RHADEGUND LIFE SCIENCES

Factors Influencing Decisions to Innovate with New Organisms

Final Report

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RHADEGUND
Life Sciences ▽ Science Strategy

Report on the project 'Factors Influencing Decisions to Innovate Using New Organisms,' to the Ministry for the Environment and Project Reference Group.

CR 145

EXECUTIVE SUMMARY

This report identifies the key factors that influence businesses' decisions to innovate using new organisms in New Zealand. The aim of undertaking this project was to determine whether regulation for managing risks is an important determinant in such decisions, compared with other factors such as the development costs or management and staff expertise. The report covers both genetically modified and non-modified organisms that are new to New Zealand (that is, not present before July 1998, when the Hazardous Substances and New Organisms [HSNO] Act came into force). The focus of this study is on firms rather than research organisations, and it is concerned with how firms make decisions regarding new organisms rather than identifying how the regulatory system can be improved.

Data was gathered from a set of interviews with industry bodies in sectors that use or are likely to use new organisms. This was followed by an electronic survey of individual firms in those sectors, and then a final set of interviews with firm personnel to amplify survey data.

A brief literature survey was undertaken to determine what factors were likely to affect firms' decision making around innovating with new organisms and to put the results of this project in context within the broader innovation system. The Organisation for Economic Cooperation and Development (OECD) identifies a range of policies that governments need to adopt to facilitate innovation by firms. These can be collated into four sets of factors likely to be of importance in decisions to innovate: cost (or economic) factors, market factors, knowledge factors and regulatory factors. These broad factors are consistent with a range of studies on innovation conducted internationally as well as Statistics New Zealand surveys on barriers to innovation faced by firms. In this study the four factors were broken down into component factors based on Statistics New Zealand's existing surveys and discussions with officials and industry organisations. The factors likely to be involved in firms' decision making on the use of new organisms looked at in this study are summarised in Figure A below.

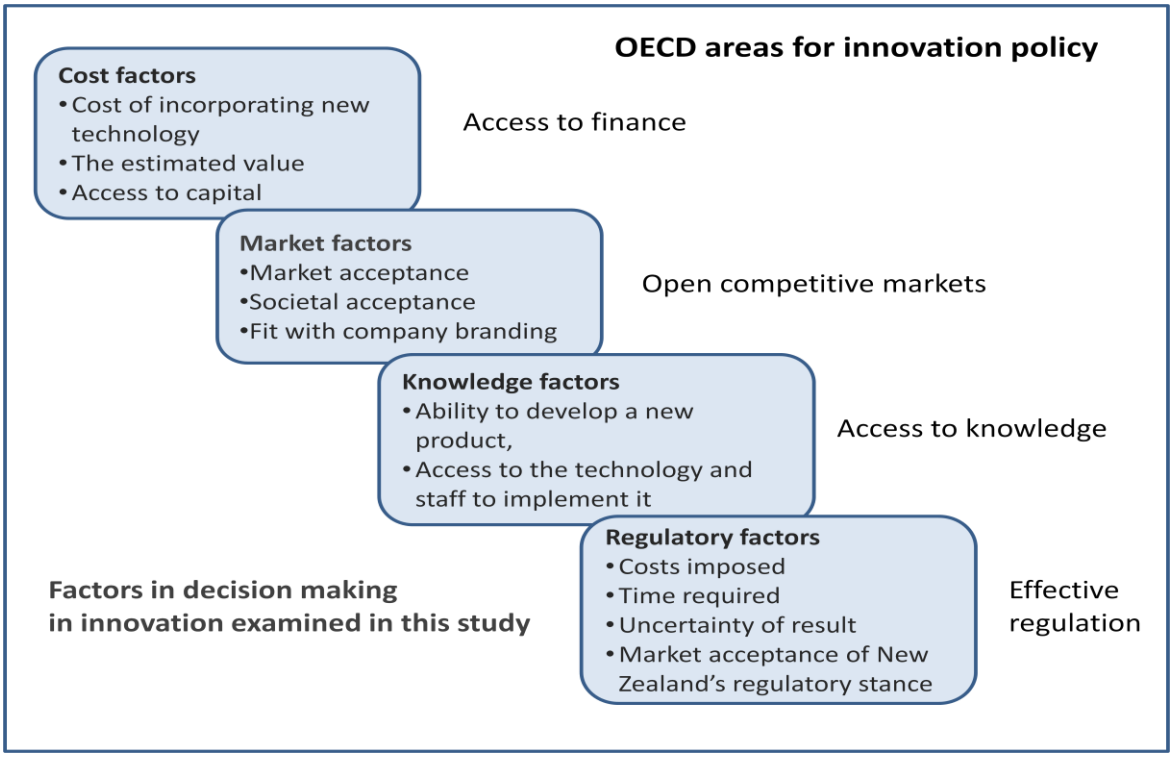

Figure A: Factors likely to influence firm's decision making on innovation with new organisms.

Sectors to survey were identified from an analysis of Environmental Protection Authority (EPA) data and by discussions with officials from relevant public agencies.

Interviews with industry organisations indicated that market and economic factors were likely to have the most influence in New Zealand firms' decision making around innovation with new organisms. Regulatory factors were likely to be nearly as important as market and economic factors, with knowledge factors less so. This differs from innovation in general, where economic factors usually are the most important influence by a moderate margin, followed by market and knowledge factors. For sectors with a strong commercial focus, it was noted that regulatory costs would be unimportant if a substantial economic benefit was likely, and the use of the new organism was acceptable to consumers. Where there were less immediate tangible economic benefits to the firm regulatory costs were considered to have greater influence. Market factors and public acceptance were likely to be more important for innovations involving genetically modified organisms than for other new organisms.

Survey data and follow up-interviews with individual firms showed that economic and market factors were the first factors taken into account in firms' decisions

around innovation with new organisms. Once firms had established that an innovation was likely to be accepted and the firm could afford to develop it other factors, including regulation, are then considered. However, regulatory factors were more important in firm's decision making than was indicated by interviews with industry bodies, and considerably more important than found in general surveys of innovation.

Consequently, the key finding of this report is that while economic factors may be considered first, regulatory factors are important in influencing firms' decisions about innovation with new organisms, and play a greater role in decision making than for firms innovating in other areas.

The HSNO and Biosecurity Acts were the regulations most commonly raised as constraining innovation involving new organisms. A schematic decision making tree for new organisms is shown in Figure B below.

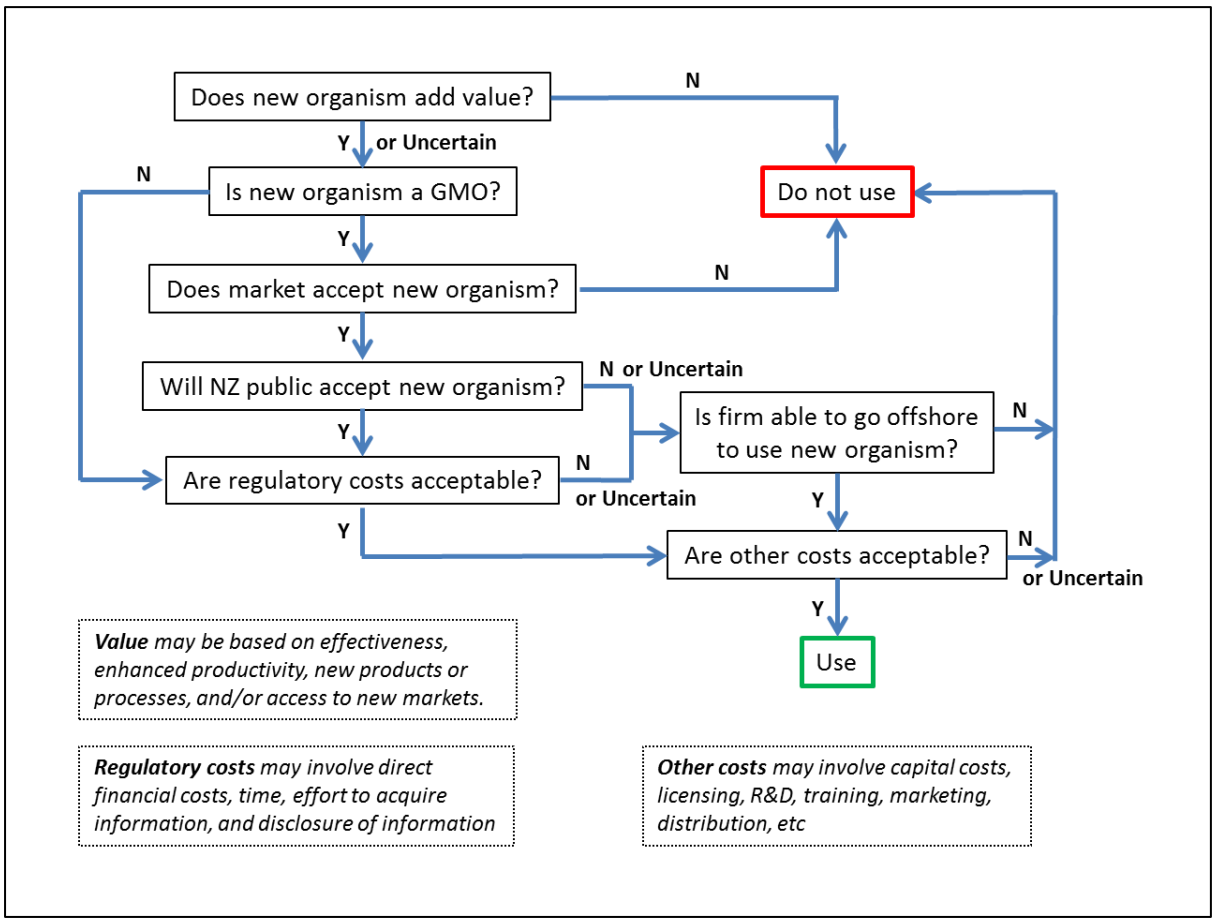

Figure B: Schematic decision tree for use of new organisms in New Zealand.

For innovations involving genetically modified organisms uncertainty around market and public acceptability is much more likely to be a factor in deciding to proceed with an innovation than with non-modified organism. For firms innovating

with non-genetically modified organisms the cost and uncertainty of the regulatory process are more important considerations.

For genetically modified organisms there is considerable interaction between market factors, uncertainties around the regulatory system and how the regulatory process will impact on the public perception of the firm, and the potential new product. Uncertainty around market perception of the technology introduces uncertainty about the potential value of any product based on it to the firm, which in turn affects how much the firm is prepared to invest in the regulatory process to bring the product to market. Decisions on innovations with genetically modified organisms were particularly complex. While many expressed an interest in the potential benefits that genetically modified organisms could provide for their firm or sector no firm in the study was actively considering introducing one in New Zealand. A mix of economic, market, knowledge and/or regulatory factors influenced this decision.

Firms were considering alternatives to going through the New Zealand regulatory system, such as not using a new organism or taking the development offshore to pursue innovations with both modified and non-modified organisms. Firms may also be making conservative decisions about what new organisms to apply for and delaying making applications. This can result in opportunity costs and may hamper innovation. Firms innovating using genetically modified organisms may also consider moving offshore because of a perceived lack of public acceptance of the technology in New Zealand.

The importation of biocontrol agents was considered to be working well when compared to systems internationally. Staff in the EPA are generally well regarded, and the HSNO system was considered by some to have become easier to use since its introduction. Firms raised a number of specific issues with the regulatory system, particularly around the cost, staff effort and information requirements needed to make an application to release a new organism.

In addition to costs and market & social acceptability, firms interested in using new organisms may also have concerns about the regulatory requirements due to questioning the validity and fairness of the regime.

Many firms did not appear to have experience with the new organism regulatory system. Their decision making is strongly influenced by perceptions or indirect knowledge of regulatory requirements, rather than direct experience with the regulator. While this may mean that some firms are basing their decisions on incorrect or outdated information, others with no direct engagement were well

informed. Even firms that had direct experience with the system still found it was expensive in both cost and time involved, and this will influence their future decision making on whether they use new organisms.

CONTENTS

INTRODUCTION

The Ministry for the Environment (MfE) has oversight of the Hazardous Substances and New Organisms Act 1996 (HSNO), which provides the basis for managing risk associated with the deliberate importation of new organisms in New Zealand. New organisms are defined in the HSNO Act as, among other things, organisms that arrived in New Zealand after 29 July 1998, genetically modified organisms, organisms in containment, and an organism with approval to be released with controls.[1]

MfE monitors and evaluates regulations to ensure that regulations are effective and achieving their intended outcomes. As part of this role, MfE has an interest in understanding the impact of HSNO on innovation with new organisms.

Many sectors in New Zealand acknowledge the importance of innovation for improved economic performance (Statistics NZ 2010[2]). Biotechnological innovation offers potential for growth in our primary, manufacturing and health sectors (OECD 2009[3]). Because HSNO regulates new economic activities (i.e. the introduction of organisms and chemicals not yet present in our economy) there is clear potential for impacts on innovative behaviour. However, MfE has little substantive evidence on whether or not HSNO is currently a key influence on innovation using new organisms. It is possible that there are other more significant factors that influence whether or not a business innovates with new organisms.

This report identifies the key factors that influence businesses' decisions to innovate using new organisms. The aim of undertaking this project was to determine whether regulation for managing risks is an important determinant in such decisions, compared with other factors such as the development costs or management and staff expertise.

Key actors associated directly or indirectly with innovating with new organisms in New Zealand are illustrated in Figure 1. The actors include government policy, funding and regulatory agencies, educational and training organisations (since they can provide the skills and training needed to use new organisms), the private sector (firms undertaking the innovation as well as those providing funding to facilitate it),

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[1] For a full definition of new organism see the HSNO Act or the EPA website - http://www.epa.govt.nz/new-organisms/about/Pages/what-is-a-no.aspx

[2] Innovation in New Zealand: 2009. (Statistics 2010).

[3] The bioeconomy to 2030: designing a policy agenda. OECD (2009).

and those we have termed "the public" (since their support or opposition can influence decisions to use new organisms, particularly genetically modified ones). The actors who are the main focus in this report (private sector, regulatory agencies and the public) are shown in solid boxes in Figure 1.

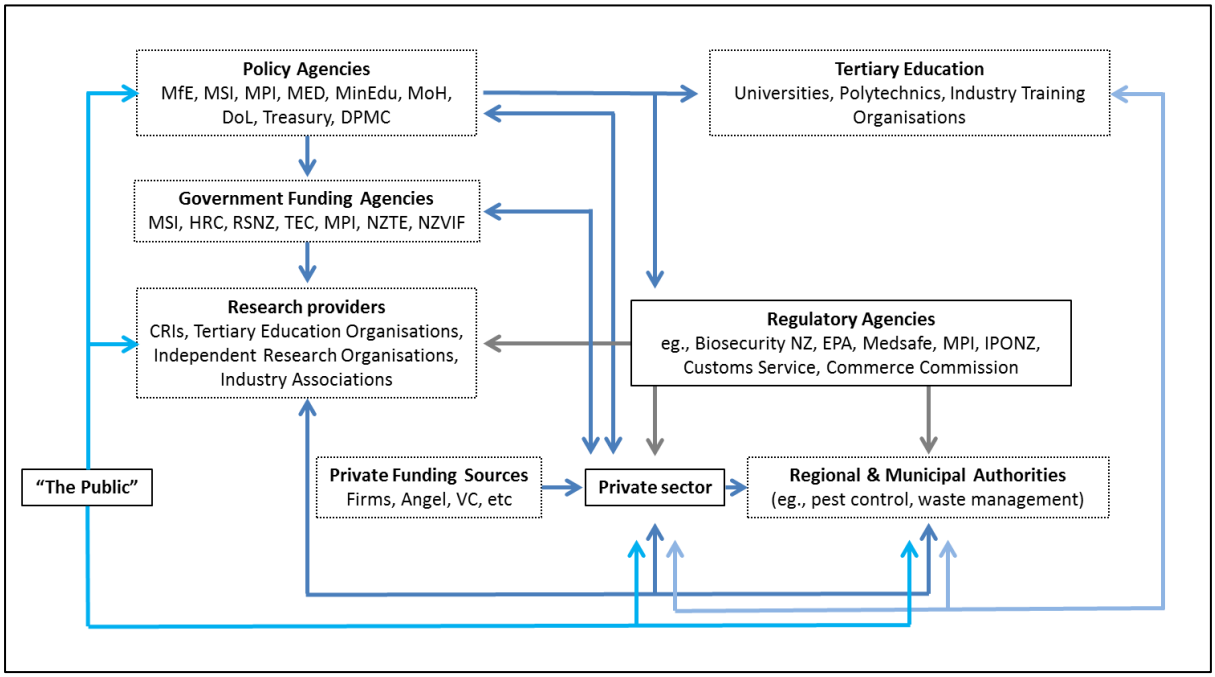

Figure 1. Actors associated with innovation using new organisms in New Zealand, and some indicative paths of interaction. Double-headed arrows indicate greater mutual influence. [MfE = Ministry for the Environment, MSI = Ministry of Science & Innovation, MPI = Ministry for Primary Industries, MED = Ministry of Economic Development, MinEdu = Ministry of Education, MoH = Ministry of Health, DoL = Department of Labour, DPMC = Department of Prime Minister & Cabinet, HRC = Health Research Council, RSNZ = Royal Society of New Zealand, TEC = Tertiary Education Commission, NZTE = New Zealand Trade & Enterprise, NZVIF = New Zealand Venture Investment Fund, EPA = Environmental Protection Authority, IPONZ = Intellectual Property Office. Note that from July 2012 MSI, MED and DoL all become part of the Ministry of Business, Innovation and Employment.]

Drivers of innovation using new organisms include population growth, changing demographics, and sustainability (OECD 2009).[4] New organisms can provide new foods, nutritional supplements, more effective medicines and diagnostics, materials to replace products derived from fossil fuels, and less environmentally damaging products and processes. Firms may use new organisms to create new market opportunities, respond to market or regulatory demands, or to produce more effective solutions for health, industrial, agricultural or environmental challenges.

[4] The bioeconomy to 2030: designing a policy agenda. OECD (2009).

Industry sectors likely to innovate were identified by analysis of data from the Environmental Protection Authority (EPA), followed by contacts with industry associations and officials to determine companies who have not yet approached the EPA. Simultaneously a brief literature survey was undertaken to determine factors known to influence decision making on innovation in various sectors. A workshop with government agencies was held to discuss potential factors that influence decision making and the sectors likely to innovate with new organisms.

Representatives of around 13 industry associations were interviewed to better determine the companies involved and scope out the key decision making issues associated with new organisms.

From the literature survey and discussions with officials and industry bodies an on-line survey was developed and sent to 243 companies likely to have the potential to use new organisms

The survey data was supplemented with face-to-face structured interviews with company representatives to provide more in depth information on their decision making processes. The methods used are summarised in Figure 2 and described in more detail at the end of the report.

