Semantically Engineered Grasses

New Zealand Developers' New Spin on GM

Summary

- New Zealand developers of GM pasture grasses are pursuing a GM renaissance strategy looks set to rely on spin to bridge the huge gap to consumer acceptance.
- Despite ongoing market resistance to use of the technology in the food chain and in key export markets, Pastoral Genomics and AgResearch are each committing tens of millions of dollars – half or more contributed by government grants - to bringing GM forage grasses to market. PGG Wrightson is also tracking this target but is underwritten more by Australian state funding.
- These efforts are still largely in the experimental phase, but Pastoral Genomics and AgResearch have been poised to apply for approval to conditionally release experimental lines in New Zealand.
- The marketing strategy developers hope will see a GM renaissance rests on a new type of GM being used to generate the pasture varieties.
- Cisgenics is GM but does not mix unrelated species, developers say. Instead plants are engineered using genes native to that species.
- No cisgenic GMOs have been approved anywhere in the world, but the technology has emerged as one of the most significant strands of New Zealand's state-funded programmes to develop GM foods and feed.
- This modified GM is to be offered to consumers as an olive branch: developers say they have learnt from the markets and have realigned their GM research directions so that the species barrier is left intact.
- Yet the language they are using to sell the concept of cisgenics to consumers suggests that the claimed reform of the GM research agendas is superficial.
- The messaging from developers suggests that cisgenics is not GM and/or that it is more like traditional plant breeding and therefore 'natural' – semantic manoeuvres that disguise the true nature of the technology and how its products are made. Of concern, the regulator has, in at least one instance, uncritically absorbed and replicated the language forged by developers.
- At the same time, efforts by developers to have cisgenic GMOs excluded from regulatory scrutiny are another leg of the strategy to make such GMOs invisible and therefore easier to pass incognito into the marketplace.

- The consistent message from consumers in New Zealand and in key overseas markets is that they want developers to be transparent about the use of GM and for GM products to be clearly labelled. While in the past labelling has focussed on GM ingredients in food, there is a trend towards requirements for the labelling of food products from animals reared on GM feed. It is already a common distinction in European markets for certain products and three European governments are considering regulating for such labelling.
- A strategy that relies upon airbrushed representations of the nature of cisgenic products to gain acceptance could not be more hostile to the transparency that consumers in key markets have set down as a basic requirement. Such conditions weigh more heavily in a country that depends on its reputation for integrity in food production to make its way in the world.
- Should consumers feel that the new drive is to force-feed them GMOs in disguise, the commercial message delivered by consumers seems far more likely to be that GM developers cannot be trusted.
- The test of the acceptability of cisgenic products is not whether they will be tolerated because their method of manufacture has been glossed over, or because they evade regulatory scrutiny. Rather, the real test is whether the public chooses to consume cisgenic food products, in full knowledge of how they came to be.

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1. Cisgenics: A GM Renaissance?

New Zealand research institutions are using a new type of genetic modification they believe will avoid the market resistance that met GM foods and pave the way for a commercial renaissance of the technology.

Three research groups have R+D programmes running to develop a range of cisgenic pasture grasses: Pastoral Genomics (a pastoral industry consortium), AgResearch (a crown research institute or CRI) and Gramina (a joint venture funded by PGG Wrightson and the Victorian State Government).[1] Meanwhile, crown research institute Plant and Food is developing cisgenic potatoes and apples, and claims to be paving the way for the cisgenic engineering of a wider range of food and non-food crops including petunia, tomato, tobacco, onions, rice and pine trees.[2] Pastoral Genomics' drought resistant cisgenic ryegrass line[s] appear to be the most advanced of this cisgenic R+D in New Zealand.

Cisgenics is said to use standard GM *in vitro* techniques to generate new plant varieties but without crossing the species barrier (as with transgenic GMOs). Developers offer this respect for the species barrier as proof that the approach of GM developers has been reformed and aligned to address public concerns about the use of the technology in food production.

As cisgenics is not yet a commercial reality, the theory that cisgenic foods will be positively received by consumers in New Zealand and abroad is yet to be tested. However public perception of this new class of GM is likely to be key in determining the commercial fate of cisgenic crops.

This briefing describes the communications strategy accompanying New Zealand cisgenic R+D. In particular, it discusses the attempt to 'talk away' the use of GM techniques to engender a more favourable market reception. Parallel efforts to weaken regulatory scrutiny of cisgenic GMOs are also assessed against claims that the technology has been reformed.

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[1] For an overview of these GM grass R+D programmes, see the accompanying background briefing, *New Zealand GM pasture grass R+D.*

[2] In 2005, Plant and Food's Tony Conner claimed to be developing intragenic vectors that would allow for in vitro modification of these crops. Anon. 2005. "Faster breeding with no outside genes", *NZ Dairy Exporter,* August 2005. See also: Yao J.-L. 2011. "Modifying apple transformation systems for production of intragenic plants". Abstract for presentation to the 19th Biennial Meeting of the New Zealand Branch of the international association for Plant Biotechnology, February 8-11 2011.

2. Coming to Terms with Cisgenics

What is meant by "cisgenics" remains open to interpretation as the technology is still under development and a statutory definition that would serve to cement in understanding has yet to be adopted. Broadly speaking, however, 'cisgenics' is used by most developers to refer to a type of genetic modification where the introduced traits/genetic material and the recipient organism are from the same 'species'. Even within this general framing, however, there is considerable room for interpretation, and a range of views as to:

- Whether all the genetic material used to introduce new traits to an organism is from within the species; and
- What is meant by species.

Creating new plant varieties via GM typically involves several components, including vectors (often a virus or bacterium), markers, promoters and the genes/genetic material that will express the desired traits. The sourcing of these biological components is where the scope for glossing over biological distinctions arises (as further discussed in section 5). Some developers, for instance, hold that the source of genetic material for vectors or promoters is of no import in cisgenics and maintain that the term refers solely to the origin of the introduced DNA.

