

**IMPLEMENTING THE GOVERNMENT'S  
RESPONSE TO THE ROYAL COMMISSION  
ON GENETIC MODIFICATION'S  
RECOMMENDATIONS ON RESEARCH  
PRIORITIES**



MINISTRY OF  
RESEARCH, SCIENCE  
& TECHNOLOGY

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TE MANATŪ PŪTAIAO

September 2003

APPROVED FOR GENERAL RELEASE

A handwritten signature in black ink that reads "Helen Anderson". The signature is written in a cursive style with a large initial 'H' and a long, sweeping underline.

**Helen Anderson**  
**Acting Chief Executive**  
**MoRST**

# TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY</b>	<b>4</b>
<b>SECTION ONE: INTRODUCTION</b>	<b>6</b>
1.1 <i>The Royal Commission on Genetic Modification</i>	6
1.2 <i>The Government's response to the RCGM</i>	6
1.3 <i>Report structure</i>	8
<b>SECTION TWO: NEW ZEALAND RESEARCH MEETING THE NEEDS IDENTIFIED BY THE RCGM</b>	<b>10</b>
2.1 <i>New Zealand biotechnology impacts research and broader biotechnology research</i>	10
2.2 <i>Organics and sustainable agricultural research</i>	15
<b>SECTION THREE: IMPACT OF THE GOVERNMENT'S RESPONSE TO THE RCGM RECOMMENDATIONS ON BIOTECHNOLOGY IMPACTS</b>	<b>19</b>
3.1 <i>The New Zealand Context</i>	19
3.2 <i>International Context</i>	23
3.3 <i>Review of environmental impacts by Dr Mark Lonsdale</i>	23
3.4 <i>Review of social impacts by Professor Brian Wynne</i>	26
<b>SECTION FOUR: CONCLUSIONS AND ACTIONS FOR NEXT STEPS</b>	<b>28</b>
4.1 <i>Biotechnology Impacts Research</i>	28
4.2 <i>Biotechnology Impacts Research and Policy</i>	30
4.3 <i>Organics and Sustainable Agriculture Research</i>	31
4.4 <i>Concluding remarks and actions</i>	31
<b>ACKNOWLEDGEMENTS</b>	<b>32</b>
<b>ABBREVIATIONS AND LINKS</b>	<b>33</b>
<b>ANNEX ONE: NEW ZEALAND VOTE RS&amp;T FUNDED BIOTECHNOLOGY IMPACTS RESEARCH: RECENTLY COMPLETED OR CURRENT</b>	<b>34</b>
<b>ANNEX TWO: NEW ZEALAND NON-VOTE RS&amp;T BIOTECHNOLOGY IMPACTS RESEARCH: RECENTLY COMPLETED OR CURRENT</b>	<b>42</b>
<b>ANNEX THREE: EXTERNALLY COMMISSIONED PROJECTS FUNDED BY POLICY AGENCIES ON IMPACTS OF BIOTECHNOLOGY</b>	<b>46</b>
<b>ANNEX FOUR: SUMMARY OF PROCESSES CARRIED OUT BY FRST TO ESTABLISH RESEARCH PROGRAMMES IN THE AREAS IDENTIFIED BY THE RCGM</b>	<b>49</b>

## EXECUTIVE SUMMARY

The Royal Commission on Genetic Modification (RCGM) in its July 2001 report made a total of 49 recommendations about genetic modification (GM) and its regulation in New Zealand. There were some suggestions for the enhancement of GM regulation, but the RCGM supported the basic regulatory framework that was in place. The New Zealand Government responded by supporting the intent of the majority of these recommendations and the overall RCGM strategy of preserving opportunities.

Of the 49 recommendations, there were four recommendations about the need for further publicly funded research. This report relates to these recommendations which were in two broad areas. In the first area there were three recommendations on the need for research aimed at understanding the environmental and social impacts, including socio-economic and ethical impacts, of genetically modified organisms (GMOs). The Government responded to these recommendations by providing additional research funding of \$1 million in 2002/03 rising to \$2.5 million per annum in 2003/04 in biotechnology impacts research<sup>1</sup>. It was thought that this research, along with other existing research would support policy and decision-making about GM and emerging biotechnologies in New Zealand.

The second broad area where the RCGM recommended further research was on organics and other sustainable agricultural systems. The Government responded to this recommendation by supporting its intent, but it considered that there was a need for an overarching strategic direction to guide research in this area, and that work was already underway to achieve this through the development of an organics sector strategy and a review of sustainability research.

The overall result has been a reprioritising of existing research funding, and the provision of new funding to support a suite of new research in the areas identified by the RCGM.

This report documents the funding levels and type of current New Zealand research that relates to these RCGM recommendations. It discusses the role of this research and its contribution to decision-making on GM and biotechnology in New Zealand. The report also summarises two reviews that have been commissioned to investigate the balance and funding of biotechnology impacts research in New Zealand as it relates to international developments. These reports are available from the Ministry of Research, Science and Technology (MoRST)<sup>2</sup>.

The report is divided into four sections: Section One: Introduction; Section Two: New Zealand research meeting the needs identified by the RCGM; Section Three: Impact of the Government's response to the RCGM recommendations on biotechnology impacts; and Section Four: Conclusions and actions for next steps.

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<sup>1</sup> The term "biotechnology impacts" in this context relates to research on the effect of a biotechnology, rather than developing the biotechnology itself. These impacts could include the social, cultural, ethical or environmental effects of biotechnologies. This report will use the term "biotechnology impacts" to cover research on all of these issues, which includes, but is not limited to the impacts of GM and GMOs.

<sup>2</sup> [www.morst.govt.nz](http://www.morst.govt.nz).

Key findings include:

- A number of new research programmes have been initiated through additional research funding provided in the 2002 Budget that meets the needs identified by the RCGM and agreed to be implemented by the Government.
- Public funding of biotechnology impacts research in New Zealand has risen from very little to at least \$7 million per annum over a three-year period since 1999-2000. The resulting capability, which in some cases is early in its development, will be able to inform and support policy and decision-making on biotechnology in New Zealand and is well placed to respond to on-going and future research needs. New Zealand regulates the development and use of GMOs through the Hazardous Substances and New Organisms (HSNO) Act 1996 and the case-by-case assessment of applications will allow new research findings to be incorporated into decision-making.
- The focus and funding levels of New Zealand biotechnology impacts research is at least consistent with comparable international research, and it is significantly more than in some countries, such as Australia.
- The international reviewers identified some areas where they felt New Zealand could supplement existing research. These areas include: social issues related to the co-existence of GM and non-GM crops; trade and economic impacts of GM; the environmental impacts at the farm-scale; and the impacts of gene flow. While these issues may be important on an international scale, it is important for them to be considered in the New Zealand context. It is likely that these issues, if relevant for New Zealand, can be incorporated into existing research, rather than through new research funding.
- There could be some enhancement of the way biotechnology impacts research is carried out and used. This includes more effective translation of research results into policy to ensure that policy development is informed by relevant, up-to-date New Zealand specific research.
- Research that specifically supports the organics sector has seen an increase of approximately \$0.8 million per annum to a total of \$3 million per annum. This increase has resulted from a review carried out by the Foundation for Research, Science and Technology (FRST) of priorities for research that contributes to sustainable development. Research in the organics sector is also supported by primary production research into sustainable agriculture which is approximately \$50 million per annum.

## SECTION ONE: INTRODUCTION

### 1.1 *The Royal Commission on Genetic Modification*

The RCGM in its July 2001 report made a total of 49 recommendations about GM in New Zealand. Four of these recommendations relate to the need for further research in two broad areas:

- (i) *Biotechnology Impacts*, in particular the environmental<sup>3&4</sup> and social<sup>5</sup> (including socio-economic and ethical) impacts of GMOs; and
- (ii) *Agricultural Research*, in particular for research that supports organics and sustainable agricultural systems<sup>6</sup>.

These recommendations are themselves aligned closely with the major theme of the RCGM, which was “preserving opportunities”, to encourage the co-existence of all forms of agriculture and that different production systems should be contributing in their own ways to the overall benefit of New Zealand<sup>7</sup>.

### 1.2 *The Government’s response to the RCGM*

The Government made a series of decisions in response to the 49 RCGM recommendations, and in order to give time to implement some of these decisions, they placed a restricted period (moratorium) on the consideration of applications for the release of GMOs (with some exceptions). This moratorium expires on 29 October 2003. One of the reasons identified by the Government for the moratorium was to allow time to “establish or continue research programmes addressing areas of socio-economic, ethical, environmental and agricultural research which were identified by the Royal Commission as needing additional work<sup>8</sup>. Other reasons were to allow time to:

- put in place amendments to the HSNO Act;
- establish a Bioethics Council;
- complete work on the economic impacts of GMO releases; and
- undertake appropriate work on other issues identified by the Commission such as conditional release and co-existence, developing a biotechnology strategy and investigating liability issues.

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<sup>3</sup> RCGM Recommendation 6.12: that ERMA require research on environmental impacts on soil and ecosystems before release of genetically modified crops is approved.

<sup>4</sup> RCGM Recommendation 7.4: that, in connection with any proposal to develop genetically modified forest trees, an ecological assessment be required to determine the effects of the modification on the soil and environmental ecology, including effects on soil microorganisms, weediness, insect and animal life, and biodiversity.

<sup>5</sup> RCGM Recommendation 6.14: that public research funding portfolios be resourced to include research on the socio-economic and ethical impacts of the release of genetically modified organisms.

<sup>6</sup> RCGM Recommendation 6.13: that public research funding be allocated to ensure organic and other sustainable agricultural systems are adequately supported.

<sup>7</sup> See <http://www.gmcommission.govt.nz/RCGM/pdfs/report/execSumm.pdf>

<sup>8</sup> CAB Min (01)33/22.

### ***Biotechnology impacts research***

In considering the four RCGM recommendations for further research funding, the Government acknowledged the research already being undertaken in these areas<sup>9</sup>. However, it was agreed that additional funding should be provided for research on social and environmental impacts of biotechnology (RCGM recommendations 6.12, 6.14 and 7.4).<sup>10</sup> Consequently, the 2002 Budget provided FRST an additional \$1 million in 2002/03 (increasing to \$2.5 million per annum from 2003/04), to support "multidisciplinary research aimed at an improved understanding of the socio-economic, ethical and environmental impacts of genetic modification and other emerging biotechnologies"<sup>11</sup>.

The reference to research on "other emerging biotechnologies", was added to widen the context of the new research and go beyond the consideration of impacts specific to GM. GM currently has a high level of focus but it is a subset of biotechnology and there are new biotechnology innovations arising all the time. Each of these has the potential to have a range of impacts which could be positive or negative.

In providing funding to these areas, the Government decided to continue with GM impacts research and progressively develop awareness of, and knowledge about, emerging biotechnologies and to help develop a research capability that is able to respond to these biotechnologies. This research, it was considered, would provide:

- more informed decision-making on the impacts of genetically modified organisms;
- greater knowledge to inform and assist the dialogue between those developing new biotechnologies and the broader community;
- improved capability to investigate the on-going impacts of GM and other emerging biotechnologies; and
- New Zealand-specific knowledge of the impacts of genetically modified organisms.

At the time the increased funding in the 2002 Budget was agreed, the Minister of Finance requested a review of the use of the funding at the end of the moratorium to confirm the continued relevance of the research. This report was prepared to address this request and it has been presented to the Ministers of Research, Science and Technology, Finance, Environment, Agriculture and Trade Negotiations.

### ***Refining Organics and Sustainable Agriculture Research***

The Government accepted the intent of RCGM recommendation 6.13 on organics and sustainable agricultural research<sup>12</sup>, but decided that this research would benefit from a more formalised, overarching direction. A strategy for the organics sector was consequently developed and released in April 2003<sup>13</sup>.

Further refinement of organics and sustainable agricultural research has since occurred through a review and reinvestment of FRST funded research supporting sustainable development (a total of \$57 million per annum). FRST's review took into account, amongst other things, the findings of the RCGM and the organics sector strategy.

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<sup>9</sup> POL Min (01) 30/4.

<sup>10</sup> The Government considered the "environmental impacts" recommendations (6.13 and 7.4) together.

<sup>11</sup> See 2002 Vote RS&T Vote Statement <http://www.treasury.govt.nz/budget2002/estimates/est02ressci.pdf>

<sup>12</sup> POL Min (01) 30/4.

<sup>13</sup> See: <http://www.martech.co.nz/oss.html>.

### **1.3 Report structure**

This report documents the actions taken to implement the Government's response to the four RCGM recommendations that related to research priorities. It does this by:

- Documenting the funding level and describing the type of research that is now occurring in these areas; and
- Providing a context for the biotechnology impacts research. This is done in two ways. Firstly through discussing the contribution of research to New Zealand's biotechnology decision-making and policy. Secondly, by comparing the balance of research areas and its funding with international trends in research in related areas.

This report is divided into four sections.

#### ***Section One (present section):***

Introduction and details of the report's structure.

#### ***Section Two: New Zealand research meeting the needs identified by the RCGM***

This section gives an overview of the range of research that is now occurring in New Zealand to meet the needs identified by the RCGM, and agreed to be supported by the Government. It also includes a description of research taking place on biotechnology impacts that has been initiated independently of the Government's response to the RCGM. Specific details of biotechnology impacts research that is occurring in New Zealand is included in Annexes One to Three.

Also included in this section is a broad overview of new research that has been funded through a recent review and reinvestment of FRST funded research contributing to sustainable development, and related to the RCGM recommendation in this area.

#### ***Section Three: Impact of the Government's response to the RCGM recommendations on biotechnology impacts***

This section describes the context for research in the New Zealand environment and provides an assessment of the balance of research areas being conducted in New Zealand compared to what is being done overseas.

MoRST interviewed relevant government policy agencies and biotechnology decision-makers to assess how biotechnology impacts research contributes to New Zealand policy on GM and biotechnology<sup>14</sup>.