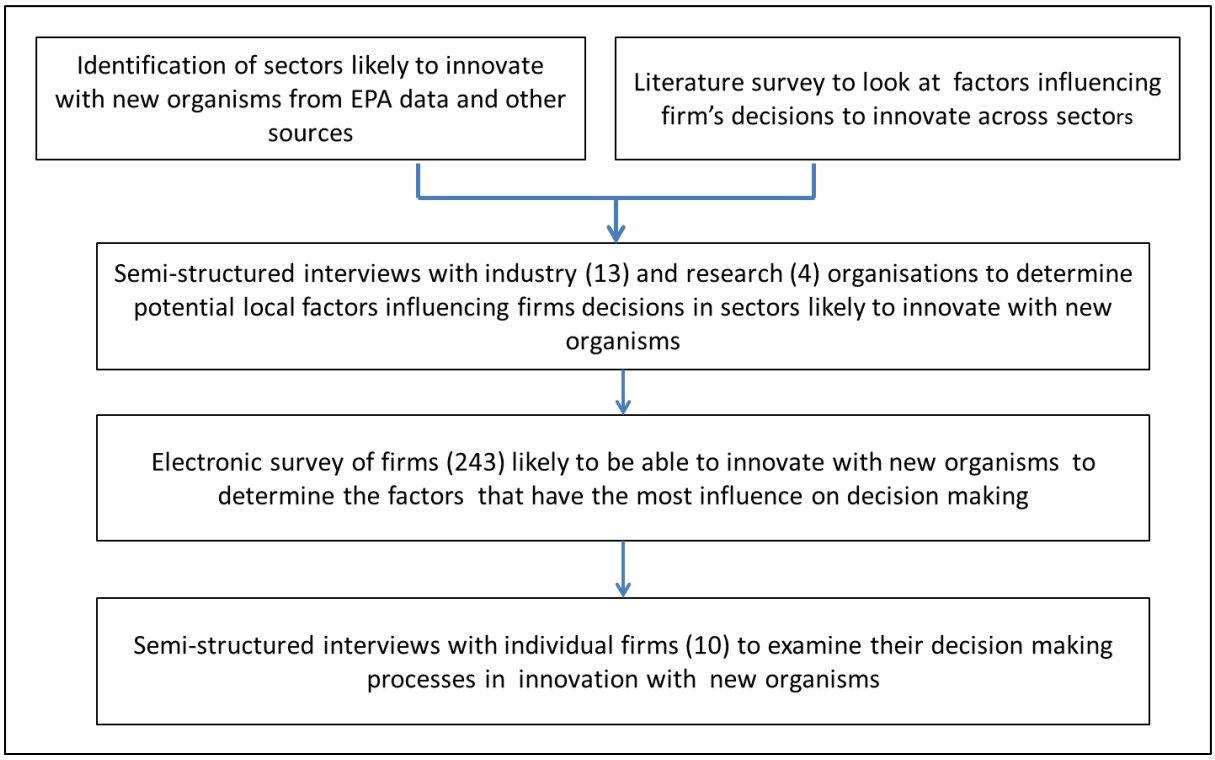

Figure 2. Summary of the method used to gather data for this report.

This report is focused on innovation with all types of new organisms, not just genetically modified organisms. Furthermore, the evaluation is not focused on assessing the merits of innovation with new organisms, genetically modified or otherwise.

BROAD FACTORS INFLUENCING INNOVATION

Key Points

- For innovation in general a range of studies have shown that four factors influence decision making:
  - Cost factors
  - Market factors
  - Knowledge factors
  - Regulatory factors
- In large developed economies across all areas of innovation, cost factors are most important in decision making on innovation, followed by market and knowledge factors, with regulatory factors least important.
- New Zealand's small size means that its access to pools of management talent and finance are likely to be less than larger or more affluent countries.
- Distance from market and poor coordination of its research system, as identified by the OECD, could also make access to knowledge more difficult in New Zealand than in other economies.
- In comparison to other countries, New Zealand has a more comprehensive regulatory environment for new organisms. A proxy for international comparisons is the biotechnology "sector." New Zealand has a relatively high number of businesses involved in biotechnology compared to larger economies, although the country's small size means they do not make up a significant portion of the global biotechnology industry. Studies indicate that access to finance is a barrier to innovation and regulatory factors are important for firms that could use biotechnologies.
- Market and public acceptance of the technology also impact on companies decisions on the use of genetically modified organisms.

Innovation is defined by the OECD[5] as:

> *the implementation of a new or significantly improved product (good or service), process, new marketing method or a new organisational method in business practices, workplace organisation or external relations.*

The emphasis is on implementation rather than just the undertaking of research and development (R&D). This report looks at only a small part of the New Zealand innovation system. Since it examines the use of new organisms it also focuses on improved products and processes, rather than consideration of marketing and organisational factors associated with innovation.

Innovation with new organisms in New Zealand would be expected to face generally the same barriers and enablers encountered by innovating firms anywhere, but with particular factors being more or less important because of the nature of the activity and its location. In assessing how New Zealand firms decide to use new organisms to innovate it is important to distinguish factors that are specific to such firms from those that generally affect innovation globally and in New Zealand.

In its Innovation Strategy the OECD identifies a range of policies that governments need to adopt to facilitate firms to innovate.[6] These include improving access to finance (particularly for early stage firms), improving access to technical knowledge by fostering public research and improving its dissemination, introducing effective regulation and fostering open and competitive markets.

To gain the perspective of individual firms on factors influencing innovation, the UK Department of Innovation Universities and Skills surveyed over 28,000 UK businesses. They identified the same four sets of barriers (and by implication, enablers) as the OECD to innovation by firms across all sectors; cost factors, knowledge factors, market factors and regulatory factors.[7] The study showed that cost factors were considered by firms to be the most significant, followed by market factors and knowledge factors. Regulatory factors were considered to be important by the least number of firms. Compared with non-innovating firms, innovative firms considered that cost factors were much more important and that knowledge factors were less important.

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[5] Oslo Manual Guidelines for collecting and interpreting innovation data, 3rd edition. OECD (2005).
[6] OECD Innovation Strategy, getting a Head Start on Tomorrow, OECD (May 2010)
[7] Revealed versus Deterring Barriers to Innovation; Evidence from the 4th Community Innovation Survey (CIS4), DIUS Research Report 09-09 (May 2009)

The influences of regulation on innovation

A detailed study undertaken by the UK's Department for Business Enterprise and Regulatory Reform[8] concluded that the relationship between regulation and innovation is complex and dynamic. They noted that "… *changes in regulation interact with other government market-based and regulatory policies to bring about changes in innovation either directly or indirectly as a result of changes in competition, skills, investment and entrepreneurial activity by altering the incentives and risks of innovation as well as the costs and benefits.*" Regulations can stimulate innovation through the creation of niche markets, but the positive and negative effects of regulation may not be evenly spread across firms and sectors.[9]

A recent study of how regulations affect small and medium enterprises (SMEs; firms with fewer than 100 employees) in New Zealand noted that about half of the firms surveyed had a neutral attitude toward regulations (New Zealand Centre for Small & Medium Enterprise Research[10]). They found that the attitude of individual firms has a large influence on their ability to manage regulations. Firms that are proactive in seeking information and advice, and have good management systems usually cope well with regulatory requirements.

The OECD reviewed New Zealand's innovation system in 2007.[11] The review panel found that the basic conditions for entrepreneurship and innovation were good but that the country did not perform particularly well compared to other advanced economies. They also reminded readers that "*an assessment of New Zealand's innovation system should first acknowledge some of the country's enduring features: its size, geographical position, topography and inherited economic specialisation*."

These factors affect the innovation system in a number of ways. The New Zealand market is small and firms need to export earlier in their development making market and other knowledge more difficult to obtain. There is a smaller pool of management talent than is available in larger economies. The research system is smaller, and the OECD panel felt less well coordinated, than other advanced economies which could make technical knowledge harder for firms to obtain. There

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[8] Impact of regulation on productivity. BERR Occasional Paper No. 3. (September 2008).
[9] Analysis of market and regulatory factors influencing innovation: Sectoral patterns and national differences. Final Report, Task 3. Europe INNOVA Sectoral Innovation Watch (December 2011)
[10] SME capability to manage regulation Martina Battisti, David Deakins and Martin Perry. New Zealand Centre for Small & Medium Enterprise Research, Massey University (2011). Available at http://www.massey.ac.nz/massey/fms/sme/Report_Regulation_NZ_2011.pdf
[11] OECD Reviews of Innovation Policy New Zealand;. OECD (2007)

is a lack of investment capital in New Zealand for innovative firms to access. These factors could potentially lower the ability of New Zealand firms to innovate and may influence the relative importance to New Zealand firms of factors that affect innovation compared to other economies.

This is borne out in a study of innovation in New Zealand firms[12], which considered that small firms in New Zealand are less innovative than expected because of innovation dampening effects resulting from the country's small size and distance from overseas markets. Based on data from the 2009 Business Operations Survey, Statistics New Zealand noted that 46% of businesses undertook innovation activity, and that the innovation rate in New Zealand was similar to, although slightly below that of Australia (Statistics 2010[13]). More recent data (Statistics 2012[14]) indicates that the Arts & Recreation services and the Education & Training sectors showed the highest level of innovation (62% of firms innovated). The manufacturing sector had an innovation rate of 55% (sixth highest out of 18 sectors), while the primary sector had the lowest innovation rate (26%).

Innovation in biotechnology

New Zealand has a more comprehensive regulatory regime for new organisms than other economies. Other countries may only regulate genetically modified organisms, and biocontrol agents. Direct international comparisons of innovating with new organisms are not possible because of a lack of comparable data. A proxy is to consider the biotechnology sector which overlaps with (rather than being a subset of) sectors using new organisms. The OECD's key biotechnology indicators[15] provide data on a range of biotechnology measures that can give a sense of similarities and differences in how new organisms are used in different countries. The OECD's definition of biotechnology[16] both includes living organisms that are not "new organisms" under New Zealand regulations (such as use of some non-genetically modified organisms long used in fermentation processes) and potentially excludes other new organisms (such as introduction of new plant species or biocontrol

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[12] Innovation in New Zealand: Issues of Firm Size, Local Market Size and Economic Geography, Shangqin, H., McCann, P., Oxley, L. . Department of Economics, University of Canterbury, Working Paper No: 04/2009 (April 2009)

[13]Innovation in New Zealand: 2009. Statistics New Zealand (2010).

[14] Business Operations Survey: 2011, Statistics New Zealand (2012).

[15] Key biotechnology indicators, available at http://www.oecd.org/document/30/0,3746,en_2649_33703_40146462_1_1_1_1,00.html (accessed 21.06.12)

[16] See http://www.oecd.org/document/42/0,3746,en_2649_34537_1933994_1_1_1_1,00.html

agents). None-the-less, examination of the OECD biotechnology data provides an overview of how new organisms are being used to develop innovative products, processes and services in different countries.

For the most recent available data (generally 2010 but 2011 for New Zealand), New Zealand ranked 9th out of 26 in terms of the number of biotechnology-related firms (with 369 reported biotechnology firms, of which 135 self-identified as dedicated biotechnology firms). This places New Zealand between the UK (496 total biotechnology firms) and Switzerland (288, with 156 dedicated); ahead of Norway (192 total), Ireland (167; 71 dedicated), Denmark (157; 66 dedicated), Finland (141; 77 dedicated) and Sweden (100; 58 dedicated); and four places behind Australia (527; 384 dedicated). The OECD classifies a biotechnology firm as one that uses biotechnology to produce goods or services and/or to perform biotechnology R&D. A dedicated biotechnology firm is one whose predominant activity involves the application of biotechnology techniques to produce goods or services and/or the performance of biotechnology R&D. The relatively high number of companies that use biotechnology or are dedicated biotechnology companies in New Zealand is likely to be a consequence of the biological base of its economy.

New Zealand undertakes only a very small proportion of international biotechnology activity. According to the OECD, nearly all (91%) of New Zealand's 135 dedicated biotechnology firms have less than 50 employees. The Statistics New Zealand 2011 Bioscience Survey[17] identified that 69% of the 147 "core bioscience"[18] firms had fewer than 10 employees. New Zealand firms filed 0.43 % of the biotechnology patents filed under the international Patent Co-operation Treaty (PCT) between 2007 and 2009 (Singapore filed 0.64% and Denmark 1.76%; the US filed nearly 42 % during this period). However, as a proportion of a country's total PCT patent portfolio New Zealand has a greater level of specialisation in biotechnology than most other countries (OECD 2011).

New Zealand's biotechnology sector is also one of the most diverse, in terms of types of application (Figure 3)[19].

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[17] Statistics New Zealand (2012). Bioscience Survey: 2011. Available from http://www.stats.govt.nz/browse_for_stats/industry_sectors/science_and_biotechnology/Bioscience_HOTP2011.aspx

[18] A core bioscience firm is one whose main activity is producing bioscience products (such as health or nutritional products, new plant or animal varieties, or environmental technologies)

[19] Source: OECD StatLink http://www.oecd.org/dataoecd/5/60/47025199.xls

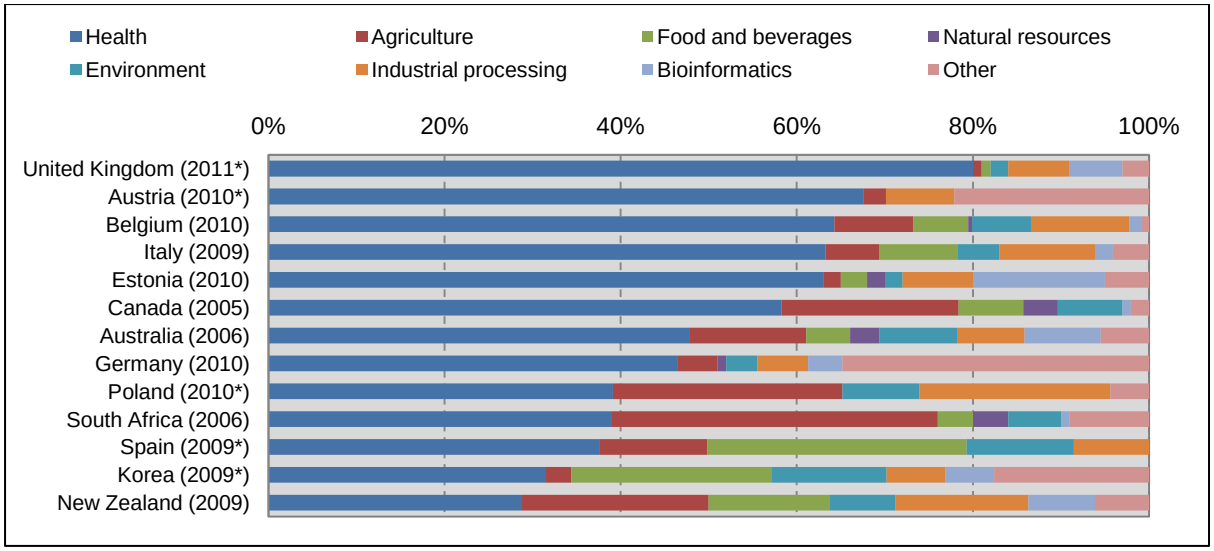

Figure 3. Percentage of dedicated biotechnology firms by application (latest available data). * Note that countries do not always classify applications in a consistent manner. (Source: OECD)

Statistics New Zealand (2012) noted that most of the bioscience technologies being used in the country were associated with research and development (R&D) activity. In 2011, 51% of bioscience activity occurred at the R&D stage, 26% in the production process stage, and 23% in the product sold stage. Income for core bioscience firms was calculated to be $677 million.

A study of New Zealand's biotechnology innovation system conducted by Waikato University's Department of Economics in 2002[20] concluded that there were poor links between research organisations and businesses (a point more generally made by the OECD in 2007[21]). While the situation may have improved since then, the study could suggest that knowledge factors are likely to be more important in New Zealand than Europe. The study also found that New Zealand biotechnology companies were concerned about the financial costs and time taken for approvals for research with genetically modified organisms. A lack of venture capital was identified as hampering growth of innovative companies but was not seen to be a particular problem for the biotechnology industry.

[20] Does New Zealand have an Innovation System for Biotechnology? Dan Marsh, University of Waikato Working Paper in Economics 3/02 (May 2002)
[21] OECD Reviews of Innovation Policy New Zealand. OECD (2007)

Regulation of genetically modified organisms

Some technological innovations can be strongly influenced by public attitudes. In a study of the Swedish nanotechnology innovation system Perez and Sundgren[22] point out that "*in order to provide innovations which give growth there must be legitimacy and acceptance for the technology in question*." This is particularly important for firms using genetically modified organisms (GMOs) in New Zealand because of on-going debate around safety, ethical and social aspects of genetic modification in the domestic market[23] and also the European[24] and Japanese export markets. Use of non-genetically modified organisms doesn't usually face this challenge.

One of the causes of debate around the introduction of HSNO inhibiting innovation with genetically modified organisms in New Zealand is a spike of applications for field trials and outdoor experiments immediately before its introduction in 1998, and a fall off since. A recent report from the Sustainability Council of New Zealand[25] indicates that the fall off in applications may be due to an increase in market sensitivity to genetically modified organisms occurring internationally at the same time, which may have been a factor in firms deciding not to use such new organisms, rather than regulatory factors.

The comparison of numbers of applications before and after the introduction of the HSNO Act is also somewhat misleading because it did not take account of the scope of some of the HSNO approvals. For instance, Scion Research had a field trial approved that could run over 20 years, and permit a range of genetic modifications to be tested. Before HSNO genetically modified field trials were usually short and more limited in scope. None-the-less, in recent years there have been fewer applications to test genetically modified organisms outside of laboratory containment. In contrast, several applications a year are received and approved to release biocontrol agents.

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[22] Nanotechnology in Sweden – an innovation system approach to an emerging area. Euginie Perez and Patrik Sundgren, VINNOVA (April 2008).

[23] The privatization of public talk: a New Zealand case study on the use of dialogue for civic engagement in biotechnology governance, Karen Cronin, New Genetics and Society,27:3,285 — 299(2008)

[24] Emerging Issues: Genetically Modified Forages, Jez Watson, Royal Society of New Zealand (March 2010)

[25] Citizen's arrest: Accounting for GM foods' arrested development, Stephanie Howard, Sustainability Council (April 2012)

INDUSTRY SECTORS LIKELY TO INNOVATE USING NEW ORGANISMS

Key Points

- EPA data on firms that have approached the regulator for advice or to make applications to release new organisms were analysed to determine the sectors likely to use new organisms.
- More than three times as many enquiries and/or applications came from the primary production sector as compared to the health, industrial or other sectors.
- These major sectors were characterised into 23 identifiable sectors that could use new organisms. This information was used to help identify firms to survey.

The EPA's databases identify firms that have applied for approvals for new organisms, requested the new organism status of particular species be determined, or made enquiries about the possibility to develop, import or release a new organism.

For the purposes of analysis we have categorized the EPA data into general areas of application. It is usual in the context of biotechnology to categorise areas of application into three key fields: primary production, industrial and health. Since new organisms in the New Zealand context encompass uses beyond these three we have also included a fourth category in our analysis – "Other" (which includes pets, tourism ventures, import of animals for films, scientific and analytical services).

Figure 4 shows the numbers of applications and enquiries in these categories made to the Environmental Risk Management Authority (ERMA) and subsequently the EPA between 1998 and 2011. We have included applications and enquiries related to determining or declaring an organism as "not new" (that is, present in New Zealand before 1998; Section 26 applications, and Present in New Zealand declarations in the EPA database), since they indicate a potential current or future interest in the use of new organisms. To better understand how new organisms are being used to innovate Figure 4 also makes a distinction between organisms involved in:

Research - further research and development undertaken on the new organism in containment (for example testing host range of potential biocontrol agents),

Products - new organisms that are themselves the innovative product (for instance, a new ornamental plant),

Processes - new organisms used as part of a manufacturing process (such as the production of therapeutic compounds) or new organism providing a service (such as a biocontrol agent).

