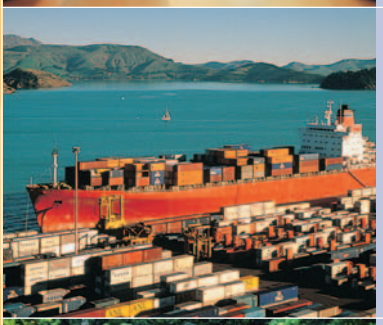
AERU

Why do Some of the Public Reject Novel Scientific Technologies? A Synthesis of Results from the Fate of Biotechnology Research Programme

John Fairweather
Hugh Campbell
Lesley Hunt
Andrew Cook

Research Report No. 295
June 2007



CHRISTCHURCH
NEW ZEALAND
www.lincoln.ac.nz

Lincoln University
Te Whare Wānaka o Aoraki

Research to improve decisions and outcomes in agribusiness, resource, environmental, and social issues.

The Agribusiness and Economics Research Unit (AERU) operates from Lincoln University providing research expertise for a wide range of organisations. AERU research focuses on agribusiness, resource, environment, and social issues.

Founded as the Agricultural Economics Research Unit in 1962 the AERU has evolved to become an independent, major source of business and economic research expertise.

The Agribusiness and Economics Research Unit (AERU) has five main areas of focus.
These areas are trade and environment; economic development; non-market valuation, and social research.

Research clients include Government Departments, both within New Zealand and from other countries, international agencies, New Zealand companies and organisations, individuals and farmers.

Two publication series are supported from the AERU Research Reports and Discussion Papers.

DISCLAIMER

Why do Some of the Public Reject Novel Scientific Technologies? A Synthesis of Results from the Fate of Biotechnology Research Programme

John Fairweather
Hugh Campbell
Lesley Hunt
Andrew Cook

June 2007

AERU Research Report No. 295

Agribusiness and Economics Research Unit
PO Box 84
Lincoln University
Lincoln 7647
New Zealand

Ph: (64)(3) 325-3604
Fax: (64)(3) 325-3679
www.lincoln.ac.nz/aeru

ISSN 1170-7682
ISBN 0-909042-81-0

Contents

List of Figures

Preface

Research at the AERU has often focussed on technology, whether it is related to farming or to consumers more generally, and it has often assessed public opinion on a wide variety of issues using a variety of methods. This report continues with these themes by reporting on public perception of biotechnologies. In recent years the Fate of Biotechnology research programme has produced a number of reports and as the programme is winding down it is timely to produce an overview of the main findings. This synthesis will be of interest to all those interested in the public's response to technological developments. It provides easy access to a considerable body of research.

Professor Caroline Saunders
Director
AERU

Summary

This report synthesises outputs from a five year programme of research on public perceptions of biotechnology. In interpreting the overall results, a pressure-response-assessment-outcome model is introduced to explain reactions to biotechnology. Biotechnology pressures or challenges peoples' attitudes and values. It invokes deep-seated reactions from people in New Zealand and there are a number of dimensions to these reactions. One is the ethical or moral question about whether the biotechnology is right and proper to use. Closely related are the spiritual issues that biotechnology raises, and while these were not strong with pakeha they were important to South Island Maori who linked these to core cultural concepts of whakapapa and mauri. Also invoked are ideas about nature, which for pakeha were linked directly to concerns about the impact on New Zealand's clean green image. Finally, biotechnology challenges the boundaries between plants and animals and between humans and non humans.

These ideas derived from reactions to biotechnology play a vital role in the perceptions and assessments of biotechnology, that is, how people make sense of biotechnology. In making these assessments people believe that they lack information and in its absence they mistrust science. People draw a distinction between themselves and scientists, and they consider the scale of the biotechnology, that is, the breadth of impact it might have. They draw on their own experience, and they have concern for animals. Regulations are not seen as addressing their concerns. One of the most important factors in assessing biotechnology is national and personal identity or sense of place.

People use all these factors to make sense of biotechnology. Each biotechnology is then assessed to judge its acceptability, to consider risks and to assess who benefits from it. In making sense of biotechnology, people are sceptical of the benefits, and they couch assessments in provisos. Typically, they do not see any personal benefits to them, and they see that it is mainly as a consumer that they can influence biotechnology development.

In making their assessments of biotechnology, New Zealanders, on balance, have concerns about GM and give more support to the beliefs that GM is wrong than they do to the beliefs that biotechnology can fix problems or that it can benefit society. Nature is seen potentially as biting back and catching us out for making mistakes. They see risks from using biotechnology, and many cleave to post materialist values (e.g., society where people count more than money) which were not compatible with biotechnology.

The outcome of this assessment was, in general, a low acceptance of new biotechnology. They were negative about GM technology and GM food in particular. Surveying over time showed little change in assessment. Some biotechnologies were preferred over others and some groups of people were more accepting of biotechnology than others.

In making their assessment of biotechnology, people can be challenged in a number of ways and this then influences their sense of identity which in turn influences their attitudes and values. Further, these public reactions to biotechnology are consistent with historical analysis which shows that people now live in a period of technology conflict rather than in the 1950-1980 period of dominant, intensive agricultural discourse which overshadowed alternative viewpoints on technology

Chapter 1
Introduction

1.1 Background

The research programme, entitled 'The Fate of Biotechnology: Why do some of the public reject novel scientific technologies?', began in July 2002 as a two-year programme seeking to develop an understanding of public perceptions of biotechnology, while working with mainly government ministries to develop and apply the results of the research. The programme was structured to cover both a qualitative understanding of public thinking and a more general assessment of public perceptions by way of surveying. In addition, there was research on the historical background to technology development.

The research team included a core of social science researchers at Lincoln University and Otago University, and subcontract researchers at the University of Auckland and Decision Research in the US. The programme continued at a reduced level for a subsequent two years to allow for follow-up research on public reactions both by survey and a case study of salmon. Finally, a one year extension allowed for synthesis and final work on the salmon case study.

End user meetings were held each year in Wellington where the latest results were presented to a wide variety of government ministry representatives. To date, the outputs include elevan research reports, five published articles and three conference papers.

1.2 Purpose of synthesis

The programme ends in June 2007 and the purpose of this report is to provide a synthesis and overview of the entire programme of research. The aim of this synthesis is to summarise the main findings and develop an account that can identify what we have contributed to the understanding of public perception of biotechnology in New Zealand. Such an account has not been possible so far. A synthesis is also useful for identifying future research directions.

1.3 Approach

This synthesis takes a grounded approach to public perceptions of biotechnology and emphasises what and how people think and feel about it, rather than emphasising prior theoretical questions. In this way, it is a repository of recently documented public perceptions and attitudes about biotechnology rather than a detailed analysis or interpretation of that thinking. Nevertheless, the results presented here reflect a social science approach to studying reactions to biotechnology, one that takes as axiomatic that perceptions of biotechnology are a social construction, meaning that viewpoints taken reflect a number of important social processes rather than a reflection of some essential unchanging qualities. The way people act in the world is based on their meanings and interpretations, so the task of the social science researcher is to attend to and document these meanings. By their very nature, these meanings and interpretations are diverse but not usually so idiosyncratic as to prevent the researchers from discerning patterns. Diversity also entails conflict or disagreement. This research endeavoured to give balanced coverage of all viewpoints.

This report starts with a synthesis of results. The synthesis was developed by first preparing a detailed summary of each report from each component of the research (see the Appendix for these detailed summaries, presented in chronological order). Each detailed summary was used to prepare a short summary and a concept map which identifies the key elements of the report, using arrows to show how the key elements are linked. The following synthesis then develops a concise overall synthesis of the research.

The approach taken thus provides readers with three ways to access the research results. Readers can focus on the following short summaries and the overall synthesis or they can seek more detailed information about each constituent report which they can find in the detailed summary in the Appendix. If further details are needed readers can seek the full report, (most of them are available on www.lincoln.ac.nz/story9430.html?#j2).

1.4 Definitions

Biotechnology means the use or manipulation of living organisms to make or improve products or develop or enhance processes. It includes established biotechnology like brewing and newer ones such as genetic modification (GM). GM is a method for altering the genetic composition of cells and organisms and can be used to alter or mix the characteristics or traits of a micro-organism, plant or animal. GM has also been called genetic engineering and when used in food production the food is called GM food. Transgenics is another related term referring to the movement of genetic material between species. Our research included examples of both GM and non-GM biotechnology.

1.5 Outline of this report

Chapter 2 works through each of the reports by providing a summary along with, in nearly all cases, a summary diagram. Chapter 3 then draws the results together into a synthesis and provides some suggestions for future research.

Chapter 2
Synthesis

2.1 Introduction

The main purpose of this chapter is to present the key findings from each component of the research. While the full reports, and the summaries in the Appendix, provide details of the methods, they need to be outlined here in advance of presenting the results.

The programme used a broad suite of methods to ensure that a comprehensive account of public perception of biotechnologies could be developed. Different methods have different strengths so it is unwise to base any study just on one approach. The methods used spanned the qualitative to quantitative spectrum and included historical research and a case study. The research began with focus groups then moved to survey research and these endeavours were paralleled by the historical research and a case study.