MoRST also contracted two internationally recognised researchers, Dr Mark Lonsdale of CSIRO Entomology and Professor Brian Wynne Professor of Science Studies of Lancaster University to provide international perspectives on the New Zealand research. They were asked to compare the New Zealand biotechnology impacts research with trends in international research, note any research gaps, and make recommendations for further New Zealand research.

This section summarises their findings (full reports can be obtained from MoRST).

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<sup>14</sup> Agencies that MoRST spoke to: ERMA New Zealand, Ministry for the Environment, Ministry of Agriculture and Forestry, New Zealand Food Safety Authority, Ministry of Consumer Affairs, Te Puni Kokiri, Toi te Taiao: the Bioethics Council, Department of Conservation and Ministry of Health.

***Case Studies***

Two research programmes working on biotechnology impacts have been included as case studies to illustrate the way research is carried out in the wider policy and societal context in New Zealand and internationally. These case studies are included as part of Sections Two and Three.

***Section Four: Conclusions and actions for next steps***

This section concludes with some actions for the way forward. These actions include:

- How the recommendations of the international reviewers will be analysed in terms of their relevance to New Zealand and what mechanisms there are to support these areas; and
- Enhancing the interface between research and policy.

## **SECTION TWO: NEW ZEALAND RESEARCH MEETING THE NEEDS IDENTIFIED BY THE RCGM**

The last three years has seen increased funding to support research in the areas recommended by the RCGM. FRST, the Government's main investor of research, has made a series of funding decisions to help implement the Government's decisions on the RCGM recommendations. These have included reprioritising existing research funding and allocating the new 2002 Budget funding.

This section provides an overview of the range of New Zealand research now occurring in the areas of biotechnology impacts and organics and sustainable agriculture. Due to its recent establishment, much of this research is early in its development so it is likely to take some time for the results to become available.

### ***2.1 New Zealand biotechnology impacts research and broader biotechnology research***

New Zealand biotechnology impacts research is carried out by a range of research providers (both CRIs and universities) and is funded from many different sources, but the majority is funded through Vote RS&T by FRST.

The total Vote RS&T public funding supporting biotechnology impacts research is approximately \$7.7 million per annum. Of this, approximately \$4.3 million per annum supports environmental impacts research, and \$3.4 million supports social impacts research (Table One). Vote RS&T supports the majority of impacts research, although there is a small amount of research that is funded from other sources. It has not been possible to quantify the amount of funding from non-Vote RS&T sources, although every attempt has been made to get descriptions of this work (see Annex Two).

Annexes One to Three include specific information about the range of New Zealand biotechnology impacts research programmes<sup>15</sup>. This information details objectives for research programmes, funding levels (where known), and the timing for the research programmes. This research includes both programmes that were initiated as a direct result of the RCGM and the Government's response that has been funded by FRST, and also research that has been established separately.

Figure One shows the programmes that FRST has supported, in order to invest in biotechnology impacts research over recent years, and in support of the Government's decisions on the RCGM recommendations in this area. FRST has carried out several relevant funding rounds. These include three funding rounds to invest in research specific to biotechnology impacts and a review and reinvestment of funding for plant gene technologies research, where an emphasis was given for research on the impacts arising from plant gene technologies and biological industries research. FRST began signalling the need for new research in the biotechnology impacts area from 1999/2000, which was before the RCGM reported. Annex Four has more details about these processes.

Many of the recent FRST funded programmes in biotechnology impacts research have been awarded five-year funding. This is at the upper end of the contract terms for research programmes funded by FRST. This was done to give sufficient time for newly established research teams to develop on-going capability in the relatively new priority area of biotechnology impacts.

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<sup>15</sup> Collated from publicly funded research contracted by FRST, the Health Research Council and the Royal Society of New Zealand through Vote RS&T (Annex One); university research programmes that are funded through sources other than Vote RS&T (Annex Two); and relevant government agencies that have contracted relevant work in this area (Annex Three).

The biotechnology impacts funding can be compared with the overall funding that supports biotechnology in general. Analysis of the total Vote RS&T funding shows that approximately \$120 million per annum supports research that can broadly be termed biotechnology<sup>16</sup>. Of this, it is estimated that \$20 million is invested in research that is either developing GM organisms in order to understand fundamental biological processes or to generate GM organisms or products for potential future release.

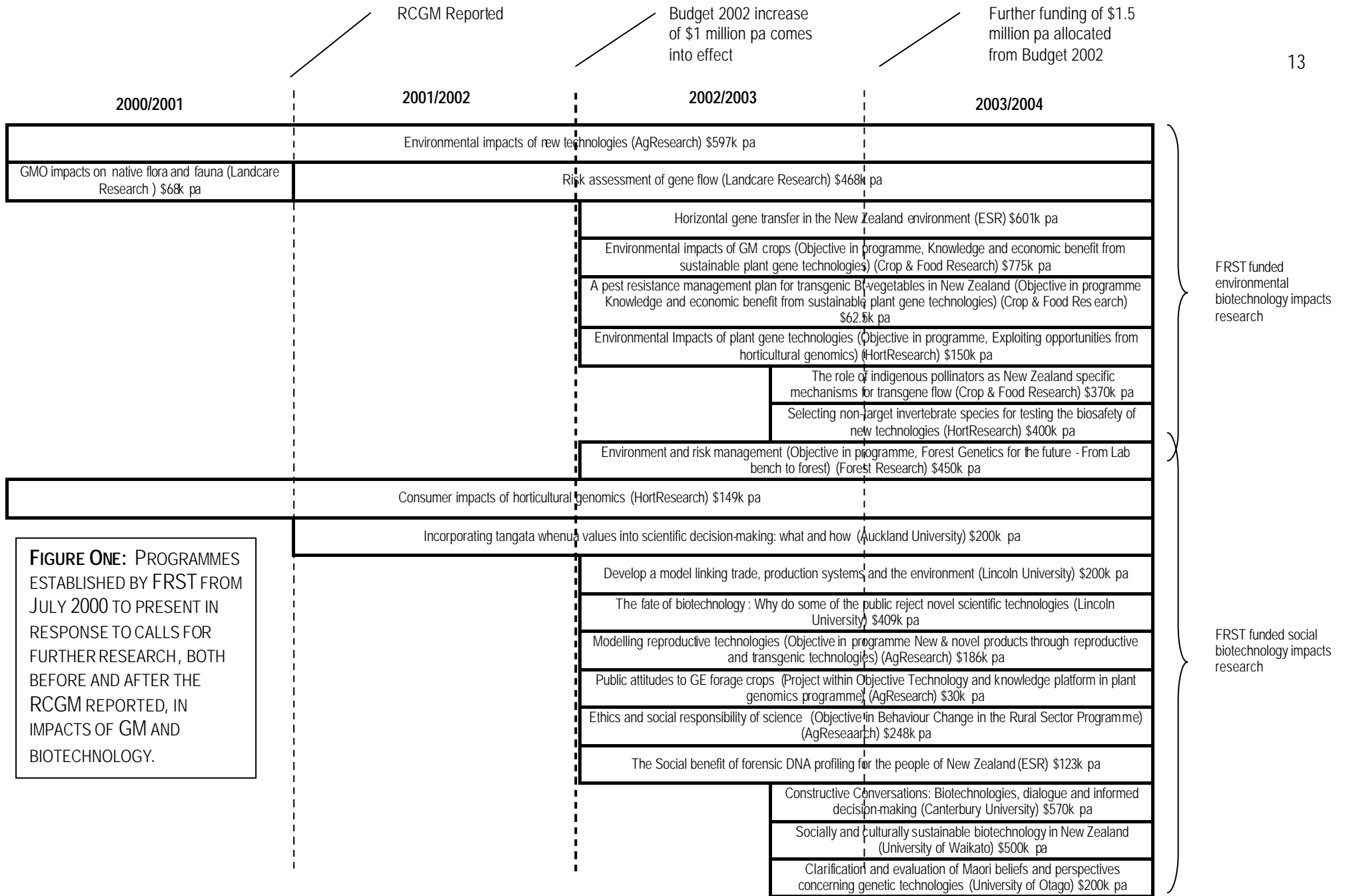
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<sup>16</sup> This includes research categorised as “modern biotechnology” and “related biotechnology”. Modern biotechnology is defined as applying biologically-based processes (or derivatives) as tools to generate greater knowledge and/or develop new products, processes or services. This definition would therefore include, but is not limited to: recombinant DNA technologies, PCR, marker-aided selection, molecular taxonomy, protein / carbohydrate expression systems, protoplast fusion studies, etc. It would not, however, include the likes of traditional plant breeding and fermentation technologies. Related biotechnology is research that does not directly utilise modern biotechnology, but it does draw from and contribute to modern biotechnology. This would include, but is not limited to, forms of physiology, pharmacology, microbiology and protein chemistry.

**TABLE ONE: APPROXIMATE AMOUNT AND TYPE OF BIOTECHNOLOGY IMPACTS RESEARCH CONTRACTED BY VOTE RS&T PURCHASE AGENTS. OBJECTIVES OF INDIVIDUAL PROGRAMMES ARE INCLUDED IN ANNEX ONE.**

Vote RS&T purchase agents, and type of biotechnology impacts research contracted	Environmental biotechnology impacts research (based on 2002/03 year funding) figures in \$000 per annum	Social, including cultural, ethical, economic, biotechnology impacts research (based on 2002/03 year funding) figures in \$000 per annum	Total (based on 2002/03 year funding) figures in \$000 per annum
<i>Foundation for Research, Science &amp; Technology</i>  Generic, underpinning knowledge in biotechnology impacts to enhance decision-making*.	3,666.5	3,040.0	6,706.5
<i>Royal Society of New Zealand (Marsden Fund)</i>  Fundamental, investigator driven research	675.3	90.0	765.3
<i>Health Research Council</i>  Health and ethics biotechnology impacts research	-	47.0	47.0
<i>Ministry of Research, Science &amp; Technology</i>  Practical methodologies to enhance dialogue between science and the public	-	242.5	242.5
<b>TOTALS</b>	<b>4,341.8</b>	<b>3,419.5</b>	<b>7,761.3</b>

\* If ERMA received a specific application to release GMOs then evidence on risks/benefits from this GMO would be expected to be presented by applicants. If applicants were FRST funded, then this work would be covered within the research programmes that involve the application.



**FIGURE ONE:** PROGRAMMES ESTABLISHED BY FRST FROM JULY 2000 TO PRESENT IN RESPONSE TO CALLS FOR FURTHER RESEARCH, BOTH BEFORE AND AFTER THE RCGM REPORTED, IN IMPACTS OF GM AND BIOTECHNOLOGY.

FRST funded environmental biotechnology impacts research

FRST funded social biotechnology impacts research

### 2.1.1 Environmental impacts research

The environmental biotechnology impacts research covers a range of research areas. The \$4.3 million includes research on:

- ecosystem impacts;
- understanding the impacts of gene flow (both horizontal and vertical);
- understanding the role of indigenous pollinators in gene flow;
- the impacts on non-target organisms such as beetles and native weevils; and
- using non-target organisms as indicators for the biosafety of GM crops.

Case Study One describes research that ESR and others are doing in the area of horizontal gene transfer (HGT) in the New Zealand environment.

There are a small number of relevant Marsden funded research programmes. These include research that seeks to understand the mechanisms for cellular processes such as horizontal gene transfer.

It should be noted that much of the environmental impact-related research undertaken uses modern biotechnology techniques (although not necessarily genetic modification)<sup>17</sup>.

### 2.1.2 Social impacts research

The social impacts research covers a broad range of impacts research from cultural, ethical, and social and socio-economic areas. This \$3.4 million of research covers issues such as:

- how tangata whenua values can be incorporated into decision-making;
- public perceptions of risks associated with biotechnology;
- socio-economic implications of GM and biotechnology;
- consumer perceptions of genomics;
- scientists' perceptions of the role of social responsibility in scientific research with a particular focus on genetic engineering technology;
- ethics issues associated with genetics;
- investigation of ways in which the public can participate in decision-making around medical biotechnologies; and
- developing processes for engaging the community around biotechnology issues.

Recent FRST funding has seen a trend towards research on broader biotechnology impacts. This relates to a focus of the new 2002 Budget funding, where research on emerging biotechnologies was identified as a priority area for funding.

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<sup>17</sup> Refer to previous footnote for a definition of modern biotechnology.

There are a number of university projects funded outside of Vote RS&T, including many post-graduate theses that are investigating the social impacts of biotechnologies. These include studies on risk perceptions, ethics, studies of media representations of GM in New Zealand, economic and anthropological studies. Non-Vote RS&T work is described in Annex Two.

Case Study Two describes a social science research programme being done by Lincoln and Otago Universities which is investigating the public's perceptions of technical risk in biotechnology.

## ***2.2 Organics and sustainable agricultural research***

When considering the RCGM recommendation for further research to support organics and sustainable agriculture, the Government noted that the development of a research strategy by the organics and sustainable farming sectors in consultation with research providers, would help prioritise public research in this area. This has now occurred through the development of the Organics Sector Strategy released in April 2003 and through a FRST review of research that contributes to sustainable development. This review took into account the Organic Sector Strategy and the RCGM findings and covered research totalling \$57 million per annum. Sustainability research is aimed at increasing knowledge of how to manage New Zealand's natural resources and production systems to create economic, environmental, social and cultural benefits for today and for future generations. This research covers a number of areas in sustainable management, sustainable cities and settlements, Maori and sustainability and environmental protection. It includes research from organics, low input farming systems and conventional farming that is aimed at sustainable outcomes. Funding for broader sustainable agricultural systems research is estimated to be about \$30 million per annum.

The FRST sustainability review did not involve a change in total funding in this broad area of sustainability research. Rather there has been a significant change in the way research programmes have been conceived and constructed and how they will be undertaken. A range of new programmes will start on 1 October 2003. Changes include:

- Integrated whole systems approaches with greater levels of collaboration between research teams and greater partnerships between the researchers and those who use the research. Research is also cutting across economic, environmental and social dimensions. For example, one programme focuses on reducing pesticide use, in particular insecticides and fungicides. This programme assesses the benefits and risks viewed not only from an economic perspective, but also from environmental and social perspectives.
- Research across different sectors, including opportunities in non-conventional sectors, such as organic production.
- An increase in research on human dimensions (integrated with environmental and social factors) and not simply on biophysical factors. Good linkages with a number of sectors have led to new research involving understanding how human behaviour, motivation and choices affect sustainability outcomes.
- An increase in research that results in beneficial outcomes for Maori, and involves Maori in redesign and control of resource management systems using both traditional Maori knowledge and western science.

