

New Zealand GM Pasture Grass R+D

Three Programmes and a New Technology

Summary

- Tens of millions of public science dollars have been directed to the development of GM pasture species in New Zealand over the last two decades.
- Two major New Zealand-based programmes are seeking to develop a range of GM pasture grasses engineered to tolerate drought, increase biomass, increase water and nitrogen efficiency, and improve the nutritional content of forage species such as ryegrass and clover.

Pastoral Genomics

- Pastoral Genomics is a consortium comprised of Beef and Lamb New Zealand, Fonterra, DairyNZ, Deer Industry NZ and AgResearch. It was formed around 2003/4 to advance research initiated by the Dairy Board under its research arm, Vialactia.
- Development of GM grasses is a major focus of the consortium's R+D. Other research strands include sequencing of the ryegrass genome and the development of pasture grasses through a non-GM technique - marker-assisted selection (MAS).
- Up to \$126M has been invested in the programme and the precursor research begun in 1999 under the Dairy Board. Since 2004, Government has provided matching funding through the Foundation for Research Science and Technology (FRST).
- There is scant publicly available information on the weighting of resources devoted to the different research lines. However it was reported in 2009 that around \$3.7M (half of annual funds) would be directed to the development of GM grasses each year until 2014.
- Since those figures were reported, Pastoral Genomics has indicated that there has been a shift in funding that slightly favours developing new pasture varieties through the non-GM MAS technique. Nevertheless, generating commercial GM pasture grasses remains a primary target for the consortium.

AgResearch

- AgResearch has stated that (through parallel but separate research) it intends to become "the main provider of plant transformation technology for multiple gene traits in New Zealand". Traits that the CRI is hoping to engineer into pasture grasses include better digestibility, nitrogen efficiency (through high sugar content) and "high energy".

- Current funding levels for this programme are uncertain as the CRI has either refused to disclose the level of public science funding directed to GM grasses or has sought substantial fees for this. However, the Sustainability Council has identified a number of FRST-funded programmes that are either wholly dedicated to the development of GM grasses or may contain a GM component.
- Although the exact proportion of the more than \$44 million that has been spent in the last decade and a half on this programme is unclear, it is a large public science investment under any reasonable split.

PGG Wrightson and the Gramina Joint Venture

- Research for a third GM grass programme by New Zealand entities is being undertaken in Australia. PGG Wrightson is seeking to bring GM ryegrass to market through a partnership with an Australian research centre. The Gramina venture, which has received at least \$5 M in grants from New Zealand Trade and Enterprise, is targeting similar traits to Pastoral Genomics and AgResearch (such as drought tolerance) as well as others including 'low allergy' grasses.

Enter GM Mark II

- Common to all three programmes is an interest in a new variation on GM. Cisgenics uses standard GM techniques to engineer plants but, according to developers, without mixing genetic material from unrelated species. This, it is hoped, will improve the chances of market acceptance for GMOs. AgResearch's exploration of cisgenics is however limited to clover in its GM pastures programme.
- Plant and Food is also positioning to make food crops using cisgenics, and the CRI says it is ready to engineer a range of species – such as apples and potatoes - using this GM technique.

Progress

- By and large, delivery of commercial GM varieties from these programmes is well behind initial projections. Pastoral Genomics GM research is now at least a decade behind schedule. Thus considerably more funds will be needed to bring varieties to market.
- In 2009, Pastoral Genomics and AgResearch were both poised to seek approval for conditional releases of two GM lines (a 'drought tolerant' ryegrass and a high energy grass). However, those plans have been suspended, apparently because it became clear that much more work was required to make the case for such activities. A decision on progressing at least one of the applications is required in the next year.

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New Zealand's GM Pasture Grass R+D

Despite persistent consumer resistance to GM foods in New Zealand's key markets, tens of millions of public science dollars are being directed to the development of GM pasture species in New Zealand. The three programmes outlined below are being conducted by:

- Pastoral Genomics - a consortium of pastoral producer boards
- AgResearch – a Crown research institute, and
- Gramina - a joint venture between PGG Wrightson and a Victorian state research institution.