The analyses exclude university and Crown Research Institute (CRI) applications and enquiries unless they involved field tests, outdoor developments, large scale fermentations, or releases. (The large number of development and importation into containment applications far outnumber all other types of application). Research involving field tests etc. is included since it sometimes involves collaboration with firms or industries as well as generally signalling more advanced R&D that could be subsequently picked up by firms. Imports of plants for botanic gardens and animals for zoos are also excluded since they aren't directly applicable to the innovation focus of this study.

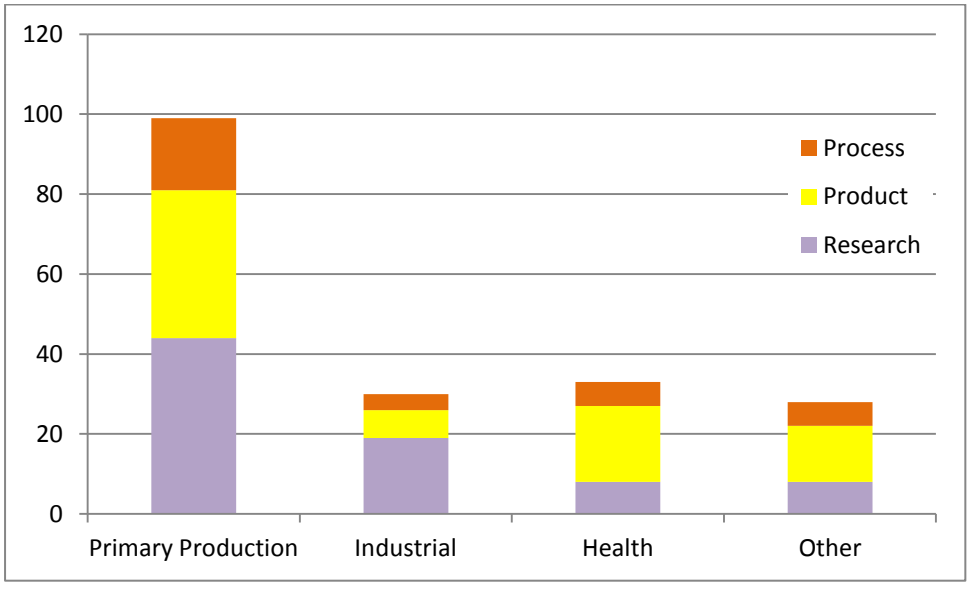

Figure 4. Numbers of applications (completed and discontinued) and enquiries to ERMA and the EPA about new organisms by firms for different types of uses. The figure also notes whether the new organisms are to be used for further research, provide new products in themselves, or provide innovative processes or services (such as biocontrol agents or producing specific compounds for industrial use).

Unsurprisingly, given New Zealand's main industries, half the new organism applications relate to primary production. Nearly one half of primary production-

related applications and enquiries and two thirds of industrial ones relate to research and development activity.

Within each of these principal categories we have sub-categorised applications and enquiries into a range of fields (see Table 1). Note that while often similar to ANZSIC codes, the sub-categories in Table 1 are not always equivalent. For example, biocontrol is not represented within ANZSIC. We have also aggregated some categories to reflect how the new organism is to be used rather than the nature of the firm, and to avoid creating too many categories with small numbers of applications.

Table 1. Categorisation of potential uses for new organisms.

Main Category	Sub-categories
Primary Production	Nursery (ornamentals and flowers)
	Crops (grains, vegetables, mushrooms)
	Horticulture (fruits & nuts)
	Pasture & Livestock
	Aquaculture
	Forestry
	Biocontrol
Industrial	Dairy Manufacturing
	Other Food Processing & Manufacturing
	Fertiliser and Pesticide Manufacturing
	Biofuels & Biomaterials
	Other Chemical Production
	Bioremediation
Health	Human Health & Nutrition
	Human Pharmaceuticals & Therapeutics
	Veterinary & Animal Health
Other	Pets
	Animals for film production
	Tourism ventures
	Testing & Analytical Services
	Scientific & Technical Services

Examples of how new organisms are, or could be, used by New Zealand firms are shown in Table 2.

Table 2. Actual and potential use of new organisms in New Zealand.

Main Category	Examples of use	Currently used in NZ?
Primary Production	Creation of new ornamental plants (through selective breeding) for local or export markets.	New varieties appear to be based on pre-HSNO imports
	Creation of new crop and fruit cultivars to improve flavour, create new tastes, improve plant growth or post-harvest characteristics, introduce disease resistance.	Research & development on going. No new commercial crops based on new organisms released post-HSNO.
	Changing nutritional composition of forage plants to enhance feed efficiency for livestock, and/or decrease greenhouse gas emissions. This has traditionally involved import of new plant species, but in the future may also involve genetic modification.	Research & development only. No new commercial crops based on new organisms released post-HSNO.
	Changing the properties of wood in plantation forests to enhance post-harvest value. This usually requires genetic modification.	Some research & development underway. No commercial products released.
	Use of biocontrol agents in glasshouse production systems to reduce chemical use.	One release of greenhouse thrip control agent made. Other agents under consideration.
Industrial	Improved food processing through use of better enzymes derived from micro-organisms	Research & development underway in dairy sector. Not aware of commercial production.
	Creating better fertilisers through formulated use of communities of micro-organisms.	Research & development underway, but not involving new organisms.
	Production of fuels and associated high value chemical co-products from plants or microbes.	Research & development underway. Pilot scale trials undertaken, but no commercial production at this stage.
	Production of new cleaning compounds and fine chemicals through microbial fermentation.	Not aware of any use.

Main Category	Examples of use	Currently used in NZ?
	Reducing waste, and creating valuable by-products from waste, though the use of specific micro-organisms.	Research & development underway. No commercial production at this stage.
Health	Human medicines based on organisms (such as vaccines) or produced by new organisms.	Research & development underway. No applications to import or release for commercial use.
	Natural health & nutrition products	Interest from a range of companies to import, but not aware of any applications to import and use.
	Veterinary medicines	Research & development on animal remedies underway. One application to import & release since HSNO established.
	Animal health	Interest expressed to import products, but not applications submitted to EPA.
Other	Genetically modified organisms for research and analytical use	Imported by range of scientific supply companies.
	Animals for film production	Selected exotic animals temporarily imported for specific films.
	Exotic animals for trekking activities	Applications made to ERMA NZ, but not approved

Figure 5 shows the numbers of applications or enquiries within these sub-categories. This illustrates the uneven distribution of potential use of new organisms within and between the main categories, and the extent to which new organisms still feature at the R&D stage within firms.

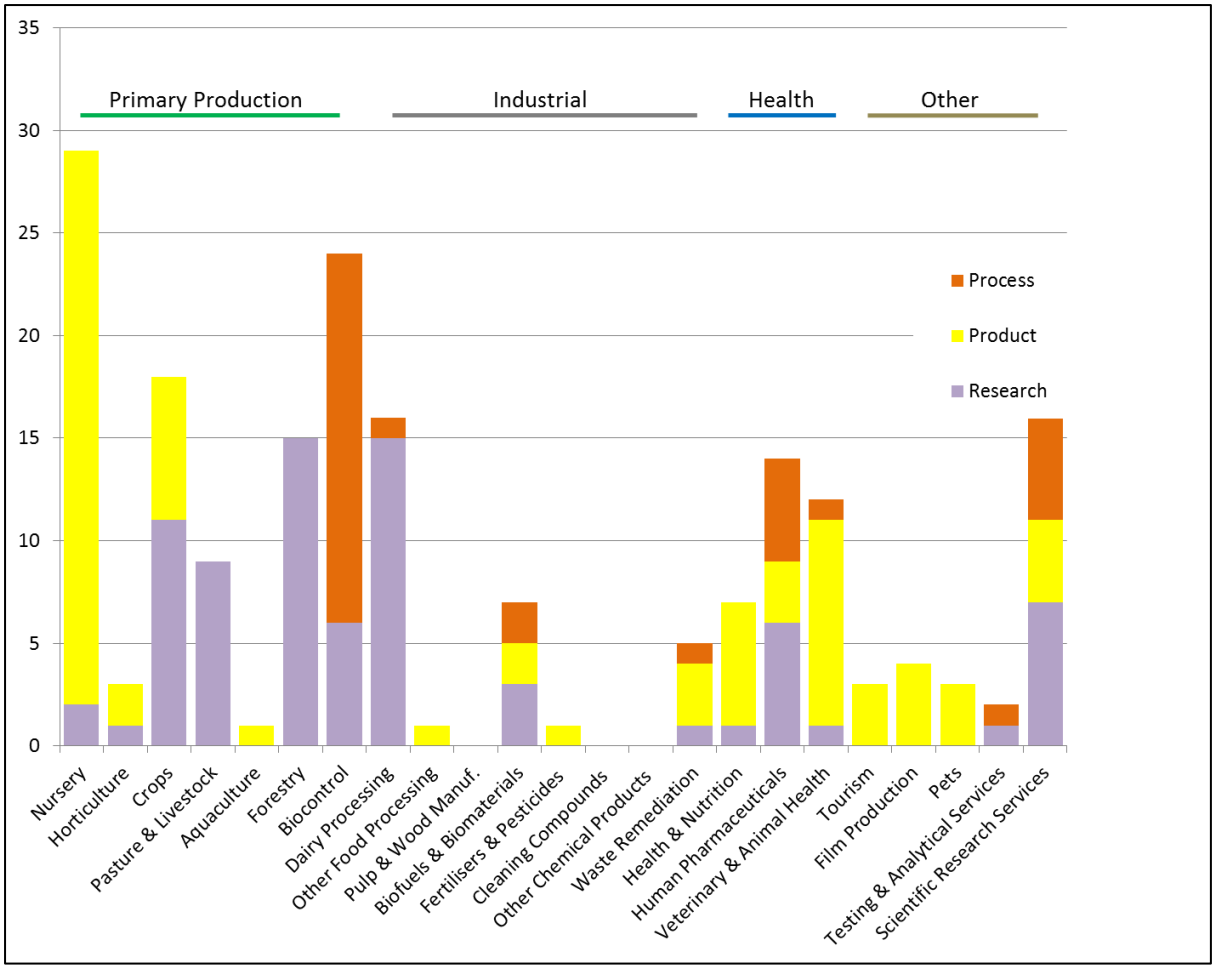

Figure 5. Numbers of applications or enquiries by sub-category. Note that the high number of applications & enquiries for dairy processing mainly relate to "Present in New Zealand" determinations.

Some areas of application that are active fields of biotechnology innovation in other countries (such as the production of enzymes or other chemical products) show no enquiries regarding the use of new organisms in New Zealand. This may reflect the relative absence of such firms here or the early stage of research into these uses. Areas such as "Biofuels and Biomaterials" are also very active internationally, but relatively few applications for such uses have been made here so far.

Figure 6 illustrates the fate of applications within these sub-categories. This includes the number of applications not formally submitted, or which were withdrawn before the Regulator made a decision; the number approved; and the number declined. Nearly all categories have applications that did not proceed to the regulatory decision making stage. The numbers are not directly comparable to Figure 4 because we have excluded from Figure 6 determinations related to whether organisms are new or not (S26 and Present in New Zealand applications), focussing instead just on applications for new organisms. The records show that some organisms named in

applications that did not proceed or were withdrawn were subsequently included in later applications.

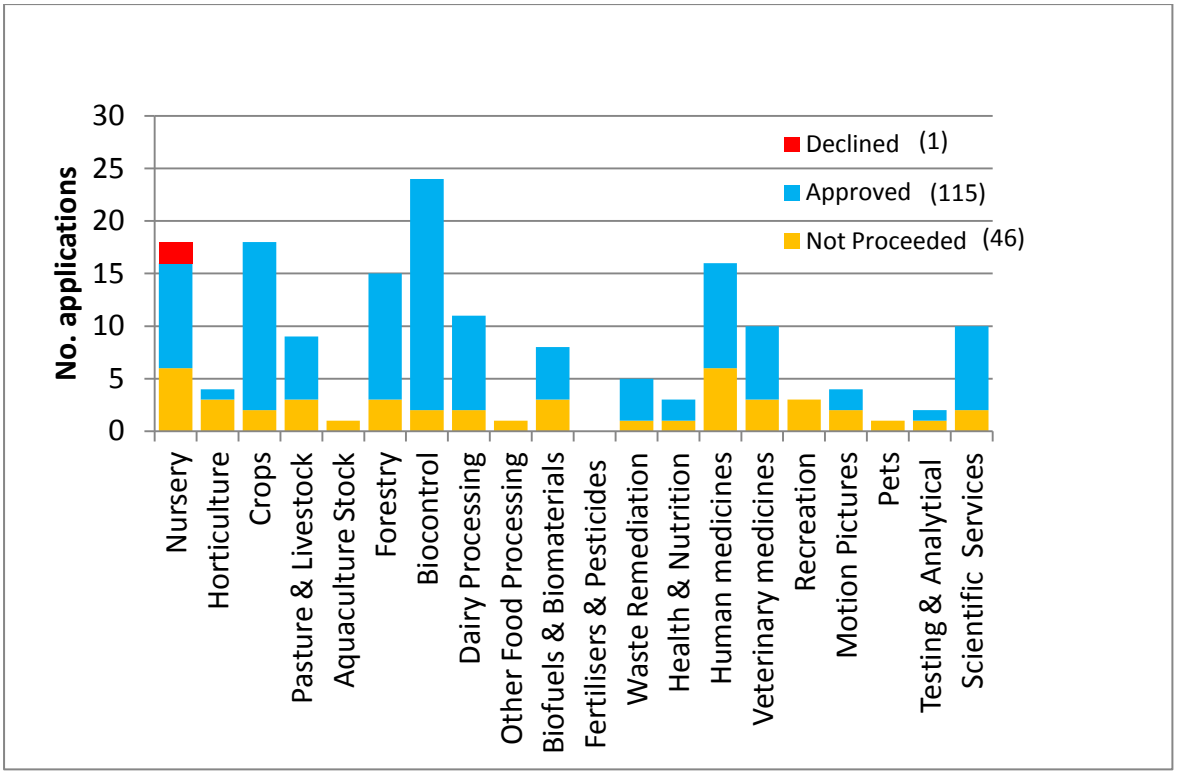

Figure 6. The fate of applications and enquiries to ERMA or the EPA between 1998 and 2011. The category "not proceeded" includes enquiries and applications that did not result in formal submission of an application, as well as applications withdrawn by the applicant before the application was considered by the decision-making panel of the Regulator. Total applications declined = 1; Total approved = 115; Total not proceeded = 46.

There is a range of reasons why applications did not proceed. These include:

- The organism(s) were found to be not new or could be covered by an existing approval;
- Applications may have been changed following advice from the Regulator;
- Insufficient information was available to proceed with an application;
- Prospective applicants considered for various reasons that it was not worth proceeding; and
- The moratorium on field testing and releases of genetically modified organisms during the time of the Royal Commission on Genetic Modification made it inadvisable or inappropriate for some applications to be considered.

We interpret Figure 6 to indicate that the regulator works closely with applicants to determine what applications are likely to be successful. Applicants (or potential

applicants) tend to not proceed to the formal decision-making stage if they consider their applications have a low chance of being approved.

The number of private sector firms (and a few individuals) making applications or enquiries within each sub-category are shown in Figure 7. Universities, CRIs, associations, societies and trusts are excluded (hence only one firm is associated with biocontrol despite the large number of applications shown in Figure 3).

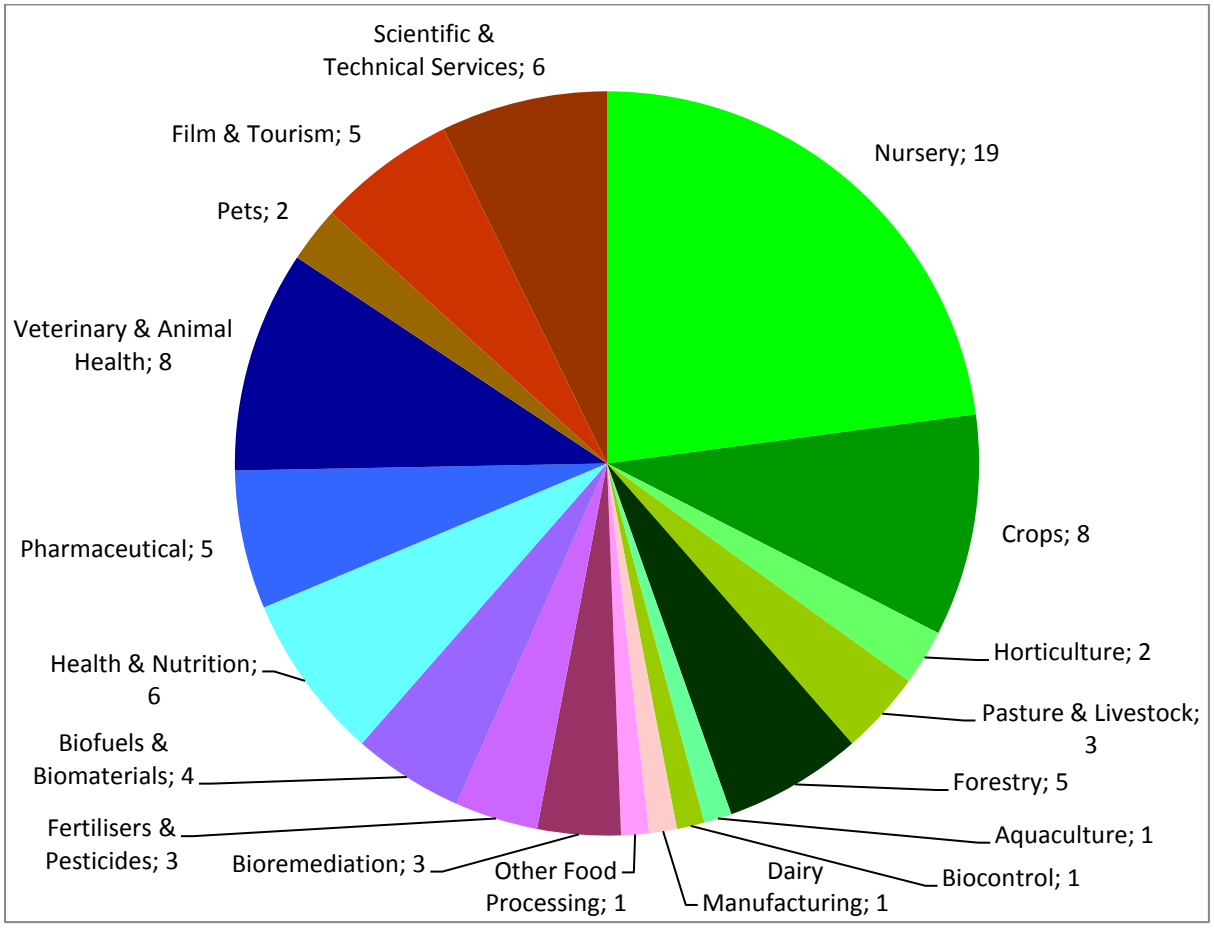

Figure 7. Number of private sector firms making applications or enquiries to use new organisms.

More than three times as many firms in the primary sector have approached ERMA/EPA with new organism enquiries as firms within the industrial sector. Twice as many primary sector firms as health sector firms enquired about new organisms. This is broadly in line with the structure of New Zealand's biotechnology industry.

DISCUSSIONS WITH INDUSTRY AND RESEARCH ORGANISATIONS

Key Points

- Thirteen industry and four research organisations were interviewed about the use of new organisms in their sectors.
- All sectors identified challenges and opportunities facing their sectors that could be addressed with new organisms, both genetically modified and new to New Zealand.
- One of the major areas for the use of new organisms is biocontrol agents.
- The organisations identified a large number of factors that could influence firms' decision making around the use of new organisms.
- Respondents indicated that market and economic factors were likely to have the most influence in New Zealand firms' decision making around innovation with new organisms. Regulatory factors were likely to be nearly as important as market and economic factors, with knowledge factors less so.
- Market factors and public acceptance were likely to be more important for innovations involving genetically modified organisms than for other new organisms.