To distinguish their work from other cisgenic concepts, Plant and Food scientists label their approach 'intragenics'. According to the CRI, cisgenics does not leave the species barrier entirely intact because foreign DNA may still be used to construct the vectors that transfer DNA to a host organism and thus leave "small 'footprints'" of the genetic modification process. Intragenics, Plant and Food scientists claim, would leave no such traces because the vectors used are also formed from within the species.[3] By this account, intragenics is the full realisation of the aim to leave the species barrier intact, while cisgenics represents a delivery in part.[4]

Pastoral Genomics – which has trademarked the term cisgenics - is using DNA not found within the ryegrass genome in what it indicates is a transitional phase. We understand that the consortium intends to release cisgenic pasture grasses in the New Zealand environment only at the point that it has managed to genetically modify pasture crops without using foreign genetic material.

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[3] "The terms 'cisgenic' or 'cisgenesis' are often used to describe the transfer of intact cisgenes using standard vectors based on foreign prokaryotic DNA. These vectors are usually based on standard 'minimal' T-DNA vectors based on the minimal features of necessary for efficient plant transformation. Cisgenic plants produced using these approaches are still transgenic for small 'footprints' of DNA sequences such as T-DNA border regions, multiple cloning sites, and remnants of recombination sites. Nevertheless cisgenes could be delivered via intragenic vector strategies to circumvent the transfer of this foreign DNA". Conner T. 2009. "New Techniques for genetic modification of plants". Paper presented for the Future Food Symposium, December 2009.

[4] Further evidence of the moveable ground, a report commissioned by the Dutch Government defines intragenics as an intermediate position between transgenics and cisgenics. See Prins T W and E J Kok 2010. *Food and feed safety aspects of cisgenic crop plant varieties.* Report for the Dutch Ministry of Housing, Spatial Planning and the Environment.

Hushing the genes: "RNAi"

A further approach to engineering changes within an organism using *in vitro* techniques that has been grouped under the heading cisgenics/intragenics is often referred to as gene silencing' or RNAi (RNA interference), but is properly called "double stranded RNA-mediated gene silencing".[5] The Bio-Protection Research Centre, a Centre of Research Excellence located at Lincoln University, describes this technique as a research tool that may provide new pest control technologies and in particular:

> the development of a GM strategy that does not rely on the expression of novel proteins in crops, an issue that has resulted in much of the public and scientific concerns over the use of GM crops in agriculture.[6]

Plant and Food appears to be using so-called gene silencing techniques to develop tearless onions.[7]

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[5] Russell A W and R Sparrow. 2008. "The case for regulating intragenic GMOs", *Journal of Agricultural and Environmental Ethics* 21:153–181. In their assessment, Russell and Sparrow define intragenics as "the deletion or silencing of genes within an organism (endogenous genes), the ''up-regulation'' or ''down-regulation'' of endogenous genes, and the introduction of genetic elements from different varieties or strains of the same species or of related, sexually compatible species."

[6] http://bioprotection.org.nz/agri-biotechnology. Accessed November 9 2010.

[7] Crop and Food. 2008. "Tearless onion breakthrough in global spotlight". Media release, February 7 2008.

3. The Power of Positive Association

The market resistance to GM foods that spread through Europe, Asia and the Pacific in the late 1990s took the GM seed and food industry by surprise. By 1999, Deutsche Bank analysts pronounced GMOs "dead"[8] – a far cry from earlier predictions that GMOs would quickly pervade all areas of food production. The Bank forecast GM "going the way of the nuclear industry" and foresaw the development of a two-tier market, with a distinct GM-free supply chain. More than a decade on, GM foods continue to be a "pariah" in Europe, with opponents outnumbering supporters three to one in all European Union countries, according to European Commission's research released last year.[9]

Against this backdrop, market research commissioned by Pastoral Genomics has identified a possible communications strategy to gain market buy-in for its cisgenic products. Key to that approach is disassociating cisgenics from GM. The research found that 28% of respondents become more positive about cisgenics than transgenics when it is likened to traditional breeding:

> [Cisgenics] allows New Zealand scientists to bring together the best combinations of a plant's own genes – much like you could in a hybrid – only faster and more precise.[10]

A further piece of market research for the consortium found that bringing cisgenics into the comfort zone of conventional breeding techniques and conventionally bred plants engendered positive perceptions of cisgenic GM:

> Overall cisgenics is something that consumers perceive as natural and many of which have directly associated cisgenics with the term 'hybrid'. When this was investigated further, it was uncovered that hybrid is positively associated with the eco-friendly cars, therefore making cisgenics more attractive compared to products which have been the result of transgenic processes.[11]

These findings, Pastoral Genomics was advised, point to the "opportunity to further educate and drive the benefits to overcome the current negative associations of GE".[12]

AgResearch social scientists have also confirmed that "people are more comfortable with GMOs developed using cisgenics as opposed to transgenics when the concepts are clearly explained and compared to traditional breeding techniques."[13] In a

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[8] Deutsche Bank. 1999. *GMOs Are Dead.* August 21 1999.
[9] European Commission. 2010. *Europeans and Biotechnology in 2010. Winds of change?* Eurobarometer, European Directorate-General for Research.
[10] Perceptive. 2009. Quantitative Study. Obtained under the Official Information Act. Respondents were also then presented with the following scenario: "There is research underway that has the potential to create ryegrass and clover plants that are tougher during droughts, need less fertilizer but as just as, if not more, productive and when eaten don't produce as many greenhouse gases. If the grass and plants that a cow was grazing on had been intragenically modified, how would you feel about eating a steak from that cow?"
[11] Perceptive. 2009. GM/GE Perception Research. Obtained under the Official Information Act.
[12] Perceptive. 2009. GM/GE Perception Research. Obtained under the Official Information Act. The consultancy has recommended using "simple, straightforward messages to eliminate some of the fears associated with genetic modification". Perceptive. 2009. Quantitative Study. Obtained under the Official Information Act.
[13] Small B. 2004. 'Public perceptions about genetically engineered forage crops and resultant animal

subsequent survey, AgResearch sounded out views on cisgenics and transgenics in general (that is, not associated with any particular crop).[14] While only a third of respondents found cisgenics acceptable, this support for cisgenics (34%) was 18% higher than that for transgenics (16%).[15] The description of cisgenics given to respondents explained that this technology was a form of genetic engineering but that a scientific breakthrough now meant that no foreign DNA was involved.[16]

A 20% Gain from Spin

Opportunities to reinvent public opinion on GM through favourable descriptions of cisgenics have also been explored in Europe. A European Commission survey of public opinion on new technologies found that while attitudes to GM foods are entrenched and negative, support for cisgenic apples reached 55% - 20% higher than for transgenic apples (33%). The description of cisgenics that elicited a more favourable response did not clearly state that GM was involved, although it did refer to the artificial introduction of genes:

> Some European researchers think there are new ways of controlling common diseases in apples– things like scab and mildew. There are two new ways of doing this. Both mean that the apples could be grown with limited use of pesticides, and so pesticide residues on the apples would be minimal. The first way is to artificially introduce a resistance gene from another species such as a bacterium or animal into an apple tree to make it resistant to mildew and scab…. The second way is to artificially introduce a gene that exists naturally in wild/ crab apples which provides resistance to mildew and scab.[17]

Even then, however, levels of concern about the risks and artificiality of cisgenics are significant: 52% of respondents considered cisgenic apples to be fundamentally unnatural, 40% felt uneasy about them and the same number believed cisgenic apples to be risky.[18]

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products', from *New directions for a diverse planet, Proceedings of the 4th International Crop Science Congress 26 September to 1 October 2004,* Brisbane, Australia. As reported in Dunahay T G. 2010. *Is the Grass Always Greener? Issues Affecting the Adoption of Genetically Modified Pasture Grasses in New Zealand.* Ian Axford (New Zealand) Fellowships in Public Policy.

[14] Small B, *Interim Report: New Zealanders' Perceptions of Genetic Engineering 2009 including a Comparison with Surveys Conducted in 2001, 2003 and 2005.* AgResearch, July 2009.

[15] Whereas only 15.8% found "across species" transformation acceptable, and just 18.5% found 'within species" engineering using foreign vectors acceptable, support nearly doubled to 34.4% for "within species" using vectors from the same species.

[16] "Genetic engineering may be divided into two types. When a quality or characteristic, already naturally occurring in an organism, is either increased or decreased, using only genes contained in that species, the process is called "within species genetic engineering." When genes from a different species are transplanted into an organism to increase, decrease or introduce a new quality to the organism the process is called "across species genetic engineering." However, until recently, even within species genetic engineering required the use of a vector from a different species, usually from a bacterial origin, on which to transfer the genes of interest. A recent breakthrough by New Zealand scientists means that the vector used to transfer the genes of interest can also be derived from the same species. Using this technique a plant may be genetically engineered using only DNA from the same species – that is, the process does not require any foreign DNA**.** (original emphasis) Small B. 2009. *Interim Report: New Zealanders' Perceptions of Genetic Engineering 2009 including a Comparison with Surveys Conducted in 2001, 2003 and 2005.* AgResearch.

[17] European Commission. 2010. *Europeans and Biotechnology in 2010. Winds of change?* Eurobarometer, European Directorate-General for Research, p. 47.

[18] Ibid.

4. The Cisgenics Song Sheet

Pastoral Genomics' descriptions of cisgenics for lay audiences suggest that the recommended positive branding campaign has been taken up. A series of pitches it and other New Zealand cisgenic developers are using position the technology within the familiar zone of traditional breeding:

Pitch #1: "Cisgenics is not 'transgenics'"

The first step to position cisgenics in consumer-friendly territory is a redefinition of the term 'transgenic'. In purely technical terms, transgenics refers to *in vitro* techniques that transfer traits into an organism, irrespective of whether the introduced genetic material comes from the same species or an unrelated species. In the market place, however, "transgenics" is indelibly tagged with GM foods and it is for this reason that cisgenic developers are likely seeking distance. In the revised GM lexicon developers now promote, transgenics is exclusively *in vitro* engineering that involves crossing the species barrier, as genes from an unrelated species are introduced into another, unrelated species. Cisgenic GMOs, by this account, are not transgenic.[19]

Pitch #2: "Cisgenics is not GM"

A second semantic manoeuvre is to disassociate cisgenics from GM altogether. In confusing double-speak, Pastoral Genomics scientists have confirmed both that cisgenics is GM but that the technology comprises "GM approaches without GM outcomes".[20]

Equally confusing is AgResearch's reported descriptions of experimental cisgenic clover R+D, in which the R+D "may result in clovers which have not been genetically modified" while, at the same time, "the white clover would be genetically engineered, though only with genetic material from other clover species."[21]

Pitch #3: "Cisgenics is like traditional breeding"

A further move is to equate cisgenics with traditional breeding: a parallel that claims legitimacy from the fact that the two breeding methods are restricted to the same gene pool (at least, according to descriptions for lay audiences). "With the development of refined techniques for genetic modification of plants", states Plant and Food, "there is

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[19] See, for example, Crop and Food Research, "Germplasm enhancement team", Infosheet No 1-7, 2004. This redefinition of transgenics has been promoted by Royal Society of New Zealand: "The process of *cisgenetic* (or *intragenic)* modification involves manipulating genetic material only from the species being transformed. When genes are sourced from a different species, the process is known as *transgenic.*" (Royal Society of New Zealand. 2010. "Genetically Modified Forages. Emerging Issues")

[20] Hanley Z. 2008. "GM approaches without GM outcomes", May 1 2008. http://bit.ly/ixguSB.

[21] NZPA. 2010. "AgResearch to go offshore for GE clover", June 16 2010. Technically, there is no question that cisgenics is a form of GM. As Professor Jack Heinemann sets out, "a genetically engineered organism is, or is related by descent to, an organism that contains nucleic acids (e.g. DNA, RNA) that have been released from their natural physiological conditions into a test tube and then forced in some way back into a cell or virus. The point is that these genes are taken out of a cellular context and inserted back, not that they derive from a particular genome". Heinemann J. 2010. " Are some scientists just taking the cis out of genetic engineering? Pt I", *Sciblogs*, Guest Work, February 11 2010. http://bit.ly/d1G5P1. Also see: De Cock Buning T, Lammerts van Bueren E T, Haring M A, de Vriend H C and P C Struik. 2006. Correspondence, *Nature Biotechnology*, Correspondence, 24(11):1329-1331.

no longer a clear *biological* distinction between traditional plant breeding approaches and genetic modification."[22] (emphasis added)

In some accounts, cisgenics is an advance in conventional breeding. Officials have adopted this perspective and have told the Minister of Agriculture that "cisgenic modification is a more precise version of traditional animal or plant breeding approaches"[23], while a briefing by the Prime Minister's Science Advisor describes cisgenics as "a more targeted version of traditional animal or plant breeding" and so offers the executive a description that is apparently politically unthreatening when it remains the GM political hot button.[24]

Pitch #4: "Cisgenics is natural"

The next step in distancing cisgenics from the artificial environment of *in vitro* plant modification is its "naturalisation". The cisgenic developer, so this line goes, is not doing anything that nature would not do. Pastoral Genomics, for example, explains that because cisgenic organisms involve the transfer of genes within species that could hybridise in nature, the technology is "[n]ature assisted plant improvement".[25] The consortium reaches for hyperbole to communicate this. Cisgenic ryegrasses are purer than nature: they are "101% ryegrass"[26].

