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

---

EVIDENCE OF DR MICHAEL DUNBIER ON BEHALF OF PASTORAL GENOMICS LIMITED

31 May 2016

EXECUTIVE SUMMARY

1 Improved cultivars of crops, pastures and trees have been important for New Zealand primary industries and will continue to be so.

2 New Zealand regulations, controlled by HSNO Act 1996 and implemented by the Environmental Protection Agency ("EPA"), for controlling importation and growing of GM organisms are amongst the most stringent in the world and rated as more stringent than our major trading partners or agricultural export competitors. At best these FNDC/WDC proposals will duplicate EPA assessments.

3 Plant breeders have to consider, dependent largely on the source of the desired trait, which of several technical options they use to develop improved cultivars.

4 All of these options have some steps in common so that GM should be recognised as an evolution of breeding methodology, rather than entirely novel.

5 All breeding methodologies carry some risk of unexpected changes but there is no evidence that GM is more likely to produce these than unregulated methods. In fact the limited evidence available suggests this is less likely. This risk is already managed through the Hazardous Substances and New Organisms Act ("HSNO Act").

6 In the two decades of commercialising GM crops they have grown rapidly because of the benefits demonstrated and are now grown on 181M hectares (7 times the total area of New Zealand) in 28 countries.

7 The Section 32 analysis of the literature is both incomplete and out of date and provides an inadequate base for defensible regulation.

8 In considering impacts of GM crops it is critical to distinguish the impact of the GM crop itself from other agronomic, economic or social change occurring at the same time.

9 International research and considerable practical experience shows co-existence of GM and other crops is practicable and can meet internationally accepted purity standards. Similarly, New Zealand farmers have extensive experience producing identity preserved seed crops to export standards.

10 Many factors contribute to the acceptability of produce from a country or region and GM use alone is unlikely to transform this.

11 Results from public opinion surveys should be interpreted exceedingly cautiously because of the influence of framing and the context in which questions are asked.

12 There is a clear scientific consensus that:

12.1 Current commercialised crops are safe;

12.2 There is no evidence that GM crops are inherently more risky than other breeding technologies.

13 Consequently these proposals fail to meet the S32 criteria of efficiency and effectiveness and should be rejected in their entirety.

INTRODUCTION

14 My name is Dr Michael William Dunbier.

15 I chair the board of Pastoral Genomics Limited.

16 Pastoral Genomics is a New Zealand research consortium for forage improvement through biotechnology. Partner organisations in Pastoral Genomics include DairyNZ, Beef and LambNZ, Grasslands Innovation, NZ Agriseeds and Deer IndustryNZ – all of which have active links with the Northland region.

17 The outcomes aspired to by Pastoral Genomics are to improve plant development and modification programmes for the benefit of NZ pastoral farmers – but within robust guidelines so as to manage plant programmes within internationally recognised and developed best practice.

QUALIFICATIONS AND EXPERIENCE

18 I hold a Master of Agricultural Science (Hons) in Plant Breeding and Genetics from Lincoln College, University of Canterbury and a Doctorate of Philosophy in Genetics and Plant Breeding from the University of Wisconsin, Madison.

19 I am a Fellow of the New Zealand Institute of Agricultural Science and a Fellow of the New Zealand Institute of Management. I was awarded the Bledisloe Medal (former student who has made an outstanding contribution to his or her chosen field of expertise, advanced New Zealand's interests, and/or brought credit to Lincoln University) by Lincoln University in 2005 and the NZIAHS Jubilee Medal (for an outstanding contribution to primary resource science) in 2011.

20 I have extensive experience of leading scientific research in New Zealand having been Director of DSIR Crop Research (1983-1992) and Chief Executive Officer of Crop & Food Research (1992-2000).

21 I have had considerable involvement in international agricultural research, including being a New Zealand delegate to the Consultative Group in International Agricultural Research from 1997-2001 and as a reviewer of research at CIMMYT (International Maize and Wheat Improvement Centre).

22 I have broad governance experience in organisations funding or undertaking research in New Zealand (including Foundation for Research Science and Technology, Dairy InSight, Foundation for Arable Research, BioProtection Centre of Research Excellence, HortNZ Vegetable Research & Innovation Board, AgResearch). I also have significant governance experience in Australia (including Grains Research and Development Corporation, SunPrime Seeds, SunPrime Research & Development and the Quality Wheat Co-operative Research Centre).

23 I have been involved in directing research on improving crop and pasture plants, including the use of genetic modification, and the development of their regulation in New Zealand since 1983.

24 I have experience in commissioning opinion surveys in New Zealand on attitudes to biotechnology from 1991 to 2011 and have tracked similar international opinion surveys over the same period.

CONTEXT

25 New Zealand's primary production sector is based on the performance of imported plant species which have been selected and improved to perform well in our climatic conditions and in our farming systems. Since our economy is heavily dependent on primary sector exports it is critical that agricultural, horticultural and forestry interests maintain access to the best performing cultivars if their industries, and the economy as a whole, are to meet societal expectations. This relatively high dependence on agriculture and the potential challenges our primary sector faces; means that New Zealand will be more heavily handicapped than overseas competitors if access to the best performing cultivars is constrained.

26 Plant breeders in New Zealand have an enviable record of contributing to industry development. For example, essentially all New Zealand pastures are sown with cultivars bred here, the kiwifruit and pip fruit industries are heavily dependent on local cultivars as is the plantation forestry sector. New Zealand scientists working to improve plants genetically interact closely with their international counterparts exchanging germplasm and technologies.

University and Crown Research Institute researchers are involved in international research programmes and New Zealand seed companies have strong commercial links with the global companies that dominate research in major crops.

27 Plant breeders have several specialised techniques to use in developing better cultivars if the desired trait is included in the natural gene pool of the crop involved. Until molecular science advanced dramatically in the latter part of last century, breeders were restricted to using traits from this gene pool, although many ingenious techniques were used to extend it. Some of these techniques were harsh and extremely disruptive to the genetic composition of the plant. However, until the molecular understanding developed, if the desired trait was not available in this gene pool the breeder had no means to use it. For example, scientists knew of the insecticidal properties of proteins produced by *Bacteria thuringiensis* (Bt) but because crop plants and their relatives did not have the genetic capability to produce these, it was not possible using any conventional breeding techniques to breed cultivars with resistance to insects using these proteins. The advent of genetic modification enabled the use of these proteins in crops – Bt maize, Bt cotton especially- that are widely grown around the world. GM can thus be regarded as an extension of conventional breeding methodologies providing more sophisticated tools to deliver desired traits in crop plants.

28 In New Zealand, researchers working to minimise the impact of grazing animals on greenhouse gas production have used genetic modification techniques to increase the lipid content in the herbage and ensure that its digestion in ruminants is optimal. This development, which is unattainable by non GM means, should both improve animal production from the same amount of plant material and reduce greenhouse gas impact. Greenhouse data shows production increases of up to 50% which, with a better protein/energy balance should give both a better feed conversion performance and reduce both methane and nitrous oxide emissions by 15% (AgResearch pers.com.).

HSNO APPLICATION PROCESS

29 The proposed District Plan assumes that current assessment of genetically modified organisms (GMOs) in New Zealand requires supplementing at a local level if communities are to be adequately protected. Experience with evaluation of GMOs since the Environmental Risk Management Authority (ERMA the predecessor of the Environmental Protection Agency (EPA)) has shown it matches international best practice and further scrutiny for risk is not justified. This is well demonstrated by the ranking of Vigani & Olper (2013) who used an index derived from the handling of six components (approval, risk assessment, labelling, traceability, agreements, coexistence) of a regulatory system to compare restrictiveness of GM regulation from 0 (no restriction) to 1 (GM banned). It shows (Table 1) that New Zealand is grouped amongst the countries with more stringent regulations for managing GM and notably ranks as more stringent than:

29.1 our major trading partners (China, Australia and USA);

29.2 the primary sector exporters (Australia, Brazil, Argentina, Chile, USA, Canada) we regard as competitors.

Table 1 Relative stringency of national GM regulations (0 = no regulation, 1 = GM banned)

Cluster	Countries	GMO Index Value
1	Hong Kong	0.10
2	Bangladesh, Peru, Sri Lanka, Turkey, Ukraine, Venezuela	0.15
3	Israel, Jamaica, Kenya	0.20
4	Canada, Guatemala, Philippines, Singapore, South Africa, Taiwan, Vietnam	0.30
5	Chile, India, Indonesia, Malaysia, Mexico, United States	0.35
6	Argentina, Thailand	0.40
7	Colombia, Russia, Saudi Arabia, South Korea	0.45
8	Brazil, China	0.50
9	Australia, Switzerland	0.55
10	Norway, Poland, Spain, United Kingdom	0.60
11	Germany, Greece, Ireland, Luxemburg, **New Zealand**, Romania, Slovakia, Slovenia, Sweden	0.65
12	Estonia, Finland, Japan	0.70
13	Austria, Belgium, Czech Republic, Denmark, France, Hungary, Italy, Netherlands, Portugal	0.75
14	Zambia, Zimbabwe	1.00

30 Approval from the EPA is needed before any GMO can be imported into containment in New Zealand and further application(s) are necessary before it can be released into the environment for either field testing or commercialisation.

31 For a field test, GMOs are kept within outdoor enclosures where there are physical barriers (such as fences) and operating procedures (such as preventing plants from flowering) to keep the GM plant or animal within its secure enclosure. Such activities are classed as being in containment within approved facilities. Genetic material must not be released outside the field test site and must be destroyed once the test is finished. These controls allow some trials (especially those with vegetatively propagated crops or other crops that do not require the grain or seed harvest) to proceed and provide useful information on performance. However, if

a grain or seed harvest is necessary, or large quantities of plant material are needed for an animal feeding trial, they are seriously constraining research and development. Furthermore, since the current HSNO regulations do not enable any significant breeding or seed multiplication to be undertaken (this would need conditional or full release approval) nothing more than proof of concept trials can currently be undertaken in containment. Additional constraints on plant molecular science research, as indicated in the District Plan are not only unnecessary because of the control already imposed through HSNO, but would further inhibit research and reduce the prospect of New Zealand farmers and growers maintaining access to cultivars with the desirable characteristics their international competitors are able to use.