Common to these programmes is the use of a variation on GM approaches used to develop GMOs thus far. Cisgenics uses standard GM techniques to engineer plants but, according to developers, without mixing genetic material from unrelated species. In addition to its application to genetically modify forages, this technology has also been used experimentally by Plant and Food and the CRI now claims to be ready to develop cisgenic apples, among a range of horticultural and other crops.¹

AgResearch is the exception in that cisgenics is currently a minor focus of its R+D, as the CRI is mostly focussed on developing transgenic commercial varieties.

By and large, delivery of commercial GM varieties from these programmes is well behind initial projections. Pastoral Genomics GM research is now at least a decade behind schedule. Thus considerably more funds will need to be committed if the varieties are to be brought to market.

In 2009, Pastoral Genomics and AgResearch were poised to file applications for conditional release of certain experimental lines in New Zealand. Initially, these releases were not to be for commercial production, but pollen flow would likely have been required to allow developers to fully test the agronomic viability of the cultivars. Those plans were suspended when developers became aware that insufficient thought had been paid to key issues such as the economic risks of a GM release to New Zealand's pastoral industry.²

¹ 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. Also see Anon. 2005. "Faster breeding with no outside genes", *NZ Dairy Exporter*, August 2005.

² 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, p. 52. MAF. 2009. Briefing on Meeting with Fonterra and Pastoral Genomics on 14 December 2009. Briefing for the Minister, December 11 2009. Obtained under the Official Information Act.

1. The Pastoral Genomics GM programme

Pastoral Genomics – whose GM ryegrass experimentation is the main focus of this briefing series – is a consortium of producer boards and research providers, including:

- Fonterra (through its subsidiary R+D company, Vialactia Biosciences)
- Dairy NZ
- Beef and Lamb New Zealand
- DEEResearch (a joint venture between the deer industry (Deer Industry New Zealand, the Deer Farmers Association) and AgResearch) and
- AgResearch.³

The consortium has also established partnerships with seed companies PGG Wrightson and Agriseeds for the commercialisation of any varieties that emerge from the R+D.⁴

The consortium's R+D programme, initiated in 1999 by the then Dairy Board, encompasses gene mapping and the development of new pasture grasses through both marker-assisted breeding and GM. Today, GM/cisgenics reportedly accounts for around half of the programme funds (see below).⁵

Among the targeted traits for pasture species are:

- Increased biomass
- Drought tolerance
- Nitrogen use efficiency
- Water soluble carbohydrates
- Increased protein content (condensed clover tannins)⁶
- Controlled flowering.⁷

³ Seed company Agriseeds is not listed as a member on the Pastoral Genomics website (last updated in August 2008), but other documentation suggests that the seed company is a participant (see, for example, FRST *Second cycle consortia exert review* of Pastoral Genomics, (No date). Obtained under the Official Information Act.) Other entities involved in the programme include Lifetech Laboratories and the Bio-Protection Research Centre, a Tertiary Education Commission-funded centre of research excellence based at Lincoln University. See, for example, Lifetech Laboratories Ltd, *Genetic Improvement of Forage Grasses*. Application to develop in containment a project of low risk genetically modified organisms by rapid assessment.

⁴ Pastoral Genomics. 2006. "Farmonics: the pastoral industries' PGT programme". 2005/6 FRST research abstract: <http://myfrst.frst.govt.nz/Public/ResearchReports/reports06/Report.cfm?Report=1>

⁵ Harris Consulting. 2009. *Assessing the Economic Impact of Cisgenic Technologies in Ryegrass*. Report prepared for Pastoral Genomics Ltd. Harris Consulting, Dairy NZ, Annette Litherland, Butcher Partners, Infometrics. December 2009.

⁶ Harris Consulting. 2009. *Assessing the Economic Impact of Cisgenic Technologies in Ryegrass*. Report prepared for Pastoral Genomics Ltd. Harris Consulting, Dairy NZ, Annette Litherland, Butcher Partners, Infometrics.