101% Ryegrass

Pastoral Genomics' depiction of cisgenics

Pastoral Genomics. 2008. *GM approaches without GM outcomes.* http://bit.ly/ixguSB

Pitch #5: Cisgenics respects whakapapa

Perhaps the most audacious PR manoeuvre yet is the claim that cisgenics is a technological response to the specific cultural realities of this country. Pastoral Genomics has cast the technology's claimed genetic integrity as an act of respect for "whakapapa and Maori issues, the lifeforce issue that's specific to New Zealand".[27]

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[22] Conner T. 2009. "New Techniques for genetic modification of plants". Paper presented for the Future Food Symposium, December 2009. http://bit.ly/kQdNNS.
[23] MAF. 2009. Briefing on Cisgenics for your Meeting in October 14 2009. Briefing to the Minister. Obtained under the Official Information Act.
[24] Gluckman P. 2009. A memorandum to the Prime Minister, Hon Dr Nick Smith, Hon Mr David Carter, Hon Dr Wayne Mapp, Department of Prime Minister and Cabinet. Office of the Prime Minister's Science Advisory Committee. Obtained under the Official Information Act.
[25] Hanley Z. 2008. "GM approaches without GM outcomes", Pastoral Genomics Presentation, May 1 2008. http://bit.ly/ixguSB.
[26] Ibid.
[27] Dunbier M. 2010. Comments during the RSNZ Media briefing on GM forages (unofficial transcript). March 2 2010. http://bit.ly/9OOvZo.

The Difficulty of Reading Between the Lines: Descriptions to Pastoral Farmers

Pastoral Genomics' R+D is half funded through levies collected by Beef and Lamb NZ and Deer Industry NZ, as well as through Fonterra. However, farmers may not be aware of the fact or even the extent to which GM pasture grass features in Pastoral Genomics research. Producer board reports the Sustainability Council has viewed describe the consortium's research in generic or opaque terms and none explicitly state that development of GM pasture grasses is a primary target of the research programme.[28]

Beef and Lamb New Zealand: None of the documents available on the association's website that mention Pastoral Genomics explicitly state that its programme involves development of GMOs:

- Annual reports from 2007-2009 describe the R&D as involving marker-assisted biotechnologies and
  - "breeding technologies to deliver better clover and hybrids to New Zealand, devising ways of accessing the wider variety of traits for improved performance" (2007),
  - "understanding the ryegrass and clover genomes" (2008) and
  - "developing new forages that perform better and have a smaller environmental footprint" (2009).[29]
- A 2009 review of BLNZ funded R+D projects casts the programme as "us[ing] biotechnology *(*e.g., *marker-assisted breeding)* to develop commercial cultivars that provide higher levels of productivity through traits that are assessed more consistently than would otherwise have been possible through conventional breeding methods." (emphasis added)[30]
- The 2009 statutory consultation required to establish a new, six-year mandate for the organisation frames the programme as "forage improvement through biotechnology" which will lead to "[p]lant genetic gains for clover from increased persistence, increased biomass and drought tolerance and for ryegrass increased water soluble carbohydrates and increased biomass".[31]
- On the organisation's website, the Pastoral Genomics programme is described as using "appropriate plant biotechnologies to improve the productivity, sustainability and quality of New Zealand forages"[32].

DairyNZ: In a 2008 "Levy Issue" newsletter to members, DairyNZ describes the Pastoral Genomics programmes as "the testing of new plant traits and production systems that will:

- increase intake and animal performance per kg DM eaten (e.g. brittle fibres)

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[28] Search of Beef and Lamb NZ, Deer Industry NZ and Dairy NZ websites using the terms "Pastoral Genomics" and "cisgenics" (January 2011). Other documents we are not aware of may make plain that commercial GM varieties are an intended outcome of the programme.
[29] Respectively: New Zealand Meat Board, *Annual Report, 2006-2007*; Meat and Wool New Zealand, *Annual Report 2008-2009*; and Beef and Lamb New Zealand, *Annual Report 2009-2010.* Cisgenics is mentioned, but not explained, in the first of these.
[30] Nimmo Bell. 2009. *Strategic Programme Evaluation. Summary of twelve projects.* A report prepared for Meat and Wool New Zealand.
[31] Meat and Wool New Zealand. 2009. *Your Industry, Your Future. Consultation 09.*
[32] http://www.beeflambnz.com/main.cfm?id=360#433

- improve drought tolerance
- give animals a better balance between energy and protein, leading to less environmental impact."[33]

Deer Industry New Zealand's annual report of 2007/8 gives no indication that GM pasture crops are a major focus of the R+D effort. In this description, the goal of the consortium is simply to "improve the biomass production of clover and ryegrass forages and improve drought tolerance and quality."[34]

Producer boards are not alone in being light on detail about what cisgenics entails. **New Zealand Trade and Enterprise's** announcement of the grant to PGG Wrightson for the Gramina venture was also opaque about the extent to which GM features in the sponsored programme. Instead, NZTE drew attention to the hoped-for product: "a new kind of grass that will reduce cattle burps, improve productivity, and help dairy farmers prepare for climate change."[35]

The ultimate compliment to the spinmeisters has however been delivered by the regulator, ERMA. On at least one occasion, it appears to have uncritically absorbed and replicated the language forged by developers. In its newsletter for Maori communities, ERMA repeatedly describes cisgenics GMOs as having "no new genes" and states that cisgenic plants "to all appearances (physically and genetically), look more like the result of breeding than of genetic engineering".[36] The article also recites wholesale other PR pitches such as "nature-assisted plant improvement".

