BEFORE INDEPENDENT HEARING COMMISSIONERS

AT NGARUAWAHIA

IN THE MATTER	**of the Resource Management Act 1991**
AND	
IN THE MATTER	**of the hearing of submissions on Proposed Waikato District Plan,**

STATEMENT OF PRIMARY EVIDENCE OF GERARD MATTHEW WILLIS FOR LIFE SCIENCES NETWORK

HEARING 8B: GENETICALLY MODIFIED ORGANISMS PLANNING

18 DECEMBER 2019

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1. EXECUTIVE SUMMARY

1.1 My name is Gerard Matthew Willis. My planning evidence addresses issues relevant to the further submission lodged by the Life Sciences Network (**LSN**) in response to some 30 submitters who seek that land use rules controlling genetically modified organisms (**GMOs**) be included in the Proposed Waikato District Plan (**PWDP**).

1.2 This evidence sets out my opinion that the section 42A report on submissions and further submissions (**s42A report**) is correct with regard to the following.

(a) Its suggestion that insufficient evidence is available in submissions to substantiate the assertions made by submitters that there are unmanaged risks associated with GMOs that must be managed by the PWDP. I discuss this issue in Appendix 1 of this evidence;

(b) Its observation that the precautionary approach is part of the Hazardous Substances and New Organisms (**HSNO**) Act and therefore is taken into account in the GMO decision-making process employed by Environmental Protection Authority (**EPA**). I discuss this issue at Section 6;

(c) Its finding that, even if a case was made that some form of control was required in the PWDP because there are some risks not otherwise adequately addressed by the HSNO/EPA regime, the Auckland GMO provisions would be inappropriate to replicate in the PWDP.

(d) Its concern about introducing an additional suite of planning provisions at this point in the process given the widespread and potentially significant implications of such provisions and the fact they were not clearly signalled as part of pre-notification consultation on the PWDP, were not included in the notified version of that plan, and were not detailed in the submissions received (accepting that some submissions did refer to wanting

provisions ‘similar to those in the Auckland Unitary Plan’). I discuss this issue at section 9;

(e) Its recommendation to reject the submissions seeking control of GMOs in the PWDP.

1.3 Although I agree with the s42A Report in most respects, my evidence also sets out my opinion that the s42A Report is *incorrect* to infer that:

(a) the general Resource Management Act (**RMA**) and Waikato Regional Policy Statement (**RPS**) principle of ‘integrated management’ necessarily requires that the PWDP’s approach to GMOs needs to be consistent with Auckland’s. That would be to ignore other adjacent districts that do not have GMO provisions in the district plans and the desirability of a consistent regime for land uses that span those territorial boundaries and the regional council policy position which does not promote the control of GMO risks through district plans. I discuss this issue at Section 5.

(b) the concept of an effect of low probability but high potential impact (which is about risk) goes further than the concept of a precautionary approach as included within the HSNO Act. I discuss this issue at paragraph 6.8 where I state my opinion that the concepts of risk and precaution are quite separate matters in resource management.

1.4 Overall, my evidence concludes that if there is a case for district plan provisions to address residual risk of GMOs (after the HSNO/EPA process has applied) it has not been clearly articulated in submissions to date, is likely to be very narrow and certainly does not justify the heavy-handed controls proposed by pro GMO control submitters.

1.5 I include an outline section 32 analysis of the options to manage GMOs as **Appendix 2** where I evaluate four options. In my opinion, the option of “Auckland-style” provisions is the least favourable of the options identified.

2. INTRODUCTION

2.1 My full name is Gerard Matthew Willis.

2.2 I am a director of Enfocus Limited, a resource management consultancy based in Pukekohe. I have practised as a planner and resource management specialist for the past 30 years.

2.3 I hold a Bachelor of Regional Planning (Hons) degree from Massey University and am a full member of the NZ Planning Institute.

2.4 My previous experience includes working in policy and regulatory planning roles in local government both in New Zealand (including as a planner in the Waikato District Council and its predecessor the Raglan County Council) and in the United Kingdom. I also spent a considerable part of my early career in central government roles including as a senior policy analyst at Ministry for the Environment (**MfE**). I was environment adviser to the Minister for the Environment during the period in which the HSNO Act was passed and at the time that Act took effect.

2.5 Since 2001, I have been a planning and environmental consultant, establishing my own practice in 2002. In that capacity I have acted for a number of district and regional councils on planning issues and provided advice to companies, Maori trusts and government agencies on the design and content of district and regional plans.

2.6 I have also been involved in policy development at the national level – particularly around management of natural and biological systems and risks. This includes reviewing the biosecurity (pest management) regime for local government and, subsequently, Biosecurity NZ. I have been closely involved in efforts to develop a national policy statement on indigenous biodiversity, most recently as adviser to the Biodiversity Stakeholder Collaborative Group.

3. BACKGROUND TO PROPOSED WAIKATO DISTRICT PLAN

3.1 I have had no professional involvement in the PWDP until December 2019 when I was asked by the LSN to provide planning evidence for Hearing 8b: Genetically Modified Organisms.

3.2 I did make a submission on the PWDP in a personal capacity. That submission was narrowly focused and addressed an unrelated matter (minimum lots sizes in the Village zone).

3.3 I am familiar with:

(a) the submissions of various parties[1] seeking the inclusion of provisions in the PWDP that would control the use of land in connection with GMOs ('the pro GMO control submissions')

(b) the further submissions of LSN opposing the submissions of the pro GMO control parties.

(c) Section 42A Report, Hearing 8b: Genetically Modified Organisms, Neil Taylor, 2 December 2019.

3.4 I have also read the evidence of Professor Arthur Grimes, Professor Andrew Allen, Dr William Rolleston and Dr Tony Connor.

Code of Conduct

3.5 Although this is a council hearing, I have read the Environment Court's Code of Conduct and agree to comply with it. My qualifications as an expert are set out above. I confirm that the issues addressed in this statement of evidence are within my area of expertise.

[1] These submitters are listed at paragraphs 52, 53 and 54 of the Section 42A Report (p49) and are not repeated here.

Scope of Evidence

3.6 I have been asked to provide planning evidence on the following matters and structure my statement accordingly.

(a) The relevant planning framework within which GMOs must be considered (including the relationship between the RMA and the HSNO Act;

(b) The planning merits of the proposals and associated reasons advanced by various submitters seeking provisions controlling GMOs;

(c) an outline section 32 analysis of the options to manage GMOs in the PWDP.

4. RELEVANT STATUTORY INSTRUMENTS

HSNO and the RMA

4.1 I am aware that over recent years there has been considerable attention given to the question of whether GMOs (or, more properly, the risks associated with GMOs) can be managed under the RMA. I understand that the Courts have stated that, notwithstanding that there is a specific regulatory regime expressly aimed at managing risks of GMOs (i.e. *mandatory* approval processes under HSNO) regional plans (and, as indicated in the s42A Report by inference, district plans) *may* also exercise control.

4.2 Despite that clear finding on jurisdiction, there is not a clear picture about *when, how, or to what extent* that ability to control GMOs under the RMA should be exercised in addition to the mandatory HSNO processes. The Court usefully noted that any such control under the RMA would be subject to the usual section 32 test but otherwise has provided no guidance.

4.3 In my opinion, section 32 will be critical but so are good public policy and planning principles. My understanding is that in developing the HSNO Act it was the then Government's intention to create a specialist *national* regulatory agency and process to manage the complex scientific and risk issues raised by hazardous substances and new organisms recognising that:

(a) There was not the level of technical knowledge or expertise at regional or district council levels to properly assess the risks associated with GMOs; and

(b) The risks associated with GMOs are not generally locally variable but relate to the nature of the organisms themselves (albeit the effects may express differently depending on local variables - temperature, wind etc).

4.4 The HSNO Act itself contains a purpose and principles in sections 4, 5 and 6 that are broadly similar to those matters listed in Part 2 of the RMA. These are set out at paragraph 30 of the section 42A report. I do not repeat them here in full, but I note that the purpose specifically focusses on protecting "*the environment, and the health and safety of people and communities*". Furthermore, under HNSO, the EPA must:

(a) recognise and provide for safeguarding the life-supporting capacity of air, water, soil, and ecosystems (HSNO Act section 5 (a))

(b) take into account the sustainability of all native and valued introduced flora and fauna, intrinsic values of ecosystems, public health and the relationships of Maori with their culture and traditions with their ancestral lands, water, sites, waahi tapu, values flora and fauna and other taonga (HSNO, section 6 (a)-(d))

4.5 HSNO also recognises the "*need for people and communities to be able to provide for their own economic, social and cultural wellbeing*". My planning assessment is that the HSNO Act is comparable in its purpose and broad decision-making framework (as reflected in sections 4, 5, 6 and in the Methodology for making decisions under HSNO [2] (**Methodology**) that must be used) to the Part 2 of the RMA. I do not see any obvious "gaps" in terms of the environment matters that must be considered that would warrant assessing the affects and risks of GMOs under the RMA.

Section 31 of the RMA

4.6 Noting again that I do not dispute that the Courts' have found that it is within the jurisdiction for regional councils to control GMOs (notwithstanding the specific HSNO regime), I note that the management of GMOs is not specifically included as a mandatory function of either regional or district councils in Sections 30 and 31 of the RMA. Authority to exercise control over GMOs must then be part of a council's general function to control land use.

Regional Policy Statement

4.7 The operative Waikato Regional Policy Statement contains no mention of GMOs or associated risks. There is, therefore, nothing for the PWDP to "give effect to".

4.8 The RPS includes an objective and two policies on integrated management. Those provisions are discussed in section 5 of my evidence.