32 When considering an application, the EPA must assess the environmental risks, and requires information on the biology of the plant, the molecular characteristics of the genetic modification so that it can examine issues such as the risk of an organism escaping from a laboratory or the risk of GMO pollen contaminating surrounding plants. In addition to biological risks and benefits, a full assessment of economic, environmental and social risks and benefits must be provided. The EPA must consult widely when considering a GMO application, and if an approval is given, will impose conditions and controls as appropriate. Members of the public and organisations can make submissions on GMO applications that the EPA is considering.

33 EPA has expert staff, including those with experience in molecular technologies, ecological sciences, risk management and community involvement. These staff report to a broadly experienced Board appointed by the Minister for the Environment. Following consideration by staff, decisions on applications are made by a specialist Committee with a wide range of science, risk and legal skills.

34 This range and depth of capability is necessary because plant molecular biology is a very rapidly advancing branch of science and new techniques and products are appearing consistently NAS 2016). Advances enabling cisgenesis, intragenesis and various genome editing technologies (e.g. CRISPR, zinc finger nuclease) as well as new discoveries such as bacterial sequences in all cultivated sweet potato cultivars (Kyndt et al 2015) challenge established regulations and definitions. Without high level expertise in related disciplines decisions are likely to be subject to challenge and risk public confidence in the regulatory regime. Since such specialised expertise is scarce internationally, it is probable that any such assessment at local body level would need to use the same expertise that EPA currently use.

35 An example of the stringency of the requirements under the HSNO Act can be seen when considering undertaking a field trial of a GM ryegrass in New Zealand. It would be a demanding and expensive operation. As there are no appropriate local precedents it is not possible to provide a cost or time estimate, but it would be unrealistic to expect it would be

less than in Australia where field tests of GM forages have been undertaken. Pastoral Genomics estimated that the application, operation, reporting of a GM ryegrass trial and ongoing surveillance of the trial site there would cost in excess of AUD2.1 million and take at least three years.

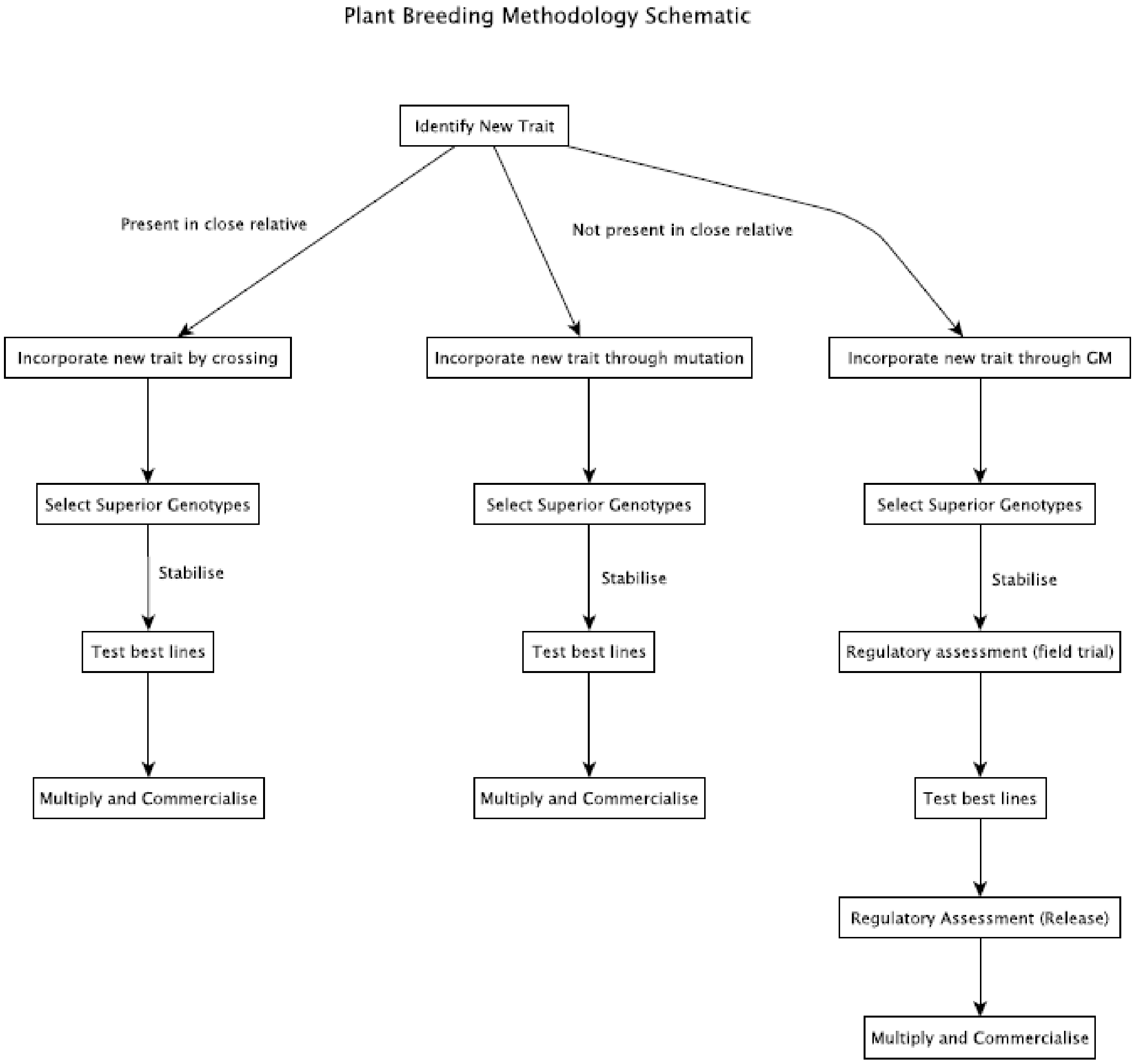
COMPARING RISKS OF DIFFERENT PLANT BREEDING METHODOLOGIES

36 Modern plant improvement is a multi-step process with many possible options (see Figure 1) depending on the situation the breeder faces. Modern science and new technological developments have enabled much improved accuracy of selection and greater efficiency in breeding programmes. However the key determinant in programme design and execution is the source of the desired trait; if it is not included in the common gene pool of the crop in question then improved accuracy and efficiency will not uncover a trait that was not present in the first place. Those who advocate marker assisted selection (as does Dr Small in his economic evidence for Council) or genomic selection as alternates for GM options are in error. As stated in NAS (2016) "*Treating genetic engineering and conventional breeding as competing approaches is a false dichotomy; more progress in crop improvement could be brought about by using both conventional breeding and genetic engineering than by using either alone."*

37 There are many ways in which plants can be improved (yield, pest resistance, quality, seasonal growth pattern, maturity etc.) and the breeder will choose the best genetic tool for the particular task. In New Zealand, the GM option will be the breeding choice of last resort because it is subject to a longer and more expensive development pathway for a small domestic market.

38 All of the plant breeding options, including those using GM, have common steps – it is only the initial step of the means of incorporating a new trait and those steps imposed by regulation that differ. For this reason it is legitimate to describe GM as an evolution of breeding methodology, rather than as entirely novel.

Figure 1 Schematic of Plant Breeding methodology



39 In considering regulation of GMOs it is critical to accept that GM is a set of processes and not a product. GM only enables new traits to be expressed in an organism- the choice of organism, trait and growing environment is the determinant of the level of benefit or risk- not whether GM or another breeding method is used to produce that combination. As with other technological developments (e.g. fire, wheel, electricity, nuclear) it is a process that can be used wisely or recklessly and hence it is important that appropriate risk analysis and management is undertaken. Risks of GMOs can only be evaluated on their phenotype- the result of the interaction between their genetic composition (host genes plus GM trait) and the conditions under which they are grown. Furthermore, advances in molecular sciences are continually identifying new phenomena that challenge regulatory boundaries as well as developing new techniques which are increasingly blurring the lines between breeding methodologies. Consequently, regulation of GMOs needs to be on phenotype on a case by

case basis, as the techniques used risks and benefits can vary so much that regulation as a single entity is illogical.

40 In Paragraphs 129 and 130 of the Council evidence of Professor Heinemann, he suggests that Pastoral Genomics is requesting that current and future GMOs should be unregulated. This implication is incorrect and misleading. Nowhere in Pastoral Genomics evidence is there any intent explicit or implied that no regulation of GMOs is necessary. Paragraph 39 above shows that Pastoral Genomics advocates for and expects to be subject to appropriate regulation. However, the position we put forward is that existing regulation in New Zealand through HSNO is amongst the most stringent in the world and that the S32 analysis fails to provide any justification for additional regulation.

41 The Section 32 analysis of the literature on GM risk assessment and risk management is both incomplete and out of date. Sanchez (2015) notes over 31848 reports published on GM crop safety before 2006 and since 2005 there have been hundreds more peer reviewed studies published on GM safety (see Sanchez ibid) and impacts of GM on the environment, the economy and society. Further, there have been several comprehensive reviews of impacts of GM technologies published in reputable journals. One of the key principles of risk management is that the best scientific evidence is used, clearly this is not the case here. Given the amount of information available, its limited use in the Section 32 analysis is inexplicable if the intent was to provide a base for development of sound policy and a defensible regulatory regime. Some peer reviewed papers and a selection of recent reviews are included in the references listed below. Consideration of these will provide a more comprehensive and balanced perspective of issues surrounding GM use than that included in the Section 32 analysis.

42 Mutation breeding had been an established plant breeding technique for decades prior to the development of GM techniques and developed from the exploitation of spontaneous mutants. In the hope of finding useful characteristics, mutation breeding subjects large numbers of seeds or plants to ionising radiation or toxic chemicals to make changes, random in terms of location and magnitude, to the DNA. Amongst the genetic changes created- some lethal, some sub-lethal and some deleterious - it is hoped there will be some with useful characteristics and, if the population treated is large enough, the trait desired may be apparent. This can then be developed and if proven stable and sufficiently advantageous commercialised with no constraints, monitoring or any other regulatory scrutiny anywhere in the world. It is estimated that over the period mutation breeding has been practised over 3000 cultivars (including ornamentals, herbs, fruit, vegetables and grains) derived from induced mutations have been commercialised around the world.