[33] Anon. 2008. "Informing your feed decisions", *Dairynews* Levy Issue, 2008, p. 17. Descriptions in the annual reports, if not specific, imply that GM may be included in the research ("us[ing] modern biotechnology approaches to develop new ryegrass and clover plants that are more productive and persistent") but later characterizes the programme as "finding and breeding plants with greater drought tolerance". DairyNZ. 2010. Annual Report 2009/10, pp. 17 and 19 respectively.
[34] Deer Industry New Zealand. 2008. *Annual Report 2007-2008.*
[35] New Zealand Trade and Enterprise. 2008. "New grasses for a new climate?" Media release, April 1 2008.
[36] ERMA. 2008. Genetically modifying plants without using new genes. *Te Pütara* 13, p. 6.

5. Science Fictions and Dysfunctional Families

Underlying the messaging to lay audiences is a proposition that has an appealing simplicity: risk in creating new plant varieties arises exclusively from the source of biological material. That is, the "genetic proximity" of the donor DNA and the host organism defines the risk.

By keeping GM "in the family", cisgenic developers imply, only minor changes and therefore 'natural' and 'safe' modifications occur. Thus, Plant and Food presents intragenics as a gentle method for the development of new crops that brings about "a *minor* rearrangement in plant genomes" (emphasis added)[37] while Pastoral Genomics claims that "no new genes" have been introduced.[38]

The focus on biological sources also emboldens some developers to assert the neutrality or even the safety of the technology used to move genetic material from one organism to another. In a flourish of designer logic, Plant and Food concludes that because similar types of new plant varieties could be achieved through traditional breeding, this "reinforces the concept that there is nothing inherently unsafe with GM technology".[39]

The Royal Society Scheme

The Royal Society has been somewhat more cautious about the proximity theory, noting that cisgenics "*may appear* to conform more to the "natural order" of species isolation" (emphasis added), and that the scope of rearrangement of genetic material within an organism is limited by the source of genetic material, while noting, albeit faintly, that there are other views within the science community about such assertions.[40] Nevertheless, the scheme it provided (drawing upon one developed by Pastoral Genomics scientists[41]) that sets out breeding techniques and source of donor genetic material suggests the proximity argument to the reader and an alignment of cisgenics with conventional breeding.

Categories	**Source of new genes**	**Potentially achievable with conventional breeding?**	**Genetic distance**
Cisgenic	From species genome	Yes	Low
Famigenic	Species in the same family	Maybe	
Transgenic	Unrelated species	No	
Xenogenic	Synthetic genes	No	High

[37] Conner T. 2008. "The changing nature of GM crops". http://bit.ly/kS97hl.
[38] Hanley Z. 2008. "GM approaches without GM outcomes". Pastoral Genomics Presentation, May 1 2008. http://bit.ly/ixguSB.
[39] Conner T and J Jacobs. 2005. "Genetic engineering of crops without foreign DNA". *NZBio Newsletter*, Feb/March 2005, p. 20. In Europe, researchers surveying European public opinion on GM describe cisgenics as "technolite" or even as "biotechnologically informed 'green fingers'" although cisgenics uses identical techniques to other forms of GM. European Commission. 2010. *Europeans and Biotechnology in 2010. Winds of change?* Eurobarometer, European Directorate-General for Research.
[40] Royal Society of New Zealand. 2010. "Genetically Modified Forages. Emerging Issues". March 2010, p. 3.
[41] Elborough K M and Z Hanley. 2004. "Pasture Biotechnology – not as you know it". Proceedings of the New Zealand Society of Animal Production 2004, Vol 64, pp. 101-104.

While it makes for an appealing story, the genetic proximity theory is somewhat of a biological fiction.

Firstly, the definition of species is not 'watertight' and is the subject of ongoing discussion within biology.[42] This definitional fluidity allows cisgenic developers potentially wider scope for sourcing new traits than popular understandings of 'species' might entertain. Indeed, much cisgenic activity may take place in the blurred zone which is the species barrier. Some commentators, for example, suggest that the material may come not only from the same species, but also from "a crossable donor plant" – that is, another species, but one "at least genetically close enough to make natural crosses possible."[43]

Even the source of DNA within a naturally occurring organism might surprise lay understandings and give developers licence to a wider range of options than would at first be expected. Genetic material found in any plant may originate from another, wholly unrelated species such as a virus or bacteria. For example, *agrobacterium* is a soil organism that has a symbiotic relationship with certain classes of plants and can be found in their genomes.[44] It is also routinely used to develop transgenic GMOs.[45]

Further, cisgenic engineers may be restricted in the source of genetic material, yet the scope for rearrangement of that material is wide. Indeed, cisgenic techniques allow for genetic material from within the same species to be so significantly rearranged that the result could be genetic constructs and traits equally as foreign as when donor DNA from outside the species is used. Professor of genetics and molecular biology at Canterbury University, Jack Heinemann, states:

> The cisgeneticist is confined to no minimum string length for manipulation and thus, from the raw building blocks common to all genomes, can create strings just as "foreign" to that same genome as any that came from a different species. Any gene from a human being could be rearranged to become 2%, 50% or 70% different from itself and as different as the average gene from a human was to the average gene from a single-celled soil microorganism.[46]

The source of novelty and therefore risk, as he explains, is the "changing the order of nucleotides in an existing genome that has historically been under physiological control and which we have millennia of interactions with."[47] As such, the rearrangements in Plant and Food's current experimental lines of cisgenic potatoes

[42] Prins T W and E J Kok. 2010. *Food and feed safety aspects of cisgenic crop plant varieties*. Report for the Dutch Ministry of Housing, Spatial Planning and the Environment. Also see: Heinemann J, "Are some scientists just taking the cis out of genetic engineering? Pt I". *Sciblogs,* Guest Work, February 11 2010.
[43] Struik P and E Lammerts van Bueren. 2010. "Why organic farmers should resist the temptations of cisgenesis". *Innovative Science: Agriculture and Food Edition* 1:15-20.
[44] See, for example, Prins T W and E J Kok. 2010. *Food and feed safety aspects of cisgenic crop plant varieties*, p. 13.
[45] Ibid. Also see Schubert D and D Williams. 2006. "'Cisgenic' as a product designation". Correspondence. *Nature Biotechnology* 24:1327-1329.
[46] Heineman J. 2010. "Are some scientists just taking the cis out of genetic engineering? Part 2: If it looks like a duck and it quacks like a duck, it probably is a duck", February 12 2010. http://sciblogs.co.nz/guestwork/2010/02/12/are-some-scientists-just-taking-the-cis-out-of-genetic-engineering-pt-ii/
[47] Barton C, "Hopes pinned on GM milk", *New Zealand Herald,* April 3 2010.

could lead to potato varieties just as 'foreign' or novel as the CRI's earlier, controversial potatoes engineered with toad genes.