Iwi Management Plans

4.9 Section 74(2A) of the RMA states that when preparing a district pan the council must take into account management plans recognised by an iwi authority.

[2] As set out in the Hazardous Substances and New organisms (Methodology) Order 1998

4.10 As I understand it, there are two iwi management plans relevant to consider in the Waikato District: The Waikato Tainui Environmental Management Plan (**WTEMP**) and the Maniapoto Environment Plan (**MEP**)

4.11 The WTEMP includes the following provisions:

> ***Objective – new organisms and Genetically Modified Organisms***
>
> *15.3.5 A precautionary approach to the introduction of new organisms and GMO's shall be adopted.*
>
> ***Policy – Protection of natural heritage from risk of new organisms***
>
> *15.3.5.1 Applications for new organisms and GMO's must demonstrate that there are no risks to humans, indigenous ecosystems, indigenous species, or primary production*
>
> ***Methods***
>
> *(a) Applicants will engage with Waikato-Tainui prior to the submission of applications to the Environmental Protection Authority and/or other regulatory agency.*
>
> *(b) The relevant authorities will work with Waikato-Tainui to ensure that all cultural and spiritual beliefs are appropriately recognised, respected and thoroughly considered.*
>
> *(c) All efforts must be made by the relevant authorities to ensure that the effects of current and future introduced pests, new organisms, and Genetically Modified Organisms are minimised on taonga species, areas of significant indigenous vegetation, spiritual and/or cultural significance, and on the ecosystems in which these species and areas of significance occur.*

4.12 In my option, those provisions anticipate Waikato-Tainui exercising their kaitiaki responsibilities by encouraging interaction with GMO applicants before they seek EPA approvals. There is no presumption in those IMP provisions that there would be a parallel district plan approval process (or prohibition). While there is understandable attention on proper risk assessment and the protection of values of importance to Tainui there is no role for the district council specified at all.

4.13 I note also that the concerns expressed in the WTEMP relate to both non-GMO new organisms and GMOs.

4.14 Very similar provisions are included within the MEP. Relevant excerpts of the management plan are attached to the s42A Report. Again, while those provisions express concern about the risks that may be posed by GMOs, and seek that iwi be involved in regulatory processes, they do not expressly advocate for district scale regulation. At best, references to "regulatory authorities" (rather the "district councils"), suggests to me that the IMPs are agnostic about who make the regulatory decisions provided the appropriate iwi is consulted.

Conclusion on relevance of the planning framework

4.15 For the reasons set out in in paragraphs 4.1 to **Error! Reference source not found.** above, there is, in my opinion, no compunction for the PWDP to include provisions relating to GMO's. A case must be made that, despite the absence of any higher order policy direction to include such provisions, it would be consistent with the purpose of the RMA and good planning practice to do so.

4.16 In my opinion a case must be made by the proponents of controls on GMOs in the PWDP that:

(a) it would not promote sustainable management to have a district plan that did not include such provisions; and

(b) that such provisions are the most effective and efficient means of achieving the objectives of the plan (having regard to s32 of the RMA).

4.17 In other words, the 'pro GMO control submitters' need to demonstrate that such provisions would *add value* to the management of risks by the EPA. Such district plan provisions would need to do something that is necessary to do to promote the purpose of the RMA but which cannot be achieved under the HSNO Act with the EPA acting in accordance with its functions and responsibilities as a competent regulatory authority.

4.18 It would not, in my opinion, promote the purpose of the RMA, or good planning practice, nor would it constitute good public policy, if GMO provisions were included in a district plan that simply:

(a) duplicated consenting process (where the same questions were asked and the same evidence was considered). That would be to merely add cost for no benefit;

(b) relitigated matters already determined by the EPA by applying non expert judgements in a way the over-rides expert evidence considered by the EPA;

(c) erected unnecessary barriers to the development and uptake technologies that could improve the economic, social, cultural and environmental well-being of people and communities.

4.19 For the reasons I set out in **Appendix 1** of this evidence, and consistent with the s42A report, I do not consider that the pro GMO control submissions have demonstrated that GMO provisions under the PWDP would add the requisite value to the risk management assessment process.

5. INTEGRATED MANAGEMENT

5.1 The s42A report (page 65) notes that the Waikato RPS includes (at section 2.2.2) as an objective:

> *The integrated management of natural and physical resources in the Waikato Region achieved.*

5.2 Two associated policies are identified [3]. Policy One focuses on recognising and providing for the interconnected nature of all the elements of the environment and inter-relationships between natural and physical resources. Policy Two focusses on ensuring *inter-agency* integration and cross boundary processes.

[3] I set these out in fill in Appendix 1

5.3 I agree with the s42A report that the Waikato RPS section 2.2.2 Policy Two raises two issues relevant to these proceedings. The first is whether the policy is best given effect to by having GMO provisions in the district plan that "overlap or potentially duplicate HSNO controls". In my opinion, the answer to that is obvious. The notion of integration, as it applies to inter-agency matters is that there is a seamless interface between the work of agencies over the same geographic area. Processes that overlap, duplicate or otherwise result in unnecessary complexity or create potential for contradictory decisions and outcomes would be the antithesis of integrated managed and would not, in my opinion, give effect to the RPS as required.

5.4 Again, this reinforces the point that unless the pro GMO control submitters can demonstrate that PWDP provisions sought offer something new and additional - in the sense that they address matters that cannot be adequately addressed (for jurisdictional or evidential reasons) by the HSNO/EPA regime – then they have no place in the PWDP.

5.5 The second issue is whether the fact that Auckland Unitary Plan (**AUP**) has GMO provisions ought to influence these proceedings. And, more particularly, whether the RPS's integrated management policy necessitates that, as a bordering district, Waikato should adopt corresponding plan provisions.

5.6 While the s42A report appears to give some weight to that argument I hold a different opinion.

5.7 In my opinion, it is wrong to look only in one direction. Other districts bordering the Waikato do not have GMO provisions in their district plans. Integrated management does not mean that all contiguous authorities need to conform to the approach of the most onerous.

5.8 Taking to its logical conclusion, that argument would result in the district with most onerous regulation dictating the approach of all others in a kind of 'domino effect' which would spread throughout the country until it is entirely covered by the same approach. That cannot be what inter-agency integration means. Waikato District Council must form its own view of the merits of the controls. It is quite likely that this process will include information/evidence which was not before the Auckland IHP. It would be wrong to assume Auckland has 'got it right'.

6. PRECAUTIONARY APPROACH

6.1 I agree with the s42A report that there is considerable academic literature on the meaning and application the precautionary principle (or 'precautionary approach').

6.2 The common element is that there are issues where there are 'unknowns" because insufficient information is available or research has not been undertaken or is incomplete. Famously, there can be 'known unknowns' (things we know we do not know enough about) as well as 'unknown unknowns' (risks we do not even know exist).

6.3 GMOs can present some 'known unknows' in terms of the risks presented. Some risks are sometimes better understood than others. There can be varying degrees of uncertainty about the likely effects of any activity (including the introduction of a GMO into the environment). Where there is no information, caution should prevail and the activity should not be permitted (or perhaps, depending on circumstances, a careful adaptive management approach applied). Where there is incomplete information the quality and extent of that information and the gaps that exist need to be assessed and weighed. Where there is disputed or conflicting information, the quality of the data and its provenance needs to be assessed. The Methodology (clause 29) sets out the approach the EPA must take in dealing with uncertainty. That requires efforts to reduce uncertainty and, where uncertainty persists, requires the range of uncertainty to be established and taken into account in its decisions.

6.4 In my opinion, the precautionary approach is important in all aspects of resource management and should be applied to restrict certain activities where there are unknowns but:

(a) The fact that there is an unknown is not in itself reason to restrict an activity.

(i) the degree of that uncertainty needs to be assessed;

(ii) the significance of any potential adverse effects arising from the uncertainty needs to be considered; and

(iii) the credibility of any alleged potential for an adverse consequence needs to be established (applying scientific rigour).

(b) The application of the precautionary principle is not an invitation to speculate on the possibility of 'unknown unknowns'. That would be to court paralysis in all regulatory decision-making.

Precaution and risk

6.5 At paragraph 75 of the s42A report, there is discussion of the definition of the 'effect' and, in particular, the fact that it includes potential *effects of low probability which has high potential impact*. It was suggested that this scope means that the RMA takes a precautionary approach.

6.6 I think it is important to distinguish between the need for caution in response to incomplete information and the concept of risk. The two concepts are not the same.

6.7 There can be risk but with very good information. Flood risk is an example. We often know a great deal about the likelihood of a flood of a particular size. This can be expressed as an annual return interval (ie a 100-year flood) or in terms of annual exceedance probability (eg. 1%). We also know a great deal about the potential consequences of such a flood because we will generally know the flood level and flow rates etc. There is uncertainty about when exactly the flood might occur - even if we know statistically there is likely to be only 1 in every hundred years there is a 1% chance of it happening every year. We do know though that such a flood will occur.

6.8 In my opinion the concept of precaution goes further than just uncertainty about how a statistical probability will play out. A precautionary approach might be applied (to continue the analogy) if there had was no flood modelling undertaken and no research on previous flood events but a large river and an obvious historic flood plain. In that case precaution should be applied because there is no information but credible evidence of a potential adverse effect.

6.9 The Hazardous Substances and New Organisms (Methodology) Order 1998 (**Methodology**), appropriately in my opinion, treats risk as a separate issue to uncertainty. This is important because it would be wrong to conclude that the RMA's definition of 'effect' allows for broader consideration than the HSNO's focus on a precautionary approach. In my opinion, that is not the case. In fact, the broadly expressed 'precautionary approach' of the HSNO Act is the wider concept encompassing, as it does, both uncertainty caused by a lack of information and by the inherent uncertainty associated with statistical probability.