43 Variation in the composition of plants results from differences in the genetic composition of different plants, from the agro-climatic region where they are grown and the interaction between these. Breeding of new cultivars can produce raised levels of known toxins (e.g. glucosinolates and glycoalkaloids) but no novel toxic compounds have been recorded (Steiner et al. 2013). Some of these are described below. Growing plants under different conditions can also induce changes in composition of plants. For example, in conventionally bred soybean cultivars grown in different locations (Japan, China, Brazil and USA) the levels of bio-active isoflavonoids such as genistein varied by more than an order of magnitude (Kitta 2013). Similarly, New Zealand wheat growers manipulate yield and protein content through sowing date and fertiliser application timing. These variations in composition, which produce different sensory qualities, as a result of site and growing conditions in vineyards are attributed to "the terroir" in wine production and marketing.

44 Unintended consequences can arise from the use of any plant improvement technique. Throughout the history of plant breeding aberrant plants have been rogued as new gene combinations are expressed in segregating populations. Where the crop is known to contain potentially toxic substances (e.g. glucosinolates in canola and other Brassica species, glycoalkaloids in potatoes) these levels are monitored during the breeding process, but there is no formal requirement to test, nor are there any regulations specific to assess human health or environmental impact from conventional breeding programmes.

45 Rarely, commercially released cultivars have shown a harmful level of a substance after release. Examples of these are given below. Historically this has been shown mostly where plants selected for disease and/or pest resistance have elevated levels of the compounds the plant produces to avoid predation.

46 In potatoes high levels of the glyco-alkaloid solanine are toxic and have resulted in the withdrawal of cultivars from commerce. In one instance a 19th century English heritage potato cultivar being grown in Sweden as Magnuum Bono late last century was withdrawn because of dangerous solanine levels. The cultivar "Lenape" was withdrawn from commercial use in USA in 1975 for the same reason. Similarly, celery leaves produce psoralens, a secondary plant compound, as a biological defence mechanism. The most visually attractive celery with the least fungal infection on the leaves is most likely to have elevated levels of psoralens and these can cause photosensitivity and dermatitis in those, such as pickers and produce handlers, repeatedly contacting the leaves.

47 Such unintended consequences have arisen whether from conventional crossing (e.g celery, potato), mutation induced (swede [cattle deaths in Southland (Harding 2014, Dumbleton et al. 2012) see para 60 below]) and could arise from GM.

48 This analysis is supported by more recent molecular studies (summarised in NAS (2016) showing that while phenotypes may appear uniform different cultivars of the same crop may have very different genetic composition. According to Hoekenga et al. (2013) "*Hybrid crops such as maize have as many as 10 million single nucleotide polymorphisms (or SNPs, the most common form of genetic variation) between the two parental varieties and differ by 10−20% in the number of genes present in their genomes (i.e., 5−10000 genes)*". It is difficult to predict the consequences of the interactions between these genes and, furthermore we now know that epigenetic effects on gene expression can persist inter-generationally. Mutation breeding, however has shown changes in chromosomes with duplication of segments, deletion of segments and segment rearrangement as well as SNP changes.

49 Numerous molecular studies including transcriptomic, proteomic and metabolic profiling, as well as phenotypic assessment (see Ricroch et al 2011 and Herman and Price 2013 for references) show that GM techniques induce less unintended variability than conventional breeding methodologies. Some differences were noted between a GM line and its parent, but it is important to note that these were less than those recorded between the same plants grown under different conditions or between different plants of the same cultivar grown under the same conditions.

50 Hence, while unintended consequences from the use of GM techniques cannot be ruled out; there is no reason to expect them to be either more frequent or more severe than from the use of conventional techniques and evidence available indicates they are likely to be less. It is illogical therefore to subject them to greater scrutiny by local authorities, particularly given the level of control already provided by the HSNO Act.

51 It is significant that GM crops are subject to comprehensive regulatory scrutiny in almost all countries. In Europe this is estimated to add 7 million Euro to the cost of developing a new variety (EASAC 2013), and even in the dominant USA market the time required to meet regulatory requirements (5.5 years according to Philips McDougall) and costs are very substantial, (see Kalaitzandonakes et al (2007) Philips McDougall (2011) and Van Eenennaam (2013) for commentary and estimates), especially where animal feeding studies are required. Such additional regulatory costs and time delays mean GM crop development becomes only practical for major companies and major markets. Minor crops and niche markets cannot justify these costs. Non GM varieties, even if they contained the same trait, are not subject to the same scrutiny.

52 If the EU is regarded as the most sensitive market for GM crops, numerous studies undertaken in the EU or published by researchers in the EU demonstrate no particular risks to the environment or to safety:

53 European Commission (2010):

"The main conclusion to be drawn from the efforts of more than 130 research projects, covering a period of more than 25 years of research, and involving more than 500 independent research groups, is that biotechnology, and in particular GMOs, are not per se more risky than e.g. conventional plant breeding technologies."

54 Nicolia et al. (2013):

"We have reviewed the scientific literature on GE crop safety for the last 10 years that catches the scientific consensus matured since GE plants became widely cultivated worldwide, and we can conclude that the scientific research conducted so far has not detected any significant hazard directly connected with the use of GM crops."

55 Swiss National research Programme NFP59 (2012):

"*Plant biotechnology does not pose risks to health or the environment."*

GM CROP CULTIVATION

56 GM crops are one of the most rapidly adopted agricultural technologies in history and are now grown on 181 million hectares (approximately 7 times the total NZ land area) in 28 countries (population around 4 billion) (ISAAA 2015) following the initial commercialisation of the Flavrsavr tomato in 1994 (Nap et al. 2003). The adoption rate of the major GM crops is shown in Figure 3 (ISAAA 2015).

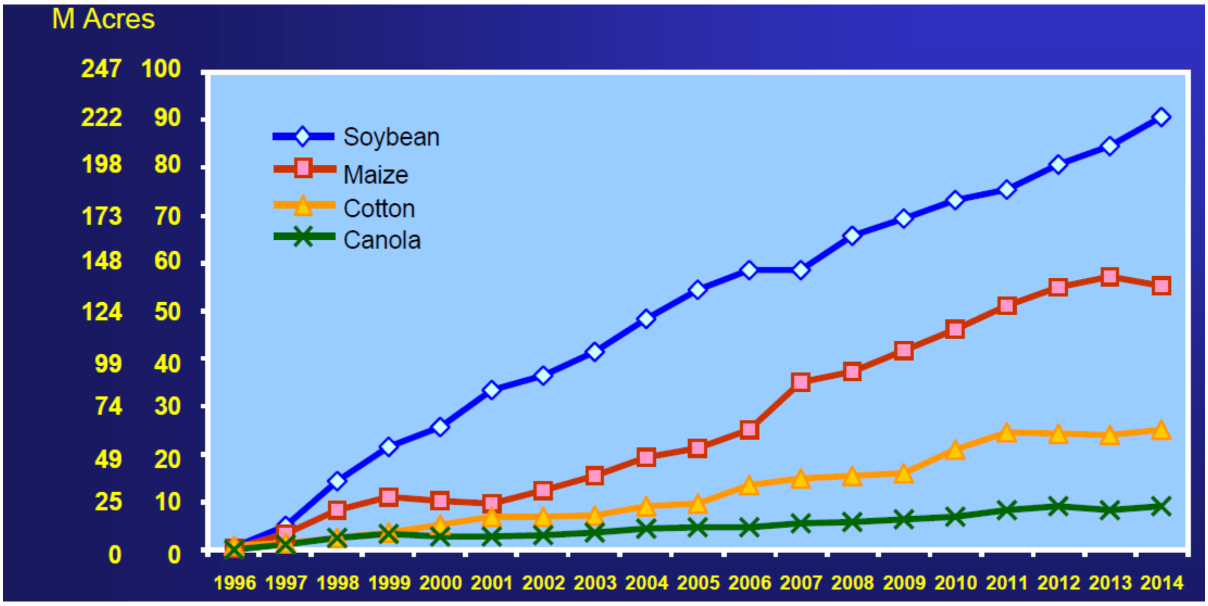
57 Professor Heinemann in 31a describes this experience of commercial production of GM crops as "limited". This is misleading because:

57.1 these crops are being grown on approximately 10% of arable land globally (a more appropriate figure than the 3% of agricultural land used by Professor Heinemann) in 28 different countries (ISAAA ibid.);

57.2 since the product life cycle for US maize hybrids is reported as having declined significantly from five years in 2000 (Magnier et al. 2010) this commercial experience has involved several generations of commercial hybrids over extensive areas so cannot accurately be described as "limited" ;