Focus groups were conducted in 11 locations around New Zealand, including the four main centres and three regional centres and included 117 participants. Participants were asked to talk about what the word biotechnology meant to them; make comparisons between the acceptability of five different biotechnology exemplars; discuss their ideas about nature and what is natural; what they thought about some other examples; and to look into the future of biotechnology as far as New Zealand was concerned. The focus was also on the acceptability of specific examples of new medical, agricultural and environmental biotechnologies, and the reasons underlying this. In the course of each focus group the participants were asked to rank five different exemplars of biotechnology for acceptability. The focus group discussions were transcribed and analysed for themes using NVivo.

In addition, for the research focusing on Maori, there were 22 interviews and/or focus groups conducted around the South Island involving a total of 91 people. Participants were asked to discuss different biotechnologies and their applications. The report focuses on what the participants said about the different biotechnologies with a view to providing a record of these views. In addition, key themes were identified and collated.

Surveys in 2003/04, 2005 and 2006 used a questionnaire to gathered data by national postal survey through the random distribution of 2,000 questionnaires giving response rates of over 30 per cent. Questions focused on measures of the acceptability of examples of biotechnology, measurement of perceptions, beliefs and affective reactions to a range of biotechnologies, and measures of general attitudes. Data were used to develop models of relationships between key variables, and to identify clusters among respondents.

To complement the focus group and survey research, historical analysis of technology crises provided understanding of contemporary conflicts. In addition, case study methods were used to review fish farming, the cultural history of salmon, and the history of salmon farming.

Each of the following sections begins with a heading that asks a key question about public perception of biotechnology, and the following summary provides an answer.

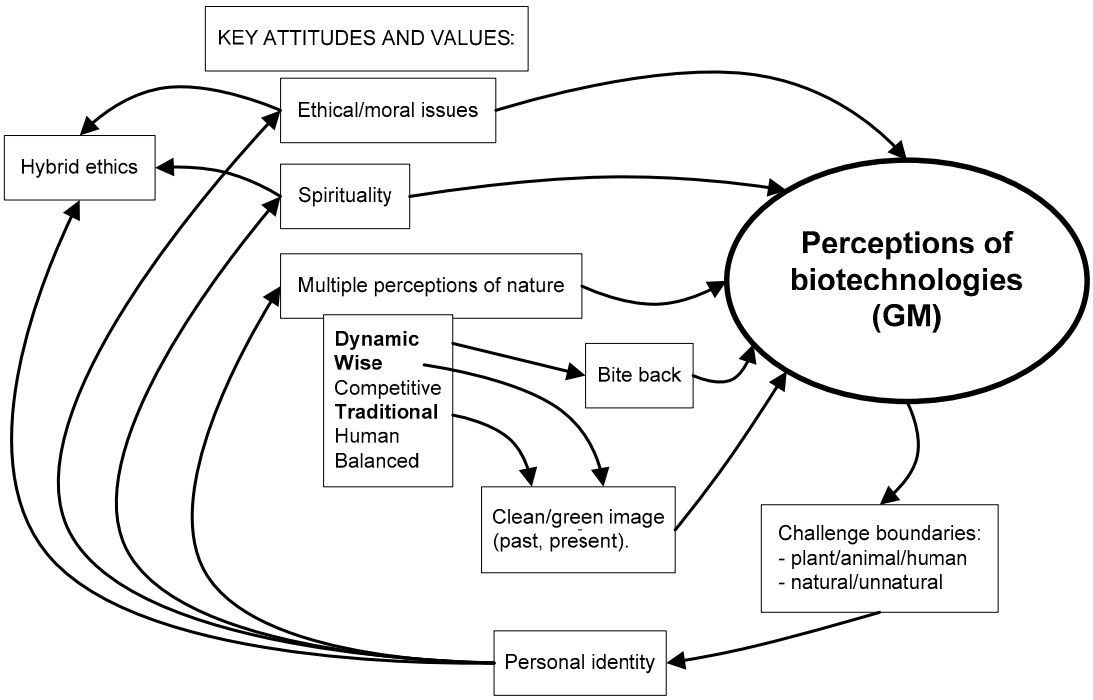
2.2 What attitudes and values influence the perception of biotechnology?

AERU Research Report No. 265

Focus group research showed that there were four main influences on the way people perceived biotechnology. Figure 1 shows that these include ethical/moral issues, spirituality, multiple perceptions of nature, and New Zealand's clean green image. One of the most important influences was perceptions of nature. The research showed that people can have a number of these perceptions, two of which, 'wise nature' and 'traditional nature', help form the sense of New Zealand's clean/green image. The dynamic perception of nature emphasises that it can bite back when it is disrupted. All these influences were found to be important in assessing biotechnology. One of the common responses in the focus group discussion was that biotechnology, usually taken to mean GM, led to questions about the boundaries between plant and animals, and between what is natural and unnatural. These questions challenged peoples' thinking. In turn, this affected their sense of personal identity. These challenges were strong and discomforting and ultimately affected key attitudes and values. One outcome of this feedback identified by the lead author was the importance of developing a new ethics which goes beyond traditional human-centred ethics built upon an autonomous human subject.

This research is saying that biotechnologies challenge thinking about a number of core issues that are important to people. These challenges are strong and mean that many people logically are uncomfortable with biotechnologies.

Figure 1: Key attitudes and values in perceptions of biotechnology



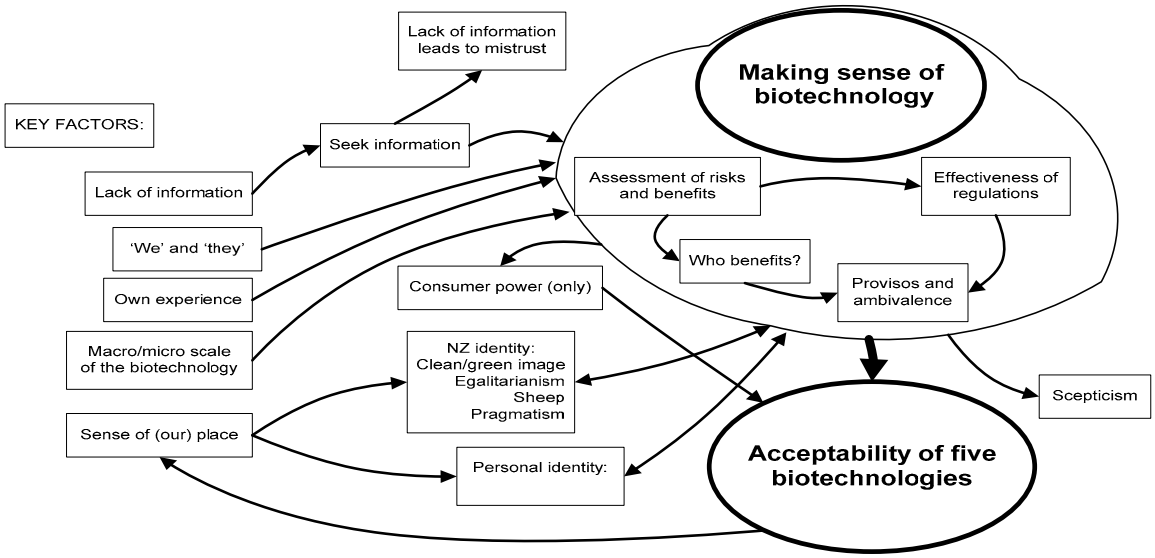
2.3 What factors do people use to judge the acceptability of a biotechnology?

AERU Research Report No. 266

When the focus groups assessed the acceptability of five different biotechnology scenarios it was found that certain factors were important. Figure 2 shows that these factors include lack of information, 'we and they', own experience, the scale of the biotechnology, and sense of place. Lack of information reflected that participants wanted to know more about particular biotechnologies, were seeking such information, and mistrusted some scientists and promoters of new biotechnology. For the 'we and they', 'we' referred to people as citizens or as members of society, and 'they' referred to scientists, companies or government who promote certain biotechnologies of which people do not approve. People also drew on their own experience of biotechnology, and they considered the scale of its application: whether it affected everyone or just a few people. All of these factors fed directly into the process of making sense of biotechnology, but sense of place was found to influence both national identity and personal identity and these then influenced making sense of biotechnology. The process of making sense of biotechnology included a number of assessments: of risks and benefits, of the effectiveness of regulations, and of who benefits. These assessments then led on to a decision about the acceptability rankings of the five biotechnologies. Alongside decisions, people made provisos about their use, they expressed ambivalence because of their awareness of both the potential benefits and risks of their use, and they expressed scepticism about who would ultimately benefit. In making sense of biotechnology people believed that they have been excluded from the process of biotechnology development and were left to influence development only by virtue of their consumer power. Making sense of the acceptability of biotechnology then influenced sense of place.

People drew on a number of perceived characteristics of biotechnology in making sense of it and determining its acceptability. For some of the biotechnologies that were considered, personal assessments come down to seeing that there were possible risks that would not be well managed by regulations, and that biotechnologies were likely to benefit those in business rather than themselves. It is rational, under these circumstances, to reject these biotechnologies.