⁷ Pastoral Genomics. 2006. "Farmonics: the pastoral industries' PGT programme". 2005/6 FRST research abstract: <http://myfrst.frst.govt.nz/Public/ResearchReports/reports06/Report.cfm?Report=1>

Funding

Public funding – through the Foundation for Research Science and Technology (FRST) - provides half of the consortium’s income, which is currently \$7.4 M per annum (according to a 2009 report). Under the matching funding arrangement, consortium members Beef and Lamb New Zealand and Vialactia are each contributing over \$800 K per annum at present; the Deer Industry Research around \$440 K pa; DairyNZ subsidiary, Insight Genomics \$1.1 M; while AgResearch is investing \$750 K pa (see table below).⁸

In 2009, it was reported that \$3.7 M – or half of annual funds – was to be dedicated to development of GM grasses, a share that was projected to continue through until 2014 (see table below). Since that report, Pastoral Genomics has indicated that there has been a shift in funding that slightly favours developing new pasture varieties through a non-GM technique - marker-assisted selection (MAS). Investment in the consortium is said to be between \$118-126 M when measured from the time of inception of the Dairy Board research until 2014.⁹ The Sustainability Council has not been able to identify the total amount of public funding since this research began. However, on present course, the Foundation for Research Science and Technology will have invested close to \$38 M in the consortium over the decade 2004-2014.¹⁰

Pastoral Genomics Funding 2009-2014¹¹

Year	2009	2010	2011	2012	2013	2014
FRST	2.834	3.437	3.437	3.437	3.437	3.437
AgriTech Clove Ltd (MWNZ)	0.635	0.826	0.826	0.826	0.826	0.826
Vialactia	0.635	0.826	0.826	0.826	0.826	0.826
Insight Genomics	0.854	1.110	1.110	1.110	1.110	1.110
AgResearch	0.058	0.750	0.750	0.750	0.750	0.750
Deer Research PG	0.034	0.440	0.440	0.440	0.440	0.440
Total	5.050	7.389	7.389	7.389	7.389	7.389
Total for ryegrass cisgenics	2.525	3.695	3.695	3.695	3.695	3.695

Progress

Of the traits Pastoral Genomics is exploring, drought tolerance is the most advanced, with proof of concept field trialling of GM ryegrass lines begun in Florida now being

⁸ As AgResearch is largely state-funded, this brings total annual taxpayer funding of Pastoral Genomics to around \$4.1 M pa.

⁹ Nimmo Bell reports \$118.3 M until 2014 (Nimmo Bell. 2009. *Strategic Programme Evaluation. Summary of twelve projects*. A report prepared for Meat and Wool New Zealand). The upper estimate was reported in: Brosnahan T. 2009. “Meat & Wool levy report questioned”. *Country-Wide*, July 1 2009. Around \$50 M by the Dairy Board and then Fonterra until 2004, \$42m on Pastoral Genomics between 2002-2009 and \$34m until 2014.

¹⁰ Figures 2004-2008 from the online FRST database: 2004: \$3,493,326; 2005: \$3,900,000; 2006: \$4,100,000; 2007: \$3,094,875; and 2008: \$3,094,875. From 2009, the figures are taken from Harris Consulting. 2009. *Assessing the Economic Impact of Cisgenic Technologies in Ryegrass. Report prepared for Pastoral Genomics Ltd.*, as set out in the table.

¹¹ Harris Consulting. 2009. *Assessing the Economic Impact of Cisgenic Technologies in Ryegrass. Report prepared for Pastoral Genomics Ltd.* Harris Consulting, Dairy NZ, Annette Litherland, Butcher Partners, Infometrics.

furthered in Australia. The other traits foreshadowed would appear to be in varying stages of infancy, while some would appear not to have moved beyond the realm of theoretical possibility.¹²

In 2002, commercialisation of GM lines was predicted to occur from 2007 onwards. Two years later, Via Lactia assured the pastoral industry that “[g]razing cows is about 3 years away.”¹³