6.10 In that sense I do not consider that the RMA has a scope that allows risks and uncertainties to be considered that are not able to be considered under the HSNO Act. However, there remains the question as to whether, in practice, there might be residual risks and uncertainties that have not been accounted for under HSNO that need to be considered under the RMA. As noted elsewhere I am not of the opinion that there are but I await further evidence on that point.

7. REVIEW OF REASONS GIVEN IN SUPPORT OF DISTRICT PLAN GMO PROVISIONS

7.1 At paragraph 58 (pg 50) the s42A Report the submitters' reasons for proposing GMO controls in the PWDP are usefully summarised. In **Appendix 1** of my evidence I respond to each of those reasons and to several other points raised by submitters not summarised by the s42A Report.

7.2 Appendix 1 demonstrates that in policy terms, the gaps and deficiencies alleged to justify RMA control do not exist when assessed against the requirements of the HSNO Act and its decision-making requirements as set out in the Methodology.

EPA authorisations to date

7.3 The fact that the HSNO Act and associated EPA process appears to address the matters of concern must mean that the pro GMO control submitters consider that the EPA does not implement those requirements and processes as it should, meaning that some risks are not properly analysed or managed despite the legal requirement to do so.

7.4 To understand the basis of that apparent concern I have undertaken a review of the decisions made on GMO under HSNO since it came into force in 1998.

Field trials (in containment)

7.5 In terms of GM field tests in containment, only 20 organisms have been approved (although only 14 ever proceeded to actual trial, with six approvals never actioned). Nine of the 20 approvals were vegetable or arable crops or ornamental plants. Four were for trees for plantation forestry. Seven were for animals.

General release of GMOs

7.6 In terms of general release of GMOs, the EPA (and its predecessor ERMA) have approved just six GMOs in the period since 1998 – all but one with controls. One application was declined. All those GMOs approved are therapies/vaccines for medical or veterinary purposes. No GMP crops or genetically modified animals have been approved for general release in 21 years.

7.7 The decision on the application declined recorded:

> "…*potential exists for live GM BoHV-1.1 to undergo recombination with wild BoHV-1 strains in the field, resulting in the generation of a virulent abortifacient BoHV-1.1 strain. The Committee had insufficient information to conclude that it is highly improbable that live GM BoHV-1.1 could form an undesirable self-sustaining population and have significant adverse effects on any valued species"*[4]

7.8 This decision demonstrates that:

(a) Precautionary approach is applied by the EPA and does have a material bearing on decision-making; and

(b) Veterinary vaccines can also be uncertain (something that would appear to undermine the rationale of exempting these vaccines from the RMA/prohibited activity approach promoted by the pro GMO control submitters).

7.9 In addition, I am aware of at least one application for a new organism that was declined on the basis that the adverse effects of the organism and any inseparable organism outweigh the positive effects[5].

7.10 On that basis, I see no *prima facie* case that the EPA has, over the past 21 years, been irresponsible in its regulatory functions. That is an unlikely conclusion to draw at least from the evidence currently available to me.

7.11 Furthermore, based on the evidence of Dr Tony Conner, I understand that the HSNO regime is known as being very challenging and time consuming and that a number of biotechnology companies and individual experts and researchers have gone overseas to continue their work at least partly because of the difficulty of undertaking that work under New Zealand's stringent regulatory regime.

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[4] Para 3.4, Decision on application APP201842, July 2015

[5] This decision was issued in June 2019. The EPA declined consent for the import of an arbuscular mycorrhizal fungus (intended to improve agricultural yield and the commercialisation of mycorrhizal inoculum products. While this was not a GMO its does illustrate how the EPA considered the risks involved.

7.12 The LSN submission noted that other jurisdictions (including the US, Australia, Sweden, Brazil and Japan) are in fact *deregulating* some gene editing techniques on the basis that risk is understood to be so low as to not warrant the level of regulatory scrutiny previously required.

7.13 For those reasons, I concur with the s42A Report that the evidence currently available suggests that the HSNO regime adequately addresses the concerns raised. I would revisit that conclusion if further evidence is advanced by the submitters.

7.14 As a final point on the reasons for seeking PWDP controls on GMOs, I observe that there does appear to be an inconsistency in the logic applied in the pro GMO control submissions. The HSNO Act and Methodology govern the introduction of *all* new organisms into the New Zealand environment – whether genetically modified or species/organisms not already present here (non-GMO new organisms). The same risk and decision-making framework applies to both equally on the basis that both types of 'new organism' present risks to human health and safety, the economy and the environment. The pro GMO control submissions do not seek PWDP control over new organisms that are not GMOs. In that regard they apparently accept the HSNO/EPA processes are adequate and effective. This despite the fact that significantly more non-GMO new organisms have been approved for release in New Zealand than GMOs [6] and that there have been significantly more breaches of controls of non-GMO new organisms than with controls on GMOs[7]. This suggests to me that, notwithstanding the reasons stated, the underlying concern of those submitters may be more about the fact that these organisms are GMOs than it is about the adequacy of the breadth and depth of the HSNO/EPA risk assessment process.

[6] 61 non-GMO new organisms have been approved for general release and one for contained field trials.

[7] The 2015 EPA report, for example, cites 73 non GM incidents (some of which had adverse effects) vs 10 GM incidents (none causing adverse effects).

8. SECTION 32

8.1 Section 32 of the Act requires the Council to produce an evaluation report that examines:

(a) the extent which the objective is the most appropriate way to achieve the Purpose of the RMA; and

(b) whether the policies, methods and rules are the most appropriate way to achieve the objective having regard to their effectiveness and efficiency, including by assessing costs and benefits (with specific focus on impacts on economic growth and on employment). Costs and benefits should be quantified where possible.

8.2 Where provisions are proposed through the hearing process (that is they were not supported by the pre-notification section 32 evaluation), section 32AA requires that the section 32 process applies to such new proposals before decisions are made. Accordingly, in practical terms, before it could include any GMO provisions into the PWDP the Panel would have to have the benefit of a section 32 report that demonstrates that a GMO objective is appropriate and that the implementing provisions are the best option of all reasonably practicable options (having regard to the section 32 matters) of meeting that objective.

An objective for GMOs

8.3 I accept that an objective of protecting human health and safety, the environment and economic and social well-being from adverse effects of GMOs is within the jurisdiction of the council to adopt for the PWDP. I would suggest, however, that in planning terms any such objective should be balanced by that objective also clearly articulating that the plan should seek to *enable* GMO use where risks of adverse effects can be managed and positive human health, economic and/or environmental outcomes will result. To not do so would, in my opinion, not be an appropriate way to achieve the Purpose of the RMA (ie. to enable people to provide for their social, economic, and cultural well-being and for their health and safety).

8.4 Accordingly, I disagree with the s42A report that any GMO objective should be stronger than that adopted in Auckland and include the word "avoid". That would be too restrictive and risk disenabling technologies that have the potential for very significant social, economic and environmental benefit.

8.5 In more general terms, I consider that an objective on GMOs *could* be adopted even if the plan contained no implementing provisions (on the basis that it relied on methods of implementation outside of the plan – ie. HSNO). However, I do not support that approach as it may mean that the objective is taken into account in decision-making (resource consent processes) in unanticipated ways.

8.6 In my opinion, whether it is necessary and appropriate to include any GMO objective in the PWDP depends on whether implementing plan provisions are justifiable under section 32.

8.7 I also note that there seems to be no clear rationale for singling out GMO's as a source of risk from other new organisms (certainly there was nothing in my planning assessment that would cause such a distinction to be made). Hence it is not clear to me why any additional objective would be so limited.

Reasonably practicable options

8.8 The reasonably practicable options include more than simply (a) the pro GMP control submission proposal; and (b) the notified PWDP proposal. A wide range of intermediary options are possible. I provide an *outline* s32 evaluation in **Appendix 2** of this evidence. While not comprehensive, it examines four possible options as follows:

(a) *Proposal 1*: Rely on HSNO. Do not seek to control GMOs through the PWDP (essentially the same approach that has been place in all previous generations of Waikato district plans and by far the majority of other district pans around the country).

(b) *Proposal 2*: Rely on HSNO with a backstop strategy (identified as a method in the PWDP) of plan changes and/or requests to the Waikato Regional Council for a regional pest management plan under the Biosecurity Act should there be a likelihood of the EPA approving an organism for release that would of particular concern to the Waikato district community.

(c) *Proposal 3*: Introduce limited control under the district plan by way of a requirement for controlled activity consent for specific GMOs in some, or all of the district, where they may have a heightened risk that is not likely to be considered by the EPA.

(d) *Proposal 4*: Introduce the heavy regulatory approach that prohibits outdoor release and requires discretionary consent for field trials as proposed by the pro GMO control submitters.

8.9 The evaluation set out in **Appendix 2** demonstrates that, assuming the EPA undertakes its responsibilities under HSNO as a competent regulatory authority (which is an appropriate assumption for the purposes of the PWDP):

(a) The proposal put forward by the pro GMO control submitters (Proposal 4) is not efficient since it:

(i) imposes high costs on applicants, on the council and, to the extent that the introduction of GMO technologies will likely be deterred by such high regulatory barriers, on social, economic or environmental well-being that might arise from GMO use to solve production and environmental challenges. Any additional benefit is negligible; and

(ii) is untargeted, imposing the same scrutiny and the same costs for potentially very different levels of risk and effect.