Figure 2: Key factors in making sense of the acceptability of five biotechnologies

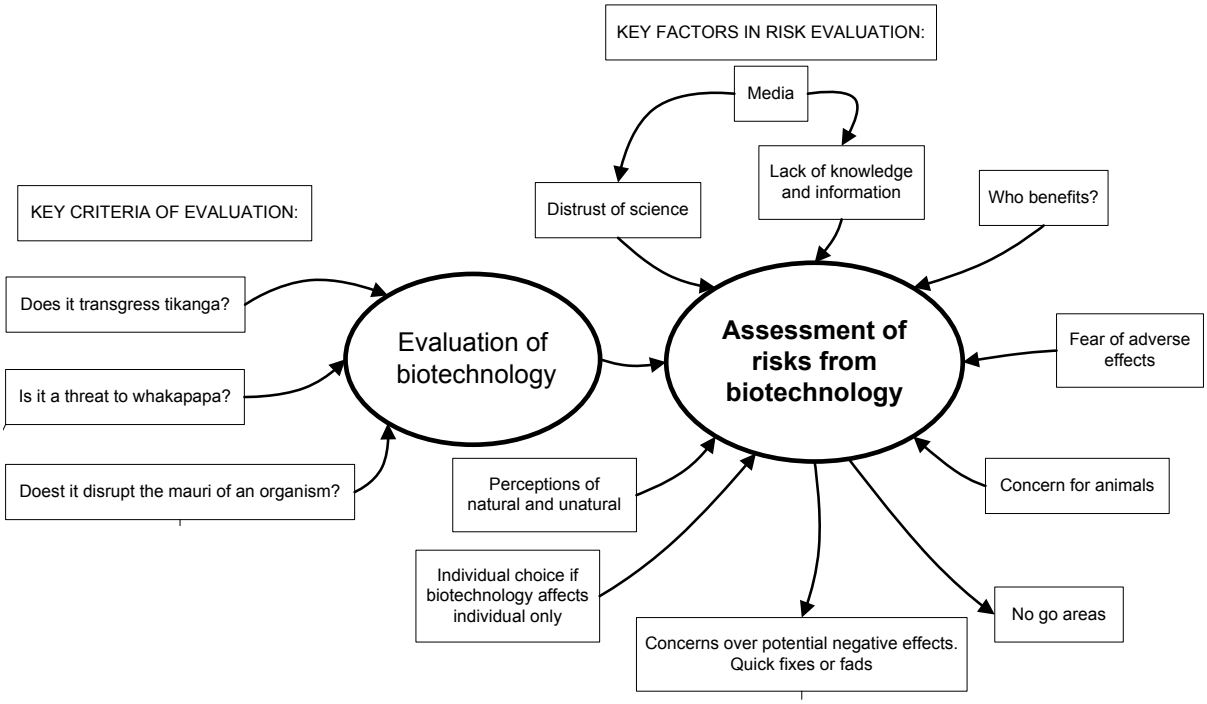


2.4 How do South Island Maori assess risks from biotechnology?

AERU Research Report No. 268

The focus group research with South Island Maori showed again that people used a number of criteria to evaluate biotechnology. Figure 3 shows that these included an assessment of the effect of biotechnology on tikanga (what is right), on whakapapa (genealogy, cultural identity) and on the mauri of the organism (life force). These criteria for the evaluation of biotechnology then led to an assessment of the risks from biotechnology, a process that is influenced by distrust of science, lack of knowledge, and an assessment of who benefits. The media were seen to influence the first two factors. Assessment of risks from biotechnology was also influenced by perceptions of natural and unnatural, the scope of the impact of the biotechnology and concern for animals. The assessment of biotechnology was also influenced by fear of adverse effects. The research suggests that for many South Island Maori the outcome of this risk assessment was concern over potential negative effects on humans and the environment. These concerns were strongest for GMOs and transgenics. New technologies, especially GMOs, were seen as quick fixes or fads which might solve some problems but would create others. One outcome wanted was 'no go' areas in which biotechnology should not be developed because those areas are considered sacred to Maori. South Island Maori generally were not in favour of biotechnology because it carried too many risks and threatened their spiritual and cultural values.

Figure 3: Key factors in South Island Maori risk assessment of biotechnology

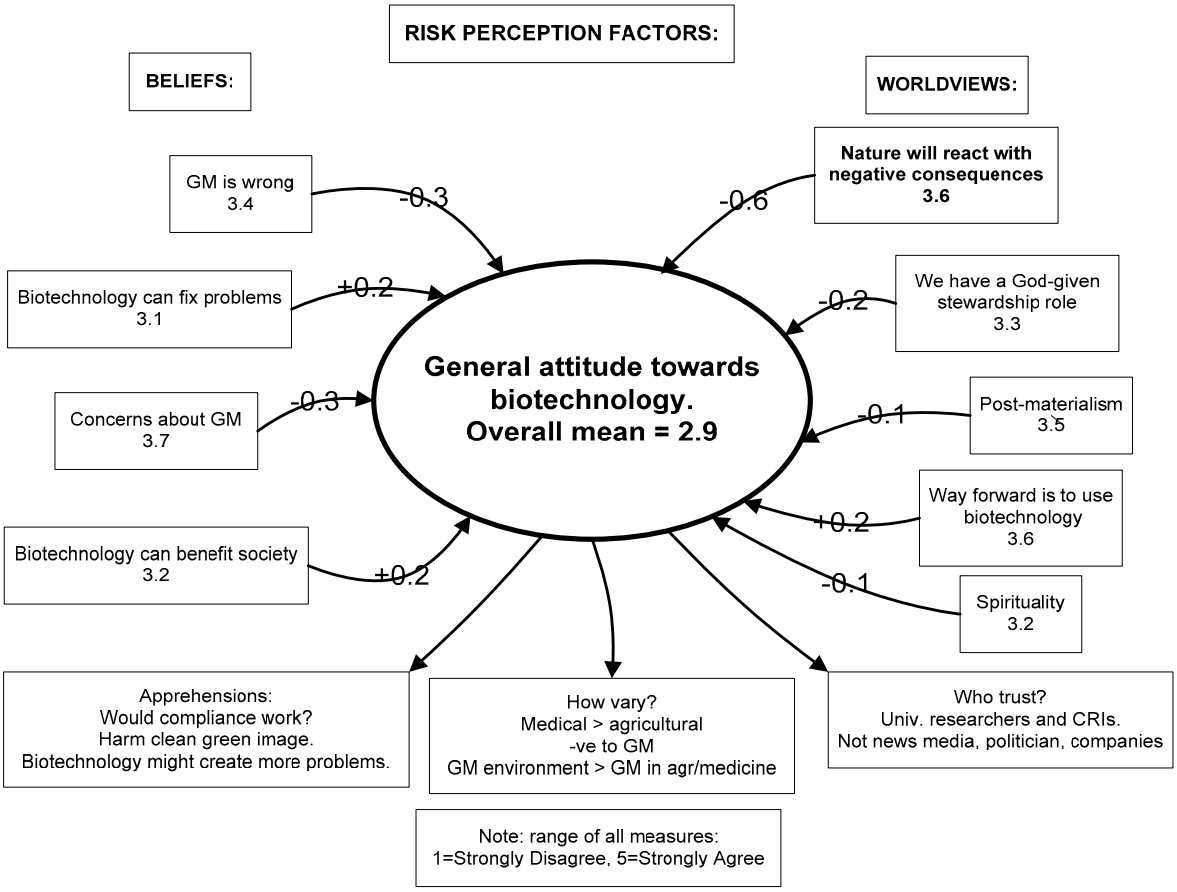


2.5 What risk perception factors are involved in the public's attitude to biotechnology?

AERU Research Report No. 269

A survey of the public in 2004 showed that there was a tendency for respondents to be against biotechnology. On a five point scale, where one is strongly disagree and five is strongly agree, people gave an overall rating of 2.9 in their attitude to biotechnology, as shown in Figure 4. There were four main beliefs about biotechnology that were connected to attitude towards biotechnology and these had only modest strengths of connections. Further, the ratings of statements in each belief set showed that people slightly agreed with them, with the highest scores going to the belief that GM is wrong (3.4) and GM concerns (3.7). Agreement with these negative beliefs about biotechnology means that they were negatively associated with attitude to biotechnology. In addition, the worldview statements were all agreed with and nature's revenge was strongly related to general attitude towards biotechnology. These results show that people have an ambivalent attitude to biotechnology when expressed in non-specific form, have doubts about its correctness and believe that nature will react negatively to being interfered with. Accordingly, there is a strong tendency for people to reject certain biotechnologies to which these beliefs apply.