Finally, because cisgenics – like transgenics – relies upon the random and uncontrolled insertion of new genetic material into an organism's genome, this new type of GM is susceptible to the same technological limitations and drawbacks that other types of GM encounter, including:

- Insertional mutagenesis, which occurs when the insertion of the new genetic material disrupts one or more of the organism's own genes (effectively causing a mutation in a resident gene).
- Instability of the introduced genetic material, especially in subsequent generations, due to: (1) a genome's natural defense mechanisms against inserted genetic material from any source; (2) the likelihood of unequal crossover occurring during breeding (since the introduced gene usually contains one or more repeats of itself).
- Linkage drag: deleterious effects caused by GM insertions cannot be removed by breeding for the added trait because they are genetically linked to the inserted gene.[48]

Indeed, the notion that cisgenics is inherently innocuous because the sourcing of genetic material is kept "within the family" defies biosafety understandings.[49] Biosafety issues that accompany *in vitro* engineering processes cannot be 'defined away', as Dutch commentators argue, simply because the introduced genes are from within the same species:

> Juiciness, enhanced taste, color, pest resistance and improved storability or processing quality are novel traits compared with the traditional crop, but the moment that the traits originate from a "closely related species", these potentially 'risky' novel genotypes are defined away as safe cisgenic plants without possessing an 'extra trait'. Extra traits, novel genotype or just novelty are not well defined and tend to serve the needs of the one who hijacks them.[50]

Similarly, the idea that cisgenic organisms pose no risk because of the source of genetic material is not defensible, according to a review commissioned by the Dutch government:

> cisgenic plants cannot be assessed on the basis of reduced data requirements only because of a relatively 'safe' choice of the inserted gene alone. Other factors like method of insertion, place of insertion and possible accompanying (unintended) changes in the genome and physiology of the recipient plant should be taken into account. The exact data requirements will have to be determined on a case-by-case basis, as is the case for transgenic GM crop varieties.[51]

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[48] Schubert D and D Williams. 2006. "'Cisgenic' as a product designation". Correspondence. *Nature Biotechnology* 24, p. 1328.
[49] De Cock Buning T, Lammerts van Bueren E T, Haring M A, de Vriend H C and P C Struik. 2006. Correspondence. *Nature Biotechnology* 24(11), p. 1330.
[50] Ibid.
[51] Prins T W and E J Kok. 2010. *Food and feed safety aspects of cisgenic crop plant varieties.* Report for the Dutch Ministry of Housing, Spatial Planning and the Environment.

6. A Bid to Duck the Regulatory Radar

Parallel to PR strategies that seek to distance cisgenics from GM in the marketplace, developers want cisgenic GMOs to be classed as non-GM in law. Developers are not widely publicising their efforts to have cisgenics excluded from HSNO in lay publications. However, it has been observed that, internationally, cisgenic approaches appear to hold appeal for some GM scientists because the technology 'invents around' existing regulatory scrutiny of GM products, thus locating the technology beyond the regulator's reach.[52]

Plant and Food has been the most vocal for "regulatory escape" by way of cisgenics and is evidently confident that lobbying efforts will be successful: it has forecast that regulatory compliance costs will be "minimized" for cisgenic organisms.[53]

The regulatory 'out' is justified, according to the CRI, because "there is no longer a clear biological distinction between traditional plant breeding approaches and genetic modification". It further claims that intragenic organisms pose a fundamental challenge to regulators because "[t]here is no longer a clear point of demarcation on which to base a legal definition of genetic modification which has biological relevance and is enforceable by law."[54] Even tracking cisgenic organisms in the field and in the marketplace is claimed to be difficult because they are "indistinguishable from their conventional counterparts or natural variants and cannot be detected to be the result of genetic modification", the CRI contends (discussed in greater depth in our briefing, *Hide and Seek: New Zealand developers skirt around detectability of cisgenic GMOs*).[55]

Pastoral Genomics has also made known to the Government that it wants cisgenic GMOs to be exempt from HSNO scrutiny. This, although it declares it has not adopted cisgenics as "a way of getting around the regulations".[56] On at least three occasions in 2009, the consortium approached Cabinet ministers to press for "relaxation of the HSNO requirements" for cisgenics.[57] The consortium presented ministers with several reasons for this. Firstly, cisgenics was not GM, it claimed.[58] Secondly, HSNO was created before cisgenics came into being and while cisgenics

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[52] Russell A W and R Sparrow. 2008. "The case for regulating intragenic GMOs", *Journal of Agricultural and Environmental Ethics* 21, p. 173.

[53] Crop and Food. 2004. "Precision breeding: a new genetic technique providing international opportunities for crop improvement". Media release, November 16 2004.

[54] Conner T. 2009. "New Techniques for genetic modification of plants". Paper presented for the Future Food Symposium, December 2009.

[55] Conner T. 2009. *New techniques for genetic modification of plants.* An internal report prepared for: The New Zealand Institute for Plant & Food Research Limited. http://bit.ly/kQdNNS.

[56] Dunbier M. 2010. Comments during the RSNZ Media briefing on GM forages (unofficial transcript). March 2 2010. http://bit.ly/9OOvZo.