(b) A heavy regulatory approach cannot be effective in making Waikato "GE-Free". Any future GMOs approved for general release to New Zealand's environment that cannot be controlled by district plan rules (animals released for pest and predatory control for example) will eventually populate the Waikato.

(c) On the basis of existing information available to me, Proposals 2 and 3 do not appear necessary but should further information justify PWDP intervention, the options offer benefits at significantly reduced costs (relative to Proposal 4). These options might be considered further depending on the information provided by the submitters at hearing.

(d) At this time, I consider that Proposal 1 remains the most efficient and effective option.

9. PROCESS CONSIDERATIONS

9.1 The s42A report expresses concern about introducing an additional suite of planning provisions at this point in the process given the widespread and potentially significant implications of such provisions and the fact they were not:

(a) clearly signalled as part of pre-notification consultation on the PWDP;

(b) included in the notified version of that plan; or

(c) detailed in the submissions received (accepting that some submissions did refer to wanting provisions 'similar to those in the Auckland Unitary Plan').

9.2 That is a concern I share. In my opinion, it would not be good planning practice to introduce into the PWDP an entirely new set of provisions that have effect across the whole district at this point in the process. That is in because of:

(a) the widespread public interest;

(b) the stringent nature of the proposal; and

(c) because the Auckland provisions are not "plan ready" in the PWDP context (as the s42A report notes).

Gerard Matthew Willis
18 December 2019

APPENDIX 1 – Response to reasons given

Summarised pro GMO control reason (p50 s42A report)	**Planning Response**
GMO contamination may adversely affect economic wellbeing to the community, including losses to business, forestry and farming, loss of organic and GMO-free certification, loss of environmental branding, and loss of markets and premiums paid for GMO-free crops.	As noted in paragraph 4.4 of this evidence, section 5 of the HSNO Act includes as a principle: *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* Similarly, section 6 of HSNO states as a matter relevant to the purpose of the Act: *the economic and related benefits and costs of using a particular hazardous substance or new organism:* Clause 8 of the Methodology expressly provides for the principle of section 5 as listed above to be provided for and for the other matter to be taken into account. In my opinion that provides ample scope for the specific costs and risks to be raised and considered within the HSNO process. That is, the RMA does not provide a wider or different scope which would mean that the Council under the RMA is able to consider this issue differently to the way the EPA can under HSNO.
Release of GMOs could adversely affect social and cultural wellbeing	As above this is a matter that the HSNO Act and decision-making methodology expressly requires the EPA to consider.
GMOs, once released into the environment, would be difficult, if not impossible, to eradicate	Section 37 of the HSNO Act expressly requires the EPA, when making a decision, to have regard to this matter. Clause 10 of the Methodology requires the EPA to evaluate: *The ease with which the organism could be eradicated if it established an undesirable self-sustaining population*

The risks outweigh the benefits, especially as expected benefits have not come to fruition.	Whether the risks and costs outweigh the benefits is a matter expressly provided for in Clauses 26 and 27(1) of the Methodology. The EPA must take those matters into account on an application by application basis.
Local regulation is necessary when it comes to GMOs' release in the regions, because the EPA has no role under HSNO after a GMO is released.	The EPA has broad enforcement powers under section 103 of the HSNO Act to monitor compliance with the conditions or controls placed on the approval to release any new organism. A new organism is only released without conditions or controls where the authority is confident the risk is negligible. In the unlikely event of unforeseen issues occurring after full release of a GMO, those issues can be managed at the national and/or regional scale under the Biosecurity Act.
Integrated management and precautionary approach to GMOs under the RMA is the best available technique for managing potential adverse effects posed by GMOs on the environment and other land use activities.	I address integrated management and the precautionary approach comprehensively in sections 5 and 6 of my evidence. The RMA does not expressly provide for the precautionary approach. The HSNO Act does.
Other councils have found local regulation necessary. There should be a consistent approach across Northland, Auckland and Waikato, to eliminate cross-boundary issues.	The fact that some councils may have included GMO provisions in their district plans is not itself a reason why Waikato should take the same approach. Issues of integration and cross boundary issues are discussed in sections 5 and 6 of my evidence
Overseas, GM crops have caused increased pesticide use on crops, with deleterious human health effects.	The potential risk to, and effects of, GMOs on human health is a core consideration of under the HSNO approval process. Both section 6 of the HSNO Act and Clause 9 of the Methodology require the EPA to take into account the risks, costs, benefits relating to public health. Section 36 of the Act requires the EPA to decline an application for a new organism where *"it is likely to cause any significant adverse effects on human health and safety".* I am not aware of any evidence of effects on human health attributable to GMO crops. No GMO crops have been approved for release in NZ after 21 years of the HSNO regime.
There is a risk of cross-contamination of non-GMO	As noted above, this issue is well within the power of the EPA to consider under

crops, causing conflicts between farmers.	HSNO. I also note that the LSN further submissions points out that major markets have regulated tolerances for GMO material in non-GMO crops and human and animal foods so concerns for absolute purity from a market perspective appears to be overstated.
Consumer resistance is high – there is a market premium for non-GMO produce.	As noted above, the EPA is required to consider issues of economic cost and market factors. Hence information on price premiums and risk to those premiums can be taken into account in the EPA processes. Issues of consumer resistance and market-premiums are outside my expertise. However, I do note the following information from the LSN submission that suggests that the demand for GMO solutions for food supply are increasing globally. In its 2017 update on the *Global Status of Commercialized Biotech/GM Crops* (Attachment C) the International Service for the Acquisition of Agri-biotech Applications noted: • In 2017 up to 17 million farmers in 24 countries planted 189.8 million hectares of genetically modified crops, an accumulated area since 1996 of 2.3 billion hectares • Uptake by farmers in the top five growing countries is as high as 90-100% • There has been more than a 10,000% increase in the use of GM crop since 1996 • The main biotech GM crops are cotton, soybeans, canola and corn • Other GM crops include alfalfa, sugar beets, papaya, squash, eggplant, potatoes, and apples • Crops under development include rice, banana, potato, wheat, chickpea, pigeon pea, rye grass, mustard, cassava, cowpea, and sweet potato • Economic gains from GM crops reached US$186.1 billion from 1996 to 2016 The submission also noted that there are tolerances for GM material in products and that GMO and non-GMP farming can and do co-exist without specific GMO related land use regulation.
GMO contamination could have significant adverse effects on the mauri and tikanga of tangata whenua	Clause 9 of the Methodology refers in (b) to the need to recognise cultural well-being and in (c) to the need to take into account the risks, costs, benefits and other impacts on the relationship of Māori and their culture and traditions with their ancestral lands. Water, sites, wāhi tapu, valued flora and fauna, and other taonga. Clause 25 (2) of the Methodology specifically requires that where evidence refers to

	the relationship of Māori culture and traditions with their ancestral lands and taonga the EPA musty consider those values. I consider these requirements in HSNO are as wide and comprehensive as the similar requirements in the RMA, and they allow for regional and sub-regional differences in cultural values and effects to be taken into account by the EPA.
Additional concerns/issues raised in the written submission of Soil & Health Association (as representative of the views of a number of submitters on the District Plan)	
HSNO does not consider "the geographic distribution of GMO projects"	My understanding is that the EPA can consider the distribution of GMO projects in terms of the potential for any of the risks and effects discussed above. It is generally a matter of issues being brought to the attention of the EPA and those issues being properly assessed. That opportunity exists by way of the public notification and submission process.
HSNO does not consider "the need to geographically protect areas of particular value from GMO activities, such as sensitive farming practices (including organic farming, and all farming and forestry relying on a GE−free status, beekeeping etc".	As above. Subject to further evidence on the matter, I do accept that there could be highly localised issues and risks that the EPA may not fully identify in practice (even if they are jurisdictionally able to do so). This would appear to be the potential area of jurisdictional overlap – where a territorial authority might be able to add some value to risk assessment and mitigation, notwithstanding that a national assessment has been undertaken by the EPA. In practice, however, this is likely to translate to additional or enhanced risk mitigation measures. The appropriateness of these will be organism and site-specific. As discussed in Appendix 2, a planning response that presumes approved organisms to be unacceptable everywhere in a district is not appropriate and would be well out of proportion relative to the way other risks are managed within the district planning framework.
HSNO does not consider "the preferences of a community"	HSNO can, and does, consider the preferences of a community. That is the purpose of receiving public submissions. Preferences of communities are important in understanding the weight to be accorded particular potential effects. That includes taking into account particular interests or communities within a region or district. However, fundamentally, risk assessment needs to be taken on the basis of

	a scientific understanding about whether particular effects are likely or not.
HSNO does not consider "integration of the management of natural and physical resources, and the effects of GMO activities on natural and physical resources, on a geographic basis".	HSNO does take into account the potential effects on natural and physical resources as outlined elsewhere in this table. I address the relevance of integrated management in section 5 of my evidence
"There is no mandatory requirement for the EPA to take a precautionary approach to the outdoor use of GMOs. The HSNO Act does not, therefore, provide a planning framework through which GMOs can be geographically, spatially or culturally managed in both an integrated and precautionary manner".	This statement is not correct. The HSNO Act clearly states in section 7: *All persons exercising functions, powers, and duties under this Act including, but not limited to, functions, powers, and duties under sections 28A, 29, 32, 38, 45, and 48, shall take into account the need for caution in managing adverse effects where there is scientific and technical uncertainty about those effects* The way the EPA must deal with uncertainty is specifically addressed by clauses 29-32 of the Methodology
"Consideration of the location and distribution of proposals involving GMOs on a district basis, together with protection of rural resources for organic, biodynamic or GE−free farming, forestry, beekeeping and other primary production activities, are important resource management matters that should be" controlled in the district plan.	I understand that the HSNO Act process is directed to consider these issues. The Methodology says (para 13): *When evaluating the assessments of costs and benefits associated with the substance or organism in an application, the Authority must take into account—* *(a) the costs and benefits associated with the application and whether the costs and benefits are monetary or non-monetary; and* *(b) the magnitude or expected value of the costs and benefits and the uncertainty bounds on the expected value; and* *(c) the distributional effects of the costs and benefits over time, space, and groups in the community* However, from a planning perspective, if there are spatially definable risks that cannot be accurately managed through the HSNO process then some form of