Figure 4: How beliefs and worldviews influence attitude towards biotechnology



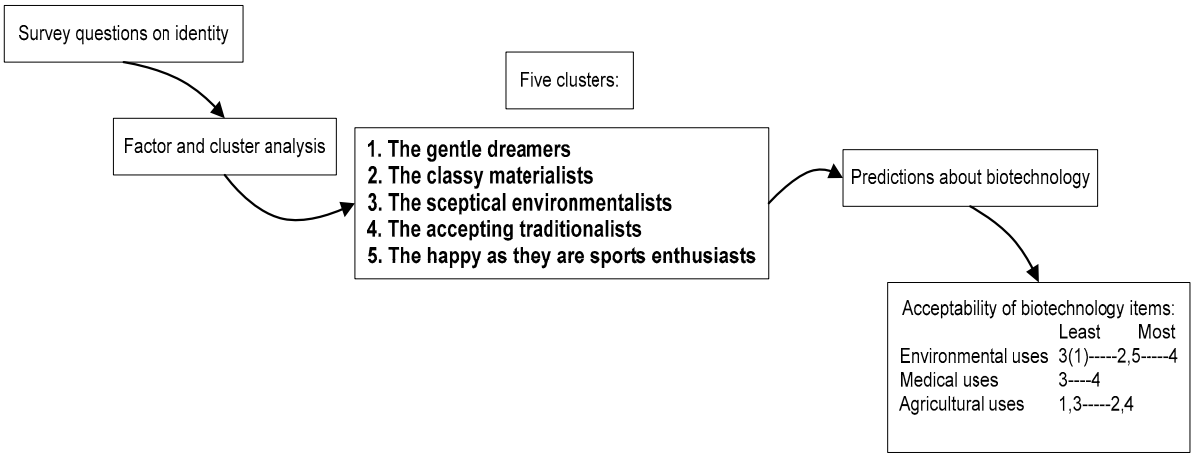
The survey results confirm the earlier focus group results by finding a relationship between beliefs and worldviews and attitudes towards biotechnology. In addition, the survey results show that there is preference for medical over agricultural biotechnologies, a general negative view about GM, and a preference for use of GM for environmental purposes rather than in agriculture or medicine. The main apprehensions are with effectiveness of regulations, what harm there might be to the clean green image, and that biotechnology might create more problems. Researchers were trusted more than politicians or companies.

2.6 How does identity influence preference for biotechnology?

AERU Research Report 286

Responses to specific questions on national identity in the 2004 national survey provided the data for characterising five groups of people shown in the centre of Figure 5. These characteristics provided the basis for hypothesising that the sceptical environmentalist would find most problems with biotechnology and the accepting traditionalists would be most accepting. The other clusters would fit between these two poles. These predictions proved to be well founded. In general there appear to be few biotechnologies that would be acceptable to all New Zealanders. Biotechnologies that take account of New Zealand identity myths may find greater acceptance.

Figure 5: Clusters based on identity, and acceptability of biotechnology items



2.7 How much are people willing to pay for GM food?

AERU Research Report No. 270

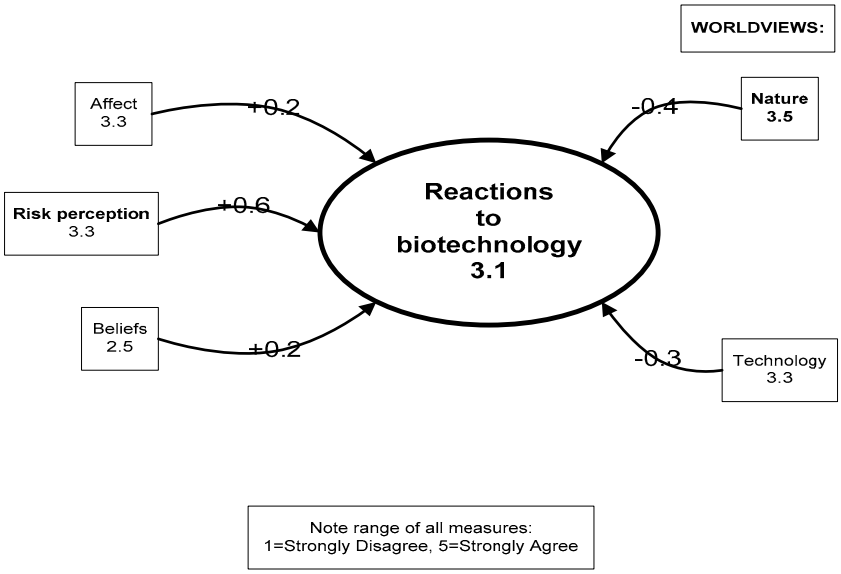
Survey results also indicated that when it comes to willingness to pay for GM products, 30-40 per cent of people were indifferent, 40 per cent rejected it, some would pay a premium and some would pay only a discounted price. Consequently, based on expressed demand, up to 15 per cent of primary production could include GM products and there must be a price premium. Under this scenario there would be a six per cent increase in agricultural revenues. People were not enthusiastic about GM food with a total of 70 per cent either not buying or indifferent to price.

2.8 Have public attitudes changed between 2004 and 2005?

AERU Research Report No. 277

A second survey of the public in 2005 showed slight improvement in the acceptability of biotechnology over approximately 12 months. However, analysis of the results showed that there was still strong resilience in public attitude such that in the short term a significant change in public opinion would be unlikely. Figure 6 shows that risk perception was the strongest factor affecting reactions to biotechnology and this was scored with modest agreement. In a further investigation of worldviews, considerations of nature were again found to have the strongest relationship to attitude towards biotechnology.

Figure 6: How affect, risk perception, beliefs and worldviews influence reaction towards biotechnology



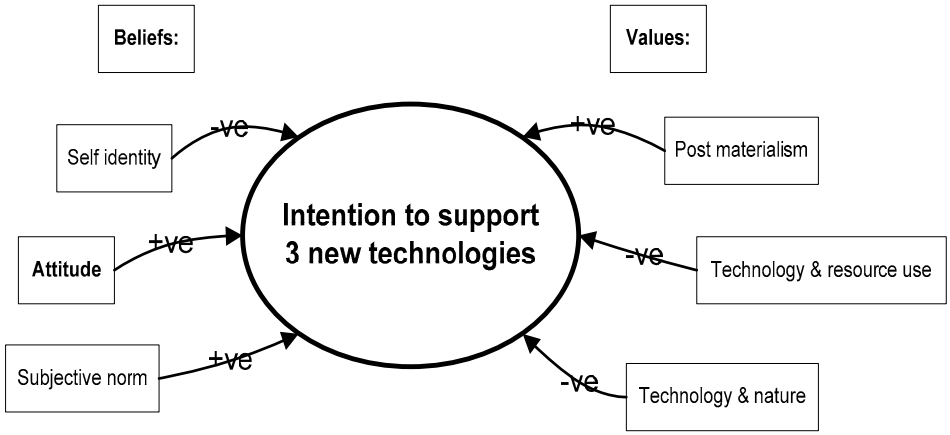
2.9 How do people react to possible developments in biotechnology, including nanotechnology, and how have reactions changed over time?

AERU Research Report No. 287

A third national survey in 2006 was used to assess acceptability of 13 examples of biotechnology. There were differences for the various environmental, medical and agricultural or food examples. These results showed that GM alone did not affect acceptability, medical examples all had similar moderate levels of acceptability, and food examples had low levels of acceptability. There was only slight improvement in acceptability over the 12 months since the previous survey. Unlike changes between 2003/04 and 2005, only the example of a GM crop to produce car fuel showed a continued trend of increased acceptability.

For each of the three specific examples included in the survey, beliefs and values were subsequently shown to be strongly linked to attitude towards supporting the new technology (Figure 7). Analysis for each example then showed that those who positively rated beliefs about biotechnology intended to support the new biotechnology. Those who have favourable intentions tend not to be the type of person to oppose it and believe they have the support of people, such as their family and friends, whose views are important to them. Apart from the new food example, those who are the type of person to oppose these biotechnologies can be expected to hold post materialist values. For all three examples they can be expected to favour a simpler lifestyle over the use of technology to conserve resources and be against environmental sustainability using technology which would tend to be viewed as damaging to nature.

