have been: to provide evidence for Auckland Council on natural and built heritage aspects of the PAUP; and to evaluate a contentious proposed change to the balancing arrangements on the Maui gas pipeline.

15. I have had no involvement in developing policies or giving evidence on this topic before 2015 but I did give evidence to the Hastings District Council on similar proposals for regulation of GMOs in its district on behalf of a local business group in May 2015.

2.3 Evidence Structure

16. This report begins by discussing some background issues (section 3), then describes the scenarios to be analysed (section 4) before analysing the costs and benefits of the proposed measures (section 5). A concluding section presents the summary of my opinion (section 6).

3. Background

17. In this section I review some data for the region that is relevant to the Proposal, discuss the legal context for my analysis, and review the status of GMO technology. The content of each of these sections is directed at informing an economic analysis of the matters at issue, rather than providing a complete review of the topic.

18. I then explain how I will approach the economic analysis (in section 3.4) and discuss several topics that are necessary background to understanding that analysis.

3.1 The Northern Peninsula

19. The Proposal covers the geographic area from the southern boundary of the Auckland Council to the northern tip of New Zealand. This is a geographically distinct area that produces 38% of New Zealand's GDP. The per-capita GDP of the region was $51,889 in 2014 which was slightly above the national average.

20. Outdoor primary production and associated primary manufacturing is economically important to the region, producing 7.5% of its GDP in 2012 which is the most recent year for which Statistics New Zealand data are available.[2] These are the sectors most directly relevant to analysis of the outdoor release of GMOs. Table 1 shows the main primary sector outputs from the region as shares of national output.

Table 1: Share of national output by crop type, averages across 2013-2014 (Source: Statistics NZ)

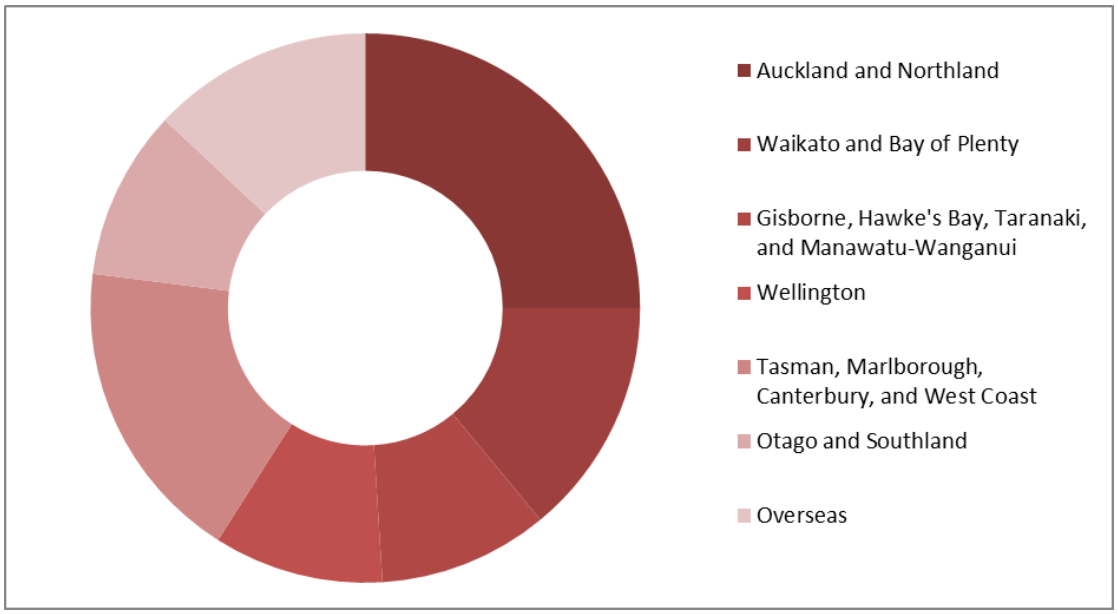
Crop	Share
Avocados	41%
Onions	28%
Wood	14%
Beef	13%
Potatoes	13%
Dairy	7%
Kiwifruit	7%
Apples	2%
Sheep	2%
Deer	1%

21. These crop types are of most direct relevance to my analysis because GMO-related advances in their production could generate opportunity costs under the Proposal. That would occur if the Proposal resulted in a *net detriment* in respect of these crops, for example if the value of productivity gains from using GMOs in these crops were more valuable than any price reductions arising from loss of value in the eyes of consumers.

[2] This figure of 7.5% materially understates the importance of outdoor primary production to the region because it omits all of the economic activity generated by income earned by suppliers to this sector.

22. The current level of business focus on bio-sciences in the region is also relevant to my analysis. Statistics New Zealand conducts a survey of this activity[3] and the most recent data are from 2011. They show that "Auckland and Northland" has the highest concentration of bio-science activity with 25% of firms that report bio-science is the "*main activity and which are focused on producing bioscience goods and services*" being located in this region.

Figure 1: Share of firms reporting bio-science as a core activity, by location (Source: StatsNZ)



23. It is clear from these data that the existing bio-science business activity is essentially independent of any outdoor release of GMOs, as no such release has been applied for to date (other than an animal vaccine for emergency use) and I am not aware of any entity that is looking to make application for a GMO release. On this basis, it seems safe to conclude that the Proposal will enable the continuation and expansion of existing bio-science business activity in the region.

3.2 Legal Context

24. Any economic analysis of this type needs to be undertaken with the relevant legal context in mind. This is because laws define the opportunities available to firms, people and communities, along with the constraints acting on them. These things are essential to an economic analysis, so although I am not a legal expert I need to consider them. In the case of GMOs there are two primary statutes to consider: the Hazardous Substances and New Organisms Act 1996 ('HSNO') and the Resource Management Act 1991 ('RMA').

[3] http://www.stats.govt.nz/browse_for_stats/industry_sectors/science_and_biotechnology/Bioscience_HOTP2011.aspx

25. The stated purpose of the HSNO Act (section 4) 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*". Two principles are set out in section 5:

    a. *the safeguarding of the life-supporting capacity of air, water, soil, and ecosystems; and*

    b. *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*.

26. Section 7 requires that the administration of the HSNO Act "*shall take into account the need for caution in managing adverse effects where there is scientific and technical uncertainty about those effects*". Under Section 7 precaution is a matter for the discretion of the EPA rather than being mandatory[4].

27. As it applies to GMOs, the HSNO Act establishes a gatekeeper role for the Environmental Protection Agency. This can be seen in section 2A which defines a "*new organism*" and particularly in section 2A(2)(b) which excludes from this definition any GMOs for which approval for release has been granted under section 38 or section 38I. Thus, once a GMO is approved for unconditional release, the HSNO Act no longer considers it a new organism and therefore the EPA has no further control or management function in respect of it.

28. Since the Proposal under consideration here includes provision for a strict liability regime for field trials, it is also relevant to examine the way the HSNO Act deals with liability. Part 7A of the HSNO Act (sections 124A to 124I inclusive) deals with pecuniary penalties and civil liability. This Part limits liability to circumstances that involve a breach of conditions for a release or other direct breach of the HSNO Act (section 124B). This does not address the principle concern of non-GM producers – that their crops will be contaminated by GM material from a neighbouring farm or supply chain, with resulting commercial losses when the product is sold. Civil liability is allowed for such cases under section 124G, but there are specified defences to such actions in section 124H which include that "*the conduct of the defendant was reasonable in the circumstances*" (s124H(a)(ii)). This exclusion from liability seems likely to cover accidental release of a GMO. Read together, these provisions mean there is:

    a. no liability for damage to the legitimate business interests of other producers arising from accidental excursions of GMOs; and

    b. No liability for damage to the environment that is not correctly anticipated by the regulator

[4] See Community Management of GMOs Issues Options and Partnership with Government: Section 32 Appendix 3.49.3 Document 1 pp16-17.

29. These are two types of financial damage that especially fall on constituents and local councils. Only if the party making a GMO release actually breaches conditions set by the EPA can that party be held financially accountable under Part 7A of the HSNO Act, and even then the damages are capped and there are broad defences available to avoid a financial penalty.

30. In contrast, the Proposal provides for genuine strict liability to apply to those operating field trials. The economic effect of this extra liability is that:

    a. Potential operators of field trials will take more care over the risk of contamination and other externalities their activities may create for the general population; and

    b. Some field trials that pose greater risks of negative spill-over effects on the general population will not proceed.