### 2.2.2 Organics research

Organics-specific research before the sustainability review was funded at approximately \$2.2 million. Much of this research was integrated into programmes focussing on reducing inputs into organic production systems. This specific research was supported by other research in the broad area of sustainability, which is applicable across a number of sectors and adds to the body of knowledge of sustainable management generally.

Following the review, FRST sought applications for research on organic production systems, the shift to organic systems, and the sustainability of these systems. The resulting funding of organics-specific research is now estimated at about \$3 million. This increase to organics research comes from a reprioritisation of existing research funding.

New organics research funded in this round falls into four areas:

- New knowledge and tools for understanding pasture weeds, and developing innovative bio-economic strategies for sustainable pasture management;
- Supporting the transition to organics by reducing dependence on insecticides in horticulture;
- Working with Maori communities to help them move from extensive, low input systems to highly intensive organic horticulture; and
- Socio-economic research to evaluate the relative economic, environmental and social performance of conventional and alternative production systems.

Following the Sustainability Review and the Organics Strategy development process, the collaboration between research organisations and the organics sector appears to have improved. This should lead to benefits for the organics sector.

The results of the funding decisions for research in the sustainability area were announced in early August 2003. FRST is now developing research contracts for this work, with research due to start in October 2003. It has not therefore been possible to list the research programmes to the level of detail that has been possible for the biotechnology impacts research (as outlined in Annex One). Details of these programmes will be available on FRST's website<sup>18</sup> once contracts are finalised.

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<sup>18</sup> [www.frst.govt.nz](http://www.frst.govt.nz)

### Case Study One

#### Horizontal Gene Transfer in the New Zealand Environment

Contract let by the Foundation for Research, Science and Technology to ESR

Contract Number C03X0202, Programme Leader, Dr Philip Carter

Funding \$601,000 per year

In 1999 ESR identified a knowledge gap existing in the area of horizontal gene transfer (HGT) processes in soil, and that this would cause difficulties in assessing risks from GMO plants. ESR moved to develop the capabilities needed to research HGT using Non-Specific Output Funding (NSOF)<sup>19</sup> in anticipation that FRST would need to fund this type of research in the future. The investment in 1999-2000 was \$123,500 and represented 52% of ESR's NSOF allocation.

FRST then issued a Tender in August 2000 seeking expressions of interest for research into *Potential Key Effects of Genetically Modified Organisms*. ESR submitted an expression of interest and was invited to submit a full proposal. In December 2000 ESR was notified that the Foundation Board had decided not to fund most of the research that it had tendered for. The Board indicated:

- that funding decisions should await the outcomes of the RCGM, which they felt would define research priorities more clearly; and
- that FRST needed to do more analysis to define priorities before further investment could be made.

ESR was convinced that HGT would indeed be a research priority identified by the RCGM and they continued to invest NSOF in 2000-2001 (\$202,500) for research on HGT. Following the RCGM report, FRST held a further tender process in October 2001.

ESR responded to the new tender by bringing together a research team with the capabilities required to determine the key factors important for HGT to occur in the NZ ecosystem and the relative importance of these factors. ESR needed to obtain the strongest team possible, and this was done by collaborating with researchers from AgResearch, HortResearch and CSIRO. The key researchers developing the proposal had excellent relationships with end users from the sector and with regulators, and were in a position to respond to their information needs in the proposal.

The research programme has a number of components:

- Horizontal Gene Transfer by Transformation. This focuses on determining the conditions that influence HGT in New Zealand soil types by developing a model soil system and conducting a quantitative assessment of the environmental factors affecting DNA stability.
- Investigation of whether transgenes transfer more frequently than wild type genes.
- Selection of Bacterial Transformants in Soil. This will determine the effect of genetically modified organisms on the bacterial soil population and the role of selection.
- Modelling GMO spread. Data from the first three components will be used to model the spread of transgenes in the environment.
- Workshop forums with key users of the research and interested parties. These forums will: help provide decision-makers and other stakeholders with information enabling them to take account of research findings when considering applications for the commercial release of genetically-modified plants or other organisms;

<sup>19</sup> NSOF funds Crown Research Institutes for public good science and technology that is independent of government priorities, in order to maintain their viability and capacity. This funding amounts to 10% of the total value of funding from the previous year.

and, act as a vehicle for discussing and disseminating the study results.

The research programme draws on related international research on HGT but does not replicate it, as this programme focuses on environmental factors influencing HGT with a view to predicting adverse effects. Collaborations developed through this programme include those with CSIRO in Australia, University of Tromso in Norway, Crop & Food in Lincoln regarding transgenic potato plants and Canterbury University, and there are plans in train to develop research collaboration with the Federal Biological Research Centre for Agriculture and Forestry (BBA) in Germany.

Several of the team have attended international conferences on HGT and soil, so they are closely linked with international research in this area.

The FRST website will have on-going information on the progress of this and other programmes that it funds, including annual progress reports (the first year report will be published in August 2003).

## SECTION THREE: IMPACT OF THE GOVERNMENT'S RESPONSE TO THE RCGM RECOMMENDATIONS ON BIOTECHNOLOGY IMPACTS

The majority of New Zealand biotechnology impacts research is aimed at supporting policy and decision-making about biotechnology in New Zealand. This research, therefore, has a strong New Zealand focus. However, because New Zealand does not sit in isolation from the rest of the world, and because the quantity of our research is small in terms of the total international research, New Zealand research and policy needs to draw on relevant international experience.

This section provides a context for the New Zealand biotechnology impacts research, both in New Zealand and internationally. It does so by describing the contribution of this research to policy and decision-making in New Zealand. In addition, an international perspective to the New Zealand research is provided. The international perspective draws on two reports prepared for MoRST by Dr Mark Lonsdale and Professor Brian Wynne, where the balance, strengths and weaknesses of New Zealand biotechnology impacts research was assessed and compared with overseas research.

### ***3.1 The New Zealand Context***

#### *3.1.1 New Zealand Policy and biotechnology impacts research*

The primary users of publicly funded research in biotechnology impacts are government agencies involved in biotechnology policy and decision-making in New Zealand. MoRST approached a number of agencies in order to assess how the New Zealand research supports their work. Agencies were given information about research projects being done (in Annex One) as a basis for discussion. Interviews or feedback were then sought from these agencies<sup>20</sup>.

They were asked a series of questions:

- How does your agency ensure that [GM/biotechnology policy or operational] decisions are informed by relevant New Zealand and overseas research?
- Does your agency contract your own research in this area?
- Does your agency participate in the early framing of [contracted or outside] research?
- How do you ensure that this research is relevant, or produced in a form that is useful to your organisation?
- Are there priorities for research that is not being carried out at present that would aid in your agency's decision making?

This assessment was done with the knowledge that much of the relevant research is newly established; many research programmes began in July 2002, with a number of others not starting until April 2003. It is likely that some parts of the policy community were not fully aware of the range of research that is occurring. The recent nature of the research also makes it likely that the full results, and consequently their contribution to policy, will not be seen for some time.

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<sup>20</sup> ERMA, MfE, FSANZ, Consumer Affairs, Bioethics Council Secretariat, TPK, DoC, MoH, MAF.

In addition, there have been a number of changes to the biotechnology policy environment in New Zealand. These changes<sup>21</sup> provide an additional context for the research, and they also introduce further complexity when considering how research contributes to policy and decision-making.

General themes arising from these interviews are summarised as follows:

- **Networks.** Agencies rely on informal and formal policy and research community networks, both in New Zealand and internationally, to ensure that policy is informed by up-to-date, relevant research.
- **Engagement between research and policy is evolving.** The engagement between policy agencies (as end users) and the research community has traditionally occurred at the research proposal development stage, prior to research being funded, rather than during the course of the research. This has changed more recently as some research programmes have begun to establish steering groups, comprising policy agency representatives, with the aim of ensuring on-going engagement. This involvement has a two-way benefit: the early input of research results into policy and feedback from policy developments into the research process.
- **Engagement between research funders and policy.** FRST has worked closely with most agencies in developing guidelines for research applications to refine priorities for the areas in which it will fund. In addition, many agencies have representatives sitting on FRST panels that assess research proposals and make recommendations for programmes to be funded.
- **A wider “social” dimension to the research supported.** Agencies note the increasing emphasis on social, particularly cultural and ethical, aspects of policy associated with biotechnology and research in general. The increased emphasis on research related to these issues is welcomed by agencies. Agencies generally felt that this type of research needs to be on-going, New Zealand specific, yet cognisant of international trends on social aspects of biotechnology. This is because prevailing views may change as new information and knowledge emerges.

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<sup>21</sup> Changes include those that have come about as a result of the Royal Commission on Genetic Modification such as:

- amending the Hazardous Substances and New Organisms Act;
- establishing Toi te Taiao: the Bioethics Council;
- developing the New Zealand Biotechnology Strategy; and
- developing strategies and mechanisms for co-existence of GM and non-GMOs.

Other changes are more broad but they still impact on policy and biotechnology impacts research. These changes include:

- Growth and Innovation Framework, where biotechnology was identified as a growth sector for New Zealand;
- Regulation of assisted human reproductive technology and related research;
- Review of legislation associated with the use of human tissues; and
- Review of the Patents Act

- **Supporting the environmental research portfolio.** Agencies support the generic New Zealand-specific environmental impacts research that has been commissioned recently, and felt this research would be useful for their work. This work will be particularly useful for supporting decisions about the co-existence<sup>22</sup> of different production systems, which is a crucial component of the “preserving opportunities” theme of the RCGM. As with the social impacts research, there was an acknowledgement that this research should continue due to its long-term nature, and that it will draw on international literature. Many agencies also have operational research budgets, which could support research specific to their own needs and impacts of specific applications to release GM organisms or products would be done through the applicant’s own research.
- **Reviews.** Much of the work contracted by agencies is in the form of literature reviews of relevant research that is occurring in New Zealand and overseas. These collate the current state of knowledge in particular areas. Twice each year, for example, the New Zealand Food Safety Authority reviews awareness of genetically modified food issues (this came about from a recommendation made by the RCGM)<sup>23</sup>. Although this kind of review gives a snapshot of where research is in terms of published literature, it cannot monitor or easily identify emerging research trends. This suggests that the moves to develop closer links between researchers and policy agencies during the course of their research should continue to be further developed. Recent projects that agencies have funded of this nature are included in Annex Three.

### ***Uptake of research into policy through “osmosis”***

Research can contribute to policy at a number of points in the policy process, from policy agenda setting through to policy formation and policy implementation<sup>24</sup>. However, the direct impact of research on policy is often hard to confirm. A wide body of international literature in this area indicates that there is rarely a direct linear link from research into policy. Rather, research involves the interaction between researchers and users of research, in this case policy makers, and research findings gradually ‘percolate’ into the policy arena<sup>25</sup>.

Professor Brian Wynne has noted on reflection from his visits to New Zealand that as a small country with generally good scientific resources, the capacity for government [policy agencies] to absorb and translate research into policy decisions is rapid relative to more dense and complex policy systems such as European ones<sup>26</sup>. This provides a positive sign that New Zealand-specific research can be incorporated into policy and decision making around GM and biotechnology in New Zealand.

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<sup>22</sup> One of the key overarching themes of the RCGM was to preserve opportunities through co-existence. Co-existence refers to a state where:

- different primary production systems – including non-GM systems such as organic production and conventional agriculture, and GM systems – are each contributing in their own way to the overall benefit of New Zealand; but
- their operations are managed so that they affect each other as little as possible.

The Government has agreed to a working assumption “that effective co-existence of GM and non-GM production can be achieved in New Zealand by proceeding carefully and rigorously examining each use of a GM organism on a case-by-case basis within the context of New Zealand’s comprehensive regulatory framework.” (POL Min (03) 8/6)

<sup>23</sup> RCGM Recommendation 8.1 “that the Food Administration Authority monitor research studies on stock feed and act on any that indicate a need for stock feed to be assessed in relation to human health”.

<sup>24</sup> See for example <http://www.health-policy-systems.com/content/1/1/2>.

<sup>25</sup> [http://www.gdnet.org/subpages/RAPNet/Abstracts/Bridging\\_R&P-Abst\\_097.html](http://www.gdnet.org/subpages/RAPNet/Abstracts/Bridging_R&P-Abst_097.html).

<sup>26</sup> See his report for MoRST “New Zealand Social Research on Impacts of Genetic Modification and Related Biotechnologies: an international strategic review”.

At the same time, however, both Professor Wynne and Dr Lonsdale stressed the importance of enhancing the interface between policy and research to ensure that research findings, particularly social research findings, are effectively translated into policy in New Zealand.

### Case Study Two

#### The Fate of Biotechnology: Why do Some of the Public Reject Novel Scientific Technologies?

Contract let by the Foundation for Research, Science and Technology to Lincoln University

Contract number LINX0204, Programme Leader, Dr John Fairweather

Funding \$409,000 per year

This programme was developed and is being led by Dr John Fairweather (Agribusiness and Economics and Research Unit, Lincoln University) and Dr Hugh Campbell (Centre for Study of Agriculture, Food and Environment, Otago University). They put in a proposal in response to the tender that FRST ran in late 2001 which identified the need for research in "the sociological aspects of biotechnology". The contract for this programme began in July 2002.

The proposal development drew on research and collaborations that the research teams were already doing in related areas such as investigating novel technologies in primary production, social aspects of innovation, opinion surveying, food scares, economic consequences of adoption of new technologies and decision making. The proposal was developed in conjunction with other researchers and policy agency staff.

The main objectives of the five year research programme are to:

- identify perceived effects of biotechnology and document the perception of risks associated with personal and general use of biotechnology;
- determine the relative importance of the key perceptions of risks;
- determine the social and cultural factors that underlie the identified risk perceptions, including international comparisons;
- model the trade impacts of various scenarios of risk perception relating to new technology uptake; and
- synthesise results into a socio-economic risk-assessment protocol in order to assist end-user decision-making and communication.