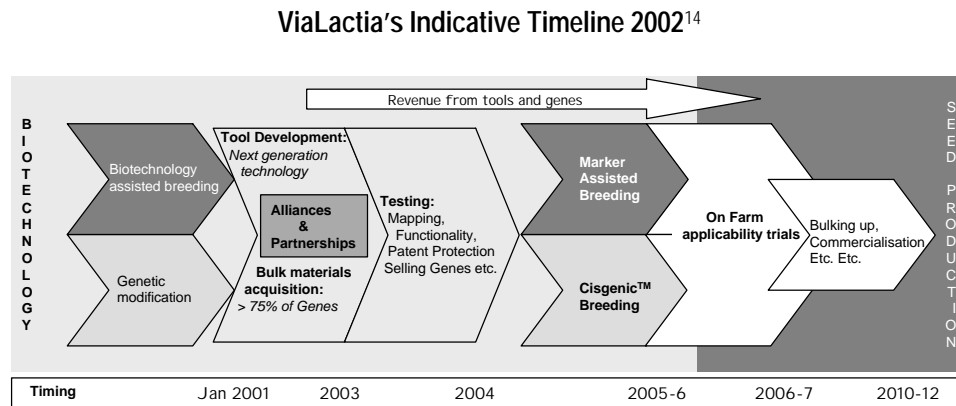


Figure 1: An indicative timeline for the application of modern biotechnology to ryegrass and clover.

Earlier this year, Pastoral Genomics CEO Mike Dunbier indicated that commercialisation could be as far out as 2020:

Even if things go swimmingly from now on, we’re not going to end up with plants that are commercially available and animals are eating them for 8 or ten more years.¹⁵

The prediction that GM varieties might not arrive until 2020 puts commercialisation beyond even the revised funding commitment made by producer boards and government in 2004. Under that arrangement, funding was pledged until 2014 (with further funding subsequently committed, we understand). Further, only drought resistance ryegrass would appear a candidate for commercialisation by 2020 and has yet to be demonstrated in the field. As of late 2009 it was stated that the GM lines being researched “have not in any meaningful way been tested, and in some cases have not even been developed.”¹⁶

¹² Harris Consulting. 2009. *Assessing the Economic Impact of Cisgenic Technologies in Ryegrass. Report prepared for Pastoral Genomics Ltd.* Harris Consulting, Dairy NZ, Annette Litherland, Butcher Partners, Infometrics.

¹³ Mountfort M, “Ryegrass R&D: Lateral look at gene technology”, *NZ Dairy Exporter*, August 2004.

¹⁴ Vialactia, “Genome Biotechnology: An option for New Zealand Dairy Farmers”. Dexcel Ruakura Dairy Farmers Conference Proceedings 2002.

¹⁵ Mike Dunbier, Transcript of RSNZ Media briefing on GM forages, March 2 2010 Available at: <http://www.sciencemediacentre.co.nz/2010/03/02/greener-pastures-gm-forage-crops-in-new-zealand/>

¹⁶ Harris Consulting, *Assessing the Economic Impact of Cisgenic Technologies in Ryegrass. Report prepared for Pastoral Genomics Ltd.* Harris Consulting, Dairy NZ, Annette Litherland, Butcher Partners, Infometrics. December 2009, p. 11.

2. AgResearch's GM Pasture Programme

In 2004, AgResearch stated its objective was to become “the main provider of plant transformation technology for multiple gene traits in New Zealand”.¹⁷ Programmes designed to achieve that goal include the Pastoral Genomics R+D and the CRI's own long-standing, publicly-funded GM forage R+D, that began in the 1980s. Over the decade that followed, GM virus- and insect resistant clover was the primary focus of experimental research.¹⁸ Over 1995-6, the research moved beyond laboratory-phase, when GM virus-resistant clover varieties were approved for field-trialling.¹⁹ That research programme was terminated in 2000, when it was concluded that the virus-resistant lines were technologically unviable and that the insect-resistant lines were unlikely to be a commercial success.²⁰

A number of pasture species are targeted in the current R+D programme including alfalfa, fescue, ryegrass and clover. With the exception of experimentation involving cisgenic white clover, the CRI is using transgenics with the aim of:

- Reducing the lignin levels in pasture grasses, to increase their digestibility;
- Increasing the lipid levels to increase forage conversion efficiency;
- Increasing the level of water soluble carbohydrates (so-called ‘high sugar’ grasses); and
- Increasing leaf triacylglycerides (high ME ryegrass).²¹