31. Turning now to the RMA, the purpose of this Act (section 5) is "*to promote the sustainable management of natural and physical resources*". It seeks to achieve this purpose by establishing a framework in which local authorities (including unitary authorities) develop, analyse, consult on and revise planning documents that have the effect of regulating activities.

32. The RMA is often viewed as an enabling statute that seeks to manage the effects of activities.[5] Communities are generally allowed the freedom to make their own choices though externalities (which are third-party spill-over effects) may be strong enough to justify exceptions to this general approach and consequent restrictions on certain activities. Cost – benefit analysis is the method by which any proposal involving restrictions on individual choices is evaluated within the context of the RMA (section 32).

33. Thus, while there are some strong similarities between the stated purposes of the HSNO Act and the RMA, the two acts are targeting different activities and are tuned to those different applications.

34. I conclude that, as they apply to GMOs, these Acts are complements rather than substitutes. This is consistent with the legal opinion of Dr Somerville QC[6] and more recently the Environment Court decision: Federated Farmers of New Zealand v Northland Regional Council (2015 NZEnvC 89). The two Acts work together in the sense that the national level assessment of whether a GMO is to be released in New Zealand is addressed through the HSNO Act, while the management of the GMO release can also be addressed at the local government level as provided for under the RMA. I note also that the Ministry for the Environment has legal advice that

[5] http://www.environmentguide.org.nz/rma/

[6] Dr R J Somerville QC (2004) *Opinion on Land Use Controls and GMOs*, p. 20 and 22.

appears to recognise separate and complementary roles for these two Acts, concluding (among other things) that[7]

a. A local authority (but more likely a territorial authority) could prohibit GMO activity through a rule in a district plan under the RMA… ; and

b. The EPA would not be required to take any policies held by local authorities into account.

35. Based on this review it appears to me that a scheme for local management, such as provided for by the Proposal, is not doubling up on what already occurs through the HSNO Act, because the two Acts are complements rather than substitutes. Moreover, the extra features that are enabled by local management are directly relevant to the wellbeing of local communities. In particular regulation under the RMA allows for

a. Local costs and benefits to be considered, which in the case of outdoor releases will often depend on the crops grown, which vary regionally with soil and climate conditions, and the potential for negative economic impacts on non-GM crops;

b. Constituents and councils to be fully protected against the financial risks of GMOs. Full liability can be imposed, which can be economically efficient because it assigns the potential external cost to the party best placed to manage the risk (which is also the party that will benefit most directly from a successful field trial); and

c. Local perceptions of risk to be weighed up in an economic cost-benefit analysis against potential benefits to local residents. This is distinct from a national level comparison which could be quite different due to local circumstances.

3.3 GMO Technology

36. I am not expert in the science of genetic modification but it is important for my economic analysis that it is characterised accurately. Professor Heinemann's evidence discusses the science of genetic modification in detail. I have read Professor Heinemann's evidence and it has helped to inform my evidence.

37. The potential scope of products arising from gene science technology is so vast that we can assume it to be infinite. There are countless distinct biological organisms in the world and each has multiple genes arranged in a particular structure. GM technology involves altering these genes, including by transferring genes from one organism to another using *in vitro* techniques. This vast number of potential GMO products makes GM technology look like what economists call a "general purpose

[7] http://www.mfe.govt.nz/more/hazards/risks-new-organisms/interface-between-hsno-act-and-rma-and-lga---crown-law-opinion

technology" ('GPT'). Professor Richard Lipsey, who has studied GPTs, summarised them as follows in a speech at the New Zealand Treasury in 2002.[8]

> *Examples include the domestication of plants, the invention of writing, the invention of the electric dynamo, and the invention of the computer. The appearance of a GPT has three stages: the introduction of the technology itself; the evolution of infrastructure, policies, education, complementary technologies to support the GPT; and a period where the benefits from the new technology are reaped. This process can take a long time: for instance the electric dynamo was invented in the 1880, but the development of supporting structures such as the assembly line took several decades, so that the electricity-derived boom did not begin until after World War II. Often it is not the technology itself but the flow of benefits that are really important. The main benefit of replacing steam by electricity, for instance, was the opportunity to reorganize factories around unit electric power sources.*

38. In my opinion it is reasonable to view GMO technology as being a GPT that is in the early stages of development. Some authors refer to different "generations" of GMO technology and this offers a potentially useful classification method. For example, Stewart and McLean (2005)[9] characterise the first generation of GMO plants as having agronomic qualities (i.e. qualities that affect how they are grown), the second generation as having product quality characteristics, and the third generation as concerning industrial products and pharmaceutical drugs. This diversity of applications is relevant to my economic assessment. So far, only first generation products have been commercialised in outdoor crops and it is proving more complex than expected to develop subsequent generations. However new first generation GMOs are still being developed, including with the aim of fixing problems caused by earlier GMOs. For example, the motivation for developing GMOs resistant to Roundup and 2,4-D is that glyphosate resistance has become a serious problem, in part because of the first generation of "Roundup-ready" GMOs.

3.3.1 Indoor vs Outdoor

39. The Proposal makes a clear distinction between indoor and outdoor use of GMOs. Indoor GMOs include medical, some industrial applications, and GMO research. As noted in paragraph 23 above, the region is already home to business activity of this type which is not constrained by the Proposal. Moreover, certain new third generation GMOs will not need outdoor release because they are used for industrial and pharmaceutical purposes. This may provide further opportunity for firms in the northern regions to develop valuable GMO products without being constrained by the Proposal.

40. Forestry and pasture grass appear to be the main outdoor-grown industrial crops in the subject region that could be affected by the Proposal. All other primary crops shown in Table 1 are foods for direct consumption by humans and I am not aware of

[8] http://www.treasury.govt.nz/publications/media-speeches/guestlectures/lipsey-oct02

[9] Patrick A. Stewart and William P. McLean, 2005, "Public opinion toward the first, second, and third generations of plant biotechnology" In Vitro Cellular & Developmental Biology - Plant, Volume 41, pp. 718-724.

them being a major focus for GMO developers in New Zealand. The views of potential developers and users of GMO trees and pasture grasses will therefore be of particular interest in this matter. I am informed that around 50% of New Zealand's commercial forests are subscribed to the National Standard for forest management that is linked to the international Forest Stewardship Council.[10] Criterion 6.8 of the National Standard states that "*use of genetically modified organisms shall be prohibited*". This is a voluntary commitment by forest owners and it is safe to infer that the signatories do not perceive a net detriment in doing so.[11] In respect of pasture grass, the work of Pastoral Genomics is relevant; this is a government subsidised research consortium that has been working on developing GMO grasses for many years, as has AgResearch. No products are currently ready for marketing however and at various stages, developers have put ten-year time horizons on the timing for likely commercial availability of the products.[12] The intended market for the grasses is overwhelmingly the dairy sector but Fonterra, which is a co-funder of the research, is on record as opposing even the field trialling of GMO grasses in New Zealand.[13]

3.3.2 Alternatives to GMOs

41. Potential alternatives to GMOs are also relevant to my economic assessment to the extent that they would or could provide comparable benefits to those available from GM technology – without triggering the proposed rules.

42. While traditional plant breeding remains popular and successful, "marker assisted selection" ('MAS') is a non-GM technique that also has the ability to provide similar genetic improvement. The MAS process combines modern gene science with traditional breeding methods. It tracks the shifting of genes through traditional breeding so that desired traits can be more readily identified from within a large number of candidate plants. MAS was described as having "enormous potential" by Collard and Mackill (2008).[14] A recent (2014) Washington Post story on marker-assisted selection contains the following passage.[15]

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[10] http://nzfoa.org.nz/plantation-forestry/certification

[11] Recall from paragraph 21 above that the economic calculation faced by potential users of GMOs involves comparing any productivity gains with any price effects arising from adverse reactions from buyers.

[12] This was last stated in 2010 and there has been no publication since of field trial data that would suggest there has been development of cultivars suitable for commercial development. Mike Dunbier, Transcript of RSNZ Media briefing on GM forages, March 2 2010
Available at: http://www.sciencemediacentre.co.nz/2010/03/02/greener-pastures-gm-forage-crops-in-new-zealand/

[13] See Fonterra statement quoted at paragraph 112 below.

[14] Bertrand C.Y Collard, David J Mackill, 2008, "Marker-assisted selection: an approach for precision plant breeding in the twenty-first century", Philosophical Transactions of the Royal Society B, 363, pp. 557 – 572.