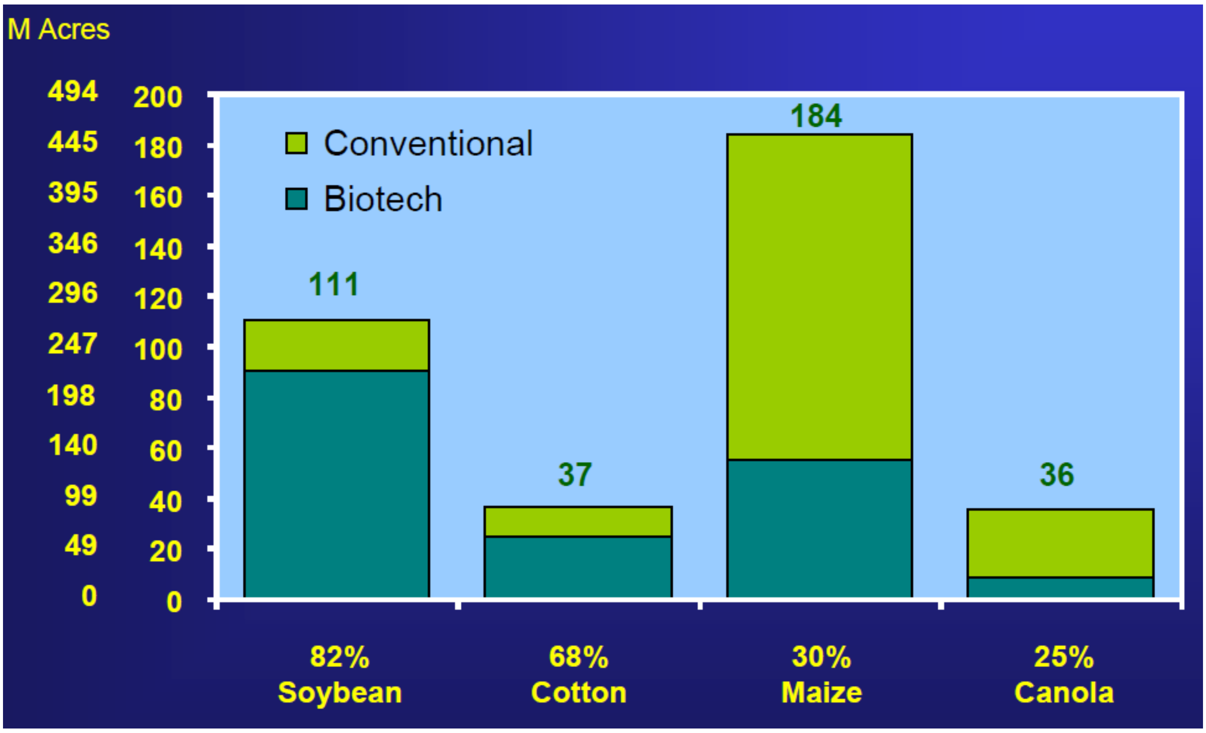
57.3 in comparison Sungold kiwifruit began its commercialisation only after the Psa outbreak in 2010 and is now a significant portion (estimated 140million trays in 2016) of Zespri production.

Figure 3 Area (million acres or hectares) of major GM crops



58 International experience in growing GM crops now spans a generation and, for a number of crops, GM varieties are a significant component of the overall crop area as shown in Figure 4 below (ISAAA 2015). It is important to note that the GM component of global crop production overall is substantial and that GM varieties are dominant in soybeans and cotton. In soybean and cotton the vast majority of production, whether used domestically or internationally traded, including into Europe, comes from GM crops. This extensive international commercial experience, along with numerous laboratory analyses show the use of GM crops is not the result of inadequate information on their performance or promotion by their developers. They are being used by farmers who see the benefit of their use. In some countries (e.g. Brazil, Argentina, India, China) the demand for the seeds with GM traits has been so strong in the face of unjustified controls that thriving unofficial markets in GM seeds have arisen and officials have lost control over their use.

Figure 4 Total area (million acres/ hectares) major crops separated into GM and conventional



RISK ISSUES FOR GM CROPS IN NEW ZEALAND

59 In addition to risk assessment and management at a global scale it is important to undertake similar assessments for the New Zealand environment. EPA assessment specifically addresses these in its evaluation of applications. The risks commonly considered most significant for GM pasture plants are:

Gene transfer and resistance development

60 Included in the S32 report, and in the evidence of Professor Heinemann and Dr Small are references to the “irreversibility” of any decision to release any GM organism based on the premise that the GM trait will spread uncontrollably. Plant breeders have for several decades been releasing cultivars that have novel traits (disease resistance, insect resistance and herbicide tolerance) globally. Of the traits listed above (with the exception of herbicide tolerance which has only been used in this century) cultivars with such novel traits have been widely grown in New Zealand at least since 1936 (Sanderson & Smith 1983) and at the time of their study (loc. cit.) 81 pest resistant crop and pasture cultivars had arisen from DSIR programmes and many more, both imported or bred here, have been released since then. With such widespread introduction of these novel traits (N.B. introduced by non-GM mechanisms) it might have been expected that evidence of the harm caused to non-target organisms or from weediness to have been presented by the Council. That it has not indicates that the claim of irreversibility is grossly overstated.

61 In considering performance of GM crops it is critical to distinguish the impact of the GM crop (i.e. the crop/trait combination) itself from other agronomic, social or economic practice change that is occurring at that time.

62 For example, unwise use of herbicides has caused some weed species to evolve resistance mechanisms to these herbicides. While this evolution of resistance can be exacerbated by the use of herbicide-tolerant crops, it is not solely a result of their use.

63 Similarly, removing weeds from crops by cultivation, herbicides or any other technique reduces biodiversity and potential food sources for birds. Since herbicide-tolerant crops enable more effective removal of weeds, they may also reduce bird numbers. However, if any other method of weed control had the same efficacy the impact on biodiversity and bird numbers would be as great.

64 Herbicide tolerant crop varieties have been grown commercially since 1984, when the first triazine-resistant oilseed rape cultivar (OAC Triton) was introduced in Canada. They have been developed through different breeding mechanisms (including backcrossing and mutation breeding) and were used commercially for more than a decade before "glyphosate-resistant" or "glufosinate-resistant" GM crops became available. For example "Clearfield" technology (non-transgenic crops tolerant to the herbicide family imidazolinones, consisting of six active ingredients, each of which controls a different spectrum of weeds) is available in many countries for canola, sunflower, rice, maize, wheat and lentils. It was first introduced in 1995 for canola and "Clearfield" products are available in North America, South America, South Africa, Australia, Asia, Western Europe, Eastern Europe, Russia and the Ukraine. In New Zealand "Cleancrop" brassica cultivars resistant to chlorsulfuron (Dumbleton et al. 2012) were produced through mutation breeding and are commercially available.

65 Herbicide resistance caused by unwise crop management occurs in conventional cropping systems as well as GM systems. Overuse of herbicides in any cropping system can cause the development of herbicide resistance. For example, the first recorded case of herbicide resistance in ryegrass in New Zealand occurred through repeated applications of glyphosate ("Roundup") for weed control between the rows of vines (non GM) over many years in a Marlborough vineyard. If herbicide-tolerant crops result in further unwise herbicide use then more resistant weeds are likely, but this is a consequence of the way herbicides are used, not because the crops have been developed for herbicide tolerance. While herbicide-tolerant crops may exacerbate the development of herbicide resistant weeds (the so called "superweeds") in crops they do not cause them. In fact, the development of herbicide-tolerant crops provides farmers with more choices when rotating management practices for weed control, thereby reducing the opportunities for herbicide resistant weeds to develop. There is

no substance to the claim of a unique risk from GM in relation to the risk of increasing weediness.

66 In 37a of his evidence Professor Heinemann quotes a Nature editorial to support his "superweed" argument. However based on a thorough review of the literature I consider a more balanced conclusion is that of NAS (2016) who conclude "*Both for insect pests and weeds, there is evidence that some species have increased in abundance as IR and HR crops have become widely planted. However, in only a few cases have the increases posed an agronomic problem*."

67 Since the New Zealand biological economy is dominated by exotic genera there is little likelihood of transfer of modified genes from either crops or their GM derivatives into native species from seed spill or pollen spread. Furthermore, since highly domesticated species are generally uncompetitive outside cultivated areas the chance of dramatically enhanced weediness through GM is unlikely.

68 In 35a of his evidence Professor Heinemann describes the case of feral canola and ascribes it to GM. It is widely known that canola is a hard crop to contain and long established feral populations have been reported from most areas where canola has been grown (Nicholas et al. (2015) from well before GM canola was developed. This example is therefore misleading and should be discounted relative to the extensive coverage of the issue in NAS (2016) which concludes p98 that "*Although gene flow has occurred, no examples have demonstrated an adverse environmental effect of gene flow from a GE crop to a wild, related plant species*."

69 The widespread and uncontrolled use of GM insect resistant crops using genes from *Bacillus thuringiensis* (Bt crops) has, as with any other pest control technology, potential to accelerate the evolution of resistant pests and decrease effectiveness of the control. This resistance development can be slowed by management techniques (e.g. susceptible refuges), and by combining different Bt proteins ("stacking") in different resistant cultivars. As with herbicide resistance, this is not unique to GM crops but has been a factor in crop breeding for many decades.

70 Concerns have also been expressed about the impact of insect-resistant crops on species that are not pests (non-target effects). Extensive field research (summarised in Scott & Ronson 2014) shows that these effects are much lower in GM than in conventional cropping systems. The impact of broad spectrum insecticides applied to the crops is more significant on the range of insects (pests and beneficial insects) in the crop and the environmental impact worse.

71 Further, NAS (2016) and NAS (2010) report extensively on arthropod diversity in Bt crops citing numerous studies and meta-analyses. They give a considered and balanced perspective of non-target effects that differ from the claims in the s 32 report and which demonstrate the inadequacies and lack of balance in Professor Heinemann's response in 33 of his evidence.

72 Horizontal gene transfer (acquiring genetic material from a donor organism by other than normal sexual reproduction) risks have been raised in relation to the transmission of GM traits from a GM crop to other organisms and were discussed in Scott & Ronson (2014). While it is known to occur at exceedingly low frequencies there is no evidence that GM enhances horizontal gene transfer over that already occurring in nature, or that transfer of "GM DNA" is more dangerous than DNA from any other source. Recently (Kyndt et al 2015) it has been shown that cultivated sweet potato contains DNA sequences from a bacterial pathogen, presumably through horizontal gene transfer, and hence could be regarded as a naturally occurring GMO.

73 New Zealand farmers, as well as those in other agricultural countries have significant experience in producing identity preserved crops and seeds. There are established certification standards, technologies and practices, such as the Seed Crop Isolation Distance (Anon 2009) to ensure adequate isolation distances and manage processing so that seed lines are separated throughout. For example in the self and wind pollinated cereals malting and feed barley, as well as milling and feed wheat are kept separate. Amongst the cross and bee pollinated crops oilseed rape is kept separate from vegetable brassicas and numerous other seed crops, including high value hybrid vegetables, are produced to meet international purity standards. There is no reason to suppose that any future crop system options should be foreclosed because of the field testing or commercial introduction of GM crops if the customary commercial standards of cultivar purity are accepted.

74 In para 127 of the evidence of Dr Small provides some quotes purporting to demonstrate current European approaches to co-existence. These do not accurately represent the actual situation. These are better shown by the Conclusions of the 2nd Report of the European Commission 2009 (reproduced in full in Appendix 2) which portrays a more accurate overview and lead to the Seventh Framework Research Programme referred to in para 56 and immediately following.