This funding has enabled some research related to Maori perceptions to be carried out and it has enabled research capability to be further developed in areas such as focus group research and analysis of focus group data.

The work is related closely to overseas work, in particular work done on public perception of biotechnology in Europe<sup>27</sup>. During the research, public perceptions in New Zealand will be compared with those in Europe and other countries. Formal research arrangements have already been developed with researchers Australia, the UK and the US.

High quality research in this programme is assured by: (1) engaging suitably qualified researchers; (2) organising the on-going research in ways that allows researchers to do work that meets target standards (publishing in peer-reviewed international journals); (3) arranging working meetings among the research team to discuss emerging results; and (4) drawing on the proven expertise of at least four international collaborators to add independent critical scrutiny of the emerging results.

The FRST website will have on-going information on the progress of this and other programmes that it funds, including annual progress reports (the first year report will be published in August 2003).

<sup>27</sup> See <http://www.lancs.ac.uk/depts/ieppp/pabe/>.

### ***3.2 International Context***

MoRST contracted two internationally recognised researchers to look at general themes and future trends on the global research scene. Where possible they were asked to note how New Zealand research aligns with international trends, what if any gaps existed in the New Zealand research, and to make recommendations as appropriate. The contractors were given the information that is outlined in Annexes One to Three as a basis for their analysis. This information is largely a summary of the research objectives (as many programmes are recently established) rather than an overview of the research results and methods for disseminating these results. The contractors were also provided with more specific contract information for FRST programmes.

Dr Mark Lonsdale is the Strategic Director of Entomology Division of CSIRO in Australia. He was involved in the establishment of the CSIRO programme on ecological implications of GMOs (2000-03), and became coordinator in July 2000<sup>28</sup>. Dr Lonsdale provided an analysis on the New Zealand impacts research with a particular focus on the environmental impacts.

Professor Brian Wynne is Professor of Science Studies and Deputy Director of the Research Centre for the Economic and Social Aspects of Genomics (CESAGen)<sup>29</sup>, at Lancaster University. He has developed extensive experience of international research and policy on environmental, risk, science-policy and public understanding of science issues. Professor Wynne provided an analysis on the New Zealand impacts research with a particular focus on the social impacts.

Although the two international reviewers were asked to review the environmental and social aspects separately, they did look at the whole of the impacts related research and in some cases have made comments that relate to the other areas. The reviewers, in some instances, chose to make comments about issues that were broader than research, such as the use of research in policy processes. While this was not the focus of their work, some useful insight may be gained from these perspectives. The following is a summary of their conclusions. Full reports are available on the MoRST website.

In general, these reviews assessed New Zealand's research effort in biotechnology impacts favourably, both in terms of amount of research funding and the balance of the research areas that are being supported. There were some areas that were recommended as opportunities for further research and also recommendations for the way research is used, carried out and taken up by policy. These recommendations will be considered for their relevance to New Zealand in Section Four.

### ***3.3 Review of environmental impacts by Dr Mark Lonsdale***

#### ***3.3.1 Trends in international literature***

Dr Lonsdale has noted the following themes that are currently being explored in the international literature relating to environmental impacts:

- Gene escape into related species and unrelated species;
- Potential for a GMO to invade natural or semi-natural ecosystems;
- Pesticide and herbicide resistance and resistance management;

<sup>28</sup> <http://www.ento.csiro.au/GMO-impact/index.html>.

<sup>29</sup> <http://www.cesagen.lancs.ac.uk/>.

- Direct impacts on biodiversity;
- Indirect impacts and impacts of changed farming practices on biodiversity; and
- Use of non-GMO introductions as model systems.

Dr Lonsdale noted future trends that are discernible in international literature:

- Increasingly broad framing of risk studies to consider off-site, off-target, and ecosystem level effects;
- Risk studies that take in a wider range of GMOs than the pest-protected crops currently being planted;
- International tensions around invoking the precautionary principle in risk studies;
- Increasing emphasis on GMOs in a broader sustainability context; and
- Disagreements over appropriate baselines for comparison of GMO impact.

### 3.3.2 Strengths of New Zealand environmental GM/biotechnology impacts research

Dr Lonsdale noted the following key strengths about the New Zealand impacts research portfolio:

- The overall size of the activity, at NZ\$7 million per year, is impressive. By comparison, the comparable CSIRO effort in Australia is around AUD \$1 million per year.
- There is a commendably large relative effort in social research and risk communication research.
- There seems to be a good emphasis on broader framing of the risk studies and on indirect effects of various kinds.
- There seems to be a substantial effort in studying community or ecosystem level and off-site impacts.

### 3.3.3 Opportunities for New Zealand environmental impacts research

The following issues were identified by Dr Lonsdale as research areas that were not obviously present, or not strongly represented, in the New Zealand biotechnology impacts research.

- **Farming systems effects.** Dr Lonsdale was of the view that it is arguable that the main effects of GMOs will not be from the GMO itself but in how the GMO is used – how it affects the farming system. This is likely to be more important in more intensive farming systems and where regional biodiversity is dependent upon on-farm conservation. Dr Lonsdale noted that farming-systems thinking should be included as part of New Zealand research. He also noted that this would not easily occur in the current regulatory regime, but that the proposed conditional release category would allow for larger scale studies to be carried out.
- **Effects (not just probability) of gene transfer.** Dr Lonsdale noted there is likely to be a shift in gene transfer research internationally, from establishing the probability of its occurrence to

exploring the consequences of its occurrence. Although there is some research occurring in this area in New Zealand, he considered that more could be done.

- **Potential for invasion of natural or semi-natural ecosystems by a GMO.** This has been an area of activity internationally, but Dr Lonsdale commented that it seems comparatively little-represented in the New Zealand portfolio. It was noted that synergies could be possible with New Zealand biosecurity researchers, not just for risk assessment, but also for managing any risks if GM technology is taken up.
- **Improving risk assessment.** Dr Lonsdale noted that, globally, the science of risk assessment as it applies to GMOs is early in its development. This is in part because of the newness of the technology, but there is also a need for systems thinking that will identify the range of risks that are pertinent to a particular GMO.

### 3.3.3 Challenges for future research in environmental impacts

Dr Lonsdale noted the issues below as areas that could require attention. These issues are related more to the way in which research is carried out than to actual gaps in the research programmes:

- **Risk management approaches.** If GM crops are to be taken up, the community will demand: comprehensive long-term monitoring schemes; emergency response plans; and systems designed to minimise cross-contamination. Designing and implementing such schemes requires input from scientists, including New Zealand's biosecurity researchers, but research to plan for this will be required in New Zealand. Generic research should cover: (1) translating findings in the present New Zealand research portfolio into monitoring frameworks; (2) linking with New Zealand's biosecurity infrastructure to gain insights from past incursion responses; and (3) designing farming systems that are more robust to unforeseen hazards.
- **Appropriate baselines.** In carrying out studies of the impacts of GMOs on the environment, the baseline for comparison has to be established. Appropriate baselines may include: current conventional agriculture, or they could relate to an ideal which a country or region is aiming for.
- **Policy interfaces.** Translating the research findings – especially perhaps from social research – into policies and/or regulations will be a challenge. Dr Lonsdale felt that New Zealand will need to feed its research findings into the international policy debate to ensure that its desired outcomes are achieved. He noted that policy staff will need to interact with specialists in farming systems, integrated pest management, and agricultural economics, in deciding the best way forward for New Zealand. As a first step along this road, one- or two-day technical-policy workshops between scientists and policy developers and regulators are recommended as useful vehicles for knowledge transfer in both directions. Secondments of scientists into policy units could also be valuable.
- **Methodological approaches.** It has become clear that research into the environmental risks of GMOs will be held up to very detailed scientific scrutiny. Dr Lonsdale noted the importance of rigorous experimental methodologies and suggested this could be achieved by reviewing proposed methodologies before the research is started and by publishing in highly regarded international publications.
- **Decision theory.** Weighing up the risks and benefits of an action is the domain of decision theory. Dr Lonsdale noted "for GMOs, even where benefits seem less equivocal, the long term sustainability of those benefits is not obvious. Policy staff will need to interact with specialists

in farming systems, integrated pest management, and agricultural economics, in deciding the best way forward for New Zealand.”

### **3.4 Review of social impacts by Professor Brian Wynne**

#### 3.4.1 Strengths of New Zealand social impacts of biotechnology research

Professor Brian Wynne has noted the following strengths in New Zealand social impacts research:

- The overall volume of New Zealand social research relating to GMOs and biotechnology is relatively substantial, if recent. The balance and weight of the portfolio looks creditable overall, which for a small country “punches its weight”. The shift towards more qualitative and interactive forms of attitude and dialogue research in the portfolio is well-founded and reflects international trends.
- There has been a recent substantial growth of New Zealand biotechnology social research effort with an overall emphasis on public attitudes, dialogue and communication, and of ethical issues.
- New Zealand appears to be capable of rapid assimilation of scientific research knowledge into policy thinking, perhaps because of its relatively low-density policy ‘networks’ and its relatively sophisticated and resourced scientific base.
- The level of support for Maori cultural-ethical research compares well with other nations with similar multicultural issues. Professor Wynne suggested that this research could then integrate into with the wider social and scientific research agenda.

#### 3.4.2 Opportunities for the New Zealand social impacts research portfolio

Professor Wynne noted the following aspects of social research as areas which could require further focus. He noted that many of these aspects could require more focus for overseas research also.

- **Research on Real Human Behaviour as this affects, for example, co-existence.** Professor Wynne noted the need for social research to ascertain the viability of the co-existence of GM and non-GM production systems, and the credibility of this to international consumers, across the whole food chain. Co-existence related human-behavioural issues such as farmer behaviour were seen as a research need in New Zealand. This was also seen as a gap for international research.
- **Economics and Political Economy of Science in Globalised Networks:** Professor Wynne noted that “international political and trade conflicts over GMOs are intensifying” which will “highlight the processes by which existing decision-rules were established and regulatory science is constructed.” Thus Professor Wynne considered that “attention is likely to be focused quite intensely on how legitimate factors which are not easily amenable to scientific measurement are represented or excluded as decision-rules in such processes, and then administered in decisions.” “The international politics of these ‘regulatory’ knowledge-processes are obviously crucial to New Zealand as a global food exporter, but it is not clear that New Zealand has a social sciences research capacity to respond to these questions.”
- **Intellectual Property, Knowledge-commodification, and Global Responses.** Professor Wynne noted that he “international political economy of innovation knowledge includes its

transformation into an increasingly global commercial knowledge-culture”, which could have implications for whether a small country like New Zealand can keep hold of intellectual property. “The changing processes of opportunity and constraint on knowledge and its practical forms of exploitation, new kinds of international collaborative network, new forms of global resistance, and the legal-political as well as epistemic, cultural and ethical issues involved may need more social research attention.”

- ***Liability and Unanticipated Consequences.*** Professor Wynne wrote “as in other countries the issue of defining responsibility for future harm from GMO releases, and protecting those livelihoods and sectors at risk from such effects, is a difficult issue especially with international pressure for standardisation of approaches.” The cluster of philosophical, social, legal, ethical and political issues intertwined in this domain was noted by Professor Wynne as needing further attention.

### 3.4.3 Challenges for the way social impacts research is done, and used in New Zealand

Like Dr Lonsdale, Professor Wynne had some reflections about the way social research is carried out in New Zealand.

- ***Upstream Reorientation.*** Professor Wynne noted the importance of an “upstream focus” and integration of social research at the earliest possible stages of scientific and technical research and innovation. This would expose scientific knowledge-production to ethical, cultural and social issues at an early stage. An associated recommendation was to develop methods for anticipating the implications of future innovations, and in particular the intersections of GM sciences with other areas such as nanotechnologies and informatics. Related to the reorientation towards upstream framing of research, Professor Wynne has suggested the renaming of this area, that is currently referred to biotechnology “impacts” research. He thought that “impacts” can imply effects following from applications of research, rather than aspects that might be important before the scientific knowledge is developed.
- ***Inter-relationship between different science disciplines.*** Professor Wynne considered that the inter-relationships between natural science, environmental impacts-oriented research and social science research (for example, on farming practices which affect environmental processes and risks) need to be carefully reviewed. Where appropriate, he considered closer integration could be developed between natural and social research on such mixed human-environmental processes.
- ***Science Processes.*** There are international trends towards more critical scrutiny of peer-review and other scientific quality-control processes. Professor Wynne thought that New Zealand could consider how to make New Zealand policy and public uses of science (including social science) more transparently evidence-based; peer-reviewed; reflect uncertainties; and clear about assumptions. This would be a means of defending the robustness of knowledge used to make and underpin policy trajectories and decisions.

## SECTION FOUR: CONCLUSIONS AND ACTIONS FOR NEXT STEPS

### 4.1 *Biotechnology Impacts Research*

Since 1999 funding for New Zealand research to understand the impacts of new biotechnologies has moved from very little to a sizeable, comprehensive portfolio of multidisciplinary research with funding of over \$7 million per annum. The majority of this research capability is funded through Vote RS&T by FRST. There is a range of providers that carry out the research, with many CRIs and universities involved.

Biotechnology impacts can now be considered as a priority strategic research area for public good science and technology in New Zealand. This has resulted from:

- the early identification by FRST of this as a research need;
- the priorities agreed by the Government following the recommendations of the RCGM;
- the broader biotechnology policy work that has been occurring in New Zealand, particularly the Biotechnology Strategy<sup>30</sup>; and
- the Government focus on biotechnology as one of three important sectors to support growth in New Zealand.<sup>31</sup>

Policy agencies, as one of the key users of biotechnology impacts research, are often involved in the framing of the research, both with researchers and funding agencies. They are also increasingly involved during the progress of the research itself, to help ensure that the research remains relevant and useful. These agencies support the need for on-going biotechnology impacts research to support their work.