[15] Adrian Higgins, "Scientists breed a better seed, trait by trait", Washington Post, April 16 2014

The big multinational companies, including Monsanto, Syn-genta, DuPont Pioneer, Bayer CropScience and Dow AgroSciences, have invested heavily in the new plant-breeding programs, which will increasingly require colossal data-processing abilities.

"In many ways, the company has gone beyond" genetic engineering, said Robert T. Fraley, Monsanto's chief scientist. "The breeding technology has changed dramatically in the last few years."

Marker-assisted breeding won't bring an end to GMOs, scientists say, because genetically engineered crops can achieve highly specific tasks now unobtainable through even marker-assisted breeding. But given the obstacles to GMO development — $100 million to create one variety, at least 10 years for regulatory approval and widespread public opposition — marker-assisted breeding has become alluring to such companies as Monsanto.

43. Closer to home, the Pastoral Genomics consortium divides its research funding between MAS and GMO research, allocating slightly more than half of its funding to MAS and the balance to GMO research.[16] This is a clear indication that MAS is viewed by the Pastoral Genomics consortium as having at least as much potential value as GMO technology.

44. The future potential of non-GM genetic advancement also shows up in recent business reporting[17] on the global bio-technology company Syngenta which warned of "*slowing growth in the GM seeds sector*" and

…underlined its progress in developing higher yielding seed through non-GM technologies, including in barley, where it claimed peak sales potential of more than $500m for its hybrid seed. In wheat seed, it boasted of "game changing non-GM technology" with peak sales potential of more than $3bn a year.

45. This reference to grains (barley and wheat) supports the view that the potential benefits of GM technology vs other techniques will vary across crops, depending in part on the productivity gains available through each method. The recent achievement of Canterbury farmers in breaking a 25 year old world record for barley yield suggests that non-GMO methods still perform well for some crops.[18]

3.3.3 Time to Market

46. As will become clear in section 3.4, the timing of benefits and costs is very important to economic analysis of this topic. We therefore need to review the likely timescales for GMO developments to generate actual benefits for the northern population. The time required to develop a new plant variety through from initial research to market release is generally long. For example, the Washington Post article cited in footnote

[16] Sustainability Council, "Betting the Farm: Economic Impacts of Introducing GM Grasses", June 2011, footnote 61,

[17] http://www.agrimoney.com/news/syngenta-warns-of-slowing-growth-in-gm-seeds-sector--8601.html

[18] http://www.stuff.co.nz/business/farming/cropping/68146316/world-barley-yield-record-set-by-timaru-farmers

15 above suggests "*at least 10 years for regulatory approval*" which we take to include research and development time, at least for the New Zealand setting. However development times are also likely to be highly variable because a degree of chance is involved in any such project.

47. Most new development projects exist as commercial secrets until it is possible to claim intellectual property rights over them. This makes it difficult to accurately summarise the time taken to develop new organisms to a marketable state. There are exceptions however such as Golden Rice, a GMO that has been the subject of considerable controversy.

48. The intent behind Golden Rice is to boost the vitamin A content of rice. This has been reported since at least 2000, and some authors believe it had reached a marketable stage of development in 2002.[19] However it is clearly not yet ready. Following field trials in the Philippines the International Rice Research Institute reported in March 2014 that that more work was needed.[20] Preliminary results were mixed. While the target level of beta-carotene in the grain was attained, average yield was unfortunately lower than that from comparable local varieties already preferred by farmers. An important goal of the trials was to test whether the agronomic performance of the new rice variety would be acceptable to farmers. The initial results indicate that more research is needed, with greater focus on increasing yield and making the vitamin A content be expressed in actual farm conditions.

49. While Golden Rice is itself not directly relevant to this matter, it illustrates two points of relevance to an economic analysis of this matter.

    a. There can be long time lags between the announcement of a GMO project and its eventual marketing to growers. The actual opportunity costs of prohibiting outdoor release are incurred only at the point a GMO is ready for sale.

    b. Developers of GMOs are naturally positive and optimistic about timeframes for releasing new organisms to the market. Materially greater weight should therefore be attached to actual GMOs that are ready for sale and for which there is demand from growers.

50. These time frames for the production of GMOs need to be viewed alongside the timing of the Proposal. The plan will endure for a maximum of 10 years before mandatory review, but any aspect of the plan (such as the GMO provisions) can be changed before that time if the benefits of doing so outweigh the costs.

[19] http://blogs.scientificamerican.com/guest-blog/golden-rice-opponents-should-be-held-accountable-for-health-problems-linked-to-vitamain-a-deficiency/

[20] http://irri.org/golden-rice/faqs/what-is-the-status-of-the-golden-rice-project-coordinated-by-irri

3.4 Economic Approach

51. The aim of my economic analysis is to weigh up the costs and benefits of the proposed measures. In this section I outline some principles that underpin this analysis.

52. A proper economic cost-benefit analysis can only proceed through a comparison of the Proposal with one or more other approaches. It is the *relative* costs and benefits that matter. For example, the cost of the Proposal is the amount of value that would be foregone by it *but not foregone* by some other management approach.

53. To clarify, suppose we consider three broad options for managing the outdoor release of GMOs at the local level.[21]

- Prohibition on outdoor release of GMOs (except medicines and veterinary vaccines) and discretion for field trials (the Proposal)
- No controls (i.e. permitted activity)
- Discretionary approach where proposals are considered on a case-by-case basis

54. Both of the alternatives to prohibition are more permissive but each of the three approaches has a different set of relative costs and benefits. For example, of the three options, the discretionary approach incurs the highest costs for decision-making, prohibition avoids the most risk,[22] and the permitted activity status is likely to lead to the most outdoor release of GMOs and minimise opportunity costs.

55. In evaluating the relative costs and benefits, I take the perspective of the aggregation of all residents of the Northland/Auckland region. This is because local authorities are obliged to act in the interests of their local populations. Thus, if someone located outside the region earns profits from trading inside the region, these profits do not count as a benefit (other than that portion which remains with the region by virtue of employment and similar local gains).

56. Negative externalities as perceived by local resident X reduces her benefits (or increases her cost) even if another local resident Y gains a benefit. The net effect of such activities is found by deducting the externality cost on X and others like her from the benefits accruing to Y and others like her.

3.4.1 Timing

57. Council planning documents are expected to last for 10 years, so that is the relevant time horizon for this analysis. Any analysis of costs and benefits that occur over time needs to recognise that future values are worth less than current values. A dollar due to be paid next year is worth less than a dollar paid today because we can use it to obtain value during the intervening period.

[21] The proposal extends beyond this "outdoor release" activity as discussed below. However it is sufficient to illustrate the analytical method.

[22] Prohibition could also be seen as the outcome of risk assessments and cost-benefit analyses already undertaken in New Zealand and elsewhere.

58. The standard method for accommodating this effect is to apply a discount rate to future costs and benefits, and then add up the discounted streams of costs and benefits to express them in "present value" (PV), meaning in the dollars of today. This process is not mathematically difficult, but it does require us to choose a discount rate.

59. The Treasury recommends using 8% discount rates as the default setting for regulatory analysis.[23] Private firms operating in risky industries are likely to use higher rates, but lower values could also be used in some situations. Patient individuals might be comfortable with quite low discount rates for example and appropriate rates used in analysing longer term issues such as climate change may be much lower[24] and/or variable[25].

60. The implications of discounting are illustrated in the following table which might be indicative of the matter at hand. Suppose there are immediate benefits arising from the Proposal valued at $200 and that this benefit is expected to continue for ten years. Suppose also that some new GM technology could be released after 5 years at which time it would be worth $500 per annum. Thus, excluding the GMO would impose a cost of $500 per annum from the time it was first available for use.

61. If we simply counted the raw costs and benefits we would conclude that the costs are higher. However the timing of the costs and benefits is relevant and when discounting is applied we find that he present values of the benefits exceed the present values of the costs by $10.

Year	Benefit	Cost	Discount Factor	PV
1	200	0	1.00	200
2	200	0	0.92	184
3	200	0	0.85	169
4	200	0	0.78	156
5	200	0	0.72	143
6	200	500	0.66	-198
7	200	500	0.61	-182
8	200	500	0.56	-167
9	200	500	0.51	-154
10	200	500	0.47	-142
Totals	2000	2500		10

62. For the avoidance of doubt, these numbers are merely being used for illustration; there is no suggestion they accurately reflect costs and benefits of the Proposal or of any potential GMO release. However they do show that immediately available annual benefits can outweigh much larger annual costs if the costs are deferred.