[57] The consortium met with the Minister of Agriculture in February 2009; with the Minister for the Environment in March; and again with the Minister of Agriculture in December that year (MfE. 2009. Status Report, Minister for Environment, Minister for Climate Change, Week beginning March 9 2009). In a briefing note for the Minister for the Environment, the consortium announced it sought "clarification from Government of their intentions towards the future regulatory regime for cisgenic plants" (Pastoral Genomics. 2009. Briefing for the Minister, [February 2009]. Obtained under the Official Information Act)

[58] Ministry for the Environment, Email May 4 2009. Obtained under the Official Information Act.

might technically be GM, it had such a different risk profile to transgenics that it was "likely to raise fewer social, ethical or cultural issues"[59] and therefore did not warrant the same regulatory scrutiny.[60] Finally, it argued, the HSNO regime was having a chilling effect on research, would add around four years to the development path and, ultimately, did "not favour progressing [Pastoral Genomics'] work in this country."[61]

Policy campaigns by GM developers have routinely portrayed HSNO as stifling innovation.[62] It is therefore encouraging that some officials and the Minister for the Environment, at least, were not wholly moved by the consortium's arguments.[63] Officials observed that cisgenics was not an unforeseen casualty of the HSNO regime (the technology had been identified by the Royal Commission on Genetic Modification); that the HSNO assessment process would likely favour the application if cisgenic ryegrasses indeed raised fewer concerns.[64] They also noted that negative public opinion and the possibility of a legal challenge to an approval (rather than regulatory compliance costs) were of greatest concern for most GM developers.[65]

The Minister for the Environment also noted the political risks from any attempt to water down the regulatory regime. He informed Pastoral Genomics that "an attempt to short-circuit or bypass the regulations by changing them to suit would be likely to politically backfire (for the Government and developers) and undermine the aim to get a more science-based focus on the GM debate."[66] Nor would he move to change the Act unless there was evidence that it was unworkable.[67] MAF officials similarly warned their Minister that deregulation would be seen as a "'back door' mechanism to impose GM on New Zealanders without the risks or the public's views being considered".[68]

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[59] As reported by officials (Ministry for the Environment. 2009. Status Report, Minister for Environment, Minister for Climate Change, Week beginning March 9 2009).
[60] Ministry for the Environment. 2009. Status Report, Minister for Environment, Minister for Climate Change, Week beginning March 9 2009.
[61] Ministry for the Environment. 2009. Meeting with Pastoral Genomics: Tuesday March 29 2009. Briefing for the Minister, March19 2009.
[62] In its now abandoned bid to gain a conditional release approval for its GM pasture grasses, AgResearch similarly claimed that regulatory regime was a barrier to pursuing such activities in New Zealand although, as discussed later, acceptance by the rural community as well as urban New Zealanders, among others, is probably the single greatest barrier the CRI faces. See for example, NZPA. 2010. "AgResearch to go offshore for GE clover", June 16 2010.
[63] The Minister for the Environment's office initially questioned the need for a meeting with Pastoral Genomics, stating that there was nothing the Minister could do to change the law and that the consortium would simply have to follow due process. Email from the Minister for the Environment's Office to the Minister of Agriculture's Office, March 6 2009.
[64] Ministry for the Environment. 2009. Meeting with Pastoral Genomics: Tuesday March 29 2009. Briefing for the Minister, March19 2009; Email from the Ministry for the Environment to the Minister of Agriculture's Office, summarising the outcomes of the meeting with PG and Nick Smith, March 25 2009.
[65] Despite statements that suggest officials would not be swayed by the consortium's arguments for deregulation, Ministry for the Environment officials were to consider whether a "different policy approach" was warranted (a policy brief that they recognised could be quite controversial) Email from a Ministry for the Environment official, May 4 2009.
[66] Email from the Ministry for the Environment to the Minister of Agriculture's Office, summarising the outcomes of the meeting with PG and Nick Smith, March 25 2009.
[67] Ibid.
[68] Ministry of Agriculture and Forestry. 2009. Briefing on Cisgenics for your Meeting in October 14 2009.

Some time after meeting with the Minister for the Environment, the consortium appears to have changed its view about whether HSNO is too restrictive.[69] Nevertheless, the deregulation agenda has not entirely dissipated. Pastoral Genomics late in 2009 continued to lobby the Minister of Agriculture for sweeping changes to the GM regulatory regime. In particular, the Australian approach to regulation of GMOs was praised as superior and it was argued that New Zealand's regime should be brought in line with that across the Tasman. This would involve removing consideration of the economic and social risks or benefits of GMO varieties.

[69] Minister for the Environment to Pastoral Genomics, (no date). In the draft letter obtained under the Official Information Act, the Minister noted: "I am gratified that it appears you now consider that New Zealand's regulatory requirements for approval under the Hazardous Substances and New Organisms Act 1996 may indeed not be as onerous as you feared when we talked."

7. A Very Partial Engagement with the Public

Developers offer cisgenics as a reformed technology: consumers have spoken, the R+D community has listened, and have adjusted GM accordingly. Pastoral Genomics attributes its adoption of cisgenics to public rejection of other types of GM and describes its cisgenic programme as an attempt "to learn from objectors to genetic engineering and farmers, to redefine its direction"[70]. The new GM strategy is "designed to address some of the major objections made by the general public to GE technology".[71] Plant and Food, meanwhile, states that cisgenics "does not raise the ethical concerns usually associated with the GM debate"[72] and that cisgenic/intragenic GM is "a socially acceptable and responsible way forward for the transfer of genes"[73]. PGG Wrightson is more confident yet. The company "[doesn't] see any downstream issues at all".[74]

Market surveys and social science research identify a number of deeply held concerns about GM foods and the GM industry. In addition to anxiety about crossing the 'species barrier', long-term environmental impacts, potential health effects, trade and national identity and branding considerations, consumer right-to-know and consumer choice are frequently identified. Lack of trust in GM developers, a sense that the industry was not being 'upfront' and that consumers have been "'part of an experiment' without having given consent" are also recurring themes of direct relevance to the GM developers seeking a new found acceptance and trust from consumers.

In New Zealand, multi-year research by Lincoln University's Agribusiness and Economics Research Unit (AERU) identified that:

- GM research has "an air of secrecy about it that breeds mistrust" and that "[i]n order for scientific and government institutions to be trusted the research process should be rendered more transparent."[75]
- Public skepticism about science is such that "New Zealand science must address issues of integrity, trust and purpose in new technology developments and communicate these with the public."[76]

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[70] Mountfort M. 2004. "Ryegrass R&D: Lateral look at gene technology", *NZ Dairy Exporter,* August 2004.
[71] New Zealand Dairy Board, ViaLactia Biosciences Ltd and Dexcel Ltd. 2001. Submission to the FRST Plant Gene Technology Review 2001.
[72] Conner A J, Barrell P J, Jacobs J M E, Baldwin S J, Lokerse A S, Ashby J W and J P H Nap. 2004 *Intragenic vectors for developing non-transgenic GM plants.*
[73] Jacobs J M E, Baldwin S J, Lokerse A S, Barrell P J, Nap J P, Conner A J. 2005. "Intragenic Vectors For Developing GM Plants Without Foreign DNA" Abstract, *Plant & Animal Genomes XIII Conference* January 15-19, 2005.
[74] PGG Wrightsons. 2003. Application to the Australia New Zealand Biotechnology Partnership Fund.
[75] Fairweather J, Campbell H, Hunt L and A Cook. 2007. *Why do Some of the Public Reject Novel Scientific Technologies? A Synthesis of Results from the Fate of Biotechnology Research Programme*. Lincoln University Agribusiness and Economics Research Unit, p. 26.
[76] Fairweather J, Campbell H, Hunt L and A Cook. 2007. *Why do Some of the Public Reject Novel Scientific Technologies? A Synthesis of Results from the Fate of Biotechnology Research Programme*. Lincoln University Agribusiness and Economics Research Unit, p. 19.