This report has described the research that has resulted in New Zealand being in the position to respond to the on-going research needs in understanding the impacts of biotechnologies. It has shown how the Government has responded to the research priorities noted by the RCGM, through new funding and reprioritising existing funding to establish new research in these areas. It has also described how this research will be used for decision-making around biotechnology in New Zealand.

Two overseas reviewers have also contributed to the development of this report, to provide a better understanding of the balance of research in the two broad areas of social and environmental impacts of new biotechnologies research. These reviewers noted that New Zealand funding levels are at least consistent with those in many other countries. In some cases New Zealand funds significantly more research in these areas. The international reviews also noted that the coverage of research areas within the environmental and social impacts area was comprehensive. They also noted that in some areas New Zealand is well placed to become an international leader through drawing on [New Zealand specific] research to inform its regulatory policy; integrating its social and environmental research; and understanding how a unique biota will interact with biotechnology.

Notwithstanding these strengths, there are some specific research areas that the international reviewers indicated could be further developed. These areas include research on:

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<sup>30</sup> <http://www.morst.govt.nz/?CHANNEL=BIOTECHNOLOGY+STRATEGY&PAGE=Biotechnology+Strategy>.

<sup>31</sup> The other two sectors were Information and Communication Technologies (ICT) and Creative Industries.

- the large-scale farming systems effects of GMOs;
- the effects (not just probability) of gene transfer;
- the potential for invasion of natural and semi natural ecosystems by GMOs;
- risk assessment;
- the social issues associated with co-existence; and
- economics, trade and regulatory issues.

#### 4.1.1 Analysis of recommendations made by international reviewers and implications for New Zealand research

Departments have reviewed the two international reviewers reports. Officials consider the issues identified by the international reviewers need to be considered in light of the New Zealand context, both in terms of the most pressing research areas for New Zealand (reflecting the most likely uses of GM organisms), and the policy work that has been carried out to date. For example, most of the GM crops commercially grown around the world have been broad acre crops such as maize, soybean, cotton or canola. The types of GM crops that are likely to be used in New Zealand in future will initially be on a much smaller scale (in the form of field tests and conditional release for evaluation purposes)<sup>32</sup>. They will also likely be of a different type (such as potatoes or onions) than those used overseas because our climate, market needs and crop growing industry are different. Further, medicines, animal vaccines, and pasture species are other areas where there could be uses of GM organisms in New Zealand in future. This will mean that New Zealand will need to develop its own models for the co-existence of GM and non-GM organisms relevant to its needs. It is also important to recognise the very large amount of work, though not specifically aimed at biotechnology, that has relevance to the management of GM and biotechnology. This includes biosecurity research and policy<sup>33</sup>, risk assessment methodologies and sustainability research (funded by FRST, MAF and MfE).

The case-by-case decision-making around the introduction and development of GM organisms in New Zealand allows the consideration of their benefits and risks. Decisions are made with the evidence presented by applicants and information from public submissions. This process supports new impacts research findings being incorporated into decision-making processes.

The HSNO Act is being amended to allow for the release of GM organisms with controls ("conditional release"). This will allow for more comprehensive research trials to be undertaken to help answer some key research questions, such as monitoring the environmental and socio-economic effects of using GM organisms in New Zealand where needed. It may also be a useful mechanism to look at some of the social science questions such as farming behaviours related to co-existence.

Some issues that were raised by the international reviewers are policy issues rather than research issues that may need further work. There has been extensive policy analysis carried out in a number of areas, some of which (such as liability issues) have culminated in the legislative changes proposed for the HSNO Act. Other policy work, such as economic analysis and co-existence, will continue to monitor international and local research and policy, and draw on New Zealand and international research. While there has been much generic work done in these areas, the detailed work will only be able to be

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<sup>32</sup> Results from a survey carried out by ERMA indicate that prior to June 2004 there is one likely pre-commercial (i.e. research) application for the conditional release of a GM plant.

<sup>33</sup> See for example the Biosecurity Strategy at [www.maf.govt.nz/biosecurity/bio-strategy/index.htm](http://www.maf.govt.nz/biosecurity/bio-strategy/index.htm)

dealt with once there is a better indication of the types of organisms that are likely to be introduced here.

The issues noted by the international reviewers therefore need to be considered in light of the New Zealand policy, regulatory and research context. The overall balance of research areas and funding allocated to existing research programmes does, however, appear to be adequate. That is not to say that research programmes should not consider incorporating some of the reviewers' ideas in their research programmes. Policy agencies and researchers already have mechanisms available to address these areas through existing FRST funded research programmes or, where there are specific policy uses, through the operational budgets of government agencies, such as MAF.

#### ***4.2 Biotechnology Impacts Research and Policy***

Research is an on-going process which can be long-term in nature and which can evolve as questions are answered and new questions arise. There was a low level of environmental biotechnology impacts research occurring prior to the RCGM reporting. Most of the research programmes arising from the Government support for more research in this area have been established since July 2002 (see Figure One). It is therefore likely that the full contribution of this research to policy will take some time. This means that it is important to maintain a close interface between research and policy to ensure that research results can be incorporated into policy at the earliest stages and in a form that is readily used. This will be assisted through the close engagement of policy and research staff throughout the course of research, from proposal development, to selection of high-quality relevant research programmes and the contracting of research, through to the research process itself and finally the delivery and uptake of results.

Professor Wynne noted that the incorporation of research results into policy is faster in New Zealand than in other countries. Although research may not necessarily directly link into policy, this flexibility and rapid promulgation of results into the policy sphere is useful.

The total amount of research funding in New Zealand is small in comparison with global research investment. In addition to New Zealand-specific research, the policy and regulation of emerging biotechnologies will continue to require close links with international research and policy in related areas. The international links that have been developed through the funding of this research will continue to build a research capability in New Zealand that is able to respond rapidly to current and emerging New Zealand policy needs. New Zealand research will also be of international interest.

The international reviewers were contracted to provide recommendations for future New Zealand research. In addition, these reviews commented on the way in which the research is carried out, and how it is used by policy. These comments included recommendations for:

- continued scrutiny of science processes both before research is carried out, and its interpretation into policy including peer review;
- improving the interface between research and policy;
- continuing to expand the nature of 'impacts' research, particularly social research, to an involvement at an earlier stage in the research process through the closer interaction of social and biophysical (both biotechnology impacts and biotechnology development) research. This change in focus could also be reflected through considering the terminology of "impacts", and changing the title of this research to "biotechnology aspects" or "biotechnology implications" research.

### ***4.3 Organics and Sustainable Agriculture Research***

Organics and sustainable agriculture research has had a change in focus following the recent FRST review. This research, along with other sustainability-related research, has moved from a focus on individual production systems to a more holistic, systems approach. The government funding for research specific to organic farming needs to be considered in the broader context of funding for research contributing to sustainable primary industries in New Zealand. Following the FRST review, approximately \$3 million per annum is now invested in research specific to the organic sector (compared with approximately \$2.2 million previously), and more than \$50 million is invested in research that benefits the sustainability of all primary industries. Organic farming utilises the benefits from much of this research.

It is not considered that any further immediate actions or recommendations are required for this area, given that FRST has recently completed a review and reinvestment in this area. The programmes that have been funded following the FRST review will commence in October and are likely to run for five years. There is capacity for programmes to be reviewed in this time, to ensure the on-going relevance of the research is maintained.

### ***4.4 Concluding remarks and actions***

Since the report of the RCGM in 2001, research into the environmental and social impacts of GM has been co-ordinated and consolidated into a comprehensive portfolio of research which addresses a wide range of issues relating to the use of GM and biotechnology in New Zealand. A number of the research programmes began recently, but already there has been useful dialogue between the environmental and social research teams and this relationship is likely to increase over time.

This research package was not intended to, and will not, answer all the questions about the potential impacts of GM organisms in New Zealand. These research programmes are intended to address the generic social and environmental issues about GM and biotechnology impacts in New Zealand. The results will support policy agencies and regulators with responsibilities relating to GM and biotechnology. Any application to release a particular GMO will need to have comprehensive information about the potential impacts of the particular organism based on New Zealand and/or overseas research.

The on-going review of the impacts of biotechnology and its relevance to policy and decision-making in New Zealand will be considered as part of the work programme that MoRST undertakes through its work programme around the implementation of the Biotechnology Strategy. The key theme of the strategy is to develop biotechnology with care, and to ensure there is a balance between the development and the assurance (in terms of environmental and human safety and community engagement) of biotechnology. A component of the implementation of the strategy is to maintain oversight of biotechnology research and its contribution to New Zealand.

The implementation of the Biotechnology Strategy is a cross government exercise. A number of different agencies are involved in different aspects of the strategy. These agencies provide different perspectives and ensure that policies are tested and the final policy is robust. MoRST provides an overview role in relation to biotechnology and its regulation.

Departments who have reviewed this report have agreed with the following actions:

***Investigate how the research areas identified by the international reviewers for further consideration relate to the New Zealand policy and environment and, if appropriate, identify***

**ways in which these areas can be incorporated into existing research programmes, or funded through new programmes.** This will involve the on-going discussion between FRST, research providers and government agencies, in particular MAF and ERMA, to ensure that the on-going needs of these agencies are met and how any new research areas might be funded. FRST contracts are renewed every two years and during the course of programmes there is opportunity to vary work if new priorities emerge.

**Consider how impacts research, particularly the social research, can continue to move to an “upstream focus”.** This will be done through more closely aligning the biophysical research (both biotechnology development research and environmental impacts research) with the social biotechnology impacts research. (FRST, research providers).

**Improve the interface between research and policy to ensure the robust and rapid translation of research results into policy.** Departments will explore the following opportunities:

- Using steering groups, comprising policy agencies, for programmes in biotechnology impacts research to discuss research progress and allow effective engagement between research and policy (research providers, FRST and policy agencies);
- Improving awareness of research occurring in New Zealand in biotechnology and its impacts. This could be achieved through, for example, forums such as FRST’s *Impacts of Emerging Technologies* Symposium held in September 2003, MoRST’s “Biolssues Forum” which is aimed at developing awareness of science issues in policy, and the work being done as part of the Community Engagement Goal of the Biotechnology Strategy<sup>34</sup> (FRST, MoRST);
- Contracting research outputs that are relevant to the policy community, by involving policy agencies in future investment and contracting processes (research providers, policy agencies and FRST);
- Using the “future watch” capability being implemented as part of the Biotechnology Strategy, to enhance the policy-research interface in New Zealand (MoRST and others such as the Bioethics Council and policy agencies); and
- Regularly reviewing New Zealand biotechnology impacts research to investigate how it is contributing to policy development (MoRST and policy agencies).

## ACKNOWLEDGEMENTS

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MoRST wishes also to acknowledge the following for their contributions to aspects of this report: Professor Brian Wynne, Dr Mark Lonsdale and Dr Craig Grant.

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<sup>34</sup> The relevant objective in the Community Engagement Goal in the Biotechnology Strategy is to “improve access to quality information about biotechnology developments, as well as information on regulatory processes for assessing potential benefits and risks and providing safeguards”.

## ABBREVIATIONS AND LINKS

Bioethics Council	Toi te Taiao: The Bioethics Council <a href="http://www.bioethics.org.nz">www.bioethics.org.nz</a>
CRI	Crown Research Institute
	AgResearch <a href="http://www.agresearch.co.nz">www.agresearch.co.nz</a>
	Forest Research <a href="http://www.forestresearch.co.nz">www.forestresearch.co.nz</a>
	Hort Research <a href="http://www.hortresearch.co.nz">www.hortresearch.co.nz</a>
	Crop & Food Research <a href="http://www.crop.cri.nz">www.crop.cri.nz</a>
	Landcare Research <a href="http://www.landcare.co.nz">www.landcare.co.nz</a>
	ESR <a href="http://www.esr.cri.nz">www.esr.cri.nz</a>
DoC	Department of Conservation <a href="http://www.doc.govt.nz">www.doc.govt.nz</a>
ERMA	Environmental Risk Management Authority <a href="http://www.ermanz.govt.nz">www.ermanz.govt.nz</a>
FRST	Foundation for Research, Science and Technology <a href="http://www.frst.govt.nz">www.frst.govt.nz</a>
GM	Genetic modification <a href="http://www.gm.govt.nz">www.gm.govt.nz</a>
HRC	Health Research Council <a href="http://www.hrc.govt.nz">www.hrc.govt.nz</a>
HSNO	Hazardous Substances and New Organisms Act <a href="http://www.hsno.govt.nz">www.hsno.govt.nz</a>
MAF	Ministry of Agriculture and Forestry <a href="http://www.maf.govt.nz">www.maf.govt.nz</a>
MfE	Ministry for the Environment <a href="http://www.mfe.govt.nz">www.mfe.govt.nz</a>
MoRST	Ministry of Research, Science and Technology <a href="http://www.morst.govt.nz">www.morst.govt.nz</a>
MFAT	Ministry of Foreign Affairs and Trade <a href="http://www.mfat.govt.nz">www.mfat.govt.nz</a>
Ministry of Justice	<a href="http://www.justice.govt.nz">www.justice.govt.nz</a>
NZFSA	New Zealand Food Safety Authority <a href="http://www.nzfsa.govt.nz">www.nzfsa.govt.nz</a>
RCGM	Royal Commission on Genetic Modification <a href="http://www.gmcommission.govt.nz">www.gmcommission.govt.nz</a>
RSNZ	Royal Society of New Zealand <a href="http://www.rsnz.govt.nz">www.rsnz.govt.nz</a>
TPK	Te Puni Kokiri: Ministry of Maori Development <a href="http://www.tpk.govt.nz">www.tpk.govt.nz</a>
The Treasury	<a href="http://www.treasury.govt.nz">www.treasury.govt.nz</a>

## ANNEX ONE: NEW ZEALAND VOTE RS&T FUNDED BIOTECHNOLOGY IMPACTS RESEARCH: RECENTLY COMPLETED OR CURRENT

This table outlines information about the New Zealand publicly funded research (via Vote RS&T and funded through FRST, HRC and the Marsden Fund) in the area of environmental, social, ethical, cultural or economic impacts of genetic modification (GM), and, more broadly, of impacts of biotechnology research.