[23] http://www.treasury.govt.nz/publications/guidance/planning/costbenefitanalysis/currentdiscountrates

[24] The Stern Review on the Economics of Climate Change (2007) used a discount rate of 1.4%

[25] See L.H Goulder and R.C. Williams, 2012, The Choice of Discount Rate for Climate Change Policy Evaluation, Resources for the Future Discussion Paper RFF DP 12-43.

3.4.2 Option Values

63. Let us now extend the above illustrative example by considering what happens after year 10. It will be clear from the table that merely continuing these same flows of costs and benefits would reverse the conclusion we drew above. In fact that would occur in year 11.

64. However year 11 is beyond the planning cycle, so we cannot assume that the above pattern would continue. Plans usually take at least a couple of years to review, so we need to stand in the shoes of planners and councillors at year 8 and consider how they would react. If the existing provisions were costing $300 per annum (i.e $500 – $200) in the currency of year 8 then we would expect the next plan development to seek to remove that net cost.

65. This illustrates the value of the flexibility that can arise from a periodic review of the plan. By deferring the decision to release GM plants, the region gains any benefits that are currently available from its GM-free status without foregoing the option to use GM to increase productivity later, should that turn out to be desirable. So, provided the flexibility exists, we do not need to look beyond year 10 because we will have an opportunity to change the plan at that time.

3.4.3 Irreversibility

66. This flexibility to change is not always present however. Auckland Council and Whangarei and Far North District Councils currently have an option to make rules that would defer the outdoor release of GMOs (which affect their GMO-free status) and any particular GMO (which may have environmental and economic consequences). These options are the source of the flexibility discussed above and there is value arising from this flexibility.

67. Once either of these deferral options is extinguished by releasing a GMO in the region, the previous option could often never be recovered. Releasing GMOs can be an irreversible decision because of the potential for interactions between, say, those plants and other plants and insects in the environment, and because of the inability to monitor and document and track all of those interactions over time.[26] Irreversibility stems partly from the fact that pollination is decentralised and can occur in many different ways, so there is no reliable way of preventing gene transfer between GM plants and other like plants. Imperfectly controlled chains of production can also result in contamination. For example, there was a recall of over 300 human food products in 2000 because StarLink corn (intended for animal feed only) had contaminated human food products.[27] In an analysis that bears on the irreversibility point and includes reference to the StarLink corn contamination, Marvier and Van Acker (2005)[28] put it this way:

[26] Professor Heinemann provides further discussion of irreversibility from a scientific perspective.

[27] https://en.wikipedia.org/wiki/StarLink_corn_recall

[28] Michelle Marvier and Rene C Van Acker, 2005, Can crop transgenes be kept on a leash?, Frontiers in Ecology and the Environment, 3, pp. 99 – 106.

Debates about the benefits and risks of genetically modified (GM) crops need to acknowledge two realities: (1) the movement of transgenes beyond their intended destinations is a virtual certainty; and (2) it is unlikely that transgenes can be retracted once they have escaped.

68. Irreversibility is important because it implies the potential existence of a valuable option to delay release.[29] Conversely, a decision to not manage the release of GMOs destroys the option to defer that decision.

3.4.4 Real Option Value

69. The above analysis shows that Auckland and Northland councils currently hold what is known as a "real option". An option is a right to do something without any corresponding obligation. Some options are financial[30] but the Auckland and Northland councils' option is "real" rather than financial. The option is to allow (by declining to manage or restrict) the outdoor release of one or more GMOs. As discussed above, if this option was exercised by allowing an outdoor release, that decision would in many cases be irreversible.

70. Real options of this sort lie at the heart of the modern economic theory of investment under uncertainty. Many economic investments have exactly the same essential characteristics: firms have the right to invest (without a corresponding obligation) but the investment decision is irreversible if the capital invested will be "sunk" by the investment decision.[31] Because this is such an endemic problem, a set of analytical methods has been developed for valuing real options and guiding optimal decision-making in their presence.[32] These methods are used in many commercial contexts including in the oil, gas and mining industries.[33]

71. It is the *timing* of an irreversible decision that is of primary interest in the presence of a real option. The option provides decision-makers with the flexibility to wait, reviewing new information as it arrives and not taking the irreversible decision unless and until it is clearly beneficial to wait no longer.

72. The most basic prediction of real options theory is that waiting is more valuable when the expected benefit from exercising the option:

- Is growing relatively slowly over time; and
- Has a relatively uncertain growth rate.

73. There is an attractive intuition here. If the payoff (i.e. the *net benefit*) from taking an irreversible decision is growing strongly and without volatility, then we can be

[29] I note that Professor Heinemann's scientific review cites possible irreversibility of adverse affects arising from GMOs as being of material concern to scientists.

[30] For example, a financial "call option" is the right to buy a stated thing for a stated price at any time up to a stated end-date.

[31] Capital is sunk if it cannot be recovered except over an extended period of successful trading.

[32] A.K. Dixit and R.S. Pindyck, Investment Under Uncertainty, Princeton University Press, 1994.

[33] Y. Fan and L. Shu, 2010, "A real options based model and its application to China's overseas oil investment decisions", Energy Economics, 32, pp.627–637.

more confident that the information we have today is reliable and the project will indeed provide a net benefit.

74. By contrast, doubt over the net benefit of the project will intensify if the prospects do not appear to be improving rapidly or there is uncertainty over the outcome. In such cases, the option to defer a decision has more value because doing so allows time for new information to arrive.

75. This decision-making guidance is very general: it applies to all situations where one has the ability to defer an irreversible or partly irreversible decision. Applied to the matter at hand, it implies that Auckland and Northland councils should defer a decision to allow GMO releases unless/until the benefits to the region of doing so are clearly evident. It should also be clear that this analysis (and therefore the optimal timing of release) will vary across different GMOs.

3.4.5 Precautionary Principle

76. The real options analysis presented above can be seen as a form of risk management that requires caution before making irreversible commitments with uncertain benefits. The theory is largely based on the view that the potential error cost is limited to the amount of cash invested in a project with uncertain benefits, which is a reasonable assumption in the case of commercial investments.

77. A related risk management approach is embodied in the precautionary principle, which allows for conditions where costs could become high, but yield predictions are standard. The precautionary principle applies where there is an uncertain risk of serious harm. Recent academic work by risk expert Nassem Talib[34] and co-authors has placed the precautionary principle into a statistical and probabilistic structure of "ruin problems" and applied it to nuclear energy and GM technology.[35] Their analysis concludes that severe restrictions should be placed on GM technology. The paper considers GM technology to be much more risky than nuclear energy because it carries a public risk of global harm whereas the risk from nuclear energy is both localised and better understood scientifically. Even a very small probability of ruin will eventually lead to ruin over time.

78. Auckland and Northland councils have local rather than global jurisdiction however, and it might reasonably be argued that GMO releases in the Auckland/Northland region are very unlikely to initiate global ruin. In effect, Auckland and Northland could free-ride on the global risk as a result of its relatively insignificant size. Along the same lines, one could argue that Auckland and Northland councils have no obligation to protect the world from greenhouse gas emissions and should concentrate on looking after the interests of their own population.

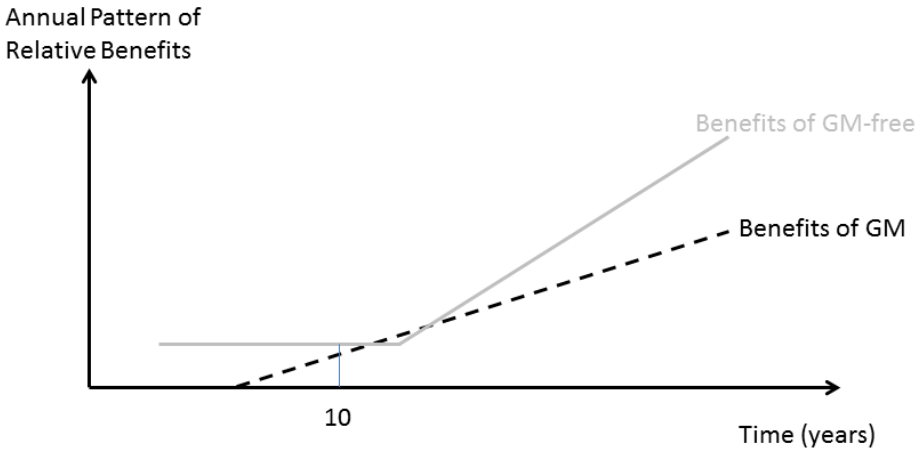
79. If Professor Talib is correct however, then the benefits of remaining GMO-free are likely to grow over time as other parts of the world experience harm from adopting

[34] http://en.wikipedia.org/wiki/Nassim_Nicholas_Taleb

[35] http://arxiv.org/abs/1410.5787v1

GMOs. That could occur even while narrowly defined productivity benefits from adopting other GMOs emerge. For example, the pattern of relative benefits over time might look like Figure 2. Equally, even without any obvious harm being identified, if consumers are aware of the risks and avoid GM products, the region would lose through growing produce that consumers perceived as risky.