The CRI has also been experimenting with transgenic mechanisms for controlling flowering of ryegrasses.²²

Progress

As yet, no experimental lines have progressed beyond proof of concept phase. (GM alfalfa was used to experimentally increase fat levels and the CRI is now attempting to bring about similar changes in ryegrass.²³) In 2009, AgResearch was poised to seek approval for the conditional release of sufficient levels of experimental ME ryegrass

¹⁷ AgResearch. 2004. Parliamentary Report 2003/4 New Opportunities from Forage Plant Genomics, C10X0203. At that time, the programme involved a number of research agencies: AgResearch, Crop and Food, HortResearch, Universities of Auckland, Otago, Victoria, Massey and Agriculture Victoria.

¹⁸ Woodfield D. 2000. AgResearch, Royal Commission Transcripts, p. 145.

¹⁹ Approved by IAG, and conducted at the Aorangi Lowland Research Farm in Palmerston North.

²⁰ Woodfield D. 2000. Testimony to the Royal Commission. Royal Commission Transcripts, p.147.

²¹ AgResearch. 2010. *The Science Review*; AgResearch. 2009. *Our Science. Your Future*. Highlights 2009. Annual Report.

²² http://www.intl-pag.org/13/abstracts/PAG13_W100.html

²³ The CRI has claimed 200% increases in the omega-3 fatty acids and that GM plants in glasshouse were “half way towards the team's goal of a total fat content of eight per cent (Respectively ERMA. (No date). Excerpt from a debrief report on the COMBIO conference held in December 2009. Obtained under the Official Information Act; and Anon. 2009. “Small Countries could benefit from downturn”, Chemistry and Industry April 13 2009). Also see AgResearch. 2009. *Our Science. Your Future. Highlights 2009*.

that would be grown for livestock feeding studies but has since suspended those plans.²⁴

In 2010, the CRI announced that it was working on cisgenic white clover that would increase the protein content for livestock and reduce methane emissions and increase nitrogen efficiency. This, the CRI speculates, can be done by condensing the tannin content of clover with the theoretical potential to reduce methane emissions by as much as 10%.²⁵

Predictions about commercialisation timeframes are not readily available, however in 2009, the CRI stated that: GM ryegrass with high energy/increased lipid content would be ready for field trialling in 2012; the lines with higher sugar and reduced lignin are targeted for 2013/14; and the condensed tannin GM clover for 2015.²⁶

Funding

The current operating budget and the extent of funding over time for AgResearch's GM pasture programme are unclear, despite attempts by the Sustainability Council to clarify these. In 2004, the Foundation for Research, Science and Technology (FRST) and AgResearch refused to state how much public funding had been used for the programme and more recently has sought to charge substantial fees for this information.²⁷

The table below lists FRST funding of AgResearch pasture grass programmes since 1995. This may not cover the full set of public funding sources for the programmes, as in addition to FRST, there are other institutional funding lines such as the CRI Capability Fund, which provides bulk funding which the CRI may then allocate at its discretion. Further, some of those listed may not be fully dedicated to GM as a means of delivering new commercial varieties. Italics indicate where the extent to which GM forms a research component is unclear. Nevertheless, although the exact proportion of the more than \$44 million that has been spend in the last decade and a half is unclear, it is a large public science investment under any assumed split.²⁸

²⁴ We understand that Pastoral Genomics and AgResearch were working collaboratively to secure conditional release approvals for their respective GM grasses, and suspended filing approvals at the same time. (MAF. 2009. Status For the Week Commencing November 30 2009. Obtained under the Official Information Act.)

²⁵ AgResearch. 2010. "World-first science GE discovery that could lead to more productive farms, and reduced greenhouse gases". AgResearch News, June 15 2010.

²⁶ MAF. 2009. "Briefing on meeting with AgResearch", September 7 2009.