Figure 7: How beliefs and values influence intention to use the three technologies

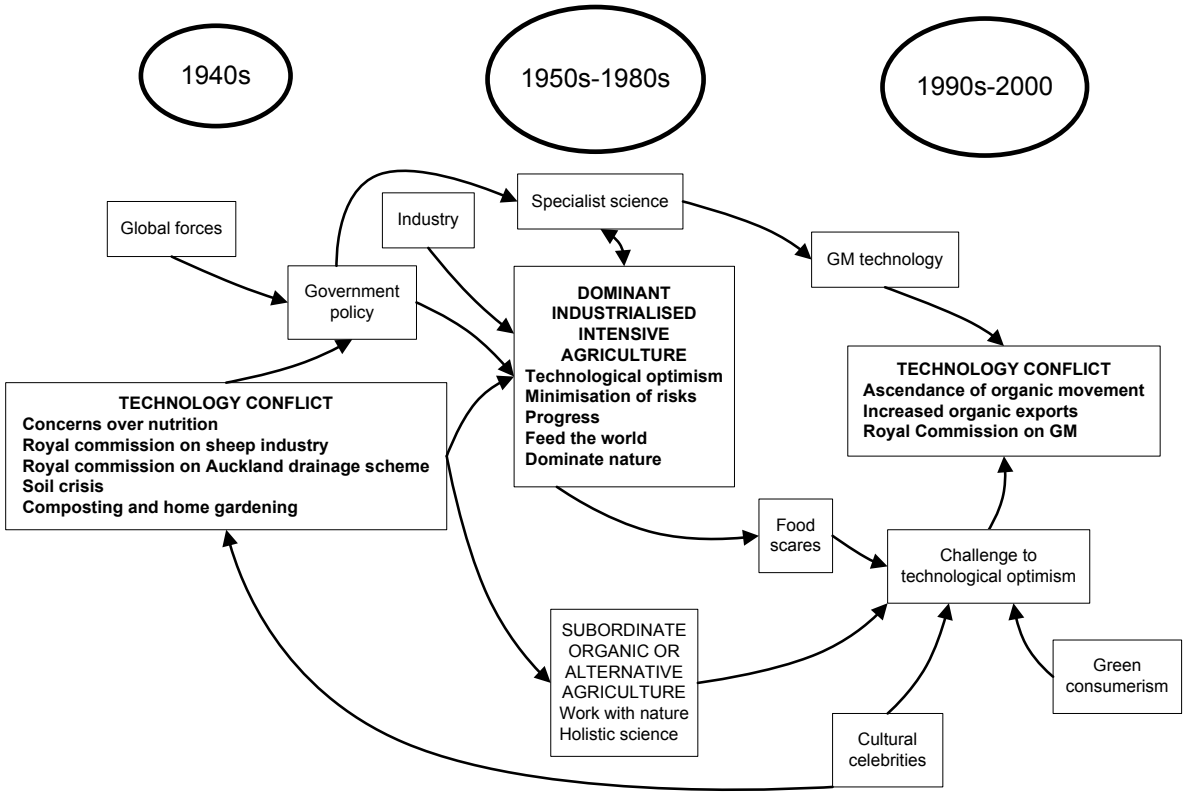


2.10 What historical factors explain the present tensions in technology options?

CSAFE Research Report No. 2

Another reason that some of the public reject novel biotechnology is because the present time in our history is different from the 1950s to the 1980s when there was more of a consensus about the nature of our agricultural system (see Figure 8). There have been periods in New Zealand's agricultural history that can be characterised by either technological optimism or technological conflict. In broad outline, before the 1950s there was technology conflict, concerns over nutrition, a soil crisis and two Royal Commissions. At that time there was greater currency for alternative production systems. However, during the 1950s and 60s, following the adoption of powerful new productivity enhancing technologies, there was greater optimism about technology in agriculture, less concern about risks and support from ideas about making progress and strong motivation stemming from the political discourse of 'feeding the world'. Since the 1980s there has been a challenge to the technological optimism of the post World War 2 era. Food scares, environmental problems and green consumerism have helped support the rise of the organic movement as a successful export industry in New Zealand. Thus now there is far less consensus about the appropriate configuration of mainstream agriculture, and there has been a Royal Commission in response to the rise of GM technology, itself emerging from the specialist science of the intensive agriculture era. In summary, the natural state of agricultural politics is one of conflict and contestation. Those periods where technological optimism provided a strong consensus over future directions in agriculture were historically specific and the current period has reverted to the normal state of conflict.

Figure 8: Outline history of technology conflicts in agriculture



2.11 How does salmon aquaculture challenge traditional understandings of salmon?

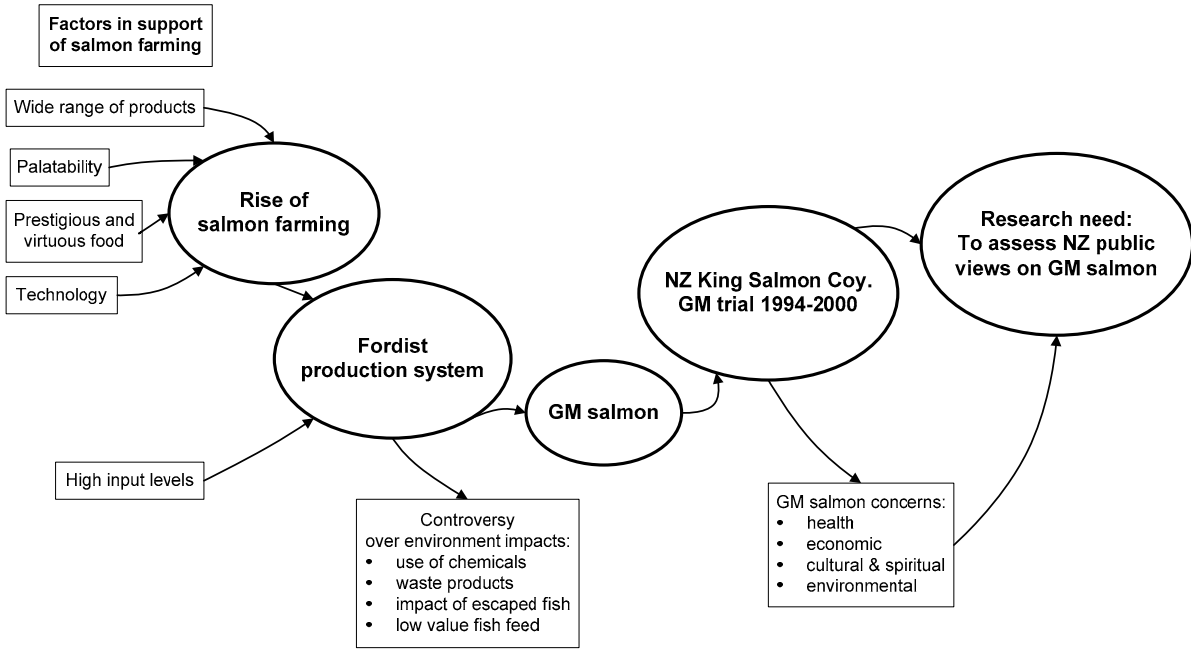
CSAFE Discussion Paper No. 5

Salmon are important culturally and economically in many countries in the world. Salmon has been an important food in many cultures but extensive fishing has led to declines in fish numbers. Salmon farming was established by the late 19th century and in the last few decades has become a major activity (Figure 9). Salmon have become a commodity in part due to its palatability, the wide contemporary range of products, its prestige and virtue as a food, and technological developments which had aided commoditisation. There is now an industrialised, Fordist system of production with high levels of inputs and outputs with controversy over environment impacts. Problems with intensified salmon farming include: the high use of pesticides and antibiotics, waste products, the impact of escaped fish on wild fish, and the amount of low value fish needed to provide feed. GM salmon have been developed internationally and trialled in New Zealand. However, there is general opposition to salmon farming, focused on health, economic, cultural and spiritual, and environmental concerns.

The New Zealand case study focuses on the New Zealand King Salmon Company. In 1994 the company began trials with GM salmon but debate about deformed fish led to the end of the trial in 2000. While there is developing knowledge about the New Zealand public's view of GM food there is no research to date on views of eating fresh GM fish. Salmon is a cultural touchstone for many people and the introduction of GM salmon raises many issues particularly because GM salmon is unusual in that it is a food compared to a pharmaceutical product. In conclusion, the salmon case clearly demonstrates two key dynamics about food

in New Zealand. First, food has both cultural and technical dimensions and the current crises are very much centred around a disjuncture between the cultural imagining of salmon and the pragmatics of industrialised salmon production. Second, salmon production has demonstrated a paradigmatic post-WW 2 trajectory of increasing intensification and industrialisation, which was culturally accepted for a period of time before sliding into a series of conflicts.

Figure 9: Outline of the industrialisation of salmon farming and attendant issues



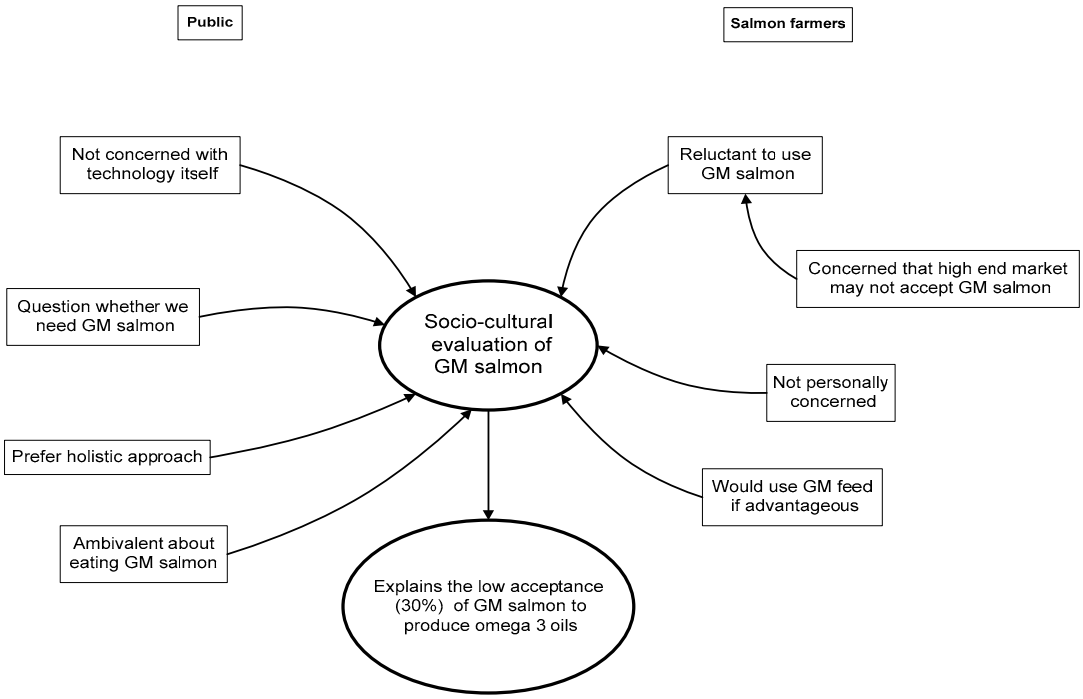
2.12 What is the publics' views on GM Salmon?