	district planning intervention may be appropriate. This would be the same for any new organism which is not a GMO. However, as discussed in section 0 of my evidence, a planning response that presumes all approved organisms will be unacceptable everywhere in a district is not an appropriate planning response, would fail a section 32 test and would be well out of proportion to the way other risks are managed within the district planning framework.
"There is no provision under the HSNO Act for financial liability for GMO contamination resulting from the release of an approved GMO, meaning those causing harm may not be held liable. Furthermore, the full financial cost of the remediating any damage generated by GMOs cannot be readily quantified if the effects of any introduced GMOs are not yet understood".	There is strict liability for any breaches of controls. S38D(2) of the HSNO Act states that the types of controls (an obligation or restriction) on conditional releases is not limited. It is possible for the EPA to not grant unconditional release if it thought controls (even if limited to a bond) were necessary. Royal Commission's report concluded that there is nothing special about GMOs to warrant changes to the common law remedies
"Unregulated control of GMO's will directly impact on the integrity and market perception of organically certified products. This is a significant financial and enterprise risk for organic and GE free producers. Should GMO contamination occur and on a wider level, the "GE free" status of a district would likely be lost permanently along with the market advantages of that status".	There is no unregulated control of GMOs. All GMOs must be approved under HSNO. As noted above, the matters raised are all relevant considerations under HSNO. The extent to which the substantive claims are valid is outside my expertise However the suggested controls alone would not confer a GMO free status on the district because at least: a) live GM vaccines and human medicines which have been approved for release would be permitted under the proposals, and b) Approved GM animals and insects released for pest management in other districts may cross the territorial boundary.
"There is also a potential risk that escape of GMOs from a controlled environment would attract widespread publicity. Any such publicity of control breaches or potentially public criticism of a lack of an appropriate precautionary approach carries with it a significant risk of damage to both the 'New Zealand' brand and organic	The extent to which the substantive claims are valid is outside my expertise.

farming sectors on the international stage".	
In terms of cultural effects "the management of GMOs and the potential effects they may generate is required at a district level to ensure the principle of being kaitiakitanga to all living things is adhered to".	This implies that kaitiakitanga can only be exercised at a district level. I am not aware of anything in the RMA that suggest that is the case. There are already many regulatory decisions regarding 'living things' made at the national level (including many biosecurity and conservation decisions) or at the regional level. As I have noted at paragraphs 4.9 to 0 of this evidence, while noting some concerns, the applicable iwi management plans (**IMPs**) do not assert that the released of an EPA approved GMO should be prohibited in Waikato (or even that contained field trials of GMOs be subject to resource consent). The Waikato Tainui IMP clearly anticipates that applicants for EPA approvals can and will interact with the Iwi prior to making their applications. There is no expectation that management must be on a district scale for the principle of kaitiakitanga to be adhered to.

APPENDIX 2 – OUTLINE SECTION 32

Effectiveness – effectiveness is a measure of how well and/or how quickly the objective will be met. I do not propose a specific GMO objective for the PWDP but for the purpose of this evaluation I propose that an appropriate resource management objective would one that seeks to ensure that:

a. human health and safety, cultural values, social and economic well-being and the environment is not compromised by GMOs; and
b. to the extent that (a) above is achieved, GMOs are enabled where they would enhance social, cultural, economic and/or environmental wellbeing.

Efficiency – efficiency is a measure of net cost. The option that achieves the objective with the least net cost (taking into account all benefits and costs) can be said to be the most efficient. (Another way to think about efficiency is that for a given cost, which options will deliver the most benefit?)

Good practice suggests the efficiency is best assessed by looking at all the benefits and all the costs likely to be experienced by different affected parties and/or across all four 'well-beings'. Accordingly, good section 32 evaluation will consider and benefits costs on individuals, different communities/groups affected and the administering local authority. It will consider costs in terms of impacts on desired social, cultural, economic and environmental outcomes.

A good section 32 evaluation will quantify costs and benefits as much as possible or at least provide an indication of the likely range of costs and benefits in quantified terms including by case study if comprehensive information is not available. It will expressly consider (to the extent relevant and possible) effects on economic growth and on employment as required by s32(2)(a).

It is also necessary to consider the risk of acting (ie. intervening with a planning control) or not acting (having no additional controls). Where there is a high risk associated with not acting the evaluation will point to acting. However there can also be risks of intervening (such as perverse outcomes, or adverse outcomes that are broader than the issue at hand).

The following tables consider the four options described at paragraph 8.8 of this evidence. I have not been asked to provide and full and comprehensive s32 evaluation. Rather I have been asked to outline what the costs and benefits are that should be considered and provide a general assessment of what the likely scale of those costs and benefits is likely to be.

Nature of costs and benefits

Due to the nature of this issue and to avoid repetition in the tables that follow, it is most efficient to discuss at the outset the approach to costs and benefits I have taken in the following evaluation.

The costs I have considered are as follows.

1. *Opportunity costs* associated with GMOs that are unable to be used because:
    a. district level regulation acts as a deterrent to innovation and adoption and subsequently an application to the EPA ever being made; or
    b. an application to the EPA is made and an approval granted but PWDP regulation acts as a deterrent to potential users even attempting to gain authority at the Waikato District level; or

c. Regulatory approval is sought at the district level but the conditions imposed on consents and or via plans make the use of the GMO unviable/impractical.

The nature and scale of those opportunity costs will be GMO-specific. Over time, however, opportunity costs of not progressing with GMOs are likely to be very significant in social, cultural, economic and/or environmental terms.

GMOs can provide a major opportunity to increase productivity (particularly agricultural productivity). Professor Grimes notes at paragraph 10 of his evidence that if the adoption of technological advancements is curtailed, so too is income growth.

GM technology can have major social benefits in terms of improving medical therapies, increasing food production reliability, reducing food production costs (and hence costs to consumers) and making diets healthier. In terms of food, gene editing has enabled, for example, soybeans with a healthier oil, low gluten wheat (suitable for coeliacs) and oil seed crops with high Omega 3 fatty acids.

GMO technology can also have significant environmental benefits by, for example:

- providing solutions to pervasive animal and plant pests (being the major threat to indigenous biodiversity); and
- providing tools to reduce anthropogenic greenhouse gas emissions (particularly from agriculture).

There will often be corresponding benefits in terms of protecting taonga species that will have cultural benefits.

Because the EPA is unlikely to approve GMOs that do not have significant benefits, I consider that district level regulation has the potential to impose significant opportunity costs, hence I rate the likely opportunity costs imposed by the four options according to how onerous they are and how much of a deterrent they are likely to present.

An example that illustrates the range and magnitude of the opportunities potentially foregone by deterring the research, development and use of GMOs is the presented by a GM ryegrass developed at AgResearch's Grasslands facility. According to a paper by Dr William Rolleston[8], the genetically modified ryegrass contains a high metabolizable energy (HME) system enabling them to produce 16 and 18 carbon chain lipids. According to in-lab testing and observation, the GM ryegrass has a 20% increase in photosynthesis giving a 40-50% increase in production, a 10% increase in metabolizable energy and, potentially, a 30% reduction in water demand. *In vitro* rumen assays have measured a 15-30% decrease in methane production. A supplementary feeding trial suggested animals could eat 16% less of the GM ryegrass for the same liveweight gain. A potential benefit of this is a lower total N load on pasture and reduced nitrous oxide emissions, making this forage a valuable tool for reducing nitrate leaching and greenhouse gas emissions from livestock.

[8] Conditions for co-existence of genetic modification in a pasture based system – a farmer perspective. WBR, Rolleston, 2016. (Attached as Appendix 3)

Given that greenhouse gas emissions from the agricultural sector, over allocation of freshwater (particularly for pasture irrigation) and nitrate loss to water ways also from the agricultural sector, are three of the most pressing environmental challenges facing New Zealand, regulatory barriers to the uptake of potential solutions impose not just an economic cost to farmers but an environmental cost to all New Zealanders.

2. *Strategic cost* to New Zealand as a centre of research and development in biotechnology. If the regulatory environment in New Zealand is so stringent that research becomes difficult, professionally constraining and local demand for GM solutions to economic and environmental challenges dries up, then scientists and biotechnology business will have little option but to relocate to other jurisdictions significantly undermining New Zealand's science capability. Again, the four options are rated according to the extent they will impose barriers likely to have this effect.

3. *Administrative cost* for the Waikato District Council (**WDC**). Administrating plan provisions would inevitably come at a cost to the WDC. While assessing and determining consent application can be cost recovered, in practice there is seldom full cost recovery. Moreover, there is an administrative burden associated with simply having rules in place. These include providing public advice and dealing with requests for information (including where necessary contracting specialist expertise), monitoring compliance (which can only be cost recovered when a consent is in place), taking enforcement action and dealing with appeals on consents or plan change requests. Waikato District Council does not currently retain staff with expertise in GMOs. While that expertise could be contracted in on an 'as needed' basis there could be significant cost given the specialist nature of the capability required and the public interest. I note that this issue was raised in the s42A report.