75 Considerable theoretical and field research has been undertaken in Europe (PRICE 2015) to establish that coexistence of GM, conventional and organic systems was possible and that EU standards for purity and rules for labelling could be met. The research results show that singly or in combination isolation, buffers and asynchronous planting enable current thresholds to be practically achieved. Additionally, biological measures like cytoplasmic male

sterile (i.e. non - pollinating) maize were also effective. This capability for different farming systems to coexist is confirmed by USA experience where it is reported (EuropaBio 2015) that 18% of organic growers also grow GM crops.

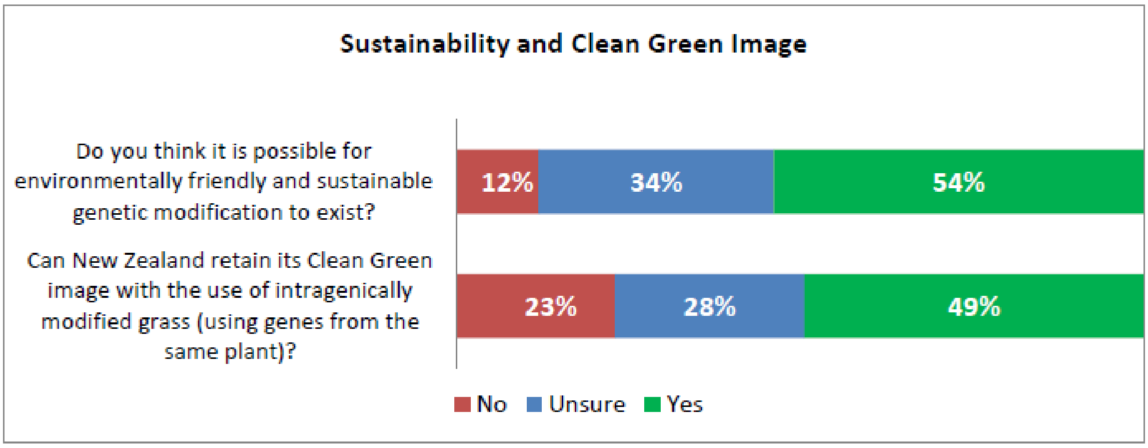
Economic

76 The widespread use of GM crops and their involvement in international trade has meant that most countries have regulations to cover low levels (frequently <0.9%) of adventitious presence of approved GM in product. In most cases, therefore, the argument that a trace level of GM will damage trade is a hypothetical one. Harris (2009) modelled potential economic benefits from GM ryegrass and showed these could be large. Harris (ibid) also showed that the economic losses in a scenario where international competitors had access to the GM ryegrass, but New Zealand farmers did not, were larger than the economic gains if New Zealand farmers had exclusive use. Further, Harris & Manhire (2010) modelled the economic impacts of adventitious presence of GM forage in New Zealand. They point out that market access issues are likely the most significant costs and the quantified direct costs were small, but go on to point out that since these have not arisen on a widespread basis in other countries there is a low probability of them impacting on dairy and meat exports from New Zealand.

77 Research by Knight et al (2013), supported by Macquarie Franklin (2012), show that region or country branding is not affected in a primary way by the use of GM technology. Knight et al interviewed gatekeepers in food distribution channels in Europe (5 countries), China and India concluding that use of GM plants in New Zealand would not adversely impact perceptions of food products sourced from New Zealand. Further, from interviews with incoming tourists, it is highly unlikely that our attractiveness as a tourist destination would suffer (Knight et al ibid). Independent survey research (Perceptive 2011) shows in Figure 5 that only 23% of the public disagree that New Zealand can maintain its clean green image with the use of intragenic[1] ryegrass.

1 Intragenesis: use of genetic transformation to insert a reorganised, full or partial coding region of a gene derived from the same species (usually combined with a promoter or terminator from another gene of the same species).

Figure 5 Sustainability and New Zealand market image



All; n=1,000

78 Many factors contribute to the image of a country or region and the perception of the quality of its produce; GM use alone is unlikely to transform this. This research contradicts the assertions in the S32 analysis.

Social

79 The inadequate Section 32 analysis coverage of literature highlights social impacts as a reason for further control on GMOs. However, there is considerable international literature on environmental or socio-economic (e.g. NAS 2016, Qaim 2009, Carpenter 2010, Finger et al 2011, Qaim & Kouser 2013, Brookes & Barfoot 2014, Juma & Gordon 2015) benefits. Morse & Mannion (2013) summarised it thus:

"Overall, the impact of GM crops has been positive in both the developed and developing worlds. Agronomically, yields per unit area have increased due to enhanced pest and weed control with added benefits in the case of insect control for non-GM crops grown nearby due to the so-called 'halo' effect. In terms of energy investment, GM crops are 'greener' than non-GM crops because reduced insecticide applications lowers energy input i.e the carbon footprint.---- Ecologically, non-target and beneficial organisms have benefitted from reduced pesticide use, surface and ground water contamination is less significant and fewer accidents occur to cause health issues in farm workers. ------ In relation to socio-economic impacts, GM crops have increased income for large- and small-scale commercial and subsistent farmers with associated downstream impacts through investments. Increased gross margins are due to higher revenues and reduced costs in relation to pest management. ----- Health benefits have also been achieved, especially through a reduction in pesticide use. ------- Overall, GM crops have proved to be a positive addition to the many technologies which comprise modern agriculture."

80 There seems no reason to expect that the New Zealand experience would be different if GM crops were introduced here since the HSNO requirement for full consultation, including Maori, is mandatory.

PUBLIC OPINION SURVEY DATA

81 Various groups in New Zealand have carried out opinion surveys on GM use here. Careful interpretation of any results is necessary because surveys show that the NZ public admits to a considerable lack of knowledge about GM and there is confusion about which GM products are on sale or would be coming on sale in NZ. Independent surveys carried out by Perceptive in 2009 and 2011 show that 55% and 52% of the NZ respondents claimed they had a low level of knowledge of GM. It is unrealistic therefore to assume their response is not driven by cultural cognition factors (Kahan 2015), rather than a considered evaluation of risk.

82 Additionally there is significant literature to show that there is a "framing" effect that influences (especially so if knowledge of the topic is low or opinions are polarised) views on GM and other contentious issues (Heiman and Zilberman 2011, Lee et al 2013). The context in which questions are asked, or the additional information provided, influences the answers provided. To get meaningful answers it is necessary to ask a range of questions around a topic, interspersed randomly with other questions to minimize the framing effect. Any question on attitudes to GM in relation to regulatory control or that was accompanied by information relating to risk, as in the Colmar-Brunton survey included in the Section 32 analysis, could skew the results.

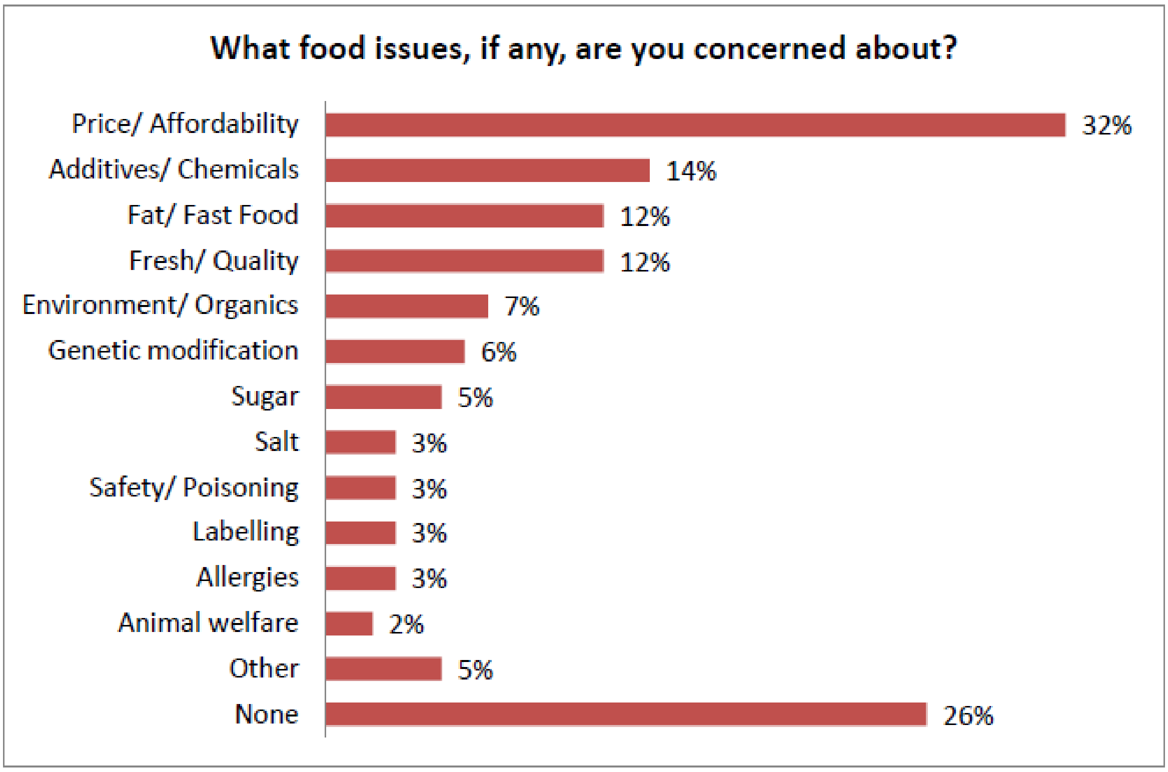
83 Desaint and Varbanova (2013) summarized the value of opinion polls in Europe thus:

"This review shows that consumer surveys can be something of a blunt instrument. Questionnaires, however well-constructed and professionally delivered, are answered in a vacuum of knowledge and elicit misleading responses. People recurrently admit they lack information on the technology behind GM food. It is a part of the general unfamiliarity with the food production process with which people show equal, if not greater, concern. Lacking control over a process involving such an emotive subject like food makes people uneasy and reluctant to accept "unknowns". In addition, if people give answers to hypothetical questions, they do so as "cautious citizens" rather than consumers and this is not a good guide to actual behaviour in real life."