Figure 2: Possible future pattern of relative benefits



80. Other patterns are of course entirely possible. We simply do not know how these relative benefits are going to change over time. However that is all the more reason to respect the predictions of real options theory (section 3.4.4) by deferring an irreversible decision to adopt or not manage GMO releases until the benefits are clearly apparent. Thus, even taking account of the potential for Auckland and Northland to free-ride on global risks, one arrives at the same conclusion which is that caution is optimal.

4. Scenarios

81. As noted above, it is necessary to define one or more specific alternatives to the proposal in order to properly evaluate it. This section will describe two scenarios to be compared.

4.1 Councils' Proposal

82. The councils perceive three types of risk arising from outdoor release of GMOs: economic, environmental and social/cultural. They describe the risk as including "*irreversible adverse effects*" on the environment and/or people and communities. To the extent that adverse effects are irreversible effects, they cannot be remedied or mitigated. This leaves avoidance as the only remaining management approach. Accordingly, the councils adopt a precautionary stance that is reflected in the proposed status for three activities types as follows:

- Prohibition of the outdoor release of GMOs into the environment
- Discretionary status for outdoor field trials which would require conditions to address economic and environmental liability, financial fitness and the posting of bonds
- Permitted activity status for research within contained facilities, veterinary vaccines and medical applications.

4.2 Fewer Restraints

83. To examine the councils' proposal we need to compare it with a slightly less restrictive alternative option. If there is a net benefit of the councils' proposal relative to the next less restrictive option, then we can safely conclude that it is also more beneficial than substantially less restrictive options.

84. There is no less restrictive option available for research within contained facilities, veterinary vaccines and medical applications, so the two scenarios are the same in respect of these activities and no further comment on them is required.

85. For outdoor release of GMOs, the next step down from prohibition would be discretionary status in which the councils would reserve discretion over all matters (rather than restricting it to a defined list of matters).

86. For outdoor field trials, a slightly more liberal approach than the councils' proposal would be to restrict discretion to a stated list of matters. Alternatively, one might consider weakening the conditions of consent.

5. Costs and Benefits

87. In this section I analyse the costs and benefits of the councils' proposal relative to the less restrictive option described above.

5.1 Costs

88. Costs will arise from the Proposal if it prevents or delays the use of a GMO that would be economically beneficial. From an economic perspective we can identify two types of potential cost:

a. a non-cash *opportunity cost* equal to the extra profits that would accrue to landholders and/or GMO developers without the constraint on GMO-related activities; and

b. *transaction costs* that would be incurred by those parties bearing the opportunity cost as they seek to over-turn the policy that denies them extra profits.

5.1.1 Transaction Costs

89. It will be helpful to start our analysis of costs with the transaction costs. To fix ideas, suppose that a farmer, perhaps acting jointly with a GMO developer, wants to release a GMO in the region for the purpose of increasing her profits. This would not be possible if the proposal is adopted because the outdoor release would be prohibited. However the RMA allows for plan changes to occur, on the application of council or any other person, provided it can be shown that the benefits exceed the costs. For example, section 65 (4) states

Any person may request a regional council to prepare or change a regional plan in the manner set out in Schedule 1.

90. A similar provision exists for District Plans under section 73(2). The plan change process therefore offers a safety valve to those bearing an opportunity cost from the proposed prohibition on outdoor release of GMOs, because it acts as a limit on the costs of prohibition. The farmer will only pursue a plan change if she expects to profit from doing so. The expected cost of the plan change process will be compared against the expected benefit, bearing in mind the risk associated with applying for a plan change. If we let 'p' represent the probability of succeeding in the plan change process (i.e. actually changing the plan), the farmer will rationally consider whether

$$\text{Anticipated\_Extra\_Profit} \times p > \text{Cost\_of\_Plan\_Change\_Process}$$

91. If the farmer expects this to be true, she will pursue a plan change. Notice that the left hand side is exactly equal to the *opportunity cost* to the farmer of the proposed GMO measures, so the above inequality shows a direct link between the two types of cost outlined in paragraph 88 above. In particular, it tells us that the opportunity

cost cannot exceed the expected (i.e. risk weighted) cost of the plan change process because if it did, rational farmers would change the plan.

92. At the time a plan change is being considered, the probability of success ('p') is not known with certainty. However the criteria that will be used are known, and the strength of the case for a plan change can therefore be assessed. The stronger is the case, the more likely is success.

5.1.2 Opportunity Costs

93. Notwithstanding the above analysis of plan change options, it is important to directly consider the potential scale of opportunity costs. If these are already large and certain then it could be inefficient to implement the proposed provisions; a better strategy may be available.

94. To inform myself as to the likely opportunity costs I have reviewed the section 32 evaluation and submissions from Scion, NZBIO, Federated Farmers, Pastoral Genomics and Professor Peter Shepherd. All of these submissions oppose the Councils' proposal, so they are obvious points of reference for analysis of opportunity costs. My review of these submissions was particularly focussed on looking for evidence of well documented opportunity costs that will arise now or within the next two to three years. I focus on this category of costs because of the timing issues discussed in section 3.4 above and the natural optimism of GMO developers discussed in section 3.3.3 above.

95. Federated Farmers' submission does not cite any particular opportunity cost. NZBIO cites one type of opportunity cost which is an anticipated gradual decline in competitiveness as Australia and South America are "*likely*" to "*begin using GMOs in areas such as horticulture, meat and dairy production*". This is a deferred and uncertain opportunity cost.

96. Pastoral Genomics says (at ¶22) that the proposed measures impose "*a potential cost to science and innovation… [that is] likely to result in this innovation occurring outside NZ*". This seems exaggerated. Since the proposed measures are regional in nature it would seem quite straightforward for the (unspecified) science and innovation Pastoral Genomics has in mind to occur in some other part of New Zealand.

97. Professor Shepherd argues that the proposed measures will cause our farmers to "become increasingly less productive compared with foreign farmers" and that "*the value of non-GM trees [will] diminish"* once the "*imminent*" arrival of GM trees occurs. These are deferred and uncertain examples. No particular crops of relevance to the region are cited as being more productive in GMO forms, and even if GM trees were already available (they are not) the opportunity cost to the region would only arise from new plantings (not existing forests) and even then would be limited to the difference in productivity between GMO and non-GMO trees.

98. Scion's submission is primarily that the proposed measures are un-necessary. However it does also claim the measures will actually cause harm (opportunity cost) in the long term and the short term. Scion says that "*in the long term [it] threatens*

Northland's forest industry" and that "*in the short term [it] significantly limits options to save indigenous trees from extinction*". I examined Scion's submission closely for evidence in support of these claims is in section F under the sub-heading "benefits" where item (c) is a list of seven "potential benefits for New Zealand of GMO trees". In my opinion "potential" is the key word here. Each of the seven items is an unsupported assertion that lacks an evidential basis for including it as an opportunity cost of the proposed measures.

5.1.3 Other Information

99. I noted above (paragraph 40) that only two of the main crops grown in the region (wood and pasture grass) appear to be the active subject of GMO research in New Zealand, and that in neither case are GMOs ready for outdoor release. There remains a possibility that some of the minor crops could benefit from existing GMO technology and that new GMOs might emerge that could provide benefits. I consider that possibility now.

100. While it is theoretically possible that some of the minor crops might be able to benefit from existing GMO technology, a brief survey of the candidates for this shows there is no obvious match with the chief crops of the Auckland/Northland region. While GM potatoes exist, their commercial production overseas in essence lasted two growing seasons before the great bulk of it was abandoned while the project to produce a GM potato for New Zealand conditions was also abandoned after ten years. GM onions were field trialled in New Zealand but as the main export market is the EU and European buyers were uninterested in GM production, the GM variety was not taken up locally. GM apples have recently debuted in North America but again, the resistance of EU customers to GM foods means there are no plans to adopt GM apples in New Zealand.