²⁷ In 2004, the Sustainability Council approached both the Foundation for Research Science and Technology and AgResearch to ascertain the level of public funding dedicated to GM forages. AgResearch declined to provide any figures. In December 2010, the Council again approached AgResearch and had already gone through FRST's online database to compile a list of contracts funded that seemed likely to contain GMO development and included this inventory as part of its request. FRST funding is made public on an online database. However, details are scant and it is unclear whether or to what extent GM is a component of programmes funded due to the minimal reporting recipients must undertake to inform the public of their activities.

²⁸ Of the \$44,066,250 total, it is unclear what proportion of \$32,020,250 that makes up the funding from 2002 onward has been devoted to GM pasture grasses.

AgResearch's FRST-funded forage programmes that do or may involve GM 1995-2008

Year	Code	Programme	Investment
1995	C10405	Gene Expression and Transformation of Pasture Plants	1,040,000
1996	C10405	Gene Expression and Transformation of Pasture Plants	840,000
1997	C10405	Gene Expression and Transformation of Pasture Plants	840,000
1997	N10273	Plant Genes for Quality Animal Product	77,000
1995	C10311	Transgenic Pest Resistant Plants	873,000
1996	C10639	Transgenic Pest Resistant Forage Plants	873,000
1997	C10639	Transgenic Pest Resistant Forage Plants	873,000
1998	C10639	Transgenic Pest Resistant Forage Plants	873,000
1999	C10639	Transgenic Pest Resistant Forage Plants	873,000
1996	C10636	Phosphorus Acquisition by Pasture Plants	289,000
1996	C10643	Genetic Improvement of Ryegrass†	280,000
1997	C10643	Genetic Improvement of Ryegrass†	280,000
1997	C10636	Phosphorus Acquisition by Pasture Plants	289,000
1998	C10636	Phosphorus Acquisition by Pasture Plants	289,000
1999	C10636	Phosphorus Acquisition by Pasture Plants	289,000
1998	C10828	Forage Plant Molecular Genetics	1,329,000
1999	C10828	Forage Plant Molecular Genetics	1,329,000
2001	N10X0103	A toolkit of white clover and ryegrass promoters	200,000
2001	N10X0106	Development of a ryegrass transformation system	160,000
2002	N10X0220	Development of a ryegrass transformation system	150,000
2002	C10X0203	New Opportunities from Forage Plant Genomics	4,240,000
2003	<i>C10X0203</i>	<i>New Opportunities from Forage Plant Genomics</i>	<i>4,240,000</i>
2004	<i>C10X0203</i>	<i>New Opportunities from Forage Plant Genomics</i>	<i>5,610,000</i>
2005	<i>C10X0203</i>	<i>New Opportunities from Forage Plant Genomics</i>	<i>4,560,000</i>
2006	<i>C10X0203</i>	<i>New Opportunities from Forage Plant Genomics</i>	<i>4,560,000</i>
2007	<i>C10X0604</i>	<i>Delivering sustainable forage productivity gains</i>	<i>2,125,125</i>
2008	<i>C10X0815</i>	<i>Exploiting Opportunities from Forage Plant Genomics</i>	<i>3,420,000</i>
2008	<i>C10X0203</i>	<i>New Opportunities from Forage Plant Genomics</i>	<i>1,140,000</i>
2009	<i>C10X0604</i>	<i>Delivering sustainable forage productivity gains</i>	<i>2,125,125</i>
TOTAL Programmes			\$44,066,250

3. PGG Wrightson and the Gramina Venture

PGG Wrightson's ambition, as formulated in 2005, is to "develop and commercialise the world's first genetically modified perennial ryegrass"²⁹. The vehicle is Gramina, a \$36 million joint venture with a subsidiary of the Victorian AgriBiosciences Centre of Australia (a state-level research centre based at La Trobe University).³⁰ Since 2005, PGG Wrightson has received \$5 million from New Zealand Trade and Enterprise to help secure its stake in the venture, which is also receiving Australian Federal Government funding.³¹

Broadly speaking, the stated aims of the venture are to provide new pasture varieties via "cut and paste"³² or GM techniques to accelerate delivery of new varieties to global markets. The targets are for varieties for temperate region pastoral farming such as those with enhanced herbage quality and reduced pollen allergenicity.³³ Specifically ryegrasses and fescue are being engineered for:

- Higher energy content (though increased sugar content; reduced lignin content (for increased digestibility));
- 'Low allergy' ryegrass (through silencing of two proteins contained in ryegrass pollen); and
- Drought tolerance; and grasses that will reduce methane emissions from livestock (by preventing the expression of the enzyme O-methyl transferase).