Representatives of thirteen industry organisations and four research organisations (see List of Organisations, below) covering the most significant industry sectors likely to use new organisms underwent a semi-structured interview. The interview asked what were the main challenges and opportunities facing the sector, what the bodies saw as potential uses for new organisms in their sector and explored what factors influenced the decisions of the firms in their sector to innovate or not with new organisms.

Challenges and opportunities facing the different sectors

The main challenges and opportunities identified by the industry bodies facing their sectors were:

- growing production in their industry;
- better utilisation of resources; and
- using innovation to drive industry growth.

The full spectrum of opportunities and challenges raised by interviewees are shown in Table 3. The majority of these relate to economic factors. More challenges were raised than opportunities.

Table 3. The most common challenges (C) and opportunities (O) facing biologically-based industries in New Zealand based on 17 interviews with industry bodies and research organisations. The number of organisations that raised each factor is indicated in [brackets].

Economic Factors	Market Factors	Knowledge Factors	Regulatory Factors	Other Factors
Increasing production or productivity (C) [4]	Establishing new markets (C) [2]	Technologies not yet mature enough to deploy (C) [2]	Regulatory costs (including compliance) (C) [3]	Conservative nature of some sectors or companies (C) [2]
Improving innovation - (C) [3] - (O) [2]	Market demand - (C) [2] - (O) [2]	Better linkages between researchers and industry (C) [2]	Inconsistencies within or between regulatory schemes (C) [2]	Workforce supply - (C) [1] - (O) [1]
Inherent competitive advantages in New Zealand (O) [4]	Public concern in relation to new organisms (C) [2]			Lack of debate about genetic modification (C) [2]
Maintaining/increasing profitability (C) [3]				Quality of strategic management (C) [1]
Competition from other sectors/countries (C) [3]				
Improving sustainability (C) [3]				

Based on the discussions with industry bodies, sectors' current use of new organisms varied from "not at all" to "extensive." All industry bodies interviewed saw some potential for the use of new organisms in their sector. Of the 13 sectors, two stated that new organisms are used a lot, seven noted they are used in some cases, while the remaining four stated new organisms were not used at all. Biocontrol agents appear to be the mostly widely currently used type of new organism (see Box 1), followed by new plant species (for production or ornamental use). Current and potential uses identified by interviewees included additional biocontrol agents, biofuels, biomaterials, human and animal foods (as both fresh foods and processed ingredients), health treatments, fermentation and processing agents, and decorative and commercial crops.

The tomato and potato psyllid pest (a small sap-sucking insect that spreads a bacterial infection) was raised as an example of how regulatory processes can impede attempts to develop new organisms as solutions to pests. In this case, the psyllid was listed as an unwanted organism under the Biosecurity Act, meaning that even though it was present in New Zealand tests of potential biocontrol agents could not be easily conducted until it was removed from the unwanted organism list. This took considerable time and effort to achieve. A more streamlined approach to dealing with these types of cases was hoped for by interviewees.

Horticulture sector representatives also noted a non-regulatory factor that can inhibit the use of biocontrol agents is a lack of commercial rearing facilities. Such facilities are common in countries such as the Netherlands, where they help growers control specific pest outbreaks through "inundation release" of biocontrol agents as and when required. Releases of biocontrol agents in New Zealand so far are for the purpose of creating self-sustaining populations in the wild. Such release strategies can work well for perennial pests, but industry representatives noted that this may not be so effective for rapid pest outbreaks in seasonal crops, particularly those grown in commercial glass houses. Lack of security of access to control agents when they are needed may discourage growers from supporting (financially or otherwise) applications to release some new biocontrol agents.

Most of the organisations saw potential for both genetically modified and other new to New Zealand organisms, although they were all careful to point out that market factors were very different in the case of genetically modified organisms and this currently restricted their actual use. Natural Products NZ said its sector had made a decision not to consider the use of genetically modified organisms at this stage.

Two interviewees commented that firms can also be reluctant to use new organisms because the science and technology required for particular applications are not yet mature enough for commercial deployment.

Business New Zealand, an umbrella group for business and employing sectors, felt that the introduction of innovative new products for the export market was the biggest opportunity to be addressed by New Zealand businesses and that since the economy was largely biologically based, innovation with new organisms was particularly important.

Box 1: Biocontrol agents

Thirty five biological control agents have been approved for release since 2000 (this includes 11 species of dung beetle). All of these have been sponsored by research organisations and/or councils, and the majority involve the release of insects to control weeds. Interviews with sector and research organisations indicated that there was still considerable potential for use of other biocontrol agents. Significant drivers for use of biocontrol agents mentioned in several of the interviews were the rising costs of chemical and mechanical control of pests, increasingly stringent market requirements for low or no spray residues, and the relative scarcity of newer more environmentally friendly pesticides.

Costs for gaining approval, and the research costs needed to underpin an application, were stated as being considerable for biocontrol agents. One industry body noted pre-application research may cost up to $500,000 (depending on how many non-target species need to be tested) and take up to three years to complete. Consequently, firms have been reluctant to apply for biocontrol releases, and significant effort can be required to identify the highest priority targets for control. This supports the findings of an earlier ERMA New Zealand report (ERMA 2010). Interviewees indicated that applications to release biocontrol agents often rely on a few people with the passion and energy to develop the application.

After initial concern about the adverse impact that the HSNO Act would have on the release of biocontrol agents, some of the country's leading biocontrol scientists consider that the Act provides a good framework for assessing risks, and the regulatory authority has developed considerable experience in addressing uncertainties associated with unintended effects (Barratt et al. 2010). None the less, there are still concerns about the time and costs associated with the regulatory process (ERMA 2010). Many of the biocontrol applications, and the research supporting the applications, have been funded through government via CRIs or local or regional councils. One of the interviewees pointed out that private firms (or industry bodies) involved in biocontrol "don't usually have that amount of funding" ($500,000 for research plus application fees).

References

Barratt, B.I.P. et al (2010). Progress in risk assessment for classical biological control. Biological Control 52, 245–254.

ERMA New Zealand (2010). Investigating biological control and the HSNO Act. ERMA New Zealand Report April 2010

Potential for other uses of new organisms

Pastoral organisations, whose sector is based on a relatively well established group of farmed species, see little potential to use new species (outside of biocontrol agents) unless there is a compelling economic incentive. Their focus is on improving

the productivity and value from existing species. This can involve importation of wild relatives of species in New Zealand for breeding programmes or, potentially, genetic modification. At this point the sectors do not use genetic modification because of public attitudes and market resistance in New Zealand and also export markets. However, interviewees noted that these sectors needed to be ready to respond quickly when an economic incentive, such as adoption of a new technology by competitors or failure of existing cultivars through disease or climate change, was identified.

Several sectors see considerable untapped potential for new organisms as a means to introduce new products or processes. This is especially the case for the forestry and bioenergy sectors, where there can be overlapping interests, and the pharmaceutical and human health sectors. These sectors are taking their lead from developments offshore, and interviewees noted that if New Zealand firms do not stay up to date, they risk becoming less competitive. The forestry and bioenergy sector representatives were particularly enthusiastic about the potential for new plants and microbes to replace petroleum-based goods and services.

Some industry representatives noted the difficulty of their sector to innovate in general because of the conservative nature of the industry (where improvements generally occur slowly and incrementally rather than through a step change), and/or the small size of more innovative firms (where it can be difficult for them to gather the resources to enable them to develop and implement innovations).

Two industry organisations in the food and health sectors noted that multinational corporations operating in their sectors had products based on new organisms available internationally but were yet to introduce them to New Zealand. This was either because the multinationals were unsure of the market response to their product in New Zealand, or were concerned about the unfamiliar regulatory system.

Factors influencing the use of new organisms

The industry organisations were asked to identify factors that might influence firms in deciding whether or not to innovate using new organisms. The responses were classified as twelve different factors under the four categories identified by the OECD and other commentators on innovation: economic factors, knowledge factors, market factors and regulatory factors. The order in which the factors were raised by the interviewee was also recorded as a potential proxy for importance to the interviewee (

Table 4). None of the interviewees needed prompting to identify factors.

Market factors were raised as influencing decision making slightly more often than economic factors, although individual economic factors were raised first more often than market factors and generally raised earlier in the interview. Regulatory factors were the third most common factors raised by the organisations as influencing decision making. Many of the interviewees noted that the limited acceptance of genetic modification in food or the environment by markets and/or the general populace was a factor that their industry took account of. Many noted that genetic modification could potentially be used in their sector if opposition to it decreased and the technologies were commercially ready and safe.

Table 4. Factors influencing firms in their sectors decisions to innovate with new organisms.

		Order factor raised by interviewee				
Number of times raised[26]	Factor raised by industry organisations	First	Second	Third	Fourth	Fifth
12	**Economic**					
3	Cost of technology (need for investment)	3				
7	Potential returns	3	4			
1	Risk precautions (unsure of returns)		1			
1	Support from Govt (including but not limited to funding)			1		
2	**Knowledge**					
2	Technical ability to use		2			
14	**Market**					
2	Ability to access new markets	2				
6	Consumer sensibility	2	2	1	1	
1	Effect on 'Brand NZ' or industry brand					1
5	Wider public attitudes		1	3	1	
9	**Regulatory**					
7	Cost of regulation	2		3	2	
1	Protection of confidential information	1				
1	Interaction of regulatory system with public attitudes[27]		1			

[26] Note some categories sum to greater than the number of Industry Bodies interviewed because more than one factor for each category may have been mentioned.

[27] This refers to the feeling by some actual or potential applicants that for contentious applications they may be exposed to particularly negative publicity or even to personal attacks.

For sectors with a strong commercial focus interviewees noted that regulatory costs would be unimportant if a substantial economic benefit was likely and the use of the new organism was acceptable to consumers. Where there were less immediate tangible economic benefits to the organisation carrying the costs of any regulatory approval (as in the use of biocontrol) regulatory costs were considered to have greater influence.

Several interviewees noted that the R&D time and costs, including the cost of regulatory approvals, associated with developing a new organism (genetically modified or not) to a state where it is suitable and safe for use are substantial. They commented that these costs are unlikely to be fully borne by the firm or sector, but much of it would fall on research institutions, and these stages of innovation also need to be accounted for by policy makers. Regulatory costs were also considered likely to inhibit innovation where expected returns were marginal or uncertain. They recognised that a decline in R&D activity on new organisms by research organisations would affect the ability of firms to develop, adapt, or adopt new organisms. In many cases, interviewees noted, a new organism or process based on a new organism developed elsewhere could not be adopted here without additional research and development, which firms may not want to pay for.

Several of the interviewees noted that there can be inconsistencies within or between regulatory measures that discourage use of new organisms. For example, while the HSNO Act and overseas chemical regulatory schemes encourage the use of more environmentally benign chemicals or non-chemical options, industry bodies felt that regulatory requirements for new organisms did not facilitate this because of the perceived costly and lengthy approval process. In the forestry sector one interviewee noted that several international forest stewardship schemes encourage reduced agri-chemical use but prohibit biocontrol and genetically modified organisms, so innovation with new organisms is not incentivised.

Two industry bodies raised the issue that regulatory factors interact with market factors as the regulatory process provided an opportunity to interest groups to publicise their views on market issues related to an application.

Industry organisations in the food and health sectors said that while it was not directly a factor in their sectors' decisions around new organisms, the existing good reputation of New Zealand's regulatory system was an important part of the country's brand value.

The results of the discussions with industry bodies were combined with the survey of factors that influence innovation in general were combined to give a set of factors likely to affect decisions on innovation with new organisms. These are summarised in Figure 8.

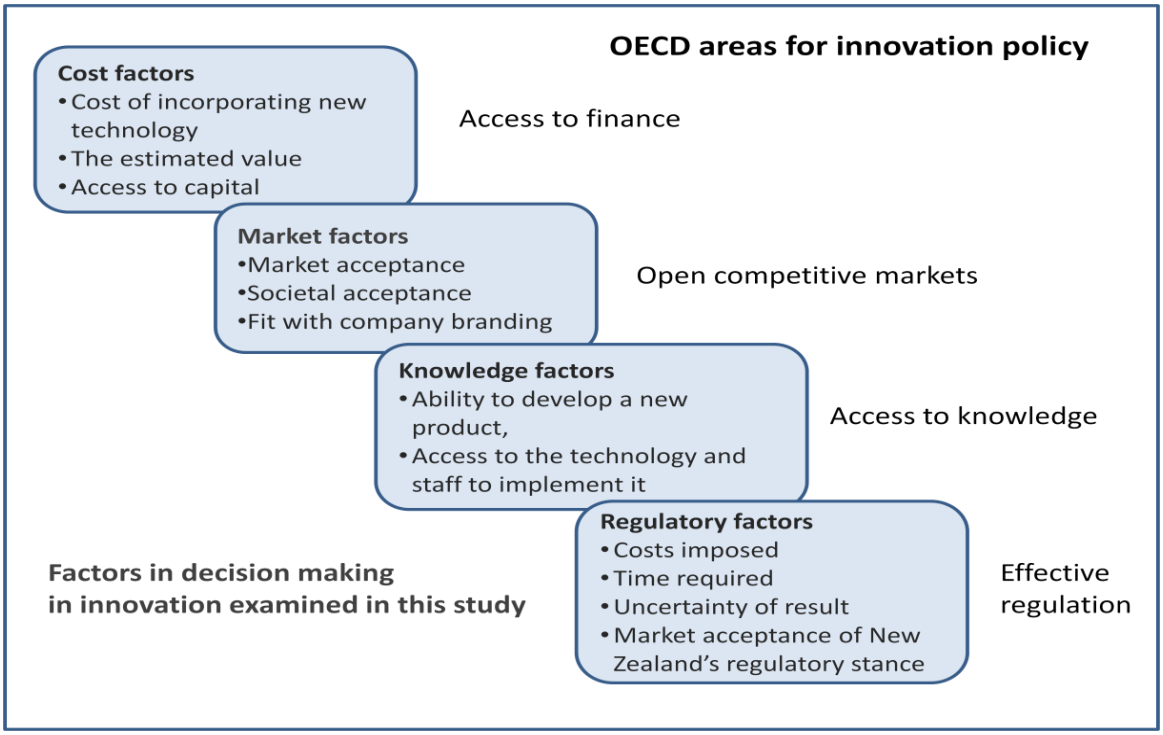

Figure 8: Factors likely to affect decisions on innovating with new organisms.

The data from interviewing the industry bodies indicates that for New Zealand firms' market factors are more important in decisions to innovate with new organisms than has been seen for innovation in general. Other studies (such as the DIUS study) have indicated economic factors have predominated by a considerable margin. Particular concerns have been raised by some industries, but the regulations do not appear to be an overriding issue across a broad range of industry sectors according to the industry bodies. Financial factors were important but not the overriding factor that has been seen in other areas. Knowledge factors were seen as much less important. The biotechnology sector in general is generally considered to be highly regulated compared to some other sectors. However, innovation can thrive when there are high levels of regulation (Europe Innova 2011[28]).

[28] Analysis of market and regulatory factors influencing innovation: Sectoral patterns and national differences. Final Report, Task 3. Europe INNOVA Sectoral Innovation Watch (December 2011).

ANALYSIS OF SURVEY DATA

Key Points

- 243 Firms in sectors likely to use new organism were surveyed on their use with a 30% response rate broadly representative of the numbers sent surveys in each sector.
- Most firms indicated that they were using, or could potentially use, new organisms. The main reasons given for the use of new organisms was to establish or exploit a new market opportunity and to respond to customer demand.
- In contrast to the interviews with industry and research bodies, firms cited regulations as the most significant constraint to the use of new organisms.
- Firms also saw the attitude of the New Zealand public and market acceptance as constraints to the use of new organisms, particularly for genetically modified organisms.
- The new organisms approval process and biosecurity requirements were identified as the most constraining regulatory factors.
- Compared with broader surveys of New Zealand businesses, development costs and regulations are viewed as considerably greater constraints for firms using new organisms.

Based on the literature survey and discussions with officials and industry bodies an on-line survey was developed to investigate how firms use new organism (see Summary of Methods below). The survey was sent to 243 companies identified as likely to have the potential to use new organisms

Seventy two firms (30%) responded to the electronic survey. Responses came from a broad spectrum of businesses (Figure 9), with the majority representing firms in the primary and industrial sectors (Figure 10). Perspectives from some sub-sectors that did not respond to the survey were captured through interviews (for example, dairy processing).

Figures 9 & 10 represent how we had characterised each firm before the survey. One of the survey questions asked firms to identify which areas they operated in. Of the 58 firms answering this question, 194 responses were recorded, suggesting that on average each firm operates in 3 sub-sectors (eg, horticulture, crops and biocontrol). Most firms indicated they operated within one sector (eg, primary, industrial or

health), but some firms indicated that they had activity between sectors. For example, fertiliser (industrial sector) and some nutrition (health sector) firms also usually selected categories within the primary sector. Firms providing testing or research services also operated across the other sectors.

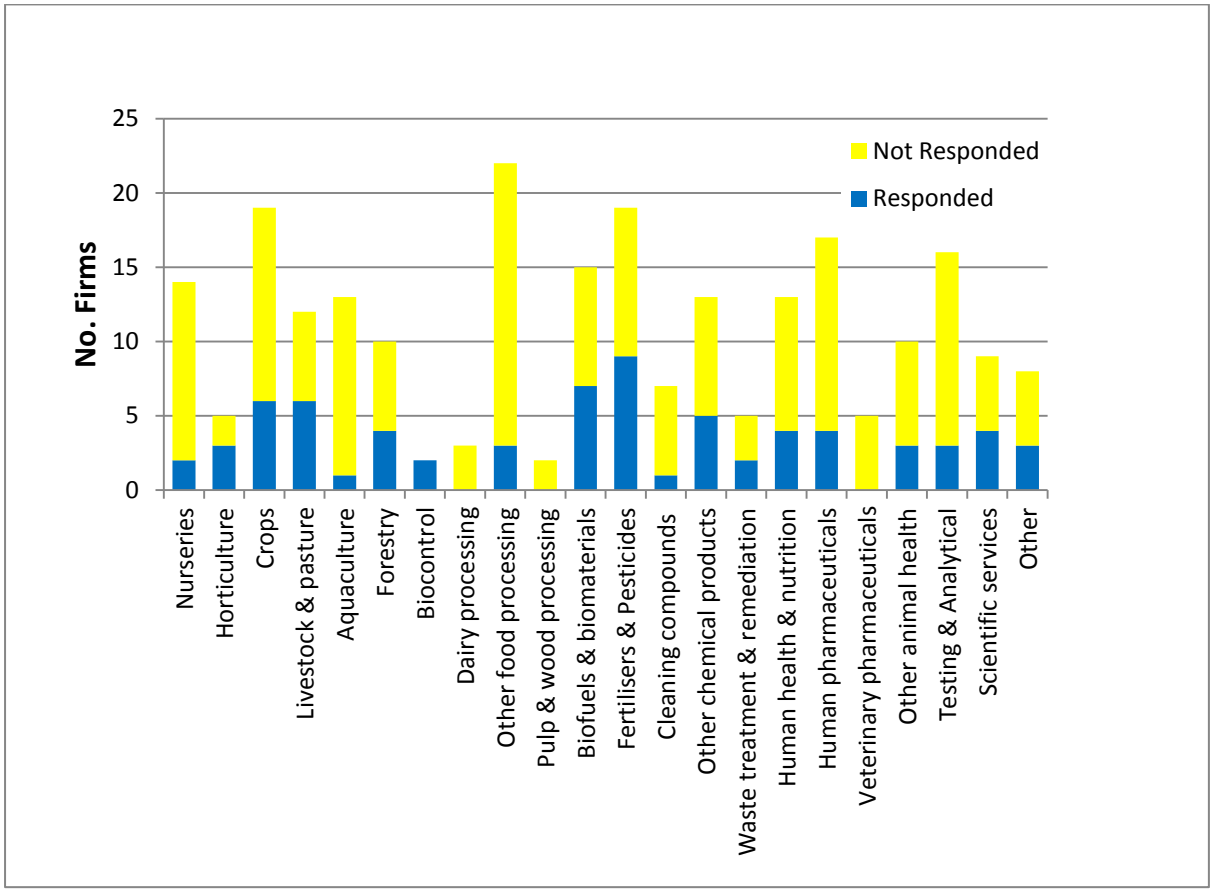

Figure 9. Responses to survey characterised by sub-sector. The "Other" category includes consulting and R&D support firms.