101. Regarding new GMOs that might emerge in the future, I consider that there are two reasons to believe that the Proposal is unlikely to result in any material costs. The first comes from the supply side of the GMO sector. The future availability of such GMOs will be known in advance by their developers, yet there appears to be no evidence from those opposing the Proposal suggesting such GMOs are close to being ready. I have discussed above (paragraph 49) the risk of accepting forecasts of market-readiness from GMO developers, so any such claims would need close scrutiny were they made. However an absence of such claims is even stronger evidence that the outdoor release aspects of the Proposal will have no near-term opportunity cost in the sense of foregoing valuable GMO opportunities.

102. The second reason that the Proposal is unlikely to create significant opportunity costs in respect of future GMOs is the time-limited and flexible nature of the planning process. In particular, the planning documents have an expected lifetime of ten years but can be changed if there is credible information that doing so would generate net benefits. As discussed above (paragraphs 90 - 92), the plan change option acts as a safety valve by limiting the costs of the Proposal to those associated with changing the plan.

5.1.4 Summary

103. The above analysis suggests to me that the costs of the Proposal are low. In particular, I note that the existing business activity in the bioscience field is focused on areas of biotechnology that are unaffected by the Proposal, there is no apparent opportunity cost in the form of market-ready GMOs for which outdoor release is desired, the time frames associated with GMO development suggest that any opportunity costs will not arise until the plan is due or close to being due for review anyway, and there is a low cost safety valve available through the plan change process should these expectations turn out to be materially incorrect.

5.2 Benefits

104. In my opinion there are three potential areas of benefit arising from the Proposal. These are discussed below.

5.2.1 Market Preferences

105. To the extent that consumers and potential consumers of products from the Auckland/Northland region care about its GM status, those preferences may show up in various ways including:

- Willingness to pay higher prices for food products;
- Preferential access into food markets; and/or
- More inbound tourism

106. These are all potential benefits from the Proposal. While there is argument about the extent to which such benefits exist and how large they are or will be in future, I have seen no claim that there would be consumer preference for GM products and thus a cost arising.

107. What is clear however is that pressure is growing for transparency regarding GM content, and this includes the use of GM feed in animal products. In addition to the more than 60 countries that mandate labelling for GM content, supermarket chains in other countries are establishing private standards – such as the largest natural foods retailer in the US, Whole Foods Market, which has declared that all products in is 350 stores will be labelled for GM content by 2018.[36]

108. It has been argued by NZBIO that "*consumers are less concerned about GM than has been supposed*" and that "*even in Europe, consumers express a spoken preference for non-GM products but when it comes to purchase are happy to accept GM products with a price or quality advantage*". Reports from 2003 and 2005 are cited in support of the latter claim.

109. That view contrasts with recent (2014) work by the US Department of Agriculture on GM in the European market which concludes that "*due to the fact that European*

[36] http://www.wholefoodsmarket.com/gmo-your-right-know

consumers are exposed to consistent negative messaging from activists, their perceptions are mostly negative" and that "*food retailers adapt their offer to consumer perceptions*".[37]

110. It is a basic tenet of economics that consumer preferences are sovereign. Whatever we might think about the reasoning or emotion lying behind these preferences, they are the main determinant of value from the consumers' perspective. Even if European consumers have been misled by "consistent negative messaging from activists", they are still the people who might or might not buy products from the Auckland/Northland region.

111. Also important in the food market context is that "*food retailers adapt their offer to consumer perceptions*" – that they act as "gatekeepers" and screen from their shelves products with attributes consumers generally dislike. A number of supermarket chains across Europe effectively exclude products with GM content (eg Migros and Coop).[38]

112. These crucial points seem likely to lie behind the views of Fonterra in respect of GM releases and field trials. Even though Fonterra is an investor in the Pasture Genomics consortium developing GM grasses, it is opposed to release of GM plants and to field trials. Fonterra's view was expressed in 2012 as follows.

Customers view New Zealand dairy as GM Free and the introduction of GM pasture would have a significant impact for some customers and New Zealand's reputation. […] However Fonterra does not support field trials of GMOs in New Zealand at this time and would only support such trials if we can be convinced that this would not be perceived as a release; containment could be assessed; and that doing so would not be counter to the needs and desires of customers, consumers and key stakeholders. At this time we do not have the confidence that such criteria can be met.[39]

113. Dairy is an important industry in the Auckland/Northland region. I note that Fonterra's views are heavily oriented towards the "*needs and desires of customers, consumers and key stakeholders*". As an organisation selling dairy products to customers and consumers, I consider that Fonterra is likely to be well informed about their views and their "*needs and desires*".

114. Horticulture is also a significant industry in the Auckland/Northland region, so the views of the industry association Horticulture New Zealand on GM are also relevant. Its 2009 policy includes the following statements.

Horticulture New Zealand recognises that there is considerable consumer opposition to genetically engineered food products and that it is critical that the industry continues to be market focused supplying products that exceed customer and consumer requirements.

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[37] USDA, Biotechnology and Other New Production Technologies, GAIN Report Number: FR 9169, 31 December 2014.

[38] Harris Consulting, *Economic Impacts: Adventitious presence of genetically modified forages*, a report prepared for MAF, November 2010, p 25.

[39] Statement on Radio New Zealand 9 December 2012.

New Zealand horticulture industry must stay at the forefront of science and innovation. However, research for the New Zealand horticulture industry should at this stage focus on the application of technologies in areas other than those that will result in the production of genetically engineered crops.

115. These views and policies of major food exporters directly contradict the NZBIO view. It is important to note that NZBio's aim is to promote "bioscience", which is a potential input for agricultural producers, rather than to sell food products to customers and consumers. The distinction is important for two reasons. First, NZBIO is at least one step removed from the relevant markets, limiting its ability to understand consumer preferences in those markets. Second, as an association of technology sellers, it also has a clear incentive to understate consumer opposition to those technologies.

116. For these reasons it seems safe to conclude that there is indeed significant consumer opposition to GM food crops. If there was no such preference, the stated positions of major producer groups such as Fonterra and Horticulture New Zealand could not be rationally justified.

117. Bearing in mind the timing relevant to this Proposal (a ten year plan) it is important to note that the consumer preferences that are influencing Fonterra and Horticulture New Zealand are apparent right now: they are not preferences that might emerge at some future time.

118. When considering consumer preferences regarding GMOs in the current context, it is the *marginal* or extra effect of the GMO attribute that matters. Consumers often care about many different attributes of products, such as their price, appearance, reliability etc. The only attribute that is relevant here is the GMO attribute. For example, the fact that consumers might rank other attributes as more important than GMO content is irrelevant. What matters is the absolute extent to which consumers care about GMOs. The above views of Fonterra and Horticulture New Zealand can be interpreted as saying that, in their view as market-facing exporters, consumers do care enough about GMOs to make them unattractive for New Zealand producers and a commercial risk.

5.2.2 Risk Avoidance

119. The fact that consumers do indeed care about GMO foods raises the potential for risk avoidance benefits to arise from the Proposal. In the absence of outdoor cultivation of GM plants, there is no risk of spill-over effects that harm the business of non-GM producers. Such effects could arise from:

- The escape of a GM organism into the broader environment with consequent ecological and/or biosecurity risks plus costs for clean-up and/or containment; or

- Contamination of non-GM outputs that is subsequently detected by customers resulting in a loss of trade or a value downgrade.

- The perception that non-GM production was contaminated as a result of the presence of even unrelated GM crops and the inability to brand the region as a non-GM growing area.

120. The recent fruit fly outbreaks in Auckland are an illustration of how organisms can relocate and impose ecological and biosecurity costs. Notwithstanding the best efforts of all involved, accidents and errors do occur.

121. There are several previous examples of GM plant products contaminating non-GM products. They include the following:

- Between 2000 and 2008 there were five "field events" in New Zealand involving the detection of GM in maize products as a result of contaminated seed imports.[40] The cost of these events is not known with certainty however the July 2008 event involved quarantine of 13,500 tonnes of maize seed plus tracing and testing work. A July 2003 event is reported to have cost the company involved around $500,000.

- Contamination in 2009 of flax exports from Canada with a GM flax called "triffid" that was supposed to no longer exist. This was estimated to have cost $29m - which is 15% of the total annual export *revenue* of Canadian flax. The profit impact would have been proportionately much larger.[41]

122. In addition there have been major costs incurred by USA producers as a result of attempts to pre-empt regulatory approval in export markets (e.g. gaining approval in the USA, then exporting before the buying country approves the product). The Financial Times reports that costs of "hundreds of millions of dollars" were incurred in 2013 alone from this effect and that more are likely.[42]

123. The Proposal may not totally eliminate the risk of such events originating from outside the region, but it removes the far greater risks that would arise from intentionally grown GM crops contaminating non-GM production. .