As lines such as the lower lignin grasses are claimed to also reduce methane emissions, the project is pitched as a means "to help the Australian dairy industry adapt to future climate changes."³⁴

Under the partnership, much of the R+D lies with the Victorian state research centre. IP is to be allocated to the joint venture company itself. In addition to a share in royalties that might flow from any commercial success, PGG Wrightson is to be licensee of new seed varieties should experimental lines prove technologically and commercially viable, and the company will be responsible for multiplication, marketing, sales and distribution of those GM seeds.³⁵

Unlike Pastoral Genomics, PGG Wrightson does not intend to have New Zealand pioneer GM grasses; under current thinking, it would instead be a follower in commercial adoption of their GM pasture grasses and commercial releases sought in Australia first.³⁶

²⁹ Australia New Zealand Biotechnology Partnership Fund. 2005. Board paper, January 2005. Obtained under the Official Information Act.

³⁰ Ibid.

³¹ Hon Pete Hodgson. 2005. "\$6.5 million biotech boost", Media release, March 3 2005; New Zealand Trade and Enterprise. 2008. "New grasses for a new climate?" Media release, April 1 2008. The funding was allocated by the Australia New Zealand Biotechnology Partnership Fund (ANZBPF), which NZTE administers. Australian Federal funding announced at <http://www.gramina.com.au/>

³² Molecular Plant Breeding Cooperative Research Centre. 2009. *Annual Report 2008/09*, p. 13.

³³ <http://www.gramina.com.au/>

³⁴ Molecular Plant Breeding Cooperative Research Centre. 2007. "Cows come home to climate change friendly grass. Australia-NZ partnership awarded Aus\$1.8 M for pasture research". Nov 27 2007.

³⁵ Molecular Plant Breeding Cooperative Research Centre. 2007. *Annual Report 2006/7*, p. 14.

³⁶ ERMA. (No date). Excerpt from a debrief report on the COMBIO conference held in Dec 2009.

Progress and timelines

Field trialling of the high fructan and low lignin experimental lines began in 2008³⁷, and Gramina is already claiming that the grasses it is developing will result in up to a 20% increase in milk production for farmers.³⁸

The Gramina venture is planned as a 10-year venture with current horizon set at 2014.³⁹ Yet there is some uncertainty as to whether commercial successes will be achieved within that timeframe as various timelines have been offered for bringing GM varieties to market. PGG Wrightson maintains that GM varieties will be commercially available by 2013.⁴⁰ However, Gramina has indicated commercialisation of a new variety in 2015, while New Zealand Trade and Enterprise has suggested prospects for commercialisation are further out, and not likely before 2018.⁴¹

³⁷ Australian Federal Office of the Gene Technology Regulator. 2008. Issue of Licence DIR 082/2007 to the Victorian Department of Primary Industries for a limited and controlled release of GM perennial ryegrass and tall fescue, July 29 2008.

³⁸ NZPA. 2010. "' Super-grass' aims to boost milk production", *The Waikato Times*, March 2 2010.

³⁹ <http://www.gramina.com.au/> Last accessed October 2010.

⁴⁰ As reported in: NZPA .2010. "'Super-grass' aims to boost milk production", *The Waikato Times*, March 2 2010; Anon. 2010. "GE grasses are 3 years away" *Dairy Reporter*, March 9 2010. These timeframes were first set out in 2005 (see Anon. 2005. "Wrightson given \$3m grant for GM grass research". Otago Daily Times, March 4 2005).

⁴¹ Hopkins P. 2009. "Field trials of GM projects yield 'promising' results", *The Age*, March 30 2009; "New Zealand Trade and Enterprise. 2008. "New grasses for a new climate?" Media release, April 1 2008.