Many of actual and potential costs are discussed in more detail in the evidence of Professor Arthur Grimes.

The potential benefits I have considered[9] are as follows:

1. Ability to exercise a *precautionary approach*. While I note this as a benefit, reflecting what I understand to be a key point made by the pro GMO control submitters, I must assume that the EPA operates as a competent regulatory authority consistent with its responsibilities under the HSNO Act. As noted elsewhere in this evidence, the HSNO process requires the EPA to take into account the need for a precautionary approach. Therefore, the evaluation needs to view this as a potential marginal benefit after the EPA has applied its approach. Again, as I have noted elsewhere, I do not consider that the RMA takes a broader or different approach to precaution and accordingly and I say at the outset that, except as addressed by 2 below, I rank all RMA options as 'low' in terms of providing this marginal benefit.

2. *Ability to manage risk* across the four well-beings (including human health and market and economic risks). A subset of this benefit is the localised assessment of risks. Risk of GMOs in the environment may vary according to localised conditions (temperature, rainfall, wind etc). Similarly, the acceptability of risk may vary according to the sensitivity of the receiving

[9] These are based in part on my understanding of the benefits that the pro GMO control submissions suggest.

environment. Different iwi/hapu may have different cultural considerations. Some options may allow for this more than others. As noted earlier in this evidence, however, the HSNO process does address all potential risks and includes the ability for localised consideration, iwi and community input. Hence the marginal benefit between options is unlikely to be significant. A further subset of this benefit is the ability for communities to maintain a local GE-free status although, as I have noted elsewhere, the release of GM vaccines and medicines (not proposed to be controlled by the pro-GMO submitters) and the limited ability to control certain GMOs at the territorial border would undermine such a claim.

3. *Ability to enforce controls and to hold those with GMO approvals to account* (financially) in the event that damage is done to the environment. An effective regulatory system needs to be able impose effective controls and enforce those controls when they are not complied with. Where the consequences of failure are significant financial instruments can play a part in minimising residual risk. (Noting again though that the EPA is already able to use financial instruments so the additional benefits provided by other RMA options would always be limited).

Proposal 1 - Rely on HSNO. Do not seek to control GMOs through the PWDP

Effectiveness Based on the evidence that the EPA will undertake its responsibilities as a competent regulator, Proposal 1 will effectively achieve the objective. Relative to other options, Proposal 1 is more effective in achieving the objective as stated since it does not risk deterring beneficial GMO use.	
Costs	
Adverse opportunity costs	None (in addition to those arising from HSNO process)
Strategic cost	None (in addition to those arising from HSNO process)
Council administrative cost	None
Benefits	
Ability to exercise precaution	Precaution exercised as part of HSNO decision. All GMO use needs HSNO approval before trials/release. Benefit relative to status quo – none.
Management of risk (including local risk)	None relative to status quo but planning analysis suggests potential exists under HSNO for localised consideration of risk factors.
Ability to enforce and hold to account	None relative to status quo but planning/legal analysis suggests there are sufficient powers under HSNO for enforcement and for bonds (except where there is a full release but the EPA would not grant a full release if it considered controls (including bonds) were required.
Risk of acting or not acting Based on the evidence that the EPA will undertake its responsibilities as a competent regulator, the risk of not acting (i.e. adopting this proposal) is low.	

Proposal 2 - Rely on HSNO with a backstop strategy (identified as a method in the PWDP) of plan changes and/or requests to the Waikato Regional Council for a regional pest management plan under the Biosecurity Act should there be a likelihood of the EPA approving an organism for release that would be of particular concern to the Waikato district community.

Effectiveness The option might be assessed as more effective than Proposal 1 in the sense that any residual risk as may exist after the HSNO/EPA process could be addressed through some form of local regulation after the nature of the specific GMO and associated risk is known (ie. it could be targeted). It could achieve that without a blanket consent requirement or prohibition as per Proposal 4. The effectiveness of the proposal depends on the WDC acting quickly in the event of a particular local risk being identified that is not able to be addressed through the HSNO/EPA process. Whether it is more effective than Proposal 1 depends on the likelihood of residual risks. As noted elsewhere, I am not aware of what those risk might be and await further evidence on that matter. For current purposes, I rate this proposal as effective but not more so that Proposal 1	
Costs	
Adverse opportunity costs	Low. Any intervention would be highly targeted and well justified
Strategic cost	Low. Any intervention would be highly targeted and well justified
Council administrative cost	Medium. It would involve the WDC closely monitoring EPA approval processes and taking action on plans when warranted
Benefits	
Ability to exercise precaution	Precaution exercised as part of HSNO decision. All GMO use needs HSO approval before trials/release. Benefit relative to status quo – none
Management of risk (including local risk)	Medium. Provides opportunity to regulate locally where risk warrants it
Ability to enforce and hold to account	High (RMA tools would be available in addition to those under HSNO) although as otherwise noted, the need for additional tools is not apparent from planning/legal review.
Risk of acting or not acting Acting on this proposal would impose no additional risk since it involves reacting to rather than pre-empting issues as there might arise.	

Proposal 3 - Introduce limited control under the district plan by way of a requirement for controlled activity consent for specific GMOs in some, or all of the district, where they may have a heightened risk that is not likely to be considered by the EPA

Effectiveness Based on the evidence that the EPA will undertake its responsibilities as a competent regulator, Proposal 3 would not be effective as it would be imposing unnecessary controls.	
Costs	
Adverse opportunity costs	Low/medium. Assurance of consent being issued reduces potential deterrent effect It the consent could be obtained as a global consent the cost may be considered modest. If individual consents were need for each GMO use the costs would be at least medium
Strategic cost	Low/medium. Assurance of consent being issued reduces potential deterrent effect. (Comment above about the nature of the consent applies)
Council administrative cost	Medium. Some cost associated with assessing controlled activity consents and monitoring compliance. (Comment above about the nature of the consent applies)
Benefits	
Ability to exercise precaution	Precaution exercised as part of HSNO decision. All GMO use needs HSNO approval before trials/release. Benefit relative to status quo – none
Management of risk (including local risk)	Management of risk exercised as part of HSNO decision. All GMO use needs HSNO approval before trials/release. Benefit relative to status quo – none
Ability to enforce and hold to account	Enforcement exercised under HSNO. All GMO use needs HSNO approval before trials/release. Benefit relative to status quo – none
Risk of acting or not acting Acting on Proposal 3 poses some risk that EPA and local controls conflict or duplicate. Invites local reassessment of risk.	

Proposal 4 - Introduce the heavy regulatory approach that prohibits outdoor release and requires discretionary consent for field trials as proposed by the pro GMO control submitters.

Effectiveness While Proposal 4 exercises the tightest possible control over GMOs and therefore may serve to virtually eradicate all risk, based on the evidence that the EPA will undertake its responsibilities as a competent regulator, this proposal does so in a way that is likely to capture GMOs with very low risk and therefore not enable the deployment of GMOs that make a positive contribution to the four well-beings. In that sense I rate the effectiveness as poor.	
Costs	
Adverse opportunity costs	High. Prohibition likely to be major deterrent even though opportunity for private plan change exists. Cost of private plan change likely to be in the many hundreds of thousands (at least) and take several years.
Strategic cost	High – as above
Council administrative cost	Hard to determine. Potentially high but if there is a high deterrence effect as expected actual compliance cost may be low.
Benefits	
Ability to exercise precaution	Precaution exercised as part of HSNO decision. All GMO use needs HSNO approval before trials/release. Benefit relative to status quo – none, While a dual process might be said to reflect greater precaution it is not apparent that the HSNO process is deficient in that regard.
Management of risk (including local risk)	Management of risk is part of HSNO decision. All GMO use needs HSNO approval before trials/release. Benefit relative to status quo – none,
Ability to enforce and hold to account	Enforcement able to be exercised under of HSNO. All GMO use needs HSNO approval before trials/release. Benefit relative to status quo – none,
Risk of acting or not acting On the basis of this evaluation and accompanying LSN evidence, the potential negative impact on the future of GMO development of Proposal 4 appears significant. Accordingly, I assess the risk of acting to introduce Proposal 4 as high. I am aware that it has been argued elsewhere that the risk is in fact dependent on whether we are likely to see demand for GMO field trials and/or outdoor releases in the coming decade. If that is not likely, then any costs of Proposal 4 would, in fact, be low (or nil). In my opinion, that is a flawed argument. The deterrent effect	

will exist whether or not there are applications made for HSNO approvals. Moreover, if there are not likely to be any applications for GMOs over the next decade then Proposal 4 itself has no benefit. From an evaluation point of view the correct approach is to assume that there will be GMO applications made and assess the options to manage that demand.

The risk of not acting (or acting on Proposals 2 or 3) is low and medium respectively with benefits that are not significantly less.

Overall assessment

In my opinion, the above outline evaluation, preliminary as it is, demonstrates that Proposal 4 (being the pro GMO submitters' proposal) is the *least efficient* in that the costs are high and the benefits marginal relative to a well-functioning HSNO/EPA process. Some of the benefits might be assessed as high if there is further evidence of assessment gaps that can only properly be filled by the RMA processes proposed. I have not seen any evidence to date which demonstrates this need. However, the costs must, in my opinion, be considered high regardless.

Costs of the other three proposals are significantly lower but with benefits that are not likely to be significantly less than those achieved by Proposal 4.

Admittedly, the *effectiveness* of the proposals depends on the objective set. If an objective is set, as I have proposed, to include an element of enabling GMO use where risks of adverse effect are adequately managed, then Proposal 4 cannot be regarded as effective.