84 It is likely that this description applies equally to opinion polls in New Zealand.

85 Most international surveys show that GM is not a top of mind issue related to food. The unprompted question in the Perceptive (2011) survey (see Figure 6) shows this is also the case in New Zealand.

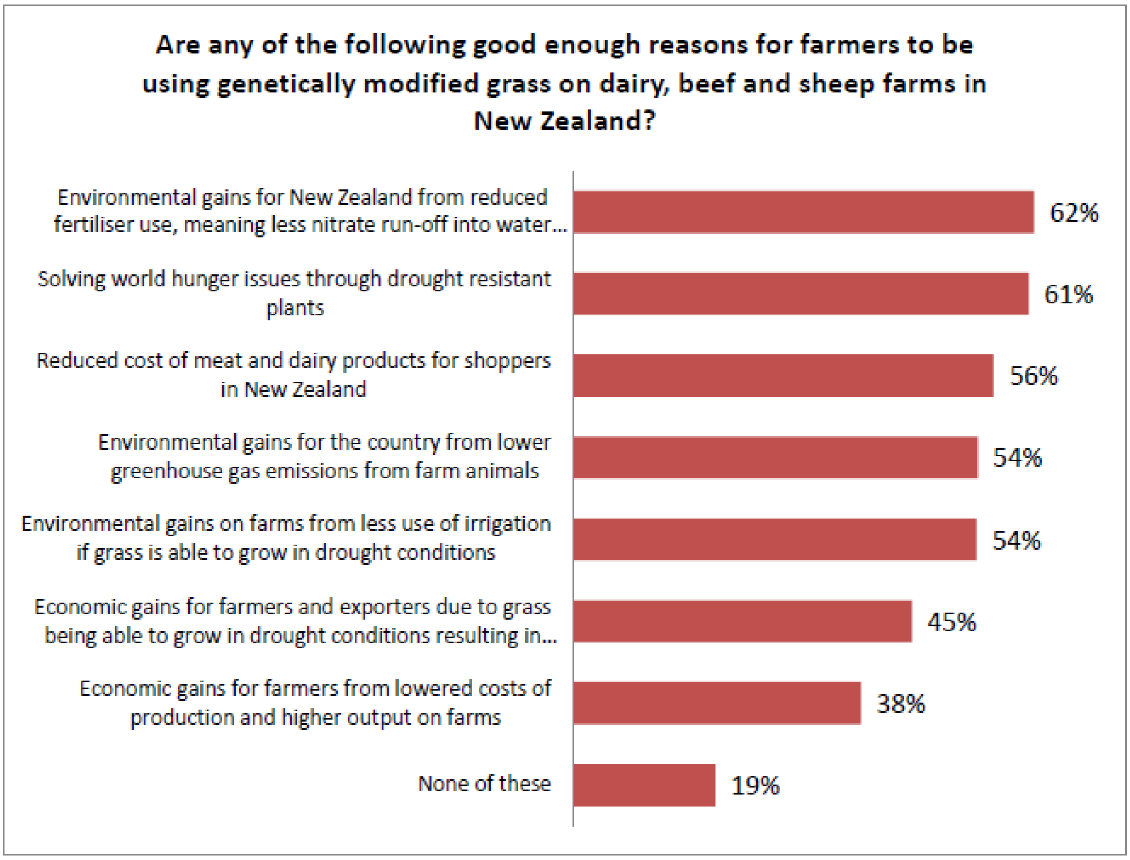
Figure 6 Unprompted responses to food issues question



All respondents; n=1,000; What food issues, if any, are you concerned about?; unprompted; multiple response

86 Further questioning will obtain more nuanced responses that are influenced by the values of individuals and communities and the context in which the question is asked as, for example shown (Figure 7) in the Perceptive study where a range of options providing some individual or societal benefits were explored. These show a more sophisticated level of understanding and aptitude for balancing potential risk against potential benefit that is markedly different than in those surveys where just regulation of risk is considered.

Figure 7 Farmer justification for using GM grass



All; n=1,000; Are any of the following good enough reasons for farmers to be using genetically modified grass on dairy, beef and sheep farms in New Zealand?

87 These responses show GM grasses as a much more favourable option for New Zealand than for those other surveys that ask questions related to corporate control or managing risk, largely because of the context in which the questions are asked.

THE SCIENTIFIC CONSENSUS

88 The Concise Oxford Dictionary defines "consensus" as *"agreement; majority view".* Scientists are trained to think independently so it is not surprising that on any science topic there will be differing views expressed. While there are different views on genetic modification there are very strong majority views amongst scientists that:

88.1 Currently commercialised GM crops are safe;

88.2 There is no evidence that GM techniques are inherently more risky than other current breeding technologies.

89 The primary evidence for this assertion is:

89.1 every peak science body that has examined the question has, after considering all the published evidence, come to these conclusions. Giving most weight to peak science body (e.g. Royal Society, National Academies of Science) views is necessary most significant as they represent all disciplines, and hence have the broadest and most considered perspectives. In contrast, Professor Heinemann uses the IAASTD report (of which he was a principal author) and single discipline or single sector based science views. These are prone to narrow viewpoints;

89.2 the recent PEW survey (PEW 2015) which showed that 88% of 3748 US scientists surveyed agreed that GM food is safe;

89.3 the NAS (2016) proposal that all new crops, irrespective of breeding process should be subject to the same tiered evaluation strategy for regulatory assessment;

89.4 conclusions in the recent Royal Society (2016) paper.

90 The Section 32 analysis comes to conclusions that are incompatible with this scientific consensus on the use of genetic modification. Professor Heinemann (paras 39-47) also expresses views that are incompatible with this consensus. In addition a number of public statements made by Professor Heinemann (see Appendices 3 - 5) show that his approach to GM risk and regulation is not strictly based on available science.

91 Numerous other peak level science bodies and scientific societies in a wide range of countries (see Appendix 1 for a representative list) have come to the conclusion that GM crops pose no specific risks. For example:

91.1 the American Association for the Advancement of science in 2013 stated:

"The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe. The World Health Organization, the American Medical Association, the U.S. National Academy of Sciences, the British Royal Society, and every other respected organization that has examined the evidence has come to the same conclusion: consuming foods containing ingredients derived from GM crops is no riskier than consuming the same foods containing ingredients from crop plants modified by conventional plant improvement techniques."

91.2 the European Academies Science Advisory Council (EASAC 2013) stated:

"*The scientific literature shows no compelling evidence to associate such crops, now cultivated worldwide for more than 15 years, with risks to the environment or with* *safety hazards for food and animal feed greater than might be expected from conventionally bred varieties of the same crop."*

91.3 the Royal Society (2016)

"There is no evidence that producing a new crop variety using GM techniques is more likely to have unforeseen effects than producing one using conventional cross breeding."

92 Additionally the Pew Research Centre (Pew 2015) surveyed members of the American Academy for the Advancement of Science for their views on science and society. 3748 US based members were asked "Do you think it is generally safe or unsafe to eat genetically modified foods?" and 88% answered that they were generally safe.

93 As Mark Lynas (2013) stated in his speech to the Oxford Farming Conference:

"Just as I did 10 years ago, Greenpeace and the Soil Association claim to be guided by consensus science, as on climate change. Yet on GM there is a rock-solid scientific consensus, backed by the American Association for the Advancement of Science, the Royal Society, health institutes and national science academies around the world. Yet this inconvenient truth is ignored because it conflicts with their ideology. "

94 Hence the Section 32 analysis and the evidence of Professor Heinemann come to conclusions that are incompatible with the scientific consensus on the use of genetic modification.

95 Opponents of genetic modification have fuelled confusion amongst the public as the House of Commons Science and Technology Committee (2015) recently explained:

"We are each entitled to our own opinion and value-based opposition to genetic modification, or any other technology, is perfectly legitimate. However, this does not justify knowingly and willingly misinforming the public. We strongly urge those seeking to inform the public about genetic modification and other advanced genetic plant technologies to provide an honest picture of the scientific evidence base and the regulatory controls to which these products are currently subject. Where opposition to such technologies is value-based, this should be openly acknowledged and should not be concealed behind false claims of scientific uncertainty and misleading statements regarding safety."

96 The confusion, at least partly engendered by such misinformation, is likely responsible for public unease as demonstrated by the Pew survey (see above) which showed only 37% of the public considered GM food safe (cf. 88% of scientists).

PRECAUTIONARY APPROACH

97 The District Plan proposal emphasises the precautionary principle and it is important to provide some context on its utility. At the Asilomar Conference in 1975 the possibility of novel risks to human health or the environment from the newly discovered recombinant DNA technology were highlighted by the science community. Regulatory policies aimed to protect society and nature from any such novel hazards, or to delay their introduction until they were shown to be harmless were introduced. Such policies were appropriate, and matched community expectations at the time.

98 Such regulatory policies embodied a precautionary approach. This has been important in the development of the GM debate, but in its application it is important that the counterfactual, such as alternative policies or not adopting the principle at all, is also rigorously considered. It is critical to understand, however, that the HSNO legislation and the EPA assessment of any application for GM already requires a precautionary approach.

99 While a rigorous application of the precautionary principle may have been justifiable when GM crops were first introduced and GM food first available, its appropriateness must be reviewed as evidence has accumulated. The significant accumulation of molecular evidence on genome structure and function has markedly improved understanding of risk as has the extent of global commercial experience. The extent of regulatory scrutiny of GM plants must be appropriate to give society confidence in the technology, but not stifle innovation and its application. One of the consequences of the current regulatory environment internationally is that the costs of meeting it are so substantial (see Kalaitzandonakes et al (2007) and Van Eenennaam (2013) that only a few multinationals researching major crops and serving global markets are able to justify the additional investment. Hence most public sector organisations, or smaller corporates are unable to afford to develop GM varieties of minor crops or for small or niche markets, such as New Zealand.

100 While it is obvious that science of the highest international standard is necessary to drive innovation, it is also essential to inform rational policy development and the initiation of regulation.

101 The precautionary principle provides a dangerous base for regulatory policy if it is accompanied by bottom-up governance. Tait and Barker 2011 point out that this combination in Europe has *“exposed decision-making on the regulation of GM crops to influences from politically motivated parties more than ever before”* and resulted in “*greater restriction of plant*

biotechnology in Europe than in other parts of the world, despite a lack of evidence for any direct risks from the wide-scale adoption of GM crop technology".