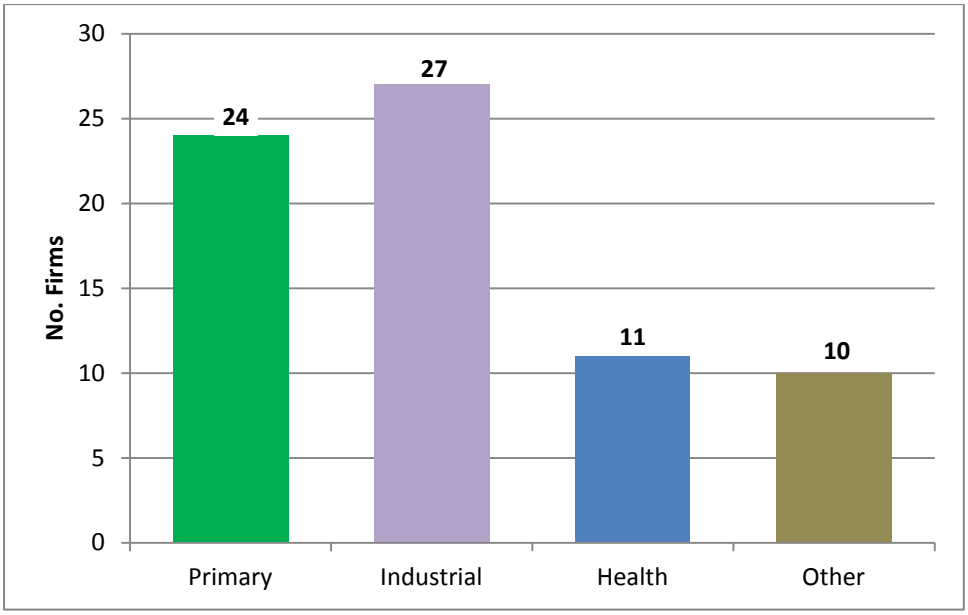

Figure 10. Responses to survey characterised by main sector. The "Other" sector includes science research service providers, testing and analytical firms, and consultancies.

Most of the firms responding indicated that they could use new organisms (Figure 11), with no sectors indicating that they couldn't use them. Twenty three firms indicated that they already use new organisms. These were firms largely operating in the primary sector and those providing scientific research services (such as importers of scientific supplies). Of the four firms indicating that they are not able to use new organisms one each came from the primary, industrial, health and other sectors.

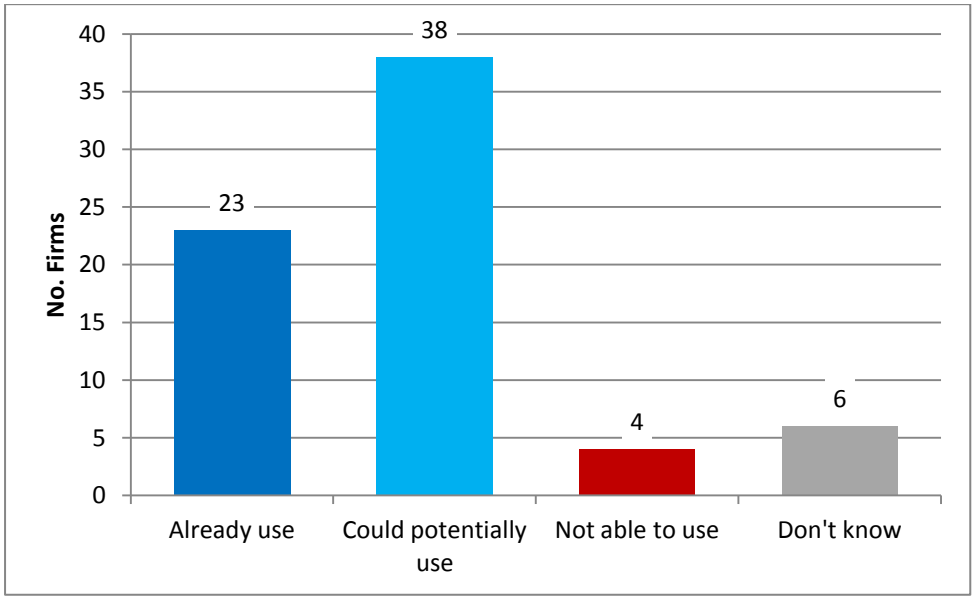

Figure 11. Numbers of firms that could and could not use new organisms.

Twenty four firms indicated that they had applied to use a new organism in the last five years, while 33 indicated that they had not. Those that had applied were predominantly from the primary sector and firms providing research services. Half of the firms (29 out of 57) had decided not to proceed with an application to use a new organism in the last five years. Sixteen of the 24 firms who had previously applied for regulatory approval, also indicated that they had decided not to proceed with an application in the last five years, suggesting that familiarity with the regulatory process doesn't necessary facilitate further applications.

Of the seven firms answering that they could not use new organisms most (five) identified lack of knowledge about how new organisms could be used in their business. Two firms indicated that new organisms weren't applicable to their business. Other reasons offered by firms for not using new organisms were that "*MAF would make it impossible*" and that the business "o*nly uses natural selection*" (which indicates this firm considered new organisms solely in terms of genetically modified organisms).

A very high proportion of firms answering the survey indicated that they undertake or fund research and development (R&D) activity (89.5% of 57 firms answering this question). Similarly high numbers indicated that they had introduced a new product, process, or service within the last five years (87.7%), and intended to introduce an innovation within the next two years (84.5%). Statistics New Zealand reported that 46% of firms undertook some form of innovative activity in 2009 (Statistics 2010[29]). Since less than half of the firms indicated that they had used new organisms in the last five years, much of this innovative activity does not seem to involve new organisms. The survey did not explore the nature of their innovative activities. Firms may also be overestimating their innovative activity, or using broader definitions of R&D and innovation that were provided in the survey.

Nearly two thirds of firms (61%) indicated that their focus was primarily on the New Zealand domestic market, with the remainder focusing on export.

Reasons to use new organisms

The main reasons firms indicated that they would use new organisms is to establish or exploit a new market opportunity (82% of firms) and respond to customer demand (70%; Figure 12). In contrast to the Business Operations Survey (Statistics

[29] Innovation in New Zealand: 2009. Statistics New Zealand (2010).

2011[30]) and interviews with industry bodies, only about half of respondents noted that increasing revenue or productivity were influencing factors. However, increasing revenue is often likely to result from exploiting a new market opportunity. Most firms did not see keeping up with competitors who use new organisms as a significant factor influencing their behaviour.

Figure 12. Reasons for using new organisms. Respondents could select a several factors, hence results are shown as number of responses rather than number of firms. Other reasons supplied by respondents included the New Zealand Emissions Trading Scheme, sustainability and disease management (which can be an aspect of improving productivity).

Constraints to using new organisms

Also in contrast with the responses from industry bodies, firms answering the survey rated regulatory requirements as a much greater constraint on using new organisms than economic or market factors (Figure 13). Of the 51 firms answering the question about what enhances and constrains use of new organisms, 44 indicated that regulations were either a constraint (19 firms) or a significant constraint (25). Of the firms where regulation is viewed as a constraint, 18 had formally applied for approval to use a new organism in the last five years and 27 firms had decided not to proceed with an application for regulatory approval.

[30] Innovation in New Zealand: 2009. Statistics New Zealand (2011).

These results suggest that regulatory factors (application processes and compliance) are influencing firms' decisions regardless of whether they had direct experience with the regulatory system. Discussions with selected firms (see the next Section) indicated that some firms may be relying on outdated or inaccurate information about current requirements, but others despite not engaging are well informed about current regulatory requirements and issues associated with them.

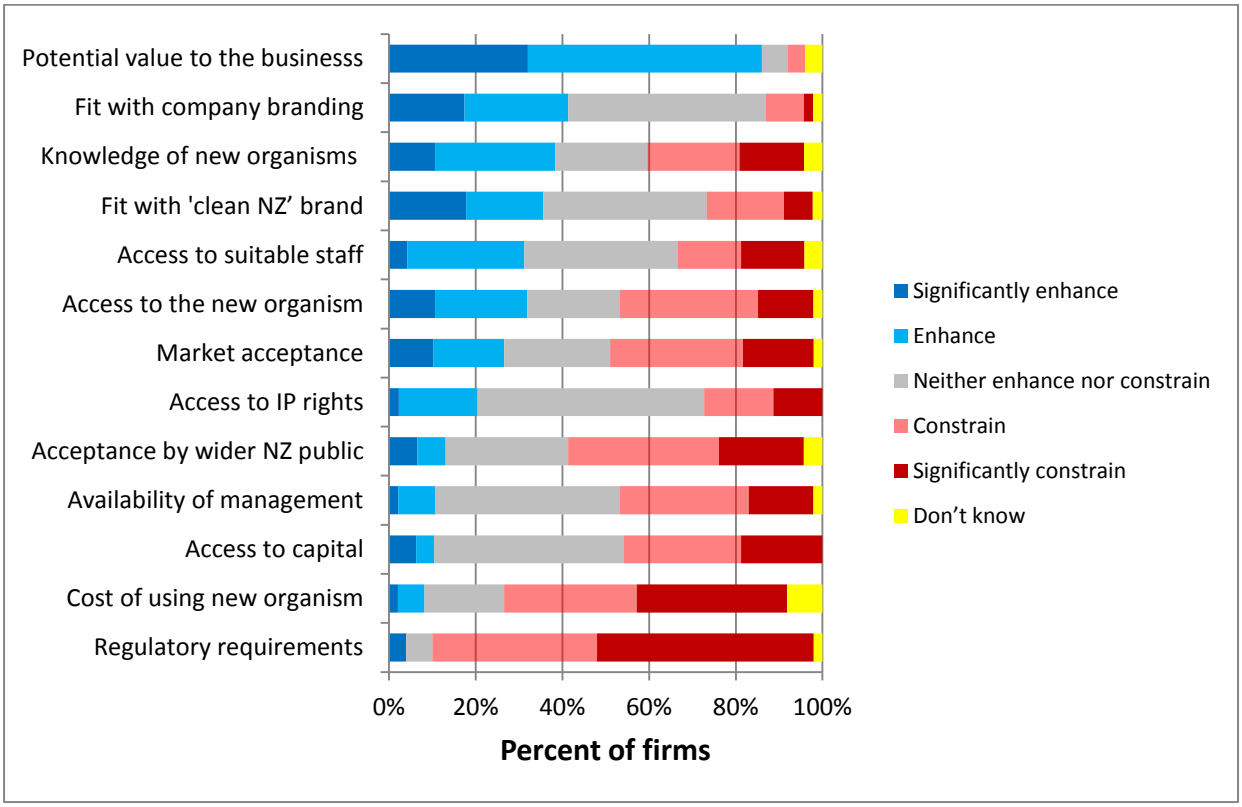

Figure 13. Factors that enhance or constrain use of new organisms. Number of firms responding was 51.

The attitude of the New Zealand public to new organisms was also seen as a constraining factor on use (55 % of survey responses indicated it as a constraint or significant constraint). This is largely, but not exclusively, related to the use of genetically modified organisms (Figure 14). Non-genetically modified organisms may have no or some positive influence with regard to acceptance or fit with branding.

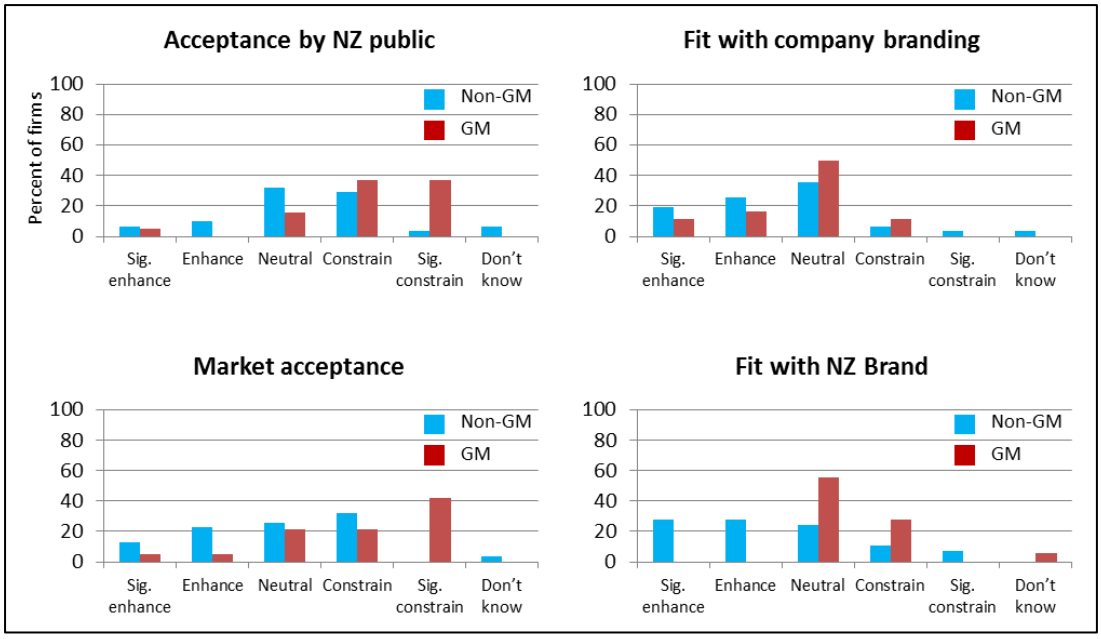

Figure 14. Differences in how genetically modified (GM) and non-modified organisms can influence decision making for acceptance and brand image.

Access to capital was expected to be a major constraint to the use of new organisms but while a majority of firms found it constraining to some degree a very significant number found it neither enhanced nor constrained their use. The same was also true for availability of management resources. Both of these factors ranked below regulatory requirements, cost of using the new organisms and public acceptance. Access to intellectual property rights was not a significant influence on firms' decisions to use new organisms.

The influence of other factors varied between firms. For some factors firms were evenly split on whether they considered them as enhancing or constraining decisions to use new organisms. For example, a similar number of firms felt they had inadequate knowledge about suitable new organisms as those that regarded they knew enough for this to have a positive influence on decision making. An equal numbers of firms also thought that new organisms would enhance fit with country and company branding as those who thought new organisms would not fit with branding.

Effects of firm size

There were some differences in what were considered significant constraints for firms of different sizes (Figure 15). Smaller firms (less than 50 employees) were more likely to identify access to capital as a significant constraint, while some larger firms (more than 100 employees) considered they had insufficient knowledge about, and

access to, new organisms as well as viewing fit with branding as an important constraint. For larger firms regulations were often regarded as a less important constraint, but was still one of the more important constraints overall.

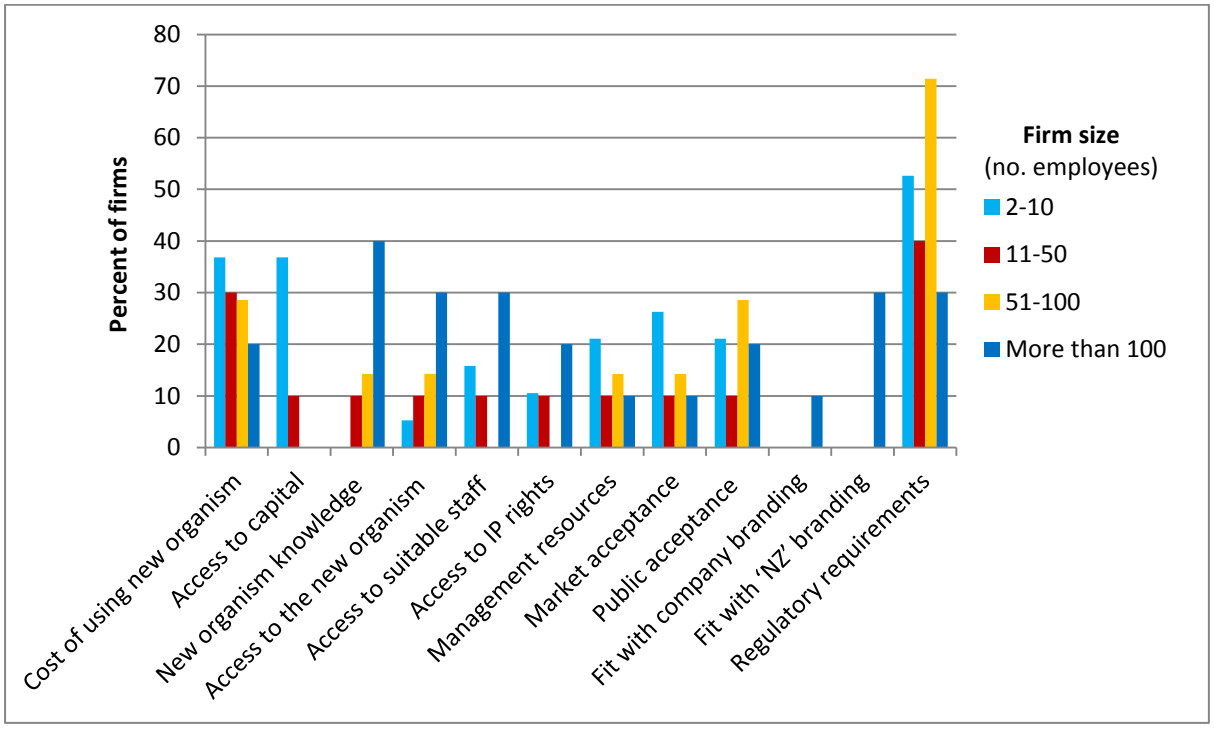

Figure 15. Significant constraints on using new organisms for firms of different sizes. Numbers of responses: 19 (2-10 employees), 10 (11-50), 7 (51-10), 10 (more than 100). Only 2 firms were sole traders and so their results are not included.

Regardless of size, firms had similar views on what aspects of regulation were the biggest constraints (Figure 16). The only substantial difference was over the extent to which release of information during the regulatory process influences the decision to use new organisms.