124. A related issue concerns the potential for co-existence between GMO and non-GMO crops. I am aware of arguments that cross-contamination is unlikely which draw on analogies with conventional seed multiplication practices. Seed growers often use buffer zones to reduce the risk of cross-contamination, and the argument posits that the same methods can be used to enable co-existence of GMO and non-GMO crops.[43]

125. One difficulty with this argument is in respect of liability for the cost of the buffer zone. Seed growers provide the buffer zone land for the purpose of improving the

[40] http://www.biosecurity.govt.nz/imports/plants/papers/gm-seeds/maize/factsheet.htm

[41] Camille D. Ryan and Stuart J. Smyth, 2012, Economic Implications of Low-level Presence in a Zero-Tolerance European Import Market: The Case of Canadian Triffid Flax, AgBioForum, 15, pp. 21-30.

[42] Gregory Meyer, Trade fears sprout in the GMO divide, Financial Times, 10 March 2014.

[43] This was argued by Pastoral Genomics at hearings before the Hastings District Council.

purity of their own crop, rather than to avoid contaminating their neighbours' crops. So at the very least this analogy suggests that strict controls (such as buffer zones) would be warranted in the event of outdoor GMO release.

126. A further difficulty concerns the scale of cost of any incursions across the buffer zone. Market sensitivity to products suffering GM contamination indicates that the consequences of a GMO incursion (in terms of market rejection) will be much higher than for a cross-contamination that occurs during seed multiplication. I note that Professor Heinemann's evidence provides references showing excursions of GMOs well beyond recommended buffer zones.

127. This is consistent with recent (April 2015) views of the European Commission which find that segregation is impossible in practice.[44]

> *Agriculture is an open process, which means that perfect segregation of the different agricultural production types is not possible in practice. Coexistence between GM and non-GM production requires specific segregation measures designed in a way that takes these limitations into account.*

It follows that peaceful coexistence must either be based on an assumption that some GM contamination of non-GM crops will be tolerated or on a system for segregation that is acceptable to all parties. The most recent (April 2015) EU guidance is clearly supportive of local management of GMO issues and includes the following policy.[45]

> *Where coexistence of certain crops is difficult to achieve due to local conditions, areas may be designated where only GM or non-GM varieties of a given crop can be grown. These measures should be based on voluntary decisions by all farmers in that area, so they can choose between conventional, organic and GM.*

128. In my opinion, the Proposal is consistent with this recent development in European thinking. If and when there are serious (i.e. commercially feasible) proposals for the outdoor release of particular GMOs the plan change process should be capable of regulating activities in a way that deals with the serious externality issues involved.

5.2.3 Policy Management Costs

129. The next most liberal approach to outdoor release of GMOs would be to make such activities discretionary. My reading of the submissions in opposition is that the objections run somewhat deeper than would be accommodated by this change. It is nonetheless appropriate to consider this alternative.

130. Discretionary status is appropriate for activities which are generally acceptable to a community but need careful attention for some reason. The reason is usually

[44] European Commission, Coexistence of genetically modified crops with conventional and organic agriculture, 22 April 2105

[45] http://ec.europa.eu/agriculture/gmo/coexistence/com2009_153_sum_en.pdf

location-specific. For example, buildings are generally acceptable, but they might reasonably be assigned a discretionary status in outstanding natural landscapes.[46]

131. Outdoor release of GMOs is clearly differentiated from such activities. There has been no outdoor release at the national level and major customer-facing exporters (Fonterra, Horticulture New Zealand) are opposed to release. In this context assigning discretionary status seems unwarranted.

[46] See PAUP Topic 019 – Natural features, Landscape and Character.

6. Conclusion

132. Gene science is a powerful, active and general field of research. It seems likely that it will generate many benefits for humans in the future. Genetically modified organisms (GMOs) are one category of things enabled by gene science and outdoor release of GMOs is a subset of potential GMO applications. The matter at hand concerns outdoor release and field trialling of GMOs in the Auckland/Northland region.

133. Auckland and Northland councils propose prohibited status for the outdoor release of GMOs, discretionary status with controls including strict liability for field trials of GMOs and permitted status for indoor GMO use. My economic analysis suggests that these are reasonable and appropriate designations. The costs appear to be very low and possibly zero (excluding council costs), while the benefits are real and present.

134. Regarding costs, I note the following.

    a. There is already a group of businesses using bioscience in the Auckland/Northland region without field trials or outdoor release. I see no reason why the Proposal will impose any future costs on this activity.

    b. No outdoor release of a GMO has been carried out in New Zealand under the HSNO Act. Opponents to the Proposal have not cited any GMO that is ready, or close to being ready for market release in Auckland/Northland.

    c. The typical timeframes for developing GMOs are at least as long as the ten year life of the councils' planning documents.

    d. Even if a highly valuable GMO emerged much earlier than expected, the cost of the Proposal would be limited to the cost of a plan change process.

135. In respect of benefits, I rely on the views of parties selling New Zealand primary products for export who consider that buyers of these products *currently* attach value to non-GM production and to our GMO free status. On this point I note that

    a. Because the benefit occurs now, protecting it is valuable; but

    b. If a clearly valuable GMO emerges at some future time, we can re-assess the merits of prohibiting the outdoor release of that GMO or set of GMOs.

136. For these reasons I conclude that the Proposal has net benefits and should be approved.

Appendix: Dr John Small's CV

John applies the tools and techniques of economics to issues at the boundary between public policy and private business, and on either side of that boundary.

He has worked in all major network industries, in banking and payment systems, construction, agriculture, food processing, and on regional economic development. He is particularly interested in competition, regulation, market risk assessment, efficient contracting, and start-up businesses.

Areas of Expertise

- Expert witness
- Competition & regulatory economics
- Economic analysis of public policy
- Financial analysis
- Econometrics

Education

PhD in economics
The University of Canterbury, 1993

BA in economics (1st class honours)
The University of Canterbury, 1990

BSc in economics
The University of Canterbury, 1989

Employment History

Director
Covec, New Zealand
2001 – Present

Lay Member
High Court of New Zealand
Three 5-year terms starting 2003, 2009, 2016

Head of Department, Economics
University of Auckland
2003 – 2004

Director
CRNEC – University of Auckland
1998 – 2004

Director
Network Economics Consulting Group, Australia
1998 – 2001

Lecturer & Senior Lecturer, Economics
Econometrics & microeconomics, University of Auckland, New Zealand
1994 – 2004

Lecturer, Economics
University of Canterbury, NZ
1993

Sample of Relevant Experience

Competition for Currency Conversion: Expert testimony in the Australian Federal Court on conduct by Visa regarding currency conversion. *Australian Government Solicitor, 2014-15.*

Port Sector Analysis: Analysis of asset valuations and pricing proposals by a New Zealand port, comparison with likely regulated pricing and estimation of benefits of regulation. *New Zealand Commerce Commission, 2014.*

Gas Pipeline Access & Governance: appointed to a Panel of Expert Advisors convened by gas industry co-regulator to reform gas pipeline access arrangements and investment approval processes.
Gas Industry Company, 2011-13

Electricity Market Rules. Expert advisor on proposed change to rules governing wholesale electricity market in Australia including related party contracting and valuation of assets. *Australian Energy Markets Commission, 2012.*

Infrastructure Valuation and Cost Recovery. Expert advisor to New Zealand Commerce Commission during development of "input methodologies" that define how regulation will be applied to electricity and gas networks and airports. *Commerce Commission, 2009-10.*

Telecommunications Negotiations: Economic modelling of compensation and direct negotiations with incumbent telecommunications company to prematurely end its statutory monopoly. Work required forecasting of company profits and valuations under status-quo and competitive scenarios.
Government of Vanuatu, 2007
Government of Solomon Islands, 2009-09

Spectrum Pricing: Expert submission to ACMA on pricing of 700MHz apparatus licences in regional and rural parts of Australia. *Australian Mobile Telecommunications Association, 2013.*

Construction sector competition. Expert advisor on inquiry into building materials markets in New Zealand. *Ministry of Business Innovation and Employment, 2013.*

Telecommunications Regulation. Expert advisor to New Zealand government on design of regulatory arrangements for nation-wide fibre-to-the-premises network. *Ministry of Economic Development and Crown Fibre Holdings, 2009-10.*