102 The proposals in this Plan could have a similar effect in a society much more dependent on continuing innovation in primary production for its economic success. This is because most crop, pasture or tree cultivars bred in New Zealand are released for use nationally. If their use is delayed, or banned entirely in particular regions our small market size will prejudice any national release. Consistency in application of regulations throughout the country is critically important for the future of the plant breeding industry in New Zealand.

CONCLUSION

103 Since the proposals in this plan are so clearly:

103.1 at variance with majority scientific opinion

103.2 at variance with the overwhelming weight of scientific and farmer experience

103.3 at best a duplication of the existing rigorous EPA criteria

they fail to meet the S32 criteria of efficiency and effectiveness and should consequently be rejected in their entirety.

APPENDIX 1: STATEMENTS FROM PEAK SCIENCE BODIES, OR GOVERNMENT ENTITIES ON GM SAFETY – (SOURCE: GENETIC LITERACY PROJECT).

1 Seven of the World's Academies of Sciences (Brazil, China, India, Mexico, the Third World Academy of Sciences, the Royal Society, and the National Academy of Sciences of the U.S.)

"Foods can be produced through the use of GM technology that are more nutritious, stable in storage and in principle, health promoting—bringing benefits to consumers in both industrialized and developing nations.

2 World Health Organization (Switzerland)

"No effects on human health have been shown as a result of the consumption of GM foods by the general population in the countries where they have been approved."

3 Food Standards Australia New Zealand

"Gene technology has not been shown to introduce any new or altered hazards into the food supply, therefore the potential for long term risks associated with GM foods is considered to be no different to that for conventional foods already in the food supply."

4 The European Commission (Belgium)

"The main conclusion to be drawn from the efforts of more than 130 research projects, covering a period of more than 25 years of research, and involving more than 500 independent research groups, is that biotechnology, and in particular GMOs, are no more risky than conventional plant breeding technologies."

5 *The American Association for the Advancement of Science*

"The science is quite clear: crop improvement by the modern molecular techniques of biotechnology is safe."

6 The National Academy of Sciences (Washington, D.C.)

"To date more than 98 million acres of genetically modified crops have been grown worldwide. No evidence of human health problems associated with the ingestion of these crops or resulting food products have been identified."

7 The French Academy of Science

“All criticisms against GMOs can be largely rejected on strictly scientific criteria.”

8 The Royal Society of Medicine (United Kingdom)

“Foods derived from GM crops have been consumed by hundreds of millions of people across the world for more than 15 years, with no reported ill effects (or legal cases related to human health), despite many of the consumers coming from that most litigious of countries, the USA.”

9 The American Medical Association

“There is no scientific justification for special labeling of genetically modified foods. Bioengineered foods have been consumed for close to 20 years, and during that time, no overt consequences on human health have been reported and/or substantiated in the peer reviewed literature.”

10 The Union of German Academics of Sciences and Humanities

“In consuming food derived from GM plants approved in the EU and in the USA, the risk is in no way higher than in the consumption of food from conventionally grown plants. On the contrary, in some cases food from GM plants appears to be superior in respect to health. “

APPENDIX 2 FROM REPORT FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT ON THE COEXISTENCE OF GENETICALLY MODIFIED CROPS WITH CONVENTIONAL AND ORGANIC FARMING {SEK(2009) 408}

1 CONCLUSIONS Since 2006, Member States have made significant progress in developing coexistence legislation. This development of the legislative framework went hand in hand with a moderate expansion of the cultivation surface involving GM crops. However, GM crop production is still a niche production in the EU, with currently only a single GM product being in commercial use and with cultivation on a very limited scale.

2 Even though there is ongoing controversy about the cultivation of GM crops in the EU within society at large, there is no concrete indication that there have been practical difficulties in introducing GM crops into EU agriculture. This assessment is, however, based on the limited commercial experience gained so far. More extensive practical experience resulting from cultivation over several years is confined to some regions within a few Member States.

3 There have been no reports of economic damage resulting from either non-compliance with the national coexistence rules or from the rules themselves being inappropriate in terms of achieving sufficient levels of segregation between GM and non-GM crop production. Monitoring programmes set up by Member States have not revealed any shortcomings in the rules in place.

4 The coexistence approaches applied in Member States differ with respect to the administrative procedures and technical segregation measures. There is no compelling evidence, however, that differences in the legislative framework are a determining factor in the choice of farmers whether to grow GM crops or not. Other aspects that seem to play an at least equally important role are the existence of suitable market outlets for GM products, regional variation as regards the possible advantages or disadvantages of GM crops over their conventional or organic counterparts, and societal drivers such as neighbours' disputes and destruction of fields. The importance of these aspects is demonstrated by the heterogeneous spatial distribution of GMO cultivation even within Member States under identical coexistence regimes.

5 The differences observed among the national measures can, at least to some extent, be attributed to the regional variation of agronomic, climatic and other factors determining the likelihood of GMO admixture to other crops. Further experience needs to be gained in order to fully assess the efficiency of national coexistence measures. The European Coexistence Bureau will develop guidance in this regard.

6 Even though different coexistence approaches between neighbouring Member States have the potential to create cross-border problems, such difficulties have not been observed in

practice. Therefore, for the time being there seems to be no need to develop specific measures on cross-border issues in relation to coexistence.

7 The Commission does not consider it appropriate to initiate the development of Community legal instruments that could interfere with the national liability provisions in relation to damage caused by GMO admixture. As explained above, much of the diversity in this regard results from differences in existing national liability and compensation systems, which also apply in relation to other economic activities. These differences have not yet led to the need for harmonisation. Furthermore, the different jurisdictions of Member States have developed individual claims cultures and a distinct compensation cultures. Creating uniform rules for the narrow scenario posed by GMO admixture may lead to parallel application of different tort law regimes within a single Member State.

8 Given the apparent absence of insurance solutions for such damage, Member States are encouraged to explore steps aimed at facilitating the development of appropriate products by insurers.

9 Research activities concerning various aspects of coexistence are still ongoing in many Member States, illustrating the need to further develop the knowledge base concerning coexistence. Further research activities will be required in the medium term to address segregation of GM and non-GM production chains beyond the farm gate.

10 An assessment of the best way forward to address coexistence must take into account commercial experience in Member States. It must include a solid assessment of the effectiveness and efficiency of the measures put in place, and an analysis of the impact of national measures on the competitiveness of farmers and the freedom of choice of both farmers and consumers. At the present time there is no indication of the need to deviate from the subsidiarity-based approach on coexistence and to develop further harmonisation on this matter.

11 The Commission sees a need to undertake the following actions in relation to coexistence:

11.1 The Commission will, at the earliest possibility, conclude an economic impact assessment concerning the establishment of potential future seeds thresholds. The Commission will propose appropriate legislative follow-up on the basis of that assessment.

11.2 The Commission will continue the activity of COEX-NET to foster an exchange of information on coexistence with Member States as regards practical experience, research and monitoring results.

11.3 Jointly with the Member States, and following consultations of relevant stakeholder groups, the Commission will develop technical guidance on crop-specific coexistence measures through the European Coexistence Bureau.

11.4 Under the Framework Programme for Community Research, the Commission will support further research based upon clearly established needs identified within ongoing or future initiatives.

11.5 In 2012, the Commission will report on the coexistence situation in Member States, based on information provided by the Member States.

References

Agnès E. Ricroch, Jean B. Bergé and Marcel Kuntz 2011 Evaluation of Genetically Engineered Crops Using Transcriptomic, Proteomic, and Metabolomic Profiling Techniques Plant Physiology April 2011 vol. 155 no. 4 1752-1761 (http://www.plantphysiol.org/content/early/2011/02/24/pp.111.173609.full.pdf+html)

Amir Heiman and David Zilberman 2011 The Effects of Framing on Consumers' Choice of GM Foods *AgBioForum, 14(3): 171-179* (http://www.agbioforum.org/v14n3/v14n3a09-heiman.htm)

Anonymous 2009 AsureQuality Seedlab http://www.seedlab.co.nz/services/seed-crop-isolation-distance-system.cfm

Brookes, G and Barfoot P 2014 Global income and production effects of GM crops 1996-2012, GM Crops and Food: Biotechnology in Agriculture and the Food Chain, 5.1, 1- 11 (http://dx.doi.org/10.4161/gmcr.28098)

Carpenter JE (2010) Peer-reviewed surveys indicate positive impact of commercialized GM crops. *Nature Biotechnology* 28:219-221. (file:///C:/Users/user/Downloads/Nature%20Biotechnology%20Volume%2028%20issue%204%202010%20[doi%2010.1038%252Fnbt0410-319]%20Carpenter,%20Janet%20E%20--%20Peer-reviewed%20surveys%20indicate%20positive%20impact%20of%20commercialized%20GM%20crops.pdf)

Committee on the Impact of Biotechnology on Farm-Level Economics and Sustainability; National Research Council 2010 Impact of Genetically Engineered Crops on Farm Sustainability in the United States (http://www.nap.edu/catalog.php?record_id=12804&utm_expid=4418042-5.krRTDpXJQISoXLpdo-1Ynw.0)

de la Hamaide, Sybille Nov 28, 2011 French court annuls ban on growing Monsanto GMO maize (http://www.reuters.com/article/2011/11/28/us-france-gmo-idUSTRE7AR19H20111128)

Desaint, Nilsy and Mariana Varbanova 2013 The use and value of polling to determine public opinion on GMOs in Europe GM Crops and Food: Biotechnology in Agriculture and the Food Chain 4:3, 183–194

Dumbleton, A.; Gowers, S.; Conner, A.; Christie, M.; Kenny, P.; Mulcock, H.; Charteris, B. 2012. CleancropTM Brassica System: The development of herbicide resistant brassica crops for New Zealand farming systems. Proceedings of the New Zealand Grassland Association 74: 25-30.