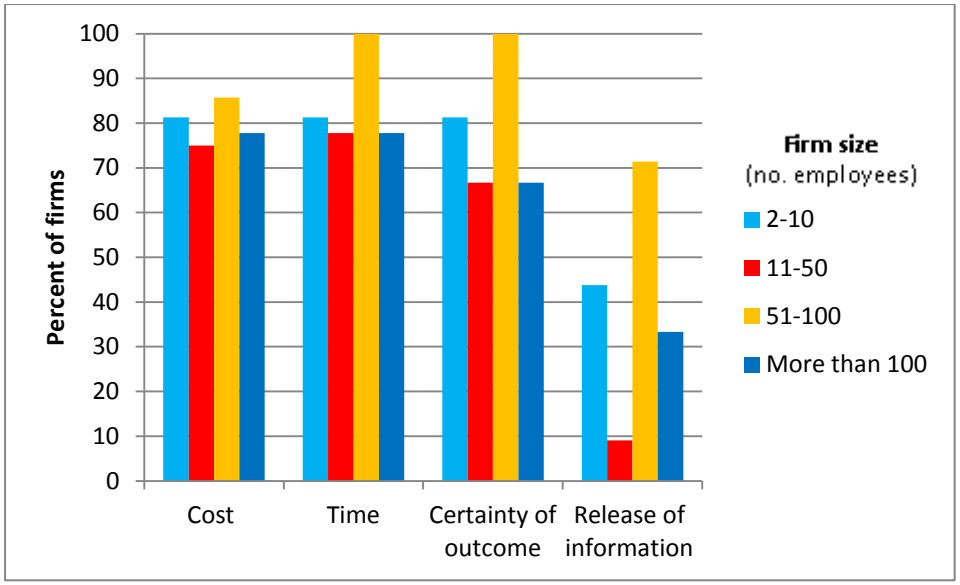

Figure 16. Comparison of responses for firms of different sizes and what they considered the main regulatory constraints.

Firms interested in using genetically modified or non-modified new organisms were also largely consistent in their views about the most important regulatory constraints (Figure 17). One difference was that firms interested in using genetically modified organisms generally have less concern about release of information compared to firms using other types of new organisms. This was borne out interviews with two firms who noted that disclosure of what non-genetically modified new organisms they were interested in could alert competitors here or elsewhere to the fact, and they could lose a market opportunity. There was also the comment that "*Releasing names to the public on the granting of a permit to import which is then used by GMO opponents in press releases. A very big issue that has potential consequences for one's personal safety*." The last sentence in this quote relates to personal attacks on at least one scientist involved in a genetically modified organism field test application some years ago. Several firms we talked to were aware of aspects (costs, protests, etc) of previous applications to trial genetically modified organisms.

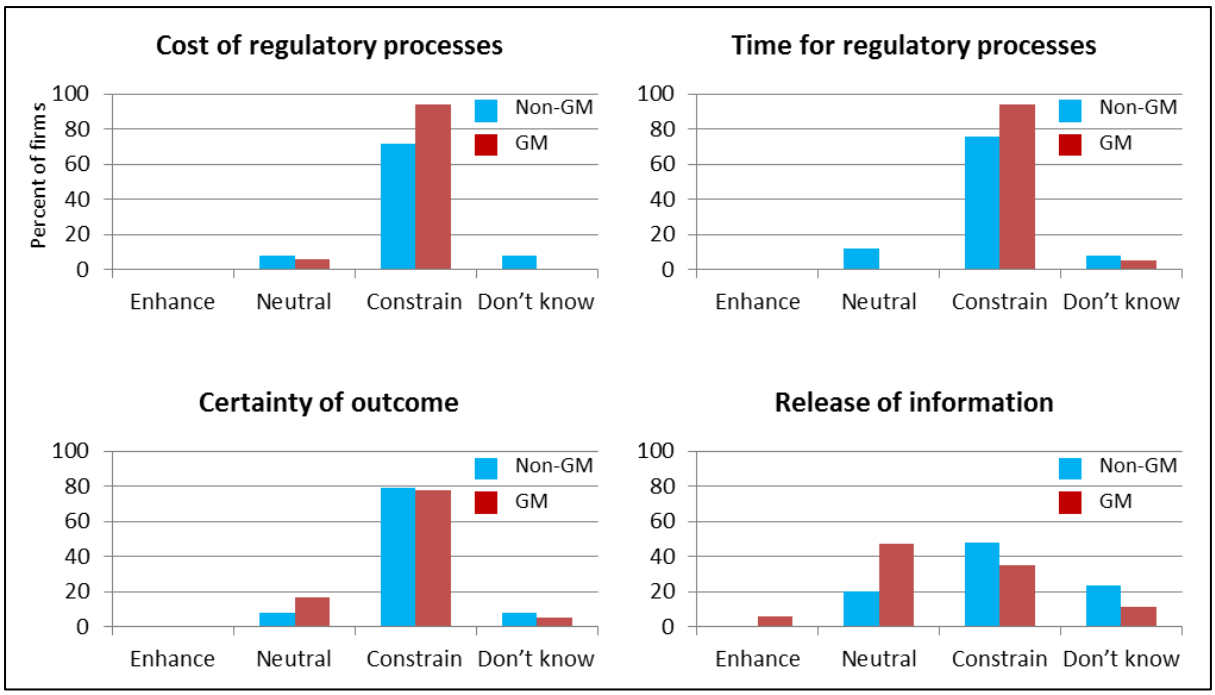

Figure 17. Similarities and differences in regulatory factors influencing decision making for non-genetically modified and genetically modified new organisms.

Influence of regulations on decision making

With respect to regulations, the requirements of, and compliance with, the Biosecurity Act and HSNO Act were identified as the regulatory instruments having the greatest constraint on the use of new organisms (Figure 18). Comments from survey respondents and interviewees noted that an absence of appropriate Import Health Standards and other biosecurity compliance requirements are aspects of the Biosecurity Act that can influence whether to use a new organism or not. Time and costs associated with regulatory approvals through the EPA were the factors most frequently raised in relation to the HSNO Act. One survey respondent did, however, comment that "*ERMA is great. Extremely thorough, professional, efficient and very helpful. They are so good it is hard to believe that they are a government entity.*"

Ten percent of respondents indicated that the need to meet international regulatory requirements can enhance the use of new organisms here. For medical applications, respondents reported the regulatory requirements had little influence. Intellectual property rights requirements were also considered to have minor influence, except in the case of plant variety rights where more firms considered that having plant variety rights enhanced opportunities to use new plants.

Firms accepted the need for regulation with a small number indicating that the regulations enhance their ability to innovate (2%) and that the rigor of the New

Zealand regulatory system in the eyes of the customer was also an advantage (7%). Respondents commented that "*Regulation is needed but the time and cost involved for niche products is too high,*" and "*Understand the need for regulatory environment but it has to be balanced by the value of being able to deliver technology that will add value to the NZ economy. Right now it is just too hard.*"

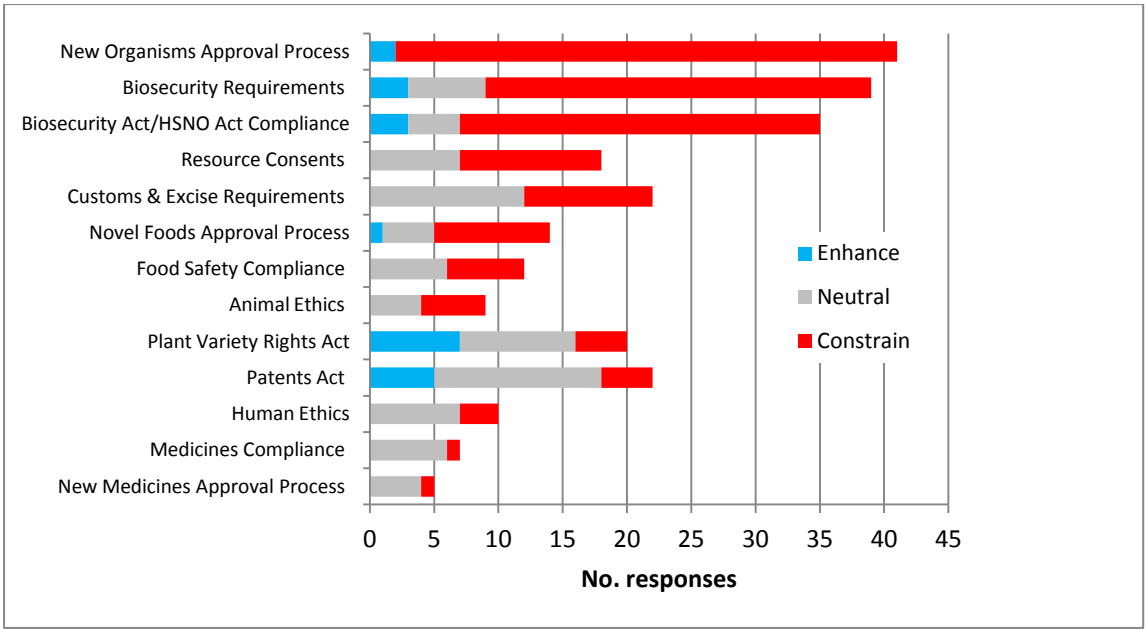

Figure 18. Influence on decision making of regulatory instruments.

Comparisons with other surveys

Firms indicated that the main factors significantly constraining innovation using new organisms are "Regulations" and "Costs to develop or introduce a new organism" (Figure 13 and Table 5). These results differ in two ways from the findings of recent Statistics New Zealand surveys. The first is in the ranking of the most important factors hampering innovation. The 2011 Bioscience survey[31] ranked "access to capital" as the greatest constraint for bioscience firms and research organisations commercialising bioscience. Regulation was viewed as a significant constraint largely for "core" bioscience firms[32] commercialising products. Core bioscience firms undertaking R&D also considered regulations as one of the more important constraints, but access to personnel was considered a more significant constraint (Table 5). Regulation ranked third as a constraint for New Zealand firms

[31] Bioscience survey: 2011. Statistics New Zealand (February 2012)

[32] A "core" bioscience firm is one where the main activity is bioscience and it produces bioscience goods and services , while an "active" bioscience firm is one that operates in fields other than bioscience but uses bioscience processes for manufacturing.

in general, behind costs to develop or introduce innovation and lack of management expertise (Table 5).

The second main difference is that firms that could potentially innovate using new organisms generally gave higher ratings for factors as significant constraints compared with the Statistics New Zealand surveys (Table 5). The exception is "Access to capital", which Statistics New Zealand surveys usually report as being the most significant constraint constraints. Substantially more firms that could use new organisms or engage in other bioscience activities identify regulatory and cost factors as significant constraints compared to New Zealand firms in general. Two thirds of firms surveyed for the 2011 Business Operations survey regarded government regulations as having no effect on their ability to innovate.

In the Business Operations Survey 2009, firms in the education, health and electricity sectors rated regulatory constraints the highest, with the education sector having the largest proportion of firms (24%) rating regulation as "hampering innovation to a high degree" (the 2011 Survey didn't report on regulatory constraints within sectors).

Compared with the survey of all businesses, development costs and regulations are viewed as considerably greater constraints for firms using new organisms. All other factors, with the exception of management expertise, were also rated higher for firms using new organisms compared with New Zealand firms in general.

Table 5. Comparison of three surveys of factors significantly constraining innovation; in the use of new organisms (this survey), commercialisation and R&D of bioscience (Statistics New Zealand Bioscience Survey 2011), and innovation more generally (Statistics New Zealand Business Operations Survey 2011).* [IP = Intellectual property]

Survey	Group	Access to capital	Lack of manage-ment resources	Costs to develop	Regula-tion	Lack of appropriate personnel	Lack of informa-tion	Access to IP rights	Lack of access to technology
		Percent of responses identifying factor as a barrier or constraint							
New organisms (this survey)	Overall	18	14	**33**	**50**	14	14	10	12
	Primary sector	8	15	**46**	**55**	8	4	8	15
	Industrial sector	15	13	**28**	**43**	13	5	10	5
	Health sector	29	14	**29**	**45**	**29**	19	14	10
	Other	13	25	**69**	**63**	0	6	0	6
Bioscience Survey * (Commercialisation activity)	Core	**47**	10	-	39	16	4	10	14
	Active	**24**	7	-	**13**	6	3	6	4
Bioscience Survey (R&D activity)	Core	**59**	6	-	16	**29**	12	8	14
	Active	**38**	6	-	**10**	**10**	8	5	6
Business Operations Survey	Overall	-	**14**	**21**	7	8	4	1	-

* Note the Statistics Surveys also identified access to marketing expertise and lack of distribution and marketing channels as constraints. "Bioscience Core" firms produce bioscience products while "Bioscience Active" firms are ones that use bioscience processes to manufacture their products. A"-" in the table indicates the question was not included in that survey.

DISCUSSIONS WITH SELECTED BUSINESSES

Key points

- Ten firms representing significant potential users of new organisms were interviewed in to provide information on decision making processes in greater depth.
- All businesses interviewed initially focussed on whether a potential product involving new organisms would add value to their business.
- Businesses in the natural health or food industries and businesses supplying the food industry then considered market and public acceptance of the product. Market and public attitudes to genetic modification meant that no firm in these sectors was currently considering introducing a product based on the technology.
- Some firms in these industries believed products involving genetic modification could potentially address global and industry challenges as well as adding value to their business and were prepared to be fast followers should genetic modification be adopted by a competitor.
- For products not involving genetically modified organisms the costs and perceived difficulty of the regulatory system were much more important.
- Outside the food related sectors, market acceptance was less of an issue for products involving genetic modification, but the potential public reaction to genetically modified organisms and the costs imposed by the regulatory issues were major concerns.
- Some firms felt that their knowledge of the regulatory system was not good, and what they did know of it came from second-hand information from other firms and media reporting. Based on this they did not feel encouraged to seek approval for the use of new organisms.
- Familiarity with the regulatory process has encouraged some applications to use biocontrol agents. However, greater knowledge of regulatory requirements does not necessarily lead to better engagement. One firm with experience of the regulatory system was not intending to make further applications because of the cost in time and resources required.

Ten firms representing some of the main potential users of new organisms were interviewed to provide more in depth information on their decision making process to complement survey results. The firms were identified by industry bodies and the Reference Group. The firms covered the medical, natural products, food ingredients, industrial biotech, research, horticultural and pastoral industries. Half of the businesses currently use new organisms, although genetically modified organisms were only currently used in research. All of the businesses saw potential to be able to use new organisms in the future.

Health & food sectors

In deciding whether to innovate using new organisms all the businesses initially focussed on whether the product would add value to their business. In the health sector proven effectiveness was the main factor influencing value. Businesses in the natural products or food industry, or businesses supplying the food industry, next considered the market acceptance and acceptance by the wider New Zealand public of the proposed products. The businesses all considered that these two factors were closely intertwined and hard to distinguish between.

For new organisms involving genetic modification market and public acceptance were the over-riding considerations in the food and natural health sectors. Concern over the potential market and public reaction made the innovation unlikely to proceed. There was some discussion of the fact that it was hard to tell if the market would actually respond negatively when presented with a genetically modified product that offered customers a clear benefit. However, no company considered it worth the risk to be the first to bring a product to market.

Some of the companies believed that the use of genetically modified organisms had the potential to meet industry and global challenges, as well as add value to their business and these firms were prepared to be fast followers should genetic modification be adopted by a competitor.

The natural products company interviewed would not use genetic modification because it was not seen as compatible with the New Zealand brand position for the sector. This was also noted by their sector body when interviewed. The interviewee was very firm on the fact that the natural advantages of New Zealand in growing natural health products meant the industry should aim to get a premium for its products which would not be possible with products based on genetically modified

organisms. This was the same position taken by a food company. They noted that genetically modified products in their sector could be used by overseas competitors in the future for the lower end of the value chain, while the New Zealand firm was focussed on the premium (non-genetically modified) end.

For innovations in the health and food sectors non-genetically modified new organisms to New Zealand did not raise general issues of market or public acceptance with firms (consistent with the survey results). Costs and perceived difficulty of the regulatory process were the major influencing factors. Where the value of the product was considered to make the costs imposed by the regulations worthwhile then businesses would continue development of the innovation. Firms recognised the need for regulations to protect the public and the environment. However, uncertainty around the effort and cost required to undergo the regulatory process and uncertainty in the potential value of the product made this a very difficult decision. Businesses indicated that they would prefer to develop new products using organisms that did not meet the HSNO definition of "new" and so avoid undergoing the regulatory process where possible.

Other sectors

Businesses not in the health and food sectors industry sectors identified the ability of a new organism to contribute to a new product or process, or provide a more effective service (such as biocontrol) as the initial factor in decision making. They raised the regulatory process as the second major influencing factor after consideration of whether the product would add value to their operation. In most cases the businesses had, in fact, taken the decision not to go through the regulatory process and sought alternatives by using organisms that were not new to New Zealand or developing the product offshore. All firms that had been through the new organism regulatory process expressed concerns about its cost and uncertainties. The Biosecurity Act was also noted as a constraining factor. In some cases this was due to the lack or delay in developing Import Health Standards that are required to import particular plants. Another interviewee commented that MAF (now MPI) seemed more interested in compliance than assisting smaller firms.

For innovations involving genetic modification acceptance by the New Zealand public was also a very important influencing factor. None of the businesses interviewed was actively considering developing such an innovation in New Zealand, although one indicated that they would be prepared to develop them elsewhere. One interviewee interested in using genetically modified organisms

expressed concern that release of some information in genetically modified field trials had resulted in attacks on property (at the field trial site, or in at least one case the personal property of a scientist associated with the trial). Some other interviewees also referred to costs and incidents associated with previous genetically modified field trial applications.

In the research sector, where genetically modified organisms are used routinely in containment with no expectation that they will be released, the regulatory system was considered to be a manageable imposition by one interviewee. They felt that a workable system had been developed that depended upon a good understanding between the organisation and ERMA New Zealand (now the EPA), as well a dedicated regulatory affairs officer who could help staff. As the system had matured since the HSNO Act came into force in 1998 a number of changes had been made that lowered the cost of compliance to researchers. They expressed concern that the formation of the EPA could result in loss of institutional knowledge and set back the understanding that had developed. The interviewee quoted an example of an important research project that had moved offshore because of regulatory difficulties. The RSNZ report on the impact of HSNO on research[33] discusses researcher views of the new organism regulatory system in more detail.

Many of the businesses interviewed did not have a good knowledge of the regulatory system. Their perception was that it was difficult and expensive and so avoided innovations that would require regulatory clearance. There were also comments that changes in government agencies made it difficult to know where to go for information. One interviewee said "*I don't know where to go. I guess that in the first instance I would approach ERMA but I bet they have changed their name.*" The interviewee suggested that as part of its innovation policy the government provide people to help businesses through the regulatory system. However, some of the organisations were well informed about regulatory processes and requirements.

Most of the interviewees recognised the necessity for regulations to ensure public safety, preserve the environment and protect New Zealand's agricultural base. Two indicated though that they would consider going offshore to develop new organisms to avoid regulatory costs here.

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[33] The Impact of the Hazardous Substances and New Organisms (HSNO) Act on Research in New Zealand. Royal Society of New Zealand (2012).

No interviewee raised access to capital, funding to implement the technology or lack of knowledge as substantial barriers to innovation with new organisms. One interviewee felt that his company's scanning of the international literature for new species that would suit their business encouraged them to innovate. There was an implicit understanding from many of the interviewees that management and technical staff resources were scarce and limited their ability to innovate.