Short Course Development and Teaching. Led development and teaching of Covec short courses on "Cost Benefit Analysis", "Competition and Regulatory Economics in Network Industries" and "Regulatory Economics". NZ *Treasury 2012-5 (annually), Government Economics Network 2012, Auckland Council 2012, Electricity Authority 2013, ChCh Council 2013, Commerce Commission 2013.*

Dairy Economics & Governance. Expert advisor to team of officials co-ordinated by MAF to investigate competition issues arising from farm gate milk pricing in New Zealand and develop oversight regime for Fonterra's farm gate pricing. *Ministry of Agriculture and Fisheries, 2011-12.*

Electricity Transmission Investment. Econometric analysis of cross-hedging strategy to support financing proposal for major Canada-USA merchant investment in DC transmission, *London Economics LLC, 2014.*

Damages Dispute. Advised major orchid grower during damages negotiation with Bayer AG which sold a new chemical spray that killed and damaged export orchid crops. *Lingar Orchids, 2010-11.*

Metropolitan Rail Economics: Estimated externalities from metro rail in Auckland and Wellington, developed funding and fare recommendations. *NZTA, 2012-13.*

Telecommunications Policy. Developed principles to guide development of sector-specific competition law in Macao. *DSRT of Macao, 2008.*

Value of Lost Load: Expert economic advisor to London Economics which is contracted to estimate the cost of electricity outages in Texas. *London Economics, 2013.*

Economic impact analysis: Comparison of economic effects of two alternative stadium locations for Auckland. *Auckland Regional Council, 2009*

Electricity Market Reform. Sequence of meetings with Minister of Energy to explore options for significant adjustments to NZ electricity market arrangements.
Ministry of Economic Development, 2006

Electronic Payment Systems: Independent review of commercial and policy issues in electronic payments sector. *Retailers Association, 2012-13.*

Electricity Transmission Pricing: Submission to Electricity Authority on its proposals to change transmission pricing methodology.
Mighty River Power, 2013.

Telecommunications Regulation. Won international tender to supply and support the first independent regulator of telecommunications in Vanuatu.
AUSAID, 2008-10.

Competition between Credit Contract Suppliers: Expert testimony in the High Court regarding the impact on competition and consumer welfare of complex fee structures in credit contracts, *New Zealand Commerce Commission, 2012.*

Demand for Fibre Services in Auckland: Report quantifying potential demand for fibre-to-the-home and modelling the business case for investment.
Auckland, Manukau and Waitakere Cities, 2008

Waste Policy. Advising on costs and benefits of alternative methods for reducing waste-to-landfill in the Auckland region.
Auckland Council, 2011-12

Aviation Merger. Economic modelling to predict the impact of a proposed trans-Tasman alliance between Air New Zealand and Virgin on aviation competition and the New Zealand economy more generally.
Ministry of Transport, 2010-11

Postal Network Access. Economic advice to several postal operators over conditions and pricing of access to New Zealand Post's network. *Freightways Ltd, 2009-12.*

Oil Security: Economic analysis of the social value to New Zealand of holding additional oil stocks and on mechanisms for increasing stocks and the competitive impacts of these.
Ministry of Economic Development, 2004

Broadcast Royalties: Economic analysis of the appropriate royalty payable by radio broadcasters to recording companies pursuant to a reference to the Copyright Tribunal, including econometric modelling of the value to record companies of radio airplay.
Radio Broadcasters Association, 2008-09

Heritage Valuation. Investigating the value to society at large from planning restrictions designed to preserve heritage features in certain Auckland locations. *Auckland City Council, 2008-10.*

Water Development Options. Two reports. One focused on evaluation of alternative (and complementary) options for augmenting supplied of fresh water (including demand management); the other evaluating network development options for waste water infrastructure. This work was undertaken as part of the "three waters" programme of work.
Watercare Ltd, 2007.

Electronic Payments. Developed an electronic payments strategy for national grocery retailer faced with significant increases in transaction costs due to industry shifts.
Foodstuffs, 2011

Electricity Network Modelling: Econometric modelling and other advice for new regulatory regime for electricity distribution companies.
NZ Commerce Commission, 2003

California Grid Investment with Real Options: Development and application of a real options methodology for assessing grid investment

proposals taking generation investment into account, with London Economics International.
California Independent System Operator, 2001-02

Bank Capital Modelling: Jointly commissioned by banks to build econometric model linking the real business cycle to the rate of bank asset impairment.
Westpac, ANZ Bank, ASB Bank, Bank of New Zealand, 2007

Consumer Behaviour – Forex Conversions: Econometric modelling of consumer reactions to extra disclosure of international currency conversion fees on credit card statements.
Bank of New Zealand, 2006

Inflation Forecasting – RBNZ: Comparative study of empirical methods for forecasting inflation.
Reserve Bank of New Zealand, 1995

Tax Policy Econometrics: Sequence of projects, 1992-97. Work included empirical analysis of tax policy and the construction of the first formal revenue forecasting model, which is still in use today.
New Zealand Inland Revenue Department, 1992-7

Publications

Cave, Martin, Michael Pollitt, John Small and George Yarrow, (2010) "Asset valuation in workably competitive markets" Report to the NZ Commerce Commission and Economic and Social Research Council Technical Report RES-152-25-1002.

Small, John, (July 2009) "Utility Regulation in New Zealand", *Network* 32: 1-6.

Guthrie, G., J. Small, and J. Wright, (2006) "Pricing access: Forward-looking versus backward-looking cost rules", *European Economic Review* 50(7): 1767-1789.

Small, J. (2004) "Market definition and the design of competitive electricity industries", *Competition and Consumer Law Journal* 12(2): 236-246

Aoki, R., and J. Small, (2004) "Compulsory Licensing of Technology and the Essential Facilities Doctrine", *Information Economics and Policy* 16: 13-29.

Small, J. (2002) "Public Sector Reform in New Zealand: Implications for Japan", *The Otemon Journal of Australian Studies* 28: 115-124.

Reeves, J.J. (2000) C.A. Blyth, C.M. Triggs and J.P. Small, "The Hodrick-Prescott Filter, a Generalization, and a New Procedure for Extracting an Empirical Cycle from a Series", *Studies in Nonlinear Dynamics and Econometrics* 4(1): 1-16.

Small, John (2000) "An Overview of Utility Regulation in New Zealand", G. Lawrence (ed.), *Utility Regulation in Australia and New Zealand*, *Thompson Financial, London* Ch 4.

Small, John (2000) "The Distribution of Estimates of the Marginal Cost of Taxation", in G.W. Scully and P.Caragata (eds), *Taxation and the Limits of Government*, Kluwer Academic Publishers, MA, 115-126.

Small, John and Patrick Caragata (2000) "The Effect of Aggregate Tax Levels on Output Growth in New Zealand", in G.W. Scully and P.Caragata (eds), *Taxation and the Limits of Government*, Kluwer Academic Publishers, MA, 89-98.

Small, John P. and Patrick Caragata (2000) "Regression Based Estimation of Effective Tax Rates" in G.W. Scully and P.Caragata (eds), *Taxation and the Limits of Government*, Kluwer Academic Publishers, MA, 289-305.

Mckenzie, D. and J. Small (1997) "Econometric Cost Functions for Cellular Telephony in the United States", *Journal of Regulatory Economics* 12: 147-157.

Small, J.P. (1997) SHAZAM 8.0: A Software Review, *Journal of Economic Surveys*, 11: 447-453.

Small, J.P. and A. Harris (1996) "Universal Service and Local Telephone Network Access", in Hansen S. (ed) *Universal Service with Network Competition*, CRNEC, University of Auckland.

Small, J.P. (1995) "Testing and Estimation with Seasonal Autoregressive Mis-specification", *Journal of Quantitative Economics*, 11: 21-33.

Small, J.P., D.E.A. Giles and K.J. White, (1994)"The Exact Powers of Some Autocorrelation Tests When Relevant Regressors are Omitted", *Journal of Statistical Computation and Simulation* 50: 45-57.

Small, J.P. (1994) "The Exact Power of Some Autocorrelation Tests When the Disturbances are Heteroscedastic", *Journal of Econometrics* 61: 383-394.

Small, J.P. (1993) "The Limiting Power of Point Optimal Autocorrelation Tests", *Communications in Statistics* (Theory and Methods), 22:2463-2470.

Giles, D.E.A. and J.P. Small (1991) "The Power of the Durbin-Watson Test When the Errors are Heteroscedastic", *Economics Letters* 86:441-446.