EASAC policy report 21 2013. Planting the future: opportunities and challenges for using crop genetic improvement technologies for sustainable agriculture (http://www.easac.eu/fileadmin/Reports/Planting_the_Future/EASAC_Planting_the_Future_FULL_REPORT.pdf)

European Commission 2010 A Decade of EU-funded GMO research (http://ec.europa.eu/research/biosociety/pdf/a_decade_of_eu-funded_gmo_research.pdf)

REPORT FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT on the coexistence of genetically modified crops with conventional and organic farming {SEK(2009) 408} (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2009:0153:FIN:en:PDF)

EuropaBio 2015 seen at http://www.europabio.org/can-gm-conventional-and-organic-crops-coexist

Finger R, El Benni N, Kaphengst T, Evans C, Herbert S, Lehmann B, Morse S and Stupak N. (2011) A meta-analysis on farm-level costs and benefits of GM crops. *Sustainability* 3(5): 743-762. (file:///C:/Users/user/Downloads/sustainability-03-00743.pdf)

George, Nicholas, Joy Hollingsworth & Stephen Kaffka (2015) A guide for canola and camelina research in California. Department of Plant Sciences, University of California, Davis

Greaves, I. K., Groszmann, M., Wang, A., Peacock, W. J. & Dennis, E. S. Inheritance of Trans Chromosomal Methylation patterns from Arabidopsis F1 hybrids. Proc. Natl. Acad. Sci. U. S. A. (2014). doi:10.1073/pnas.1323656111

Harding, E 2014 Unhappy swede link in cow deaths kept quiet http://www.stuff.co.nz/business/farming/dairy/10517220/Unhappy-swede-link-in-cow-deaths-kept-quiet

Harris, S 2009. Assessing the impact of cisgenic technologies in ryegrass. A report prepared for Pastoral Genomics

Harris, S and Manhire J 2010. Economic impacts: Adventitious presence of genetically modified forages MAF Technical Paper No: 2011/39 (file:///C:/Users/user/Downloads/2011-39-economic-impacts-adventitious-presence-of-genetically-modified-forages%20(1).pdf)

Herman, R A and W D Price Unintended Compositional Changes in Genetically Modified (GM) Crops: 20 Years of Research J. Agric. Food Chem. 2013, 61, 11695−11701 (http://pubs.acs.org/doi/pdf/10.1021/jf400135r)

Owen A. Hoekenga, Jannavi Srinivasan, Gerard Barry, and Andrew Bartholomaeus 2013 Compositional Analysis of Genetically Modified (GM) Crops: Key Issues and Future Needs. J. Agric. Food Chem. 61, 8248−8253

Heinemann, J A 2009 Hope not hype Third World Network ISBN: 978-983-2729-81-5

Heinemann, J A 2009 Want and can use Letters to Editor, The Press November 24th 2009

Jack A. Heinemann, Melanie Massaro, Dorien S. Coray, Sarah Zanon Agapito-Tenfen & Jiajun Dale

Wen, *Sustainability and innovation in staple crop production in the US Midwest*, International Journal of Agricultural Sustainability, 14 Jun 2013; and University of Canterbury, *GM a failing biotechnology in modern agro-ecosystems*

House of Commons Science and Technology Committee 2015 HC 328 Advanced genetic techniques for crop improvement: regulation, risk and precaution, Fifth Report of Session 2014–15

Hutchison, W D, E. C. Burkness, P. D. Mitchell, R. D. Moon, T. W. Leslie, S. J. Fleischer, M. Abrahamson, K. L. Hamilton, K. L. Steffey, M. E. Gray, R. L. Hellmich, L. V. Kaster, T. E. Hunt, R. J. Wright, K. Pecinovsky, T. L. Rabaey, B. R. Flood, and E. S. Raun Area wide Suppression of European Corn Borer with Bt Maize Reaps Savings to Non-Bt Maize Growers Science 8 October 2010: 222-225 (http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1223&context=entomologyfacpub)

James, C 2015 ISAAA Brief 49-2015 Global Status of Commercialised Biotech/GM Crops 2015 (http://www.isaaa.org/resources/publications/briefs/49/executivesummary/)

Calestous Juma and Katherine Gordon. 2015 "Taking Root: Global Trends in Agricultural Biotechnology." Discussion Paper 2014-07, Belfer Center for Science and International Affairs, Cambridge, Mass.: Harvard University

Kahan, D M 2015 What is the science of science communication" Journal of Science Communication in press. (file:///C:/Users/user/Downloads/SSRN-id2562025.pdf)

Kalaitzandonakes N, Alston J M and Bradford KJ 2007 Compliance costs for regulatory approval of new biotech crops. Nat Biotechnol 2007, 25:509–511. (http://www.nature.com/nbt/journal/v25/n5/pdf/nbt0507-509.pdf)

Kitta, K 2013 Availability and utility of crop composition data J. Agric. Food Chem. 2013, 61, 8304−8311

Knight JG, Clark A, Mather DW. Potential damage of GM crops to the country image of the producing country. GM Crops and Food: Biotechnology in Agriculture and the Food Chain 2013; 4:151 - 157; PMID: 24002524; http://dx.doi.org/10.4161/gmcr.26321

Tina Kyndt, Dora Quispe, Hong Zhai, Robert Jarret, Marc Ghislain, Qingchang Liu,Godelieve Gheysen, and Jan F. Kreuze 2015 The genome of cultivated sweet potato contains*Agrobacterium* T-DNAs with expressed genes: An example of a naturally transgenic food crop PNAS vol. 112 no. 18 5844–5849, doi: 10.1073/pnas.1419685112

Lynas, Mark, 2013 Lecture to Oxford Farming Conference (http://www.marklynas.org/2013/01/lecture-to-oxford-farming-conference-3-january-2013/)

Magniera, Alexandre, Nicholas Kalaitzandonakes , and Douglas J. Miller 2010 Product Life Cycles and Innovation in the US Seed Corn Industry International Food and Agribusiness Management Review Volume 13, Issue 3, p17-36

Macquarie Franklin, 2012, Market Advantage of Tasmania's GMO-free Status, Devonport TAS (http://investtasmaniamap.com.au/?a=67736)

Mannion A M and Stephen Morse 2013 GM CROPS 1996-2012: A review of agronomic, environmental and socio-economic impacts. University of Surrey Centre for Environmental Strategy Working Paper 04/13

Nap J-P, Metz P L J, Escaler M, Conner A J 2003 The release of genetically modified crops into the Environment, Part I. Overview of current status and regulations. The Plant Journal (2003) 33, 1–18

(http://onlinelibrary.wiley.com/doi/10.1046/j.0960-7412.2003.01602.x/pdf)

National Academy of Science 2016 Genetically Engineered Crops: Experiences and Prospects National Academies Press ISBN 978-0-309-43738-7 | DOI: 10.17226/23395

Nicolia, Alessandro, Alberto Manzo, Fabio Veronesi, and Daniele Rosellini An overview of the last 10 years of genetically engineered crop safety research Critical Reviews in Biotechnology

Perceptive 2011 GM/GE quantitative research. Survey findings for Pastoral Genomics

Perceptive 2009 GM/GE quantitative research. Survey findings for Pastoral Genomics

Pew Research Center, January 29, 2015, "Public and Scientists' Views on Science and Society"

Phillips McDougall. 2011. The Cost and Time involved in the Discovery, Development and Authorization of a New Plant Biotechnology Derived Trait: A Consultancy Study for CropLife International. Midlothian, UK: Phillips McDougal.

PRICE (Practical Implementation of Coexistence in Europe) http://price-coexistence.com/

Qaim M (2009) The economics of genetically modified crops. *Annual Review of Resource Economics* 1: 665-693 (http://www.annualreviews.org/doi/pdf/10.1146/annurev.resource.050708.144203)

Qaim M, Kouser S (2013) Genetically Modified Crops and Food Security. PLoS ONE 8(6): e64879. doi:10.1371/journal.pone.0064879

Royal Society (2016), GM plants Questions and answers

Miguel A. Sanchez, 2015 Trends in GE Food/Feed Safety Research: Analysis of Potential Conflict of Interests. ISB NEWS REPORT APRIL 2015

Sanderson, F R and H C Smith 1983 Breeding for pest and disease resistance. In "Plant Breeding in New Zealand" ed G S Wratt and H C Smith Butterworths ISBN 0 409 70137 8

Scott B and Ronson C 2014 Managing risks Associated with Outdoor Use of Genetically Modified Organisms. Royal Society of New Zealand Commissioned Review July 2014 (http://www.royalsociety.org.nz/expert-advice/commissioned-reviews/yr2014/managing-risks-associated-outdoor-use-genetically-modified-organisms/)

Henry-York Steiner, Claire Halpin, Joseph M. Jez, John Kough, Wayne Parrott, Lynne Underhill, Natalie Weber, and L. Curtis Hannah 2013 Evaluating the Potential for Adverse Interactions within Genetically Engineered Breeding Stacks Plant Physiol. 2013 161: 1587-1594. First Published onMarch 4, 2013; doi:10.1104/pp.112.209817

Swiss National Science Foundation (2012). Benefits and risks of the deliberate release of genetically modified plants (http://www.nfp59.ch/e_resultate.cfm)

Tait, Joyce and Guy Barker, 2011 Global food security and the governance of modern biotechnologies EMBO *reports* (2011) **12,** 763–768. (http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3147264/)

University of Canterbury press release 2013 GM a failing biotechnology in modern agro-ecosystems

(seen at http://www.biosafety-info.net/article.php?aid=980)

Van Eenennaam Journal of Animal Science and Biotechnology 2013, 4:37 GMOs in animal agriculture: time to consider both costs and benefits in regulatory evaluations http://www.jasbsci.com/content/4/1/37

Vigani, M & Olper, A 2013 GMO standards, endogenous policy and the market for information. Food Policy, 43, 32-43

Wan-chen Jenny Lee, Mitsuru Shimizu, Kevin M. Kniffin, Brian Wansink You taste what you see: Do organic labels bias taste perceptions? Food Quality and Preference 29 *33-39 2013* (http://www.sciencedirect.com/science/article/pii/S0950329313000141)

Weber N, Halpan C, Hannah L C, Jez J M, Kough J, Parrott W 2012 Crop Genome Plasticity and Its Relevance to Food and Feed Safety of Genetically Engineered Breeding Stacks. Plant Physiology **160** no. 4 1842-1853

(http://www.plantphysiol.org/content/160/4/1842.full.pdf+html)