CONCLUSIONS - INNOVATION WITH NEW ORGANISMS

Key points

- For innovation in general, surveys show that economic factors are the most important influence on firm's decision making, with regulatory factors much less important.
- The process around a firm's decision about whether or not to use new organisms is relatively complex. Economic factors, particularly the potential value of the product to the firm and the cost of its development, are taken into account as the first step in deciding to use new organisms.
- However, market and regulatory factors then become very important factors in estimating potential returns and expected costs of any new product to the firm.
- Regulatory factors were a very significant factor for firms in decisions around innovation with new organisms, more so than for other types of firms.
- Knowledge factors are often considered important influences on decision making for biotechnology firms, and for New Zealand firms in general. However, this was not the case for respondents to this survey.
- For innovations involving genetically modified organisms uncertainty around market acceptability is much more likely to be a factor in deciding to proceed with an innovation than with non-modified organism.
- For firms innovating with non-genetically modified new organisms the cost and uncertainty of the regulatory process are more important considerations.
- Some firms are considering going offshore to use new organisms to avoid regulatory costs and, in the case of genetically modified organisms, conflicts over their use.

Differences from other types of innovation

In the Statistics New Zealand Business Operation Surveys increasing revenue was the main factor that New Zealand firms identified as a reason for innovating - 90% of firms identified this as a factor (Statistics 2010[34]), compared with 78% of firms noting increasing production as an influential factor.

Industry sector bodies' responses in the current project noted increasing productivity as the main challenge facing their sectors. Cost and potential returns associated with the use of new organisms were the main economic factors influencing decision making, with the ability to move into new markets the main market factor. Regulatory factors were considered to be of lesser importance for decision making. Some industry bodies noted technology costs, or lack of mature technologies to deploy, could affect the ability of some firms in their sector to innovate with new organisms.

The survey results for firms that could potentially use new organisms indicate individual firms rated opportunities to access new markets as a more important influencing factor than productivity or economic benefits. However, access to new markets can also be viewed as a means of increasing the economic benefit to the firm, so the distinction is probably not significant. This was borne out in our follow-up interviews with individual businesses.

The difference in emphasis between the industry bodies and individual firm views is understandable. Industry bodies focus on sector growth and development broadly, while firms will be more interested in their own costs and revenues and less interested in industry development.

Both internationally and in sectors not involving new organisms in New Zealand, cost factors not related to regulation are the most significant in decision making in innovation.[35] Market factors and knowledge factors are also important constraints, with regulatory factors being less so. The major point of difference between innovating with new organisms, as opposed to other types of innovation, is the view that regulations are much more of a constraint for the former. Financial constraints

[34] Innovation in New Zealand: 2009. Statistics New Zealand (2010).

[35] Revealed versus Deterring Barriers to Innovation; Evidence from the 4th Community Innovation Survey (CIS4), DIUS Research Report 09-09 (May 2009); Innovation in New Zealand: 2009. Statistics New Zealand (2010).

not related to regulation came next. The Bioscience Survey also noted the significance of regulation (see Table 5).

In the New Zealand Business Operations Survey of 2009, two thirds of firms reported that regulations were not hampering their ability to innovate (Statistics 2010[36]). However, our survey found that eighty seven percent of firms that do or could use new organisms report regulations being a constraint. Since over half the firms responding had not applied for regulatory approval for a new organism, it appears perception of costs and information requirements is a major influencing factor. This was borne out by some of the interviews with firms. Some interviewees were knowledgeable about current requirements and issues (through contact with other firms or industry bodies), and so could be considered to be making rational and well informed decisions. Others did not appear well informed.

Firms that could use new organisms show a great deal of sensitivity to public attitudes (this is largely, but not exclusively, associated with genetically modified organisms). Public attitudes clearly influence market acceptance, and firms can face considerable difficulty distinguishing the two.

It is interesting to note that New Zealand firms did not find knowledge constraints an important issue, despite being distant from most global knowledge generation and working with a research system that the OECD considers poorly linked to business. Only five respondents noted that they had insufficient information to know whether new organisms could be of use to their firm. The Statistics New Zealand surveys also indicated access to information was a significant barrier for only a small proportion of firms (except for R&D active ones; see Table 5). This contrasts with the conclusions of Marsh[37] in his study of biotechnology innovation in New Zealand. Two industry bodies also commented on the need to improve links between firms and research organisations to enhance innovation activity involving new organisms. The perspective of the firms may be due to them overestimating the knowledge they have about new organisms, or survey respondents being those particularly well informed.

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[36] Innovation in New Zealand: 2009. Statistics New Zealand (2010).

[37] Does New Zealand have an Innovation System for Biotechnology? Dan Marsh, University of Waikato Working Paper in Economics 3/02 (May 2002).

The effect of regulations on firms' decision making

Why may firms using new organisms, or engaged in other bioscience activity, consider that regulations have a greater influence on their decision making than other firms? One factor may be that biotechnology is regarded as a highly regulated technological area.[38] However, level of regulation by itself is not an adequate explanation. Other industries can also be highly regulated and view the regulatory environment as just a part of the cost of doing business. In addition, high levels of innovation are seen in biotechnology despite the regulatory environment.[39]

Another factor may be due to limitations in the survey design. We discount this as having a significant biasing effect. Identical or similar questions to those used in the Statistics New Zealand surveys were used, and there was a general level of consistency in responses with the Statistics Bioscience Survey (Table 5). In line with OECD recommendations,[40] the questions about regulations provided examples of benefits, reducing bias about negative perceptions.

It is possible that since the focus of the survey was on new organisms and regulatory influence that regulatory issues were more in mind when firms answered the survey. We can exclude the possibility that those responding to the survey were firms who were more disgruntled with the regulatory system, or came from sectors particularly frustrated by the regulation of new organisms. Over half the respondents had not applied for a new organism approval within the last five years. Respondents also represented a broad range of sub-sectors. However, relatively few health-related firms responded (Figure 9). The extent to which this may have skewed results is uncertain, but most of the health-related firms answering the survey indicated regulations were a constraint.

Most of the firms responding had less than 100 employees, and small firms generally find regulatory requirements to be more of a challenge.[41] However, most of New Zealand firms are small (97% have less than 20 employees[42]), so this isn't expected to

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[38] Analysis of market and regulatory factors influencing innovation: Sectoral patterns and national differences. Final Report, Task 3. Europe INNOVA Sectoral Innovation Watch (December 2011).
[39] Analysis of market and regulatory factors influencing innovation: Sectoral patterns and national differences. Final Report, Task 3. Europe INNOVA Sectoral Innovation Watch (December 2011).
[40] Measuring regulatory performance. A practitioner's guide to perception surveys. OECD (2012).
[41] Summary report of the Business New Zealand – KPMG compliance cost survey. (October 2008). Available from http://www.businessnz.org.nz/surveys/504
[42] SMEs in New Zealand: structure and dynamics 2011. Ministry of Economic Development (September 2011).

bias the results from this survey. While larger firms (more than 100 employees) were less likely to consider regulatory requirements as the most significant constraint it was a relatively important consideration for them too (Figure 15).

Most of the survey respondents indicated that they undertake R&D or have introduced innovations in the last five years. This was surprising, given the more modest proportion of New Zealand firms in general that innovate (Statistics 2010).[43] This may contribute to the high level of importance attached to barriers to innovation. D'Este et al. (2009)[44] found that firms that innovate, or attempt to, attach greater importance to barriers (regardless of what they are) compared to firms with little interest in innovation.

Perception surveys can tend to reveal negative perceptions of regulations (OECD 2012).[45] Interviews with firms allowed us to explore more about the factors influencing innovation, and these were also consistent in highlighting the influence of regulatory requirements. So we are satisfied that regulatory factors associated with new organisms are significant for many firms.

A range of factors influence perceptions about regulations (OECD 2012).[46] These can be directly linked to regulations, or derive from individual attitudes. A study of SMEs and regulation in New Zealand noted that the attitude of firm owners is an important factor governing how firms manage regulatory requirements.[47] Negative perceptions can arise when the regulations are viewed as inflexible, unfair, pointless, outcomes are uncertain, they are too complex, and regulatory agencies are not perceived as respecting the efforts firms are doing to comply.[48] The attitude of small firm owners also has an important influence on how well the firm copes with regulatory requirements.[49]

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[43] Innovation in New Zealand: 2009. Statistics New Zealand (2010).
[44] Revealed versus Deterring Barriers to Innovation. D'Este, P., Iammarino, S., Savona, M., von Tunzelmann, N. UK Department for Innovation, Universities and Skills Research Report 09 09.
[45] Measuring regulatory performance. A practitioner's guide to perception surveys. OECD (2012).
[46] Measuring regulatory performance. A practitioner's guide to perception surveys. OECD (2012).
[47] SME capability to manage regulation. Martina Battisti, David Deakins and Martin Perry. New Zealand Centre for Small & Medium Enterprise Research, Massey University (2011). Available at http://www.massey.ac.nz/massey/fms/sme/Report_Regulation_NZ_2011.pdf
[48] The Burden-Hunter technique: A user-centric approach to cutting red tape, Wissing Jensen, Jørgen (2010). Presented at the OECD Workshop on Measuring Progress in Regulatory Reform: Perception Surveys, 21-22 June, see Slide 11, Available at http://www.oecd.org/dataoecd/56/58/45641644.pdf.
[49] SME capability to manage regulation. Martina Battisti, David Deakins and Martin Perry. New Zealand Centre for Small & Medium Enterprise Research, Massey University (2011).

Poor quality service from regulators can be discounted as an important factor influencing regulatory perceptions for new organisms because many respondents had not engaged with regulators, and some of those who had were complementary about regulators (particularly the EPA).

Based on the survey and discussions with firms and industry bodies', four main factors seem to elevate the influence that regulation has on firms that use, or could potentially use, new organisms. The four factors are:

- Validity
- Costs
- Fairness
- Market & societal attitudes

Regulatory validity

While the need for regulation was acknowledged by many, firms can view the new organisms' aspect of the HSNO Act as a disproportionate response to potential risks. Consequently, firms may consider the regulatory requirements as lacking validity and this will influence their attitude. This sentiment was expressed by several interviewees, both those interested in using non-genetically modified organisms as well as those interested in using GMOs.

One interviewee commented that having new organisms regulated by legislation that also considers hazardous substances created, in their view, an unfounded perception that organisms were intrinsically hazardous. They considered that assessment has shifted from establishing benefit to demonstrating absence of risk, which in their opinion is difficult to do. Another interviewee also considered that it would be impossible to demonstrate that any new organism was completely safe under all circumstances, and their interpretation of the regulatory guidelines suggested that if they followed the wording of the HSNO Act the decision makers would never be able to approve a new organism.

In contrast, one interviewee familiar with the approval of biocontrol agents was satisfied with regulatory requirements. Others have previously written that initial concerns about the adverse impact the HSNO Act would have on biocontrol of pests in New Zealand proved unfounded. Experience has led to a transparent, rigorous and routine regulatory process, at least for some types of biocontrol agents (Hill

2012).[50] Some biocontrol experts consider that the New Zealand regulatory system is the best in the world (in terms of transparency and rigour), although they acknowledge that does come with additional information and consultation costs (Barratt et al. 2010).[51]

Firms working with micro-organisms expressed frustration at the effort that they considered they would need to go through to either prove a microbe was not new or to apply for a new organism approval for a microbe that is probably not new. They considered that this was probably not what was originally intended by the legislation.

Some survey respondents and interviewees also seemed unfamiliar with current regulatory requirements and had not engaged with regulators. They seemed unwilling or unable to increase their awareness of regulatory requirements. The EPA has previously attempted to help raise awareness and support some sectors to make applications, but this hasn't always been successful.

Regulatory costs

Some industry bodies noted that regulatory costs will be relatively insignificant, compared to benefits to the firm if the economic return from using the new organism is high. But some interviews with firms indicated that they thought regulatory costs may not be offset by economic benefits from using the new organism. In the case of firms wishing to import new organisms to develop new products or processes (rather than immediately commercialise the organism), it was noted that high up-front regulatory costs can be a disincentive to using new organisms when the economic return was more distant, relatively small, or uncertain. There was also the concern that once a firm had obtained approval to import a new organism, other firms could subsequently import it without the application costs.

Concern about costs may be used as a means to rationalise decisions based on other factors, such as having insufficient resources or management experience.[52] This may be the case for some firms interested in using new organisms, but it does not apply to all the firms surveyed. One firm we spoke with had adequate resources, good

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[50]New Zealand's successful system for approving biocontrol agents. Hill, R. *In* What's new in biocontrol of weeds, Vol 59, pp. 4-5. Landcare Research. (2012) http://www.landcareresearch.co.nz/publications/newsletters/weeds/wtsnew59.pdf

[51] Progress in risk assessment for classical biological control. Barratt, B.I.P. et al Biological Control 52, 245–254. (2010)

[52] SME capability to manage regulation. Martina Battisti, David Deakins and Martin Perry. New Zealand Centre for Small & Medium Enterprise Research, Massey University (2011).

management, and good assistance from the regulator but still felt the costs were too great. Other firms responding to the survey can also be inferred to have (based on their size and reputation) good management systems and resources.

Time to get a regulatory approval is also viewed as a cost. One interviewee noted that for their firm time was a more important factor than cost and if regulatory approvals could be expedited through higher costs then they would be willing to pay more. Some interviewees and survey respondents were frustrated that a lack of relevant import health standards for specific types of plants can prevent or delay import of organisms. While the HSNO Act has statutory time frames for decision making once an application has been submitted, some interviewees noted that they were unsure of the amount of time, as well as cost, that would be required to prepare an application, and this uncertainty could discourage the use of new organisms. Uncertainty about times and costs associated with new organism approvals can also have an important influence on decision making.

One interviewee noted that only a single genetically modified organism (for an equine flu vaccine) had gone through the new organism release process, and this had reportedly cost around $1 million to prepare the application. Uncertainty around the time and costs required to prepare an application for release of a genetically modified organism in New Zealand is an influential factor, particularly if the firm has the option of using that organism elsewhere at a lower regulatory cost.

Fairness

Many interviewees considered that the regulation of new organisms in New Zealand was overly burdensome with respect to information requirements compared with the approach of other countries. As a consequence, several interviewees commented that this can place New Zealand firms at a competitive disadvantage. Differences between the regulatory requirements of HSNO and how GMOs are regulated in Australia and the US that may have led companies to conduct trials and initial commercialisation offshore were noted by Dunahay.[53] These included the requirement for a more complex risk benefit analysis, higher costs and stricter conditions for some forms of field trial.

While those working on biocontrol recognise the broader benefits the new organisms can bring, firms wanting to use new organisms in other ways may not have the same

[53] Is the Grass Always Greener? Issues Affecting the Adoption of Genetically Modified Pasture Grasses in New Zealand. Terri G. Dunahay. Ian Axford Fellowship Report (August 2010).

perspective. Businesses tend to focus on regulatory costs rather than broader benefits (OECD 2012).

Market & societal attitudes

Finally, regulatory factors may be being raised as a proxy for other factors. The Sustainability Council of New Zealand[54] considered that calls from researchers and firms to change the regulatory system for genetically modified organisms were misdirected. In their view organisations interested in using genetically modified organisms were not willing to acknowledge that the market, and society more generally, does not want genetically modified food, rather than the regulatory system hampering adoption.

In our interviews with firms interested in using genetically modified organisms reference was made to challenges raised by the public consultation part of the regulatory process. They were uncertain whether vocal opposition by a small number of groups or individuals reflected wider public opposition towards the use of genetic modification in food and the environment, but were reluctant to test this by submitting an application. Interviewees noted that the firm applying to release (or field test) a genetically modified organism, as well as the decision-makers, would need to respond to issues not directly relevant to the application. One interviewee and two industry bodies commented that it would help if the country could have a more nuanced discussion about benefits of some forms of genetic modification. Dunahay noted that a critical factor influencing whether GMOs could be used in a pastoral setting was agreement over whether GMO and organic farming systems could co-exist.[55]

Interviewees acknowledged that market attitudes are especially important for genetically modified organisms, and did not conflate these with regulatory factors. Both interviews and survey results are consistent that regardless of the type of new organism, regulatory factors are a critical factor influencing firms' decision making. In particular, HSNO Act (and to a lesser extent Biosecurity Act) requirements are seen as a significant constraining factor for many firms considering innovating with new organisms.

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[54] Citizens' arrest. Accounting for GM food's arrested development. Stephanie Howard Sustainability Council (2012).

[55] Is the Grass Always Greener? Issues Affecting the Adoption of Genetically Modified Pasture Grasses in New Zealand. Terri G. Dunahay. Ian Axford Fellowship Report (August 2010).

The process of firms' decision making on new organisms

In developing innovations in general, firms first decide if the innovation will lead to a new product (or process) that the market will want before taking the innovation further. Once they believe that is the case finding the resources needed to bring the innovation to market becomes the overriding concern. This is demonstrated by surveys showing that cost barriers and lack of access to capital are the major barriers that firms face in innovation.[56] Firms generally believe they have a good understanding of what the market wants, or have systems in place to find out. In some sectors, particularly in health and food, regulations are accepted as being important but not significant influencing factors.

When a firm decides to innovate with a non-genetically modified organism that needs to brought into New Zealand, or they believe is otherwise classified as 'new' under HSNO, the decision making process is similar, except that the cost and uncertainty of the regulatory process are more important considerations. Having determined that the innovation would be welcomed by the market firms believe that the costs, time needed and uncertainties around HSNO and biosecurity regulations may have a large impact on the development costs and time frame. Consequently, they may not proceed, or will seek an alternative development path that avoids the regulations. Where the value of the innovation clearly outweighs the costs of development (including regulatory costs), and the technology has market acceptability, then the innovation will proceed. This decision is easier if the sector has experience of previous approvals under the regulatory system.

Apart from biocontrol agents, such experience is lacking. This uncertainty then influences firms to consider other options. Some of the firms and research organisations hope that someone else will be the first in their sector to seek regulatory approval for release of a new organism to test the system.

The perception that there is an uncertain, but potentially large, regulatory cost associated with the use of new organisms contributes to the difficulty of decision-making for many firms. We detected in our discussions, and it has been noted by Barratt et al. (2010)[57] and the Royal Society,[58] that the information requirements for

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[56] OECD Innovation Strategy, getting a Head Start on Tomorrow, OECD (May 2010); Innovation in New Zealand: 2009. Statistics New Zealand (2010)

[57] Progress in risk assessment for classical biological control. Barratt, B.I.P. et al Biological Control 52, 245–254. (2010)

use of new organisms in New Zealand is, if not dissuading some uses, making firms think more conservatively about what new organisms that they could use. Some firms may make the decision to apply to use organisms that they are confident will be approved, rather than apply for new organisms that may contribute to more innovative activity but bring greater uncertainty to the regulatory assessment. Others may seek ways to avoid using new organisms. Such decisions can result in opportunity costs and potentially less innovative activity in New Zealand.

Some firms did not have a good knowledge of the regulatory system and their perceptions were sometimes strongly influenced by other firms and discussions in the media rather than direct experience with the regulator. However, firms that had experience of the system also found that it was expensive in both cost and time involved and some questioned the value of the process.

A schematic decision making tree for new organisms summarising discussions with individual companies and industry organisations is shown in Figure 19. For innovations involving genetically modified organisms uncertainty around market acceptability is much more likely to be a factor in deciding to proceed with an innovation than with non-modified organism and this interacts with uncertainties around the regulatory system and how the regulatory process will impact on public perception of the firm and the potential new product. Firms are likely to deal with this uncertainty by either waiting to see how a similar product from another firm will proceed through the regulatory system and if it will be accepted by the market, or moving to markets and regulatory systems where they believe there is less uncertainty.