CSAFE Research Report No. 3

Quantitative research in New Zealand in 2006 showed that only 30 per cent of New Zealanders found the genetic modification of salmon to produce more omega 3 oils acceptable. Statistically significant differences were found for only two variables – age and gender. On balance, men were more supportive of the application than women ($\alpha = 0.01$) and older people were more supportive than younger people ($\alpha = 0.05$). Qualitative research conducted to explain this result showed that participants were not concerned about the technology, *per se*. Instead they questioned the need to use the technology, arguing that a more holistic approach to agriculture and food consumption would achieve better results. Participants were ambivalent about whether they would eat the resultant salmon. A common response was that while they may eat it, they would not feed it to their children. In addition, it appears from the data that genetic engineering – particularly of food – has become a symbol of economic and cultural inequities. These arguments have nothing to do with health or environmental safety or even the science behind genetic engineering. Interviews with salmon and abalone farmers showed that they were reluctant to move to genetically modified animals as they were aiming their products at what they considered to be an elite, discerning market that would not accept GM foods. This was their main reason for not moving to GM animals rather than having a personal opposition to GM. On the issue of GM feeds, there were no such concerns. They would be willing to use them if they provided an advantage. This did, however, have to be weighed against (economic) advantages of possible organic status. The New Zealand public does not, at present, appear to be willing to embrace genetically

modified food products. The acceptance of the actual technology, however, means that this may alter in the future if the ecological concerns, as well as the economic and cultural inequities commented on by participants can be addressed.

Figure 10: Public and salmon farmers' views of GM salmon



Chapter 3
Conclusion

3.1 Introduction

This chapter develops an overall synthesis of the research by taking each of the summaries provided in Chapter 2 and developing an account that reflects the key points of each study. To do this it integrates the research by introducing a new model of public reaction to biotechnology. The model emphasises the four key themes of pressure, response, assessment and outcome.

3.2 Overall synthesis

The research programme has identified attitudes and values that influence perceptions of biotechnology. Four of prominence were: ethical issues, spiritually, view of nature and New Zealand's clean green image. Ethical questions of biotechnology relate to questioning whether it is right to use biotechnology. Ethics involve responsibility of choice and consideration of who benefits. Plainly, the public question biotechnology development. Spirituality issues arose because biotechnology challenges personal and national identity and at a deeper level it leads to questioning who we are as humans. Particularly for Maori, biotechnology was evaluated expressly in terms of its effect on whakapapa and on mauri. One of the complex of factors used to evaluate biotechnology is how it challenges the public's and South Island Maori views of nature. In considering biotechnology issues, people resorted to different views of nature, and these views were used to support or reject it.

Closely related to perceptions of nature were people's thoughts and feelings about New Zealand's clean and green image. While people generally were realistic about New Zealand's current status, they tended to hark back to the past when it seems we were clean and green, or looked to the future when New Zealand will be clean and green. Regardless, clean and green was often mobilised in discussion about biotechnology. Here the key issue is: what will biotechnology do to New Zealand's clean green image? Arguments were made positively and negatively. But it is not just the pictorial image that was invoked: national identity included important ideas such as egalitarianism and pragmatism, including making better use of natural resources. These ideas played a vital role in assessing biotechnology and how it fitted with a vision of New Zealand the way the participants wanted it to be. New Zealand's clean green image is part of national identity and therefore part of mainstream culture. South Island Maori did not mention clean green image but instead were more concerned about what impacts biotechnology would have on core Maori cultural values. In effect, while the particular cultural response to biotechnology varied, the general pattern was for biotechnology to challenge core cultural concepts.

People can be understood to have responded to the challenges of biotechnology by making choices and assessing risks and benefits. Since the technology is new, people lacked information on which to make a straightforward decision about biotechnology. Accordingly, they said they would like more information, and a lack of information led to mistrust of business and scientists. In assessing risks and benefits, they saw that in many cases there was no personal benefit, only risks and fears of adverse effects, and that presumably others (business and science) benefit. With this way of thinking they were unlikely to be supportive

of biotechnology and when they made positive assessments they were conditional. Overall, they were sceptical that there were benefits. People were aware that regulations may help achieve benefits for the public but these did not really meet their concerns. Many people believed that their views as citizens were not heard; their only influence is by being a consumer. Maori were particularly strong in voicing how biotechnology development should include consultation with Maori. Finally, in making their choice about biotechnology, people considered the scale of the biotechnology, whether it affects either individuals or ecosystems and they also considered animal welfare.

Overall then, the assessment of biotechnology was rational and informed even if knowledge of technical details and possible impacts were lacking. People were making rational and thoughtful decisions under uncertainty since it is unrealistic to expect members of the public to be technical experts. There is good evidence that such independent decision making can collectively lead to or represent a good decision. Also, our survey research results show that increasing familiarity with biotechnology was not related to attitude towards it. In other words, more information does not always help, in large part because people are selective in their information sources.

The Maori response was distinctive in its reference to specific cultural factors. However, for both Maori and pakeha, response to biotechnology included assessment of risks and benefits, and both groups stated that there was lack of information and distrust of some scientists and corporates. Both asked: who benefits? Perceptions of nature were invoked when considering biotechnology. The scale of the biotechnology was also involved in making assessments. While South Island Maori mentioned concern for animals in a way that identified this as a specific factor, this factor was also included in the pakeha focus group results under ethical/moral issues. Both Maori and pakeha mentioned spiritual values in their discussion about biotechnology but South Island Maori did this more overtly in their discussions about tikanga, whakapapa and mauri. What appears to be distinctive between the two sets of data is the strong reference to either national or personal identity in the pakeha focus groups results. However, while the South Island Maori comments may not have been interpreted as 'identity' as such, their three criteria for evaluation can be seen as being tied closely to their identity as Maori.

Given the challenges from biotechnology the overall assessments of it were generally negative. Survey results show that beliefs that 'GM is wrong' and 'GM concerns' were more strongly linked to attitudes towards biotechnology compared to the view that technology can fix problems and that there are benefits from using biotechnology. The strongest worldview linked to biotechnology was nature's revenge – the concern that biotechnology use will result in nature biting back, a worldview sustained by their observations and experience (DDT, opossums etc.). However, while the overall public sentiment was lukewarm to biotechnology, there were marked differences for different subgroups. The accepting traditionalists found environmental, medical and agricultural uses of biotechnology to be more acceptable while the sceptical environmentalists did not. The second survey found only a slight shift in favour of biotechnology but little change in the factors affecting assessment of biotechnology. The third survey found only slight increase in those with a positive attitude towards biotechnology. Modelling again showed that certain key beliefs and values influenced attitude towards supporting the new technology, including nanotechnology. Overall, the survey research shows that people's views on biotechnology have changed little over time. Further, in line with lack of strong support for biotechnology, when it comes to purchasing GM food, most of the public rejected it or were indifferent to variations in price.