If the objective focuses solely on avoiding all risk (as the s42A report suggests) and to give every person at the local level the ability to participant in decisions and express their views about risk, then Proposal 4 will be effective. But again, it will be at significant cost. On the basis of my planning review and the evidence available to me, such an objective would be both unnecessary and inappropriate (ignoring as it would some important aspects of section 5 of the RMA). Accordingly, I have not adopted it for the purpose of this evaluation.

This section 32 evaluation has focused (as it must) solely on the Waikato District. However, it is worth considering Proposal 4 in a national context. It becomes obvious that, should the approach be adopted widely, a general release of a GMO for use across the country would be extremely costly with not only a national approval process but, potentially 67 plan changes – and many thousands of consent applications potentially required. Little evaluation is necessary to understand that that would be a very inefficient regulatory regime.

As noted, my evaluation is in outline form rather than comprehensive and it does not attempt to quantify benefits or costs. Despite that, I consider it provides a clear indication that Proposal 1 is the most appropriate option.

My outline assessment may be summarised in the following form.

	Proposal	1	2	3	4
		No Controls	Delayed Controls	Controlled Activity	Prohibition
Effectiveness	Objective a - Protection	Effective	Effective+	Neutral	Neutral
	Objective b - Enhancement	Effective	Effective	Effective-	Poor
Costs	Adverse opportunity costs	None	Low	Low/Medium	High
	Strategic cost	None	Low	Low/Medium	High
	Council administrative cost	None	Medium	Medium	High
Benefits	Ability to exercise precaution	None	None	None	None
	Management of risk (including local risk)	None	None	None	None
	Ability to enforce and hold to account	None	None	None	None
Risk of acting		Low	Low	Medium	High
Risk of not acting		Low	Low	Low	Low

Conditions for co-existence of genetic modification in a pasture based system – a farmer perspective

W.B.R. ROLLESTON
Blue Cliffs, RD24, Timaru, New Zealand
william.rolleston@southpacificsera.co.nz

Blue Cliffs Station in South Canterbury was taken up by Henry Poingdestre in 1856, 5 years after my great-grandfather, George Rhodes and his brother Robert drove a flock of sheep from Banks Peninsula to The Levels Station to establish the first run in South Canterbury. It was from George that McKenzie famously stole 1000 sheep in 1855 and was caught in the now named Mackenzie Pass, only to escape again into the mist the same night.

The Levels was sold following George's death in 1864, but in 1879 his son, Robert, bought Blue Cliffs Station, situated just to the south of the old Levels property, to become its fourth owner. It has been in our family ever since, subsequently run by my grandparents, Dr Randal and Airini Woodhouse and now by me and my brother John.

Blue Cliffs Station was 36 500 acres (14 771 ha) when my great-grandfather bought and leased it. Over the last 137 years the leasehold land was given up and freehold land sold in the face of land tax and other policies designed to break up the large estates. Our family has purchased a number of neighbouring properties in the last decade and so the station now stands at just over 5000 ha. It consists of a mixture of rolling downs (55%) and hill country (45%) ranging in elevation from 131 m to 1180 m a.s.l. at the highest point on the Hunters Hills.

The property is managed as a sheep and beef breeding and finishing operation, running 26 000 stock units (SU) with a sheep:cattle SU ratio of around 50:50. Table 1 provides a summary of the grass and crop mix under cultivation on the downs. The hill country is predominantly native tussock over-sown with clover and ryegrass. Over the last 500 years the native bush has retreated to the hill gullies in the face of a drying climate, natural and man-made fires.

In 2015, I visited AgResearch's Grasslands facility with other farmers from South Canterbury to see the genetically modified (GM) ryegrass that had been developed. The GM ryegrass plants contain a high metabolisable energy (HME) system enabling them to produce 16 and 18 carbon chain lipids and store them in a protein sphere, protecting the lipids from internal catabolism. According to in-lab testing and observation, the GM ryegrass has a 20% increase in photosynthesis giving a 40-50% increase in production, a 10% increase in metabolisable energy and, potentially, a 30% reduction in water demand. *In vitro* rumen assays have measured a 15-23% decrease in methane production. A supplementary feeding trial suggested animals could eat 16% less of the GM ryegrass for the same liveweight gain. A potential benefit of this is a lower total N load on pasture and reduced nitrous oxide emissions, making this forage a valuable tool for reducing nitrate leaching and greenhouse gas emissions from livestock. Of most interest was the enthusiasm for this development of the other farmers in the group and I was surprised by their agitated response to the fact that this grass was trapped in the laboratory.

The regulatory process and likely practical restrictions in New Zealand have meant the HME system is currently being trialled in the USA in soyabean; eventually extending to ryegrass and alfalfa. American farming interests are closely following these trials.

GM has been a contentious issue in New Zealand since the early 2000s when the then Labour government set up the Royal Commission on Genetic Modification. The major conclusions of the Commission were that a 100% organic or a GM-free future was not realistic or to New Zealand's benefit, nor was total deregulation of GM. The Commission said New Zealand should proceed with caution on a case by a case basis, preserving opportunities.

The purpose of this paper is to consider the use of genetically modified organisms (GMOs) in the context of our pastoral farming system and to stimulate

Table 1 Areas currently cultivated and supporting various crops on the rolling downs of Blue Cliffs Station.

	Hectares cultivated annually
Perennial ryegrass/timothy/clover	116
Perennial ryegrass/plantain/clover	50
Italian ryegrass/clover	85
Lucerne	37
Kale	138
Fodder beet	82
Total cultivated	**508**

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discussion about what co-existence might look like in New Zealand agriculture. How can a product such as the HME ryegrass be used and what would need to be considered to make co-existence work?

GMOs and their products are controlled both internationally and nationally. The international agreement is the Cartagena protocol which sets up a register for notification for the trans-border movement of living GMOs.

More relevant to New Zealand trade and to farmers producing meat are the market access requirements and the customer requirements for products which may have been produced using GM. These two requirements are often very different and are commonly confused when trade in GM products is discussed.

Market access requirements are those requirements which allow products to be traded across borders and sold in foreign markets. For instance, the European Union (EU) allows the importation of GM animal feed provided it is non-viable. Perversely, the EU ignores the use of GM (e.g., enzymes) in cheese and beer making. The EU has also approved certain GM products for human consumption but requires a GM label where the level of GM presence is above 0.9%. In Japan the level is 5%. Unapproved GM food is not permitted at any level. The EU does not make a distinction between animals eating GM or conventional feed. Both are considered non-GM. Europe imports about seven billion Euro of GM animal feed per year. In fact, there are no countries in the world which restrict the importation of animal products where the animals have been fed GMOs or GM products in their diet. So as a farmer thinking about growing a GM grass or feed there are no country level restrictions to be concerned about.

Customer requirements are more complex. Those consumers who want to avoid GM products have four choices:

- buy Organic
- buy "GE-Free" labelled product
- buy "Non-GM" labelled product
- avoid GM labelled product.

The organic movement has shunned GM and there are a variety of standards around the world. In the USA, for example, the USDA organic standard prohibits the use of GMOs and their products are tested, but there is no specific tolerance level, rather, inadvertent presence of GMOs would trigger an investigation and recommendations for improvement. In an animal production system "organic" would mean not having GM animals and avoiding GM animal feed, however, the use of GM vaccines appears to be allowed.

"GE-Free" labels have not really been used, as commerce regulators around the world have taken a purist view of such a claim. Inghams, for example, was pulled up in New Zealand for claiming they had GM-free chickens when they could not guarantee their chickens had not been fed imported GM soyabean or cotton meal. That is, if a claim of "GE-free" is made, the producer needs to show more than the product itself is free of GE material. "GE-Free" labelling is likely to require a very high burden of proof requiring verification to give reasonable assurance. From the commerce regulator's point of view it is likely that a "GE- free" claim would be unacceptable if the animal had been treated with a GM vaccine, been fed a GM trace nutrient or if GM was involved in any part of the production system, even if the product itself contained no GM material.

In the absence of GM labelling (until recently) in the USA the "Non-GMO Project" was created to provide consumers with a choice to eat non-GM food. The Non-GMO Project claims this sector to be the fastest growing in the marketplace with more than 2800 verified brands, representing nearly 40 000 products and more than US$19.2 billion in sales. To put this in perspective, however, the USA food sector was worth US$5.32 trillion in 2015, so the demand for non-GM represents less than one percent (0.36%) of the USA food sector. Nevertheless, of relevance to me as a producer, the Non-GM Project has a tolerance for animal feed of up to 5% GM content on average across the year.

The USA is the largest user of agricultural GM in the world and also tops the production of organic food. Organic production utilises about 1-2% of agricultural land while 90-95% of farmers use GM in the crops in which it has been approved. In addition, New Zealand's GM-free (i.e. tested GM-free) corn seed also comes from the USA suggesting that co-existence exists where there is a will.

The USDA organic information suggests the following preventative practices for farmers with reference to genetic modification:

- plant seeds early or late to avoid organic and GMO crops flowering at the same time (which can lead to cross-pollination)
- harvest crops before flowering or sign cooperative agreements with neighbouring farms to avoid planting GMO crops next to organic ones
- designate the edges of their land as a buffer zone where the land is managed organically, but the crops aren't sold as organic
- thoroughly clean any shared farm or processing equipment to prevent unintended exposure to GMOs or prohibited substances.