[58] The Impact of the Hazardous Substances and New Organisms (HSNO) Act on Research in New Zealand. Royal Society of New Zealand (2012)

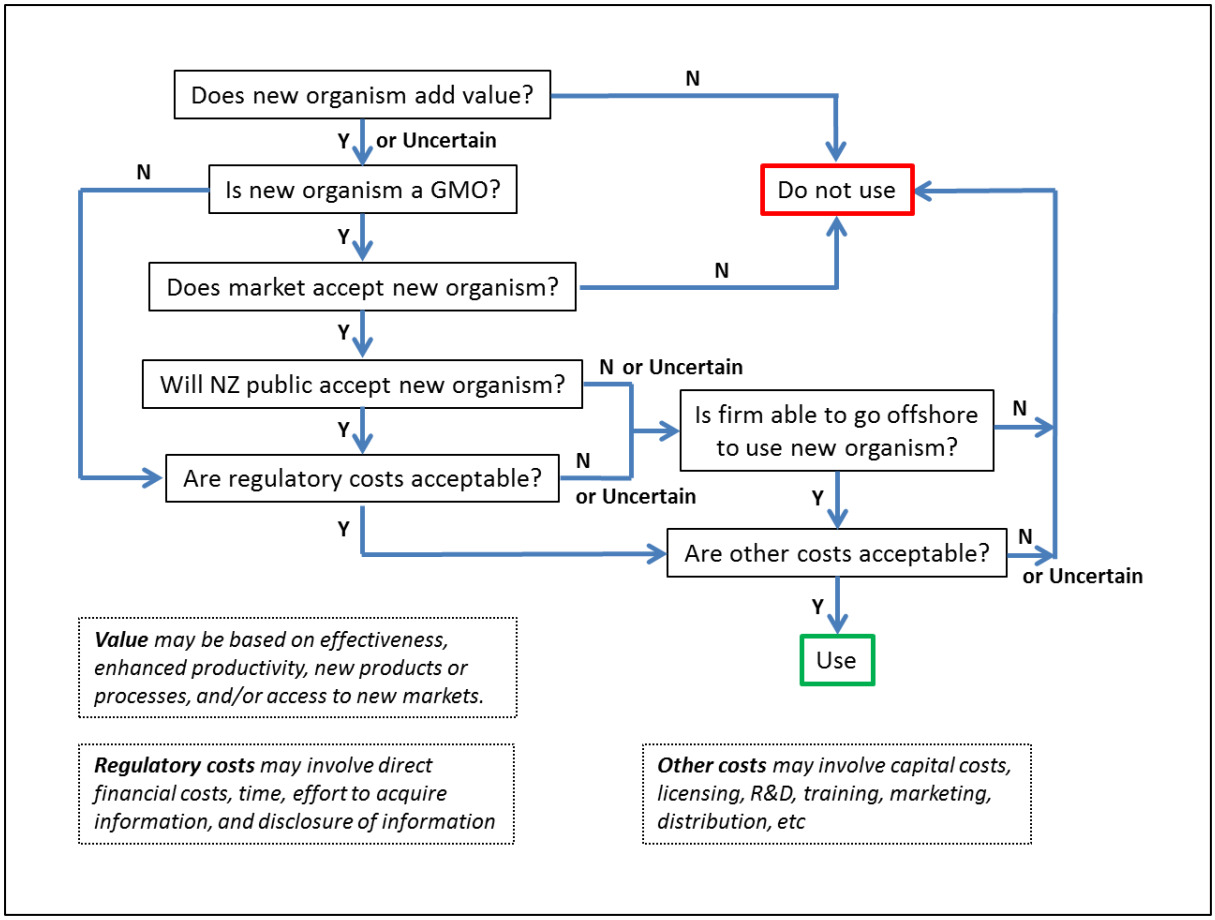

Figure 19. Schematic decision tree for use of new organisms in New Zealand.

SUMMARY OF METHODS

This project was undertaken by Dr George Slim and Dr Robert Hickson of Rhadegund Life Sciences for the Ministry for the Environment. It was overseen by a Reference Group consisting of officials from:

- The Ministry for the Environment (MfE)
- The Ministry for Primary Industries (MPI)
- The Treasury
- The Environmental Protection Authority (EPA)

Brief literature survey

A brief literature survey was undertaken to determine what factors were likely to affect firms' decision making around innovating with new organisms and to put the results of this project in context within the broader innovation system.

Statistics New Zealand collects a considerable amount of data on factors affecting firms' ability to innovate through its Business Operations and related surveys. To ensure that the data collected in this project would be compatible with that data the same broad classification of factors that might affect decisions were used. It is also important to distinguish between factors that affect decisions concerning innovation with new organisms and those affecting innovation in general. The survey looked at factors the OECD considers affect innovation generally and also other influential factors raised by businesses in advanced economies. We also looked for studies on factors affecting innovation in New Zealand and in sectors related to those that use new organisms such as biotechnology and nanotechnology.

Identification of sectors likely to innovate with new organisms

Sectors were identified by an analysis of the EPA records of firms that had approached them (or previously ERMA) to discuss applications to use new organisms. Firms were assigned an Australian and New Zealand Standard Industrial Classification (ANZSIC) code to better identify relevant sectors. Sectors that had had firms approach the regulator were included whether or not any firms in that sector had proceeded with an application. Sectors with firms that had not approached the regulator, but were considered likely to be able to use new organisms were identified by discussions with the Reference Group and other government officials.

This resulted in twenty two industry bodies being identified as covering sectors that might potentially innovate using new organisms.

Interviews with industry organisations

Thirteen industry organisations (see List of Organisations, below), representing the most significant industry sectors, were asked to undertake a semi-structured interview[59] to explore what factors influenced the decisions of the firms in their sector to innovate or not with new organisms. The interview instrument is included in the Supplementary Material that accompanies this report. The organisations were chosen on the basis of those with members who had approached ERMA or the EPA to discuss new organisms, and those bodies broadly representative enough of their sectors to give an informed view.

Six research organisations (four CRIs and two universities) were also approached to undertake a semi-structured interview on the factors that affected decision making on new organisms by companies in their sectors. The interview instrument is included in the Supplementary Material that accompanies this report.

In general the research organisations did not feel able to comment on how their client companies made decisions, preferring us to have the discussion with the companies themselves. The significant exception was in the area of biocontrol, where the research organisations involved felt sufficiently part of the process to speak on behalf of the sector.

Research organisations' own views of the regulatory system have been effectively canvassed by the Royal Society of New Zealand in the preparation of their report on the impact of the Hazardous Substances and New Organisms Act on Research in New Zealand (RSNZ 2012[60]). The main concerns expressed in the Royal Society report were the need to reduce administrative burdens and to align regulatory requirements for genetically modified organisms more closely to selected overseas regulatory processes. The Royal Society report and factors that principally concern research are not extensively discussed further here.

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[59] The Interview: From Structured Question to Negotiated Text, Andrea Fontana and James H. Fey in 'Handbook of Qualitative Research, Norman K. Denzin and Yvonna S. Lincoln(Editors), Sage Publications, (2000).

[60] The Impact of the Hazardous Substances and New Organisms (HSNO) Act on Research in New Zealand. Royal Society of New Zealand (2012).

Development of electronic survey

The electronic survey was developed from discussions with the industry bodies, review of the questions used by Statistics New Zealand in their Business Operations Surveys (2007, 2009 and 2011), and discussions with the Reference Group. A critical aspect of the survey was that results should be able to be compared with the Statistics New Zealand surveys, so some of the questions intentionally matched those in the Business Operations Surveys and Bioscience Surveys.

The process of developing the survey was consistent with the guidelines provided by the OECD.[61] The OECD guidelines are also very useful in pointing out the strengths and weaknesses of the use of perception surveys to gather data on regulations. The major strengths are that an electronic survey is a low cost way of approaching a large number of respondents which gives a broad view of the issues. The most significant drawbacks are that non-respondents may introduce survey bias (addressed here by looking to see that respondents were broadly representative) and that survey design introduces bias (addressed here by following design guidelines, peer review of the survey and piloting responses). In analysing the data we also took into account that irritation with regulations may influence responses more than actual costs and the respondents may not be fully informed (addressed here by follow up interviews with some respondents).

The focus of the survey was to identify the potential of firms to use new organisms and the main factors that would encourage or discourage their use.

The survey was structured so that firms who were using or could potentially use new organisms were identified at the start and routed through a set of questions that identified factors in their decision making. If regulatory issues were a factor, businesses were routed through a question to look at which specific regulatory factors were involved.

All the factors that had been identified from the literature on decision making in innovation and by the Reference Group and taken from Statistics New Zealand's Business Operations Survey were raised by the industry organisations with three exceptions. These were 'access to capital', 'access to the new organism and/or technology and staff to implement it' and 'uncertainty in gaining regulatory approval'. All these factors were included in the final survey as potential factors in

[61] Measuring regulatory performance. A practitioner's guide to perception surveys. OECD 2012.

decision making as they were considered likely to be of concern to individual businesses even if not raised by an overseeing body. Access to capital was included as this is the factor most commonly identified by New Zealand companies as affecting their ability to develop new products (Statistics 2012)[62].

All firms were routed through a set of questions to identify the characteristics of the firm including sector, size, export or domestic focus and involvement in innovation.

To facilitate participation, the survey was intentionally kept short (17 questions, taking about 15 to 20 minutes to complete). A draft survey was reviewed by the Reference Group and an independent social scientist with experience in undertaking surveys in this area. The draft survey was pre-tested by four people in organisations that use or could potentially use new organisms. A copy of the survey questions is included the Supplementary Material that accompanies this report.

Identification of firms to participate in the survey

Survey participants were identified from analysis of EPA records, a list of firms with the same ANZSIC codes as firms who had approached the EPA supplied to MfE by Martins Consultants (a firm that develops specialised business databases), and recommendations from the industry organisations. The types of firms not surveyed included individual farmers, veterinary practices, zoos and botanic gardens, hospitals and district health boards, local and regional councils, trusts, and television production companies. They we excluded mainly on the basis that they were unlikely to directly apply to use new organisms (such as individual farmers, vets and TV companies), their focus was on non-commercial activities (such as councils, hospitals and trusts), or their activities are primarily for display of new organisms rather than strictly being considered "innovation" (zoos and botanic gardens). Selected plant nurseries and meat processing companies, and some film production companies (who may wish to temporarily import exotic animals) were included.

The survey was distributed through Survey Monkey to 243 firms, with a 14 day period to complete. The list of firms surveyed is included below. Reminder messages were sent at the end of the first and second weeks.

[62] Business Operations Survey: 2011 Statistics New Zealand (2012).

Discussions with selected business

Ten firms representing some of the main potential users of new organisms, as identified by industry bodies and the Reference Group, undertook a semi-structured interview to provide more in depth information on their decision making processes to complement the electronic survey results. Personnel within the firms were chosen on the basis of their involvement in decision making on innovation or direct involvement with the regulator process. Respondents were generally Chief Executive Officers or owners for smaller firms, Research and Development Managers or Regulatory Affairs Officers (or combinations of the two) in larger firms. The interview instrument is attached in the Supplementary Material that accompanies this report. Because a single firm was interviewed in each sector their names are not listed for confidentiality reasons.

LIST OF ORGANISATIONS

Government agencies

Department of Conservation
Environmental Protection Authority
Food Standards Australia and New Zealand
Ministry of Economic Development
Medsafe
Ministry for the Environment
Ministry for Primary Industries (including Biosecurity New Zealand)
Ministry of Science and Innovation
The Treasury

Industry bodies

Industry bodies interviewed

AquacultureNZ
Bioenergy Association of NZ
Food and Grocery Council
Meat Industry Association
Medicines New Zealand
Natural Products NZ
NZBIO
New Zealand Forest Owners Association
BusinessNZ
DairyNZ
HortNZ
Nursery & Garden Industry Association
Seafood Innovations Ltd

Industry bodies not interviewed

Beef and Lamb NZ
FAR
Federated Farmers
Medical Technology Association of NZ
National Bee Keepers Association
New Zealand Winegrowers (Assoc w/ HortNZ)

Rare Breeeds NZ
Regional Councils (LGNZ)
Wood Processors Association

Research organisations

Contacted:

AgResearch
Landcare Research
Plant and Food Research
SCION

LIST OF COMPANIES SURVEYED ELECTRONICALLY

Aakland Chemicals 1997 Ltd
AB Annand & Co Ltd
Abacus ALS
Abacus Bio
Abron Ltd
AFFCO New Zealand Ltd
AgBioResearch Ltd
Agricom
AgriPlus
AgriSea New Zealand Ltd
AgriSource Ltd
Agronica (New Zealand) Ltd
Agvance Marketing Ltd
Alcon Laboratories
Amber Nurseries
Analytical Research Laboratories Ltd
Anchor Energy
Annton Nursery Ltd
Antarctica NZ
ANZCO Foods
Aotearoa Fisheries Ltd
Aotearoa Seafoods Ltd
APS Speciality Chemicals (A Division of Nuplex Industries)
Aquaflow
ArborGen NZ
Argenta Manufacturing Ltd
AroTec Diagnostics Ltd
Associated Process Controls Ltd
AstraZeneca Ltd
AsureQuality Ltd (Hamilton)
Aztec Packaging Ltd
Ballance Agri-Nutrients Ltd
Bayer New Zealand Ltd
Bell-Booth Ltd
Betavet

BioCell Corporation Ltd
Biodiesel New Zealand
Biodiscovery New Zealand Ltd
Bioforce Ltd
bioMérieux Australia Pty Ltd
Bionera Ltd
Bioremedies Ltd
BioStart Ltd
Biotechnologies Ltd
Biotelliga Ltd
Blakely Pacific Ltd
BLIS Technologies Ltd
Bloomz New Zealand Ltd
Blue Mountain Nurseries
Boehringer Ingelheim (NZ) Ltd
Bomac Laboratories Ltd
Cactus & Succulent Society of NZ Inc. Wellington & Hutt Valley Branch
Carina Chemical Laboratories Ltd
Carter Holt Harvey Pulp & Paper
Carter Seed Management (NZ) Ltd
Central Environmental Services
Central Tree Crops Research Trust
Chalmers Organics
Chemical Specialities Ltd
Chemiplas New Zealand Ltd
Chemwaste Industries Group Ltd
Connell Bros Company Australasia Ltd
Corson Grain Ltd
Cridge Seeds Ltd
Cropmark Seeds Ltd
CSI Processors Ltd
CSL Biotherapies (NZ)
Dairy Goat Co-Operative (NZ) Ltd
Dalton International Ltd
DB Breweries Ltd
Delmaine Fine Foods
Deosan Manufacturing Ltd
DLF Seeds Ltd

Donaghys Industries Ltd
Douglas Pharmaceuticals
Drapac
Easiyo Products Ltd
Ecolab Ltd
Elanco Animal Health
Environmental Laboratory Services Ltd
ETG Global
Everedge IP
Eyris Blue Pearls
Filtration Technology Ltd
Fonterra Co-operative Group Ltd
Forest Management Ltd
Fraser Brown & Stratmore Ltd
Fresh Produce Group (NZ) Ltd
Frucor Beverages Ltd
func.nutrition Ltd
Fusion Fertiliser
Future Forests Research
GE Healthcare Ltd
Gellerts Nurseries Ltd
Genetic Technologies Ltd
Glenorie international Ltd
Global Proficiency Ltd
GMP Pharmaceuticals Ltd
Goodman Fielder New Zealand Ltd
Grasslanz Technology
Greenpark Foods (2008) Ltd
Greenshell New Zealand Ltd
Gribbles Veterinary Pathology Ltd
Growing Spectrum Ltd
H.L.Rosevear & Co Ltd
Halcyon Bio Consulting
Hancock Forest Management
Henkel New Zealand Ltd
Hill Laboratories
I Spy Ltd
Ian Nicholas Consulting

Inghams Enterprises - Hamilton
Inspect NZ Ltd
Invitrogen New Zealand Ltd
Kiwi Seed Company (Marlborough) Ltd
Kono Seafoods
Lab Plus, Auckland Hospital
Lallemand NZ Ltd
Lanzatech
Leaderbrand Produce Ltd
Lefroy Valley Seed Co (NZ) Ltd
Lely Sensortec Ltd
Life Clinic Hirudotherapy & Healing
Lifetech Laboratories
Livestock Improvement Corporation
Livestock Inc
Living Cell Technologies
Luisetti Seeds Ltd
Manakau Village Nurseries Ltd
Marine Farming Association
Materials & Testing Laboratories Ltd
Maurice Wilkins Centre
McCain Foods (NZ) Ltd
Meadow Mushrooms Ltd
Midlands Seed Ltd
Miscanthus New Zealand
Moana Pacific Fisheries Ltd
Monsanto NZ Ltd (Seminis vegtable seeds)
Morphum Environmental
MP Biomedicals New Zealand Ltd
Multiflora Laboratories Ltd
National Beekeepers Association
Natural Health New Zealand (2002) Ltd
Natures Flame
Nestlebrae Exotics
New Zealand Agriseeds Ltd
New Zealand Forest Owners Association
New Zealand Hothouse Ltd
New Zealand King Salmon

New Zealand Laboratory Services Ltd
New Zealand Oyster Industry Association
New Zealand Scientific Ltd
New Zealand Veterinary Pathology Ltd
New Zealand Winegrowers
Ngai Tahu Seafood Products Ltd
Norske Skog Tasman Ltd
Norski Holdings Ltd
Northland Pastoral Research Ltd
Novo Nordisk Pharmaceuticals Ltd
Nufarm NZ Ltd
Nutricia Ltd
NZNutritionals
OceaNZ Blue Ltd
Oil Seed Extractions Ltd
Oregon Nurseries Ltd
Organic Technology Ltd
Orica Chemnet
Orion Crop Protection Ltd
Ovation New Zealand Ltd
Pacific Edge Ltd
Pacific Vet
Pan Pac Forest Products Ltd
Paradise Growers Ltd
Parkvale Mushrooms Ltd
Petfoodnz Ltd
Pfizer NZ Ltd
PGG Wrightson Seeds Ltd
Pharmaceutical Compounding NZ Ltd
Pharmvet Solutions
PhotoNew Zealand Corp Ltd
Phytomed Medicinal Herbs
Plasma Biotec Solutions Ltd
Polaris Foods Ltd
Polybatics Ltd
Premier Genetics NZ Ltd
Qatalyst
R J Hill Laboratories Ltd

Radiata Pine Breeding Company
Rainbow park nurseries
Ravensdown Fertiliser Co-operative Ltd
Reckitt Benckiser (New Zealand) Ltd
Richard Hill & Associates
Robin Pharmaceuticals Ltd
Roche Products New Zealand
Roots Shoots & Fruits Ltd
Rubicon Ltd
SAFA Biological Sea Plants Ltd
Saitl Dairy Laboratory
Sanford
Sanofi New Zealand Ltd
Scion
Sealord Group Ltd
SGS New Zealand Ltd
Sigma Aldrich
Silverfern Farms Ltd
Simms Jones Ltd
Solid Energy
Southern Woods Nursery Ltd
Spalding Laboratories
Synlait Ltd
Taharoa C Block Incorporation
Talley's Group Ltd
Tegel Foods Ltd
Tenon Ltd
Trents Nursery Ltd
Trilogy
Tumblar Products Ltd
Unilever Australasia
United Fisheries
Uptake Ltd
V A Innovation (2005) Ltd
Vertichem Technology Ltd
Vetpak Ltd
ViaLactia Biosciences (NZ) Ltd
Vita Power Ltd

Vitaco Health Ltd
Vital Foods Ltd
Warren Forestry Ltd
Water Alchemy Ltd
Wenita Forest Products Ltd
Westland Cooperative Dairy Company Ltd
Williams & Kettle Fruitifed Supplies
Winstone Pulp International Ltd
www.4seed Ltd
Zealandia Horticulture Ltd
Zenith Technology Corporation Ltd
ZESPRI International Ltd
Zonda Resources
Zygem