- The type of information available to consumers is key: "The lack of information *of the type they wanted* played a part in the dominant concern and distrust about the role of business in biotechnology products", according to AERU. (emphasis added).

Hortresearch's investigations reveal a similar picture. Dominant concerns amongst those it surveyed included:

- Lack of choice and control over consumption of genetically modified food, due to the lack of labelling regulations, and the resulting perception of being 'part of an experiment' without having given consent.
- The perceived monopoly big businesses have over the distribution of information, and policy/regulation formation, and hence the perceived lack of regulations and objective information available to the consumers. This adds to consumers' beliefs that they have no control over what they purchase and consume.[77]

AgResearch social scientists also found that even for "conditional supporters" of GM products (those who might support some types of GM, dependent on the benefits), "autonomy of choice" is critical. As ability to choose is facilitated by regulation, skirting around regulatory scrutiny is not advisable:

> Attempts to avoid these conditions by government policy makers and biotechnology companies will likely result in increased distrust and further strengthening of beliefs and attitudes strongly related to increased resistance to GE food technology".[78]

More recently, research commissioned by Pastoral Genomics established that irrespective of whether they would willingly eat products from animals reared on cisgenic feed, a majority of respondents wished to know whether GM was involved.[79] Honesty and transparency are baseline to building consumer confidence:

> Being open and honest about what is contained in food will add to consumer confidence and give people the information they need to make an informed choice. If consumers feel they have been deceived, then their level of trust in the product and brand, company and towards genetic modification as a whole, will be affected.[80]

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[77] Gamble J, Muggleston S, Hedderley D, Parminter T and N Richardson-Harman. 2000. *Genetic Engineering: the public's point of view*, pp. 14-15.
[78] Small B, Wilson J and T Parminter. 2002. "New Zealanders' Beliefs and Attitudes towards Genetic Engineering: Final Report and Interpretation." AgResearch Client Report.
[79] "Irrespective of foods being natural or cisgenically modified, consumers would still like to know prior to consumption". Perceptive. 2009. GM/GE Perception Research. Obtained under the Official Information Act.
[80] Perceptive. 2009. Quantitative Study. Obtained under the Official Information Act.

8. The More it Changes, the More it Stays the Same

The message from consumer research is clear: to the extent that rehabilitation of GM foods in the market is at all possible through cisgenics, a key issue will be restoring consumer trust in developers and the 'GM agenda'.

Remarkably, the consistent theme of consumer surveys - transparency around the use of GM - appears to have gone unheeded by New Zealand developers. The spin that is being scripted to communicate cisgenics to consumers suggests that developers have taken on little of the public's concerns about GM foods, despite a considerable body of research to draw upon. It also suggests that the claimed reform of the GM agenda is cosmetic and convenient. This, for a technology that has emerged as the most significant strand of New Zealand's state-funded programmes to develop GM foods and feed.

Indeed, developers seem to be operating on identical presumptions to those that generated the first generation of GM foods:

- The belief that consumer concerns are unjustified and can be overcome if the consumer is presented with sufficient information explaining the technology and presenting the benefits (the so-called 'deficit model')[81]; and/or
- By tailoring descriptions of the technology to pacify consumers, issues of social acceptability will be solved.

Ultimately, little has changed in messaging with the transition to cisgenics. Pastoral Genomics has been recruiting GM proponents to drum into New Zealanders that GM is just like traditional breeding – a line developed for transgenics and now being used for cisgenics. Earlier this year, US plant scientist Pamela Ronald was reportedly sponsored by Pastoral Genomics to come to New Zealand. And the message she brought will be familiar: "Everything we eat that is farmed is genetically altered. […] It is just the result of a long line of 10,000 years of gene manipulation."[82]

The confidence expressed by developers and supporters that cisgenics will "put a new complexion on the GM debate" and open up "a possible entrée via cisgenics into New Zealand rather than with transgenics" seems misplaced.[83] Instead, as Jack Heinemann observes, cisgenics looks set to become "just another symptom of a troubled public science system that increasingly is packaging public persuasion in the guise of dialogue".[84]

Pleas for regulatory lenience and semantic manoeuvres that make GM vanish from the picture may seem to offer a shortcut to the marketplace but cisgenic foods could well encounter a similar market response at the point it becomes known that developers are being less than transparent.

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[81] The bulk of GMOs currently produced in the US and Canada are used domestically for animal feed.
[82] Ronald P. 2011. "Forbidden Fruit: Genetically Engineered crops in New Zealand". April 4 2011. http://bit.ly/h6Na3S. Morgan J. 2011. GE - 10,000 years in the making. *Dominion Post* March 28 2011.
[83] Respectively: Barton C. 2008. "Potato pioneer stuck in field trials", *New Zealand Herald,* November 29 2008; and Stephen Goldson. 2010. Transcript of RSNZ Media briefing on GM forages, March 2 2010. http://bit.ly/9OOvZo.
[84] Heinemann J. 2010. "Are some scientists just taking the cis out of genetic engineering? Pt II", Guest Work, *SciBlogs*, February 12 2010. http://bit.ly/d1G5P1.

Being socially responsible demands transparency and accountability. This reasonably involves providing sufficient information to allow consumers to make an informed choice and for the products to be publicly assessed for their fitness, and under provisions that allow for monitoring and tracking if released into the environment.

By definition, social acceptability is not determined by developers, but by the wider community. The test of the acceptability of cisgenic products is not whether they will be tolerated because their method of manufacture has been glossed over, or because they evade regulatory scrutiny. Rather, the real test is whether the public chooses to consume cisgenic food products, in full knowledge of how they came to be.