The current level of public investment (through Vote RS&T) in GM-specific impacts research is approximately \$7.7 million per annum from 2003/04 (This includes new research projects, funded as a result of the Budget increase in the 2002 Budget which was \$1 million in 2002/03 rising to \$2.5 million per annum over the 2001/02 baseline in 2003/04 and outyears.) This Budget increase came about as a result of the Royal Commission on Genetic Modification which recommended that more research be done in these areas.

The table does not include research that uses GM as a research tool or is focused on developing new GM products, but it does include impacts research that is apart of larger research programmes that have these outcomes.

Environmental biotechnology impacts research					
Area	Lead Provider	Title	Objectives	Value	Timing
<b>Environmental:</b> Ecosystem Impacts Funding: FRST	AgResearch Dr Travis Glare	Environmental impacts of new technologies	The goal of this programme is to assess the environmental impacts of new technologies, such as GM plants and biopesticides, before they are used in New Zealand. Although measurement of direct toxicity to other organisms is easy to assess, environmental impacts may be much wider. This programme will assess the ecosystem impacts of several GM plants and biopesticides under development in New Zealand on ecosystems. Programme results will be used to develop risk assessment models for GM plants, microbes and biopesticides and areas of public concern over GMOs and other new technologies will be determined.	\$597,000 pa	1 July 2001–30 June 2004 Interim results by June 2003
<b>Environmental:</b> Vertical Gene Flow Funding: FRST	Landcare Research Dr William Lee	Gene flow risk assessment	The outcome of this program is a systematic analysis of the pathways and barriers to gene flow from GM crops in the New Zealand context. This will provide a framework and baseline data for environmental risk assessment and monitoring of potential GM crop releases in New Zealand. A major issue for GM crops is predicting the likelihood of escape or spread of the trans gene from crops to adjacent crops or to native or naturalised species. Gene flow can occur through movement of pollen, seed, or vegetative propagules. Certain gene flow processes are highly context dependent (e.g. pollinator populations, agronomic practices, climatic factors). We will provide assessment of gene flow in New Zealand conditions by producing a database, analysis of gene flow processes (pathways and barriers), and field case studies of selected crops with high gene flow potential. Our New Zealand Plant Biosafety Database will contain international and New Zealand-specific information on pollination systems, hybridisation with native and naturalised species, and dispersal abilities of all major New Zealand crops. This provides a platform for objective assessment of gene flow potential and will help identify deficiencies in our knowledge. Our field case studies of crops will provide a prototype method for rapid initial assessment of spontaneous gene flow in the wild.	\$486,000 pa	1 July 2002–30 June 2005 Prototype database by June 2003. Functional data-base by June 2004

<b>Environmental:</b> Horizontal Gene Transfer Funding: FRST	ESR Dr Phil Carter	Horizontal gene transfer in the NZ environment	This programme is aimed at understanding components of horizontal gene transfer in order to predict the risks of ecological consequences from GM field use in New Zealand, e.g., how NZ soils may respond distinctively in terms of HGT and DNA persistence. The research programme will provide decision-makers and other stakeholders with information to enable them to take account of research findings when considering applications for the commercial release of genetically modified plants or other organisms. From 1 July 2003 an additional \$74k per annum has been provided to this programme to investigate issues associated with HGT and antibiotic resistance.	\$601,000 pa	1 July 2002–30 June 2005  Interim results by July 2004
<b>Environmental</b> Funding: FRST	Crop and Food Research Dr Tony Conner	Environmental Impacts of GM Crops  (Objective in programme, Knowledge and economic benefit from sustainable plant gene technologies)	Research in the programme will contribute to an enhanced public understanding and risk assessment of the possible environmental effects of transgenic crops. It will investigate the impacts of GM crops in the New Zealand environment by assessing the invasiveness of GM crops, the potential for gene flow to other crops and the New Zealand flora, the interaction of insect-resistant GM crops on non-target pests and beneficial insects, the effects of GM crops on populations of non-target soil biota, and the measurement and persistence of DNA sequences in the environment and in food.	\$775,000 pa	1 July 2002–30 June 2008  Interim results June 2004, June 2006
<b>Environmental</b> Funding: FRST	Crop and Food Research Dr Peter Cameron	A pest resistance management plan for transgenic Bt-vegetables in New Zealand  (Objective in Knowledge and economic benefit from sustainable plant gene technologies)	The programme uses plant gene technologies to improve the competitiveness of NZ's biotechnology-based industries. The research aims to: develop technologies for using 'plants as factories' for the production of peptide gene products for high value applications such as medical or veterinary use; understand plant metabolic pathway regulation to enable development of high value plant products from plant primary and secondary metabolism pathways; discover genes underlying fundamental plant processes with an emphasis on quantitatively inherited genetic systems; and develop novel gene transfer technologies, focusing on introgression of genes between species by wide crossing and the development of novel transformation technologies. The programme also contains research that is aimed at understanding the environmental impacts of genetically modified crops. The research into environmental impacts is multidisciplinary and involves researchers from other research organisations. It will be coordinated with other research being conducted within New Zealand on the environmental impacts of genetic modification.	\$62,500 pa	1 July 2002 – 30 June 2008
<b>Environmental</b> Funding: FRST	HortResearch Dr Richard Newcomb	Environmental Impacts of plant gene technologies  (Objective in programme, Exploiting opportunities from horticultural genomics)	Research in this programme will generate new knowledge on the potential environmental impacts of products emerging from horticultural plant gene technologies research. In the first instance, this will focus on measuring the persistence of gene products in soil and along food chains.	\$150,000 pa	1 July 2002–30 June 2008  Interim results June 2004, June 2006
<b>Environmental</b> Funding: FRST	Crop and Food Research Dr David Teulon	The role of indigenous pollinators as NZ-specific mechanisms for transgene flow	The outcome of this programme is improved understanding of the environmental impacts of genetic modification by identifying New Zealand-specific pathways, especially by indigenous pollinators, for pollen dispersal within and between productive and natural environments.  The New Zealand natural environment features pollinator assemblages quite different from those found elsewhere. Very little research has been done on the pollinators of important New Zealand	\$370,000 pa	1 April 2003–30 June 2008

			<p>crops. Thus, conclusions based on data from other countries may not be valid for New Zealand conditions.</p> <p>The species composition of pollinator assemblages in two New Zealand model crop systems, over five years, will be identified, the relative importance and function of each component species quantified, and the ability of selected indigenous pollinators to transfer pollen over distance determined. Three key factors that may influence the degree of pollen dispersal will be examined.</p> <p>This research will provide critical information for developing risk assessment models to predict the risk of pollen-mediated transgene escape. The research will contribute key information for developing protocols to minimise pollen dispersal, lessening the likelihood of unwanted environmental pollution, economic loss arising from devaluation or write-off of crops, potential loss of markets, and litigation.</p>		
<p><b>Environmental</b></p> <p>Funding: FRST</p>	<p>Hort Research</p> <p>Dr Louise Malone</p>	<p>Selecting non-target invertebrate species for testing the biosafety of new technologies</p>	<p>This programme aims to develop procedures for determining how to select the most appropriate species for non-target invertebrate testing for any given proposed release of GM plants. Because New Zealand has unusually high levels of endemic species, overseas protocols are not necessarily useful. New Zealand has considerable expertise in predicting the impact of introduced non-GM organisms such as natural enemies of pest insects, but these protocols may not be appropriate for GMOs. Both will be reviewed and evaluated. The practicality and usefulness of conducting non-target tests in containment will be investigated in experiments with prototype GM plants such as pine and clover and beneficial insects such as predatory beetles and native weevils. A post-doctoral project will determine the importance of insect species in the diet of a native bird or reptile. Maori perspectives and input will be sought with the aim of ensuring that Maori interests in non-target organisms are protected.</p> <p>The main output of the programme will be a robust, rational standard operating procedure (SOP), specifically tailored to New Zealand's unique biodiversity and habitats, for selecting non-target invertebrates for testing new agri-technologies. CRIs and private companies developing or importing GM plants, and ERMA in its advisory capacity, will be among the first users of this SOP: it will help to guide them in the design of experiment to assess non-target impacts under containment. ERMA will also use the SOP to assist with the evaluation and review of applications to release GM plants</p>	<p>\$400,000 pa</p>	<p>1 April 2003–30 June 2008</p>
<p><b>Environmental and Social</b></p> <p>Funding: FRST</p>	<p>Forest Research</p> <p>Dr Christian Walter</p>	<p>Environment and risk management</p> <p>(Objective in programme, Forest Genetics for the future - From Lab bench to forest)</p>	<p>This research focuses on understanding and mitigating risks associated with modern plantation forest biotechnologies, including both technical and social/cultural aspects. Another focus is to establish formal links and ongoing interactions with Tangata Whenua regarding the scientific and commercial applications of new genetic technologies.</p>	<p>\$450,000 pa</p> <p>[estimated that the research is equally split between social and environmental impacts research]</p>	<p>1 July 2002–30 June 2003</p> <p>This contract may be extended to June 2007, conditional on meeting milestones in Year 1</p>
<p><b>Environmental</b></p>	<p>University of</p>	<p>Estimating the risk of</p>	<p>This project aims to examine the risks of Horizontal Gene Transfer (HGT) occurring between plants</p>	<p>\$50,000 pa</p>	<p>Two years funding from</p>

Funding: Marsden Fund	Otago Dr Peter Dearden	horizontal gene transfer from genetically modified crops	and the pest species that feed upon them. Horizontal gene transfer is a naturally occurring process whereby DNA is passed from one organism to another, across species barriers. The research will use a common pest species, the Two-Spotted Spider Mite, to examine three aspects of horizontal transmission. Firstly, the rate of HGT from GM plants to gut bacteria in the mite will be examined. Secondly, the rates of HGT to the mite itself will be investigated. Thirdly, the impact HGT has had on the mite genome will be studied. Natural horizontal gene transfer from normal plants will be studied to determine if this phenomenon has had a significant impact on genome evolution in nature. The programme will also study horizontal gene transfer from genetically modified crops to help us determine some of the risks of releasing genetically modified plants into the environment.		2002
<b>Environmental:</b> Horizontal Gene Transfer *  Funding: Marsden Fund	University of Canterbury  Dr Jack Heinemann	DNA transfer between bacteria and eukaryotes	This project is investigating the biochemical processes that lead to DNA being transferred from prokaryotic cells (as in bacteria) to eukaryotic cells (as in animals). This is research fundamental to the understanding of recombinant organisms and horizontal gene transfer. The possibility of transfer to the mitochondria in animal cells, as opposed to the nucleus, is being studied also. This has implications for mitochondrion-based diseases such as muscular dystrophy.	Year 1: \$176,000  Year 2: \$192,875  Year 3: \$159,125	1 March 2000–31 May 2003  Interim results published. Publications expected from mid 2003.
<b>Environmental:</b> Horizontal Gene Transfer*  Funding: Marsden Fund	University of Otago  Dr Geoffrey Tompkins	Bacteriocin-facilitated gene acquisition	Bacteriocins are substances produced by some strains of bacteria that kill other closely related bacteria. This project is investigating the role that bacteriocins play in horizontal gene transfer. Are the closely related bacteria killed to release DNA for assimilation by the bacteriocin-producing strain or are they killed to stop them competing for scarce free DNA?	\$128,000 pa	1 March 2000–28 February 2003  Interim results presented. Publications from mid 2003.
<b>Environmental:</b> Horizontal Gene Transfer*  Funding: Marsden Fund	University of Otago  Assoc. Prof. Clive Ronson	Evolution of a microbial genome	The researchers are looking at the role of gene acquisition in the evolution of a population of soil bacteria (e. can the bacteria "grow" their genome?) and how the bacteria adapt to niches. Specifically, they aim to determine the extent of newly acquired DNA adjacent to a particular gene from soil bacteria.	\$138,000 pa	1 February 2000–31 January 2003  Interim results presented. Publications from early 2003.
<b>Environmental:</b> Horizontal Gene Transfer*  Funding: Marsden Fund	University of Otago  Dr John Sullivan	Functional Genomics of the Mesorhizobium Symbiosis Island	This research aims to use a genomics approach to investigate the roles of previously uncharacterised genes on the "symbiosis island" of the soil bacterium Mesorhizobium loti. This DNA island transfers to non-symbiotic bacteria and enables them to colonise and form root nodules in lotus plants. Previous Marsden research by this team has defined the DNA sequence of this island and its genetics.	Year 1: \$178,000 Year 2: \$178,000 Year 3: \$194,000	1 March 2001–29 February 2004  Publications expected end of 2003

\* These research projects are primarily investigating naturally occurring, rather than GM-specific, horizontal gene transfer. The results will, however, have some relevance to the overall understanding of environmental impacts of GM. They are not included in the total funding estimated for GM impacts research.