The organic standards in Australia and New Zealand call for zero tolerance of GM in any food and zero tolerance on the certified farm. The reasonableness of such a standard was tested in Western Australia in a landmark case between two neighbours – organic

grower, Steve Marsh and GM canola grower Michael Baxter. Sheaves of GM canola blew from Baxter's property onto the edge of Marsh's oats field. Marsh's organic status was revoked by the certifier and he sued his neighbour. The High Court found in the GM farmer's favour rejecting that any harm had been caused to the organic farmer and suggesting that the organic grower should have sued the certifier for setting an unrealistic standard. The case was appealed and the organic farmer lost again. This time the court said that the organic grower had every right to grow organic crops but had no right to impose those standards on his neighbour.

Thus for GM to be used in New Zealand the government would need to determine where the balance of rights should lie. Should all farmers be denied the opportunity to use GM for the convenience of growers who want to set a personal standard? Or should the government allow rules and practices which give a reasonable level of protection to enable products to be traded internationally?

If the former, then many potential uses of GM would be beyond our reach. If the latter, then (for animal feed at least) no regulation would be required.

Just as we have free speech but we are not allowed to defame (i.e. our free speech has limits) so it is likely that a balanced approach would be found with respect to those who want to grow GMOs and those who want to avoid them.

If a standard were set for GM growers that provided a reasonable expectation for non-GM growers then any higher level of assurance would be the responsibility of the non-GM grower.

Given the requirements for organic and Non-GMO Project certification, and the tolerance levels in food used internationally for food labelling, a 1% level might be a useful place to start with respect to the grasses and crops used by livestock farmers in New Zealand. That is, if a neighbour who wants to avoid GM takes no preventative measures he/she would have a reasonable expectation that no more than 1% of the species in question would be cross-pollinated by the neighbour's GM crop. This of course would be at the closest point and would likely reduce moving away from the boundary.

Exactly what practices would be required would depend on the plant species, its reproduction and how it is used in the agricultural system. Stewardship programmes could be voluntary or industry standards, or regulated as part of a conditional release of a GMO. In the main, stewardship programmes would be aimed at limiting the production and/or spread of pollen or seed from the GM plant. Seed should also be considered in any stewardship programme particularly with respect to equipment hygiene but in the species considered here the characteristics of the seed means it unlikely to move in the field further than pollen.

There are four main factors relating to pollen to consider:

- species and method of dispersal
- the management of the crop and the role of flowering
- pollen deposition and the distance it travels
- receptive plants fertilised as a result of the pollen deposition.

So it is important to consider gene flow rather than simply pollen dispersal. Gene flow depends on pollen viability, receptive flowers, fertilisation and seed development.

Grasses (including corn)

For example, a number of gene flow studies have been carried out on forage grasses that are wind pollinated such as ryegrass and tall fescue, including at AgResearch in New Zealand. Pollen has been detected up to 1 km from such crops but gene flow is limited to 30-50 m for ryegrass and 150 m for tall fescue.

Corn (another grass) produces large amounts of pollen (a 1 ha field can produce as much as 10^{11} pollen grains per season) and this is detectable 4.5 km away at thousands of grains per square metre, but the gene flow rate declines rapidly, so that a distance of only 10-50 m is sufficient to keep gene flow at below 1.0%. In addition, except for corn seed production, the corn used is generally an annual hybrid so no seed is collected.

Considering the large amounts of pollen produced by corn and the rapid decline in pollen concentration with distance, the biggest barrier to gene flow is the competition with pollen from any corn plants in closer proximity to the receiving plant. Such a biological barrier will also be affected by the area of GM varieties compared to non-GM varieties; the greater the area of GM varieties compared to non-GM varieties the less effective such a biological barrier would likely be. As already noted, most corn seed comes from the USA where over 90% is GM, so while the amount of pollen dispersal seems large, co-existence of GM and non-GM is possible.

Blue Cliffs Station has produced whole crop silage from time to time and flowering is essential for effective production. While one of our neighbours produces maize silage he does not produce corn seed, nor sweetcorn, and the next nearest seed producer is more than 5 km away. If our neighbour were keen to avoid GM corn, strategies such as ensuring a buffer distance between the GM and non-GM crops of say 30-50 m could be used. This buffer area could contain non-receptive plants or non-GM corn to increase the proportion of non-GM pollen. Cultivars with different flowering times could also be chosen.

Perennial grasses would require a different approach

and so stewardship protocols could be deployed to reduce spread to extremely low levels (well below the 1% target).

These could include:

- a 150 m buffer zone (of non-receptive crops)
- controlling flowering by grazing or topping pasture
- growing a variety with different flowering dates (so that in neighbouring farms the amount of receptive plant flowers would be minimal),
- not allowing a GM ryegrass pasture to develop to full reproductive state (e.g., not producing hay, silage or baleage).
- if producing hay, silage or baleage, managing the surrounding pastures to minimise receptive flowers.

Another approach might be to develop plants which produce no pollen as Scion is developing in trees. There has been plenty of protest about so called "terminator genes" but in practice we do not save grass seed, hybrids do not reproduce true to form, and sale of modern cultivars is already covered by plant variety rights, so any supplier is paying a royalty to the developer.

In the case of the HME ryegrass, the plants require a specific fertiliser regime, and it is anticipated that any wild unmanaged volunteer plants would be at a competitive disadvantage compared to conventional ryegrass plants and, therefore, less likely to persist in the longer term. Carefully designed field trials are required to confirm this likelihood.

Can the protocols outlined above be used for outdoor development? Narrow legal definition of field trials and strict criteria for them, such as the requirement to remove all reproductive structures, would make field trials impractical in New Zealand. However, if the aim is to ensure that the GM ryegrass does not establish in New Zealand and provided the GM ryegrass has no competitive advantage, then it may be possible to consider conditional release in a way that creates an equivalent framework to field trials as they are defined overseas.

Insect pollinated crops

Insect pollinated crops such as lucerne and brassicas have a different pollen distribution pattern than wind-borne pollen and are influenced by factors such as the placement of bee hives and competing pollen sources. For example, gene flow has been detected from a single garden plant in a nearby field some 800 m away. That is, a single viable pollen could be carried some distance by insects. However, if we consider the target of <1% gene flow at the closest distance, then similar principles to gene flow for wind pollination would apply as indicated in Table 2.

We could also be informed by the MPI Seed Varietal Certification Programme requires the following minimum distances between cross-pollinating species (Table 3):

Brassicas

When using brassicas on Blue Cliffs Station for forage it is not desirable to allow them to become reproductive, thus pollen production and therefore gene flow is limited. The distance between paddocks would be easy to maintain as the hectares grown are a small proportion of the arable land area of the property. Our neighbour grows brassica seed crops such as turnips and mustard. He participates in the New Zealand Seed Crop Isolation Distance Mapping Scheme (SCID) which facilitates seed purity standards by farmers mapping the crops they intend to grow. The scheme is run by Assure Quality and is vested in the Seed Quality Management Authority of which Federated Farmers is a member. It aims for "no off types in the seed line" (a much higher standard than the one we have chosen) and has isolation distances of around 1000 m or greater, however, our neighbour has no concerns knowing that the brassicas grown on Blue Cliffs Station are used for forage. We would expect GM varieties to be no different.

Table 2 Isolation distances known to achieve <1% gene flow in various crops.

	Type of pollination	Distance (m) and degree of gene flow (%)	
Brassica Crops	Insect	50	0.02
		100	0.01
Corn	Wind	50	<0.9
Ryegrass	Wind	150	<1.0
Lucerne (alfalfa)	Insect	4	0.20
Tall fescue	Wind	150	detected
		200	not detected

Table 3 Minimum distances (m) between cross-pollinating species.

	For areas 2ha or less	For areas larger than 2ha
Grasses and herbage legumes		
To produce Breeders and Basic Seed	200	100
To produce 1st Generation Seed	100	50
Cruciferous kinds (except kale)	For all areas	
To produce Basic Seed	400	
To produce 1st Generation Seed	200	
To produce Basic Seed	700	
To produce 1st Generation Seed	400	
Kale		
To produce Basic Seed	700	
To produce 1st Generation Seed	400	

Lucerne

Lucerne is maintained in the paddock for several years, giving it the opportunity to flower. The measures needed under a good stewardship programme could include:

- a 150 m buffer zone
- management of flowering through grazing or cutting when only a few blooms are appearing (say 10%), and
- control of any feral plants or volunteers.

In addition, AgResearch's HME lucerne may also require specific fertiliser management which would make it less competitive than conventional lucerne, particularly when both are grown under optimal conditions.

The success of such a programme could be monitored through the genetic markers which are known for GM crops, such as gene promotor or novel protein sequences.

Gene editing

Monitoring plants produced using new gene editing techniques, such as CRISPR-Cas9, will not be easy. Gene editing is likely to be used extensively by plant breeders due to its accuracy, predictability and low cost. These techniques do not introduce foreign DNA and the results are often indistinguishable from organisms produced through conventional non-GM techniques such as radiation mutagenesis.

As livestock producers on Blue Cliffs Station inadvertent use of GM crops may occur, particularly as new gene edited crops are not being regulated in many of the countries where they were developed. It also means that international trade barriers, described earlier are unlikely, even to the extent they exist now.

Gene editing techniques have been categorised as genetic modification by anti-GM purists and that will be for them to grapple with. For the remainder, gene editing offers an exciting new level of plant breeding with little downside, particularly if deregulation by our trading partners continues.

Conclusion

This paper has attempted to give a perspective on the considerations necessary as farmers in our particular location if we were to use GM forage crops or grasses in our livestock system. I have tried to put this in the context of the real life situation and current market requirements.

GM is assessed on a case by case basis so the technical aspects are not detailed here, but I hope this paper will provide a "straw man" to stimulate thought and discussion on what co-existence might look like when GM crops and grasses become a reality in New Zealand.