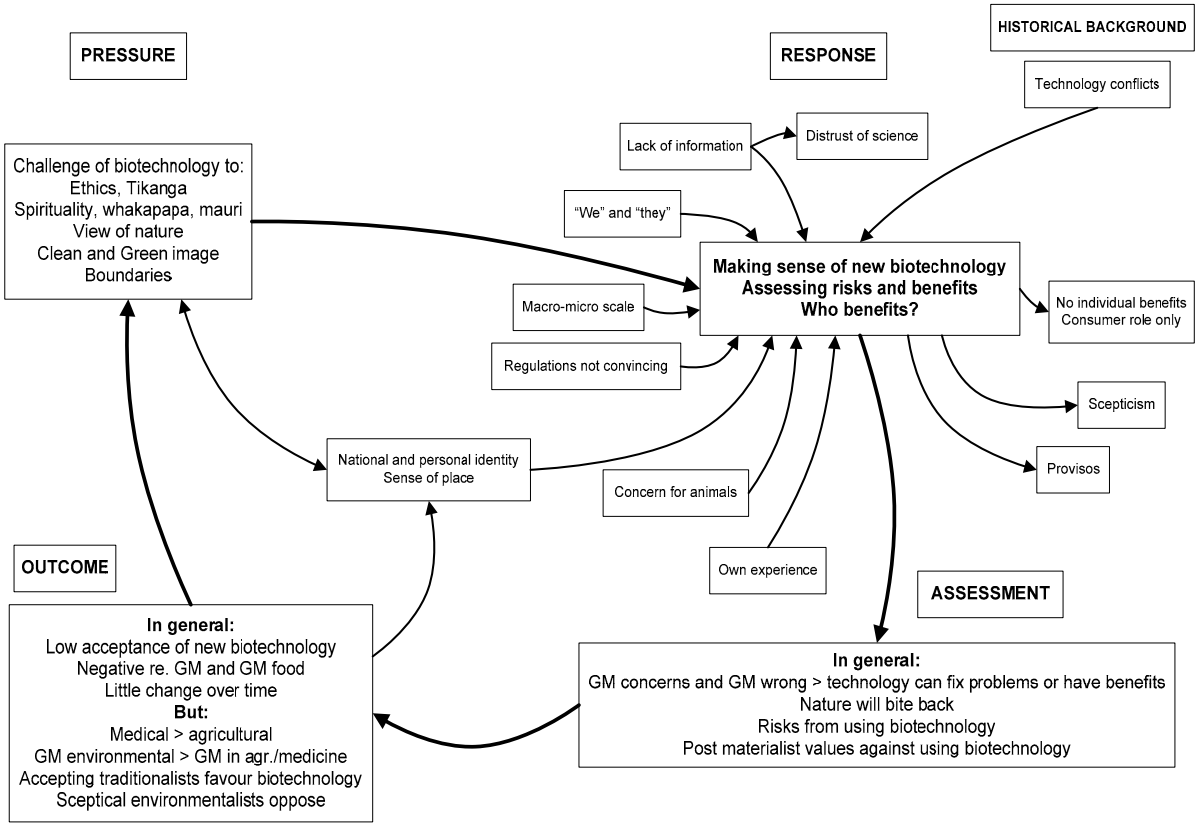
Looking at the history of technological development in agriculture shows some factors that explain the lack of strong public support for biotechnology. While the 1950s to the 1980s was a time of relatively dominant industrial agriculture, this dominance had been challenged in the last two decades. Food scares and green consumerism have both played key roles in challenging technological optimism to the extent that the products of alternative systems of production are available both domestically and in export markets. The ascendance of organic and other alternative production systems supports public questioning of biotechnology and supports the idea of alternatives, which are seen as having appeal and less risk. Also taking a historical approach, the salmon case study highlighted the issues around the industrialisation of salmon farming, the rise of GM salmon and the need to assess the New Zealand public on this issue. Assessment of public views on GM salmon showed that they questioned the need to use the technology and were ambivalent about eating it. Salmon farmers' reluctance to use GM salmon was because of market sensitivities not personal concerns.

In conclusion, biotechnology has challenged public thinking in many ways. People have resisted its use not just because it is new but because it challenges many values and beliefs. What has happened is that the beliefs and values of the biotechnology's developers and promoters tend not to correspond to the beliefs and values of New Zealanders.

The constituent reports allow us to introduce a pressure-response-assessment-outcome model of public reaction to biotechnology, as illustrated in Figure 11. Biotechnology is taken to pressure or challenge peoples' attitudes and values. It invokes deep-seated reactions from people in New Zealand and there are a number of dimensions to these reactions. One is the ethical or moral question about whether the biotechnology is right and proper to use. Closely related are the spiritual issues that biotechnology raises, and while these were not strong with pakeha they were important to South Island Maori who linked these to core cultural concepts of whakapapa and mauri. Also invoked are ideas about nature, which for pakeha were linked directly to concerns about the impact on New Zealand's clean green image. Finally, biotechnology challenges the boundaries between plants and animals and between humans and non humans.

These ideas play a vital role in the perceptions and assessments of biotechnology, that is, how people make sense of biotechnology. In making these assessments people believe that they lack information and in its absence they mistrust science. They draw a distinction between themselves and scientists and they consider the scale of the biotechnology, that is, the breadth of impact it might have. They draw on their own experience, and they have concern for animals. Regulations are not seen as addressing their concerns. One of the most important factors in assessing biotechnology is national and personal identity or sense of place.

Figure 11: Explanation of why some people reject novel scientific technologies



People use all these factors to make sense of biotechnology. Each biotechnology is then assessed to judge its acceptability, to consider risks and to assess who benefits from it. In making sense of biotechnology, people are sceptical of the benefits, and they couch assessments in provisos. Typically, they do not see any personal benefits to them, and they see that it is mainly as a consumer that they can influence biotechnology development.

In making their assessments of biotechnology, New Zealanders, on balance, have concerns about GM and give more support to the beliefs that GM is wrong than they do to the beliefs that biotechnology can fix problems or that it can benefit society. Nature is seen potentially as biting back and catching us out for making mistakes. They see risks from using biotechnology, and many cleave to post materialist values (e.g., society where people count more than money) which were not compatible with biotechnology.

The outcome of this assessment was, in general, a low acceptance of new biotechnology. They were negative about GM technology and GM food in particular. Surveying over time showed little change in assessment. Some biotechnologies were preferred over others and some groups of people were more accepting of biotechnology than others.

The figure also shows that in making their assessment of biotechnology, people can be challenged in a number of ways and this then influences their sense of identity which in turn influences their attitudes and values. Further, these public reactions to biotechnology are consistent with historical analysis which shows that people now live in a period of technology conflict rather than in the 1950-1980 period of dominant, intensive agricultural discourse which overshadowed alternative viewpoints on technology

In answer to the over-riding question of this research programme (why do some people reject novel scientific technologies?) we can say that they are rejected for the following reasons:
1. Biotechnology challenges core ideas and beliefs, especially identity.
2. People lack information and distrust science.
3. There are few perceived personal benefits.
4. There are important risks in using biotechnology.
5. People are sceptical of the claimed benefits of biotechnology.
6. Biotechnology is not compatible with important values.
7. We are, again, in a period of technology conflict.

3.3 Research implications

In terms of New Zealand's history, we now appear to be in a period in which there is less trust in science and more public concern over technological developments. This contrasts with earlier periods when, in the case of agricultural development, there was a broad post-war consensus about the positive role for technology and therefore a prevailing public sentiment of technological optimism. Subsequently, there is lowered optimism about technology and the results show this to be an embedded sea-change in public opinion about technology. While some people do favour biotechnology there are many who do not and this ambivalence is firmly set in the public mind. It is unlikely that there will be any movement back to an earlier time when the public uncritically accepted, or at least did not oppose, technology developments in agriculture and medicine.

This interpretation of an age of technological uncertainty has implications for science. One implication is that as a result of biotechnology developments it is now up to science to show that biotechnology is safe and useful. Such an endeavour cannot avoid engaging with issues of risk and risk assessment. This body of research aligns with other research into public perceptions of biotechnology to confirm that the perceived absence of sufficient regulatory scrutiny of new technologies is a major stumbling block to public acceptance.

A related issue is the status of science in the public mind. Our research shows that the public are more sceptical about science than in the past so one research implication is that New Zealand science must address issues of integrity, trust and purpose in new technology developments and communicate these with the public. It is clearly no longer sufficient to assume a Promethean view of scientific progress in which all scientific developments are assumed to be good. There is also an associated tension between higher-level scientific goals and commercial goals of technology development companies. Rather, efforts to communicate science need to adopt an 'evaluative' rather than 'promotional' position. Sceptical publics are more likely to respond positively to balanced information which lists both potential benefits and pitfalls, rather than PR style communication which only 'accentuates the positive'. This research also shows, however, that there are sections of the population that will respond to neither.

Technological uncertainty also makes it necessary to maintain an understanding of emergent public thinking about new technologies and, further, to deploy methods that can maximise the chance of achieving some kind of public agreement about new technologies. Research using deliberative democracy and constructive conversations can play a vital role in achieving this goal. However, there is still a role for more traditional social science research methods to keep in touch with public thinking. In times of ever changing technological options it would seem wise to establish some kind of regular monitoring system so that new technological ideas could be assessed for the acceptability to the public. Is it time to establish an

NZBarometer, that is, a regular national random sample survey about reactions to technologies? While such surveys have their limitations they can provide useful baseline information about public thinking and, if done on a regular basis, show changes in attitude over time.

A critical issue with using social science research to respond to technological uncertainty is deciding on where best to include the public biotechnology preferences into science decision making. While many can agree that there should be inclusion of public preferences into scientific decision making processes, the key issue is: at what point does this occur? How far upstream in the innovation process should social science insights be used? When new products are envisioned, and before the means of achieving it are developed, would it not be relevant to factor public perceptions into this thinking? While such strategies are already well embedded in areas of high ethical concern like reproductive technologies, there is also a need for commercially-oriented scientific research to consider such strategies. In the event of strong public disquiet about a possible new product, the developer has to consider whether it is worth the investment if there is significant consumer resistance. Intellectual property issues may make this process problematic since there may be great reluctance to even mention an innovative product at the early stages of its development for fear that others may produce it. However, our research shows that this is what the public want, and some groups, including Maori, are emphatic about being involved early in the development stage of biotechnologies. For all these reasons, key processes that are already implemented by ERMA need to be retained and strengthened.