Social biotechnology impacts research					
Area	Lead Provider	Title	Objectives	Value	Timing
<b>Social:</b> Economics and Consumer perceptions Funding: FRST	HortResearch Dr Joanna Gamble	Consumer impacts of horticultural genomics	This research identifies groups that are willing to invest in plant gene technologies and explore the beliefs, attitudes and perceptions that will influence their decision to invest. It also develops the technique of experimental auctions to provide estimates of demand for new products. The long-term aim is to develop an insight into consumer behaviour that can be used to identify appropriate technologies perceived to be more acceptable by consumers.	\$149,000 pa	1 July 2001 – 30 June 2003. Interim results reported May 2002
<b>Social:</b> Cultural Values Funding: FRST	University of Auckland Dr Mere Roberts	Incorporating tangata whenua values into scientific decision making: what and how?	This research programme has the following objectives: (1) identification of key cultural values and beliefs that tangata whenua from varying backgrounds perceive as being affected by GMO research. Extension of this programme will enable (2) an investigation of the relative risks/benefits of a range of GMO applications on key values and beliefs of tangata whenua, and how perceived adverse risks might be minimised; (3) the development and refinement of a process whereby key values are incorporated into a decision making framework (DMF) and; (4) the creation and advancement of Maori human capital in this area of knowledge and expertise.	\$200,000 pa	1 July 2001–30 June 2004 Interim results by 2003
<b>Economic:</b> Funding: FRST	Lincoln University Professor Caroline Saunders	Develop a model linking trade, production systems and the environment	This project involves building the capability to model the potential impact of new agricultural technologies on New Zealand's internal and external markets. The model is able to separate out GM and non-GM products in New Zealand and our key markets, for 14 agricultural commodities. This enables assessment of the impact of changes in price preferences in NZ and overseas on our producers, as well as changes in the uptake of the technology in New Zealand and overseas; the productivity gains in this technology both here and overseas; among other factors.	\$200,000 pa	1 July 2002 – 30 June 2003
<b>Social:</b> Risk Perception Funding: FRST	Lincoln University Dr John Fairweather	The Fate of Biotechnology: Why do some of the public reject novel scientific technologies	This research identifies the key socio-economic impacts of biotechnology by assessing public perception of technological risk. The research will identify generic public perceptions of biotechnology risk and determine underlying causal factors. It will also assess downstream socio-economic outcomes. The main research output will be a decision support protocol enabling policy makers to improve their decision making by incorporating social and community values.	\$409,000 pa	1 July 2002–30 June 2006 Interim results by September 2003
<b>Social:</b> Public Attitudes Funding: FRST	AgResearch Dr John Smith	Modelling reproductive technologies Objective in (New & Novel Products through Reproductive and Transgenic Technologies)	The programme provides new and improved biotechnology-based reproductive technologies and high value products to transform New Zealand's farming operations into high value biological enterprises and to improve human health. Studies in the objective are undertaken to describe public beliefs and attitudes towards biotechnology and to determine the role of the technologies in the farming industry. Public social and ethical issues examined include: intrinsic moral values regarding GE technology, extrinsic beliefs about the global consequences of GE, trust in authorities responsible for the development, regulation and production of GE products, perceptions of social norms regarding GE. These factors are considered in relationship to consumer purchase intentions regarding a hypothetical GE product. Changes in these public social and ethical attitudes over time will also be examined.	\$186,000 pa	1 July 2002–30 June 2003

<b>Social:</b> Public attitudes Funding: FRST	AgResearch Bruce Small	Public attitudes to GE forage crops  Project within Objective Technology and Knowledge Platform in plant genomics programme	This research examines public attitudes to the development of GE forage plants designed to have health benefits for humans eating animals fed on them. It contrasts attitudes to GE forage plants with attitudes to forage plants designed to have similar benefits but developed using 'marker assisted selection' rather than GE.	\$30,000 p.a.	July 2002 – June 2004
<b>Social:</b> Ethics Funding: FRST	University of Canterbury Rosemary du Plessis	Constructive conversations: Biotechnologies, dialogue & informed decision making	This programme is directed at greater public participation in technological decision-making. It has three core objectives:  1. Methodological innovation: to develop, pilot and evaluate a methodology for facilitating constructive conversations among diverse participants and contentious technology issues in the Aotearoa/New Zealand context. This component is informed by attention to appropriate methodologies for dialogue with Maori.  2. Knowledge production: to produce substantive analyses for the ethical, social, cultural and spiritual issues associated with three emerging health biotechnologies in the context of Aotearoa/New Zealand, from a variety of Maori and non-Maori perspectives.  3. Ethical framework analysis: to identify and analyse the implicit and explicit ethical frameworks of New Zealanders as they engage with new biotechnologies, and explore the relevance for policy of the frameworks they use, from both Maori and non-Maori perspectives.	\$570,000 pa	1 April 2003–30 June 2008
<b>Social</b> Funding: FRST:	University of Waikato Judy Motion	Socially & Culturally Sustainable Biotechnology in NZ	The purpose of this research is to examine the socio-economic and cultural impacts of biotechnology developments in New Zealand in order to create appropriate frameworks for dialogue and decision-making in relation to sustainable biotechnology. The project integrates innovative action research techniques to assess the sustainability indicators and potential impacts from both industry and community perspectives. The research objectives are to: <ul style="list-style-type: none"> <li>• examine the impact and potential effects of biotechnology on New Zealand society, businesses and consumers through an analysis of medical, food and fibre-related biotechnology organisations and their stakeholders;</li> <li>• examine the social, cultural and religious/spiritual dimensions of biotechnology through an analysis of advocacy groups, community organisations or networks, and their stakeholders.; and</li> <li>• develop dialogue and decision-making frameworks for socially and culturally sustainable biotechnology from a meta-analysis of the networks, social values, and discourses of New Zealand society.</li> </ul>	\$500,000 pa	1 April 2003–30 June 2008

<b>Social</b> Funding: FRST	University of Otago Professor Donald Evans	Clarification and evaluation of Maori beliefs and perspectives concerning genetic technologies	The research programme is designed to clarify and evaluate Maori perspectives and beliefs in respect of new genetic biotechnologies. The programme will have both empirical and conceptual arms. The objective is to provide a rigorous and dispassionate account by Maori of Maori traditions, beliefs and perspectives in relation to the technologies; and to evaluate these in terms of their compatibility and commensurability with the plurality of views extant in New Zealand society. The empirical element will employ quantitative and qualitative methodologies and be conducted by a team of Maori investigators using telephone and face-to-face interviews conducted in a culturally responsive manner. The interviewees will be selected from a wide cross-section of Maori society including experts (scientists), researchers and ethics committee members, laypersons randomly selected from the electoral roll, and 400 kaumatua. The interviews will be informed by expert bioethical and scientific input. The conceptual evaluation will be conducted collaboratively by the conceptual and empirical research teams based in the Bioethics Centre at the University of Otago School of Medicine and the School of Maori Studies at Massey University respectively.	\$200,000 pa	1 April 2003–30 June 2008
<b>Social:</b> Ethics Funding: FRST	AgResearch Bruce Small	Ethics and social responsibility of science  Objective in Behaviour change in the Rural Sector Programme	This research examines scientists' perceptions of the role of social responsibility in scientific research with a particular focus on genetic engineering technology. Ethical and social issues to be examined include: scientists' intrinsic moral values regarding GE, Scientists' beliefs about the extrinsic moral consequences of GE technology, and the relationship between these values and beliefs and support for a particular GE research project. Scientists' beliefs about the impacts of the increasing commercialisation of science on scientific social responsibility and innovation will also be canvassed.	\$248,000 total	July 2002 – June 2004
<b>Social:</b> Ethics Funding: FRST (NSOF)	ESR	The Social benefit of forensic DNA profiling for the people of New Zealand	This project begins to investigate key questions regarding the use of DNA technology.	\$123,000	2002-03
<b>Social:</b> Ethics Funding: Marsden Fund	University of Otago Professor Donald Evans	Ethics and genetics	This research investigates the ethical questions raised by genetics and the development of genetic technologies in New Zealand. It focuses primarily on stem cell technologies, i.e. cloning, and the issues surrounding this, e.g. cloning individuals, therapeutic cloning, the status of the human embryo, the concept of biological identity. It will examine the current range of public knowledge, and aim to make comments on the possible need for legislative and educational initiatives.	\$90,000 pa	1 October 2001–30 September 2004
<b>Social:</b> Health/Psychological Funding: HRC	University of Auckland Waioira Port	Cultural Perspectives of Predictive DNA Testing in Cancer	The project will form the basis of a PhD project. An in-depth study of Maori people with or at risk of inherited cancer will be undertaken to identify Maori views on DNA testing in such cancers. The aim is to seek true consultation.	\$94,000 total	Jan 1999–Dec 2002

<p><b>Social:</b> Public Engagement/ Dialogue Funding: MoRST</p>	<p>Waikato University:  Department of Management Communication  Dr Juliet Roper &amp; Professor Ted Zorn</p>	<p>The Communicative Properties of Science and Technology Dialogue</p>	<p>MoRST has established a fund of \$450,000 per annum to fund pilot initiatives that will create greater trust and confidence in science research and technological developments amongst New Zealanders, through the use of dialogue. That is, using conversation that enables each party to acknowledge, listen to and respect the other's viewpoint and to move forward in a way that is mutually constructive.</p> <p>This project aims to identify communication processes that have the potential to enhance the quality of public discussion about issues of importance to the future of New Zealand, in particular, controversial aspects of science and technology. Specifically, the objectives of the proposed research include: (1) to pilot, analyse, refine, and encourage alternative methods of dialogue for use in discussing controversial science issues; (2) to build expertise among participants in dialogue methods and two-way communication skills more generally; and (3) identify pathways toward applying dialogic processes in New Zealand, in order to raise the quality of public discussion on important issues.</p> <p>This project will focus primarily in the area of human bioengineering, in addition to a much smaller focus on atmospheric (climate change) science. The intention is to bring scientists into dialogue with audiences that have concerns about some aspects of these sciences. Furthermore, we intend to include a range of participants, including those not normally involved in dialogue on these issues, many of whom are least likely to be engaged in dialogue about science and technology. The people that the project will use are Maori, farmers (for climate change science), undergraduate Arts students, women with small children, and business people.</p>	<p>\$182,500 pa</p>	<p>April 2003 – June 2004</p>
	<p>Victoria University of Wellington  Karen Cronin, Dr Laurie Jackson and Professor Euan Smith</p>	<p>Hands across the water' – developing dialogue between stakeholders in the New Zealand biotechnology debate</p>	<p>This project will use the genetic modification (GM) debate as a case study of public discourse around controversial science and technology. The project will identify potential areas of agreement and disagreement to create a map of the issues as seen by key participants. A variety of methods have been developed and documented in the field of 'dialogue'. This project will engage participants in an interactive process, testing selected techniques including facilitated discussion, conflict resolution and 'appreciative inquiry'.</p>	<p>\$60,000 pa</p>	<p>March 2003- June 2004</p>

## ANNEX TWO: NEW ZEALAND NON-VOTE RS&T BIOTECHNOLOGY IMPACTS RESEARCH: RECENTLY COMPLETED OR CURRENT

This table identifies projects that have been funded through sources of funding other than Vote RS&T that are related to understanding the impacts of GM and biotechnology. These projects have not been established as a result of the government's response to the recommendations of the RCGM. This information was obtained through contacting New Zealand Universities and other agencies about their work. While every attempt has been made to gather accurate information on these projects, it is possible that this does not represent all research projects in this area.

Area	Lead Provider	Title	Project Description
<b>Social:</b> Risk Perception	Victoria University Environmental Studies; School of Earth Sciences Karen Cronin	Risk communication – the evolution of public and expert discourses on science and technology	<p>This PhD project aims to explore the literature on risk communication and to identify where it can offer support to effective decision-making on controversial science and technology proposals – and where new approaches may be required.</p> <p>The introduction of gene technology in New Zealand will be used as a case study to explore perceptions of risk. Evidence to the Royal Commission of Inquiry into Genetic Modification and a survey of key stakeholders will be used to identify the social, psychological and cultural factors contributing to the social discourse on GM in New Zealand.</p> <p>The research will also explore the public policy mechanisms used, to date, to resolve issues in the debate about GM. It will identify future options for public participation in risk management that may lead to more socially and technically acceptable outcomes.</p>
<b>Social:</b> Philosophy	Victoria University Department of Philosophy Dr Nicholas Agar		<p>Dr Nicholas Agar is interested in the ethical implications of the new genetic technologies. He has recently written a book on the ethics of human cloning titled "Perfect copy – unravelling the Cloning Debate" and is currently working on one addressing liberal ideas about enhancement. Pluralistic societies permit parents to be guided by their own visions of the good life in raising children, with the proviso that they do not impinge on the autonomy or otherwise harm those children. A question that he is considering is "Should parents be similarly free in respect of future genetic technologies?" He is also involved in a couple of international projects. One of these is the Ford Foundation funded 'Altering Nature' project, based at Rice University in Houston Texas. Information about this project can be found at <a href="http://www.bioethics.rice.edu">http://www.bioethics.rice.edu</a>.</p>
<b>Social:</b>	Waikato University Department of Political Science and Public Policy	<p>Science, Politics and Genetic Engineering: An Analysis of Institutional Practices in New Zealand.</p> <p>Media and Environment: The Influence of Journalistic Professional Norms on</p>	<p>M.Soc.Sc. project involving case study of AgResearch Ltd (Ruakura)'s application for insertion of human genes into cattle. An in-depth study of the submission process to ERMA and interviews with key actors will be used to understand the ways in which political institutions respond to public concerns about genetic engineering.</p> <p>M.Phil. project which undertakes an in-depth analysis of the press coverage of the report of the Royal Commission on Genetic Modification. The study of the press coverage of the RCGM report looks at the ways in which media report controversial environmental issues and the implications this has for both journalistic practice and public policy.</p>

		the Public Debate on Environmental Issues in New Zealand	Dr. Priya Kurian, Senior Lecturer, of the Department of Political Science and Policy is working with Dr Debashish Munshi of the Dept. of Management Communication, Waikato Management School, on socio-cultural, political and ethical implications and impacts of the discourses around biotechnology use in New Zealand.
<b>Social:</b> Philosophy	Waikato University Department of Philosophy Dr Alastair Gunn		Research to investigate issues associated with intrinsic value, such as cultural (such as kaitiakitanga), spiritual and ethical values associated with genetic modification.
<b>Social</b>	Waikato University Department of Geography Tee Rogers-Hayden	Deconstructing the Royal Commission on Genetic Modification	PhD project that applies a multidimensional discourse analysis to the Royal Commission on Genetic Modification (RCGM) to investigate if the RCGM was pre-determined in its findings. The project has analysed the social and historical context of the RCGM, the processes of the RCGM and the consequential discourses in the text produced by the environmentalists, bioproponents and the RCGM.
<b>Social</b>	Waikato University Department of Management Communication Alison Henderson	Organisational and political communication about genetically modified foods in New Zealand	<p>This PhD research project takes a critical-interpretive perspective exploring how the debate about the genetic modification of foods and crops in New Zealand is constructed by partisan organisations, through a case study of two export industries important to New Zealand. The research focuses on organisational communication, and on integrated public relations and marketing communication in the kiwifruit industry and dairy industry at key moments in the debate about the genetic modification of foods and crops in the period July 2000 to October 2003 and looks at the ways in which these industries participate in and influence the debate.</p> <p>On a practical level, the research may suggest how organisations could involve stakeholders and publics in controversial industry decisions to achieve increased understanding of policy making relating to genetic modification. The research also aims to bring new theoretical insights that may contribute to an understanding of the role of communication in the debate about this public issue, while highlighting the ways in which the dairy and kiwifruit industries represent and justify their respective strategic positions in relation to the genetic modification of foods and crops.</p>
<b>Social: Cultural</b>	University of Canterbury: Department of Sociology & Anthropology, and Department of Maori Studies Dr Anne Scott & Bevan Tipene Matua		Research project on ERMA's consultation and decision-making processes with regards to tangata whenua views. Specific focus is on the two AgResearch transgenic cattle applications, and the three associated ERMA decisions.

<p><b>Social:</b> Legal/ethics</p> <p>Funding: New Zealand Law Foundation</p>	<p>University of Otago: Centre of Research Excellence in Law and Bioethics</p>	<p>Legal implications of the Human Genome Project (HGP)</p>	<p>The research will integrate existing studies and knowledge to assess the implications the HGP will have on New Zealand law. It will analyse the law for its ability to adapt to those implications and make recommendations for change.</p> <p>Phase 1 of the research, will identify and prioritise the legal, ethical and scientific implications that the HGP raises by compiling current regulatory responses to selected biotechnology issues. Issues include privacy, intellectual property, medical, genetic engineering and cloning, research such as stem cells, and an indigenous (Maori) dimension. This information will be stored in a central web-based database to assist information management and dissemination, with researchers from all countries involved able to access and maintain it.</p> <p>Phase 2 involves an in-depth study of the issues prioritised in phase 1 to determine the state of readiness of the New Zealand legal system, institutions and government agencies to respond to those issues raised. It will recommend any necessary law changes.</p> <p>Phase 3, expected to take six months, will integrate the findings and give a final evaluation of the issues and topic areas. It will include a public seminar on the findings.</p> <p>This research is part of an international project on the implications of the HGP being co-ordinated by the Sheffield University Institute of Biotechnology Law and Ethics in the UK.</p>
<p><b>Economics</b></p>	<p>University of Lincoln Commerce Division: William Kaye-Blake</p>	<p>The logit and the lexicographic: How do consumers decide on genetically modified food?</p>	<p>This PhD research project proposes to examine consumers' genetically modified food (GMF) purchase decisions by extending recent economic surveys and experiments, while at the same time contributing to the large body of literature on consumer decision-making. A choice experiment survey will collect data on respondents' food choices, demographics, and attitudes. The data will be analysed with models from two theoretical frameworks, Subjective Expected Utility and Bounded Rationality, in an attempt to draw conclusions regarding their suitability for modelling consumers' reactions to GMFs.</p>
<p><b>Economics</b></p>	<p>Massey University Department of Marketing: Terry Macpherson</p>	<p>Evaluating the Behavioural Impact of the Australian and New Zealand Genetically Modified Food Labelling provisions</p>	<p>This project carried out a choice experiment that encompassed the labelling options outlined in the Australian and New Zealand mandatory labelling system for genetically modified foods (GMFs) and foods that contain genetically modified ingredients.</p>
<p><b>Social:</b> Anthrology</p>	<p>University of Otago Department of Anthropology</p>	<p>The Experience of Living with the Knowledge of a Genetic Susceptibility to Breast Cancer</p> <p>When Two Worlds Collide: An Examination of the Intersection Between Scientific</p>	<p>Master Health Science thesis</p> <p>This project aims to investigate how people with a high genetic risk for hereditary breast cancer integrate the impact and influences of the developing genetic technologies with their actual lived experiences.</p> <p>MA thesis</p> <p>This project aims to use Dr Parry Guilford's work on hereditary stomach cancer as a case study, to examine the variety of intersections between his and his research team's assessment of their work and the ways in which the work has been represented in popular culture.</p>

		<p>Views of Genetic Testing and Views Circulating in the Realm of Popular Culture.</p> <p>A Recent Cultural History on Amniocentesis and Chorionic Villae Sampling in New Zealand</p> <p>The Lived Experience of Working in a Prenatal Genetic Testing Laboratory.</p>	<p>MA thesis</p> <p>This project aims to produce a recent cultural history of Amniocentesis and Chorionic Villae sampling in New Zealand using women's contemporary experiences of this technique but also drawing on oral histories from physicians working with this technology. The project will also analyse descriptions of the technique in popular culture.</p> <p>MA Thesis</p> <p>This project aims to investigate the ethics and discourses scientists working in prenatal genetic testing laboratories apply to their work.</p>
<p><b>Environmental:</b> Ecosystem Impacts</p>	<p>Lincoln University Professor Alison Stewart</p>	<p>National Centre for Advanced Bio-protection Technologies</p>	<p>The Centre will undertake research in biosecurity, developing 'state of the art' sensor technologies, molecular identification systems and mathematical models to protect against pest and disease incursions. Researchers will develop advanced biocontrol technologies for sustainable agriculture and environmental protection. They will also use advanced agri-technology to create opportunities for developing superior crops with enhanced pesticide resistance. A focus of the research is in the area of Mataranga Maori bio-protection where researchers will develop agricultural technologies that value and sustain matauranga and tikanga Maori.</p> <p>Although the research that the centre carries out is not specifically related to the impacts of biotechnology, the research results will have relevance to understanding ecosystem impacts. The centre will employ a range of researchers and it is likely that at least one project will be in this area. Many projects will contribute to a better understanding of horizontal gene transfer.</p>

## ANNEX THREE: EXTERNALLY COMMISSIONED PROJECTS FUNDED BY POLICY AGENCIES ON IMPACTS OF BIOTECHNOLOGY

This table identifies projects that have been funded through New Zealand Government departments and are associated with the understanding the impacts of GM and biotechnology. These projects have not necessarily resulted from government's response to the recommendations of the RCGM.

Area	Lead Provider	Title	Date	Description/access
<b>Social/ Cultural</b> Funding: Ministry for the Environment	National Association of Maori Mathematicians, Scientists and Technologies (NAMMSAT)	Developing resources on Genetic Modification and Biotechnology issues relevant to the Maori Debate	July 2002	Report aimed at understanding the issues for Maori in relation to genetic modification and biotechnology. This report examines: <ul style="list-style-type: none"> <li>• examines and collates GM research relevant to Maori and of interest to Maori, including that on native flora and fauna, and Intellectual Property ;</li> <li>• best methods of communicating with Maori about matauranga Maori and western Science;</li> <li>• ramifications for Maori of GM, biotechnology and the knowledge economy; and</li> <li>• examines and recommends best techniques and logistics for dialogue with Maori about GM issues.</li> </ul>
<b>Social/ Cultural</b> Funding: MoRST	NAMMSAT	Advice on constructive ways on moving past the contentious debate and fostering constructive dialogue on Genetic Modification and biotechnology issues specific to RS&T without compromising the integrity of tikanga	July 2002	The report examined: <ul style="list-style-type: none"> <li>▪ best methods of communicating with Maori about Matauranga Maori/tikanga Maori and western Science;</li> <li>▪ ramifications for Maori of GM, biotechnology and the knowledge economy; and</li> <li>▪ recommended best techniques and logistics for dialogue with Maori about GM/biotechnology issues</li> </ul>

<p><b>Social:</b> Public Perceptions</p> <p>Funding: Ministry for the Environment</p>	<p>BRC Marketing &amp; Social Research</p> <p>University of Auckland</p>	<p>Genetic Modification: Public Awareness &amp; Knowledge Benchmark Survey</p> <p>Ensuring effective public participation in decision-making relating to genetically modified organisms</p>	<p>November 2001</p> <p>June 2001</p>	<p>Report prepared for the Ministry for the Environment by Melissa Harsant and Emanuel Kalafatelis.. This "benchmark" survey of a nationally representative sample was undertaken to assist MfE with the development of a public information campaign on GM. It concluded that any campaign should take into account the extent of interest in the topic, audiences, key messages, expected sources of information and key mediums for the public information. <a href="http://www.mfe.govt.nz/publications/organisms/public-survey-nov01.html">http://www.mfe.govt.nz/publications/organisms/public-survey-nov01.html</a></p> <p>Report commissioned by MfE and carried out by Willie Smith and Hayden Montgomery. This report provides a focus on institutional arrangements for handling strategic issues associated with GM decision-making. It was aimed to assist MfE in its responsibilities – in relation to the RMA and HSNO Acts – for information on effective public participation in decision-making relating to GMOs. <a href="http://www.mfe.govt.nz/publications/organisms/gm-public-participation-jun01.pdf">http://www.mfe.govt.nz/publications/organisms/gm-public-participation-jun01.pdf</a></p>
<p><b>Social:</b> Public Perceptions</p>	<p>ERMA</p>	<p>Awareness of New Organisms Issues and ERMA</p>	<p>August 2002</p>	<p>Report commissioned by ERMA and carried out by Network Communications. The objective of the survey was to evaluate New Zealanders' awareness of ERMA and understanding of the issues around introduction of new organisms (other than GMOs). <a href="http://www.ermanz.govt.nz/resources/publications/pdfs/ER-RE-01-1.pdf">http://www.ermanz.govt.nz/resources/publications/pdfs/ER-RE-01-1.pdf</a></p>
<p><b>Environ-mental</b></p>	<p>Ministry for the Environment</p>	<p>Summary of the current scientific awareness of the effect of GMOs on the natural environment</p> <p>Coexistence of genetically modified and non-genetically modified crops</p>	<p>June 2001</p> <p>June 2001</p>	<p>This report provided a summary of the current state of knowledge on environmental impacts of GMOs. This was done through reviewing the scientific literature for verifiable reports on GMO impacts. <a href="http://www.mfe.govt.nz/publications/organisms/scientific-awareness-jun01.html">http://www.mfe.govt.nz/publications/organisms/scientific-awareness-jun01.html</a></p> <p>This report provides details about GM research being conducted in New Zealand and ideas as to how GM and non-GM crops (including organic) could coexist in New Zealand. In developing these ideas on coexistence of GM and non-GM crops (including organic), information is provided on the current status of GM research and release worldwide. <a href="http://www.mfe.govt.nz/publications/organisms/coexistence-feb01.pdf">http://www.mfe.govt.nz/publications/organisms/coexistence-feb01.pdf</a></p>

<b>Social:</b> Public Perceptions Funding MoRST	NZ Council for Education Research	Commonsense, trust and science	April 2002	<p>The research provides insights into what the public knows, thinks, and feels about science. The research is relevant to biotechnology although it did not specifically or exclusively focus on this area. The research was undertaken for the Ministry of Research Science and Technology (MoRST) by the New Zealand Council for Educational Research (NZCER) in association with ACNielsen.</p> <p>Final report: <a href="http://www.morst.govt.nz/?CHANNEL=New+Zealanders%27+attitudes&amp;PAGE=New+Zealanders%27+attitudes">http://www.morst.govt.nz/?CHANNEL=New+Zealanders% 27+attitudes&amp;PAGE=New+Zealanders%27+attitudes</a></p>
<b>Economic:</b> Funding Cross-departmental Research Fund (Vote RS&T) and Treasury	Business and Economic Research Limited (BERL)	Economic risks and opportunities from the release of genetically modified organisms in NZ: the clean green image and genetic modification	April 2003	<p>This research responds to knowledge needs identified by the Royal Commission. It investigated the impacts (positive and negative) on New Zealand's GDP in the cases of a release of a GMO (e.g., crop, biocontrol or medicine). It also investigated the impacts, direct and indirect on primary production and other export sectors (including inbound tourism) of the release of a GMO.</p> <p><a href="http://www.treasury.govt.nz/gmeconomic/default.asp">http://www.treasury.govt.nz/gmeconomic/default.asp</a></p>
<b>Risk Assessment:</b>	New Zealand Food Safety Authority (FSA)		Six monthly	<p>Current awareness of genetically modified food issues</p> <p><a href="http://www.nzfsa.govt.nz/science-technology/current-awareness/gm/index.htm">http://www.nzfsa.govt.nz/science-technology/current-awareness/gm/index.htm</a></p>

## ANNEX FOUR: SUMMARY OF PROCESSES CARRIED OUT BY FRST TO ESTABLISH RESEARCH PROGRAMMES IN THE AREAS IDENTIFIED BY THE RCGM

The table below summarises the processes that FRST have carried out to invest in research to meet the needs identified by the RCGM. These processes occurred both before and after the RCGM reported.

	Year	Investment Process
Pre RCGM FRST work	1999/00	FRST developed a new set of research strategies. The CRIs AgResearch, HortResearch, Crop & Food Research and Forest Research were asked to consider the amount of research they carried out aimed at understanding the risks associated with new biotechnologies. This was done with a view to increasing this research area and a total of \$408k was set aside for impacts research.
	2000/01	FRST held a tender for research on <i>Potential Key Effects of Genetically Modified Organisms</i> . This tender aimed to generate new research programmes that would carry out independent research in this area.
Post RCGM FRST work	2001/02	<p>FRST reprioritised an additional \$800k in this year, allowing new research totalling \$1.216 million pa to be funded through a second tender process on <i>GMO Impacts</i>, following the directions set by the RCGM. The two case studies in this report were funded in this round: Horizontal Gene Transfer in the New Zealand Environment led by ESR and The Fate of Biotechnology: Why do some of the public reject novel scientific technologies? Led by Lincoln University.</p> <p>A further FRST investment process was held in this year in Plant Gene Technologies research as part of the <i>Future Biotechnology</i> portfolio. This resulted in research funding totalling \$1.375 million pa on understanding the risks of new products developed using plant gene technologies.</p>
	2002/03	<p>FRST conducted an investment process to invest new RS&amp;T Vote funds in <i>Impacts of New Technologies</i> following the 2002 Budget allocation of \$1 million pa in 2002/03 rising to \$2.5 million pa from 03/04.</p> <p>FRST conducted a review of research in the sustainability area, of approximately \$57 million per annum worth of funding. This included, but was not limited to, research to support the organics and other sustainable agriculture sectors.</p>