Beyond maintaining an enhanced appreciation of pubic thinking about novel technologies on an ongoing basis there is a need to examine perceptions of biotechnology from the point of view of different groups. Since many new biotechnologies involve farmers it would be relevant to compare urban and rural viewpoints on biotechnology developments since there appears to be growing disagreement between these two groups. This focus would require a more refined sampling process compared to the simple random sampling used to date.

Related to the need to focus on public thinking is the need to see how this thinking translates into purchasing behaviour. As noted earlier, people said that this seems to be the only way that they have of expressing their viewpoints. So how do people react to the products based on new biotechnologies? What are the key attributes in the purchasing decision? Is it just a matter of price and individual benefit or do consumers deploy ethical and cultural reasoning when they make a purchase decision? What is the nature of new food knowledge? What are their preferences for food or product labelling? Our research suggests that cultural and other 'values' attributes of food products are important, but how this translates to purchasing behaviour is less known.

Of course, studying buyer beliefs and behaviour is very difficult when the products are hypothetical or not available in New Zealand. There is a need to use experimental methods to study buyer behaviour using pseudo sales and mock auctions. Another technique is to establish innovation futures markets where people bet on the prospects for a new technology finding acceptance among the public.

Another promising line of enquiry might be to shift the focus from the person as the unit of analysis, which has been the predominant approach to date both in New Zealand and overseas, and focus on the unit of technology itself. For example, it would be possible to do case studies of specific technologies and highlight the social, economic and environmental dimensions at work in the evolution of the technology. Taking an Actor Network Theory approach, that is by examining entities whose identities are formed through shifting networks

of relations with other actors, would be relevant here. Further, the comparative case study method could be used to identify the critical factors in the success or failure of the development of the case study biotechnologies. Of course, this line of enquiry would be limited to the available technologies that have been developed but it would be very useful in showing what the characteristics of a successfully introduced biotechnology were. This would move the research into the Science and Technology Studies area.

One new area of technology development is nanotechnology. While it might seem that public reaction to the challenging aspects of this suite of possibilities can be predicted from their reactions to biotechnology, this assumption may not be well founded. Recent AERU research has shown that nanotechnology is perceived more favourably compared to biotechnology in recent times but not by a wide margin (Cook and Fairweather, 2006). It is being perceived with more caution compared to initially positive reactions to GM since the public are now more experienced in the challenge of new technologies. One trajectory for nanotechnology is that the public will have more concerns as nanotechnology is developed further. An alternative trajectory is that since the public have not started from an overly optimistic base they might in fact become relatively more accepting of nanotechnology since they are less likely to become disillusioned. Similarly, there is a perception that nanotechnology is being subject to a higher level of regulatory scrutiny than GM foods and that consultation is taking place ahead of actual commercial development. If nanotechnology developers are sensitive to public concerns, and it is possible that they learnt from the biotechnology case, they might also make the process more positive by ensuring that nanotechnology developments dovetail public preferences. Given the possibility of different trajectories it would be useful to carefully track the public response to nanotechnology, among the plethora of new innovations.

While we have provided some insight into what people think about biotechnology and why they hold their views, this developing knowledge can be enhanced by using insights from sociological and psychological theory and methods. Theorists such as Bourdieu, Foucault and LaTour in sociology, and Gibson, Harré and Austin in psychology, suggest new lines of enquiry that could provide rich insights into cultural and social reactions to biotechnology.

Appendix 1
List of Outputs from the Fate of Biotechnology Research Programme

Reports and Discussion Papers

Coyle, Fiona J., Crystal Maslin, John R. Fairweather and Lesley M. Hunt (2003), Public Understandings of Biotechnology in New Zealand: Nature, Clean Green Image and Spirituality. AERU Research Report No. 265.

Hunt, Lesley M., John R Fairweather and Fiona J. Coyle (2003), Public Understandings of Biotechnology in New Zealand: Factors Affecting Acceptability Rankings of Five Selected Biotechnologies. AERU Research Report No. 266.

Roberts, Mere and John R. Fairweather (2004), South Island Maori Perceptions of Biotechnology. AERU Research Report No. 268, Lincoln University.

Cook, Andrew J, John R. Fairweather, Theresa Satterfield and Lesley M. Hunt (2004), New Zealand Public Acceptance of Biotechnology. AERU Research Report No. 269, Lincoln University.

Kaye-Blake, William, Caroline Sunders and John R. Fairweather (2004), Modelling the Trade Impacts of Willingness to Pay for Genetically Modified Food. AERU Research Report No. 270, Lincoln University.

Stuart, Annie and Hugh Campbell (2004), Technology conflicts in New Zealand agriculture: Comparing contemporary and historical crises between publics, government, business and science. CSAFE Research Report No. 2.

Cook, Andrew J, and John R. Fairweather (2005), New Zealanders and Biotechnology: Attitudes, Perceptions and Affective reactions. AERU Research Report No. 277, Lincoln University.

McLeod, Carmen, Janet Grice, Hugh Campbell and Teresa Herleth, (2006), Super salmon: The industrialisation of fish farming and the drive towards GM technologies in salmon production. CSAFE Discussion Paper No. 5.

Hunt, Lesley and John R. Fairweather (2006), The influence of perceptions of New Zealand identity on attitudes to biotechnology. AERU Research Report No. 286, Lincoln University.

Cook, Andrew J, and John R. Fairweather (2006), New Zealanders and Biotechnology: Reactions to novel developments in medicine, farming and food. AERU Research Report No. 287, Lincoln University.

Grice, Janet, Carmen McLeod and Hugh Campbell (2007), Evaluating the Social and Cultural Implications of GM Technologies in New Zealand Primary Production: A Case Study of Salmon and Other Aquaculture Applications. CSAFE Research Report No. 3.

Articles:

Cook, A. J. & Fairweather, J. R. (accepted), Intentions of New Zealanders to purchase lamb or beef made using nanotechnology. British Food Journal.

Cook, A. J. & Fairweather, J. R. (accepted), Attitudes and intentions to support bio-pharming. International Journal of Biotechnology.

Coyle, Fiona and John R Fairweather, (2005), Space, time and nature: Exploring the public reception of biotechnology in New Zealand. Public Understanding of Science 14: 143-161.

Coyle, Fiona and John R Fairweather, (2005), Challenging a place myth: New Zealand's clean green image meets the biotechnology revolution. Area 37(2): 148-158.

Hunt, L.M. (2004). Factors determining the public understanding of GM technologies. AgBiotechNet: the online service for agricultural biotechnology, 6 (August) ABN 128. http://www.agbiotechnet.com/reviews/Database/sept04/html/ABN128.htm

Conference Papers:

Hunt, L.M., Coyle, F.J. and Fairweather, J.R. (2003). Can attitudes to biotechnology in New Zealand be related to New Zealand's identity myths (imagined community)? Conference Proceedings of Sociological Association of Aotearoa N.Z. (SAANZ) Conference 2003, 'Knowledge, Capitalism, Critique', 9-11 Dec. 2003, Auckland University of Technology, N.Z. http://saanz.science.org.nz/Quality.htm.

William Kaye-Blake, Caroline Saunders, and John Fairweather (2005), Optimal uptake of second-generation genetically-modified crops. Paper prepared for the 49th Annual Australian Agricultural and Resource Economics Society Conference, Coffs Harbour, New South Wales, 9-11 February 2005.

Coyle, Fiona and John R Fairweather, (2004), Spiritual geographies: Judeo-Christians ethics as a response to New Zealand biotechnology. Technologies, Publics and Power conference, Akaroa, 1-5 February.

Appendix 2
Report Summaries

Public Understandings of Biotechnology in New Zealand: Nature, Clean Green Image and Spirituality

Fiona Coyle, Crystal Maslin, John Fairweather and Lesley M Hunt (2003)
AERU Research Report No. 265

Research Objectives

The main objective was to use focus groups to explore public attitudes and values about the use of new biotechnologies in New Zealand.

Methods

The method used focus groups in 11 locations around New Zealand, including the four main centres and three regional centres and included 117 participants. Participants were asked to talk about what the word biotechnology meant to them; make comparisons between the acceptability of five different biotechnology exemplars; discuss their ideas about nature and what is natural; what they thought about some other examples; and to look into the future of biotechnology as far as New Zealand was concerned. The focus group discussions were transcribed and analysed for themes using NVivo.

Approach

The report builds on previous work by researchers in related sub-disciplines, particularly the European Commission's PABE report. Particular attention was given to the role of nature, New Zealand's 'clean green' image and spirituality in the perception of novel biotechnologies. These are areas that have been little explored in the current literature, but which are relevant when applied to perceptions of biotechnology in New Zealand.

Results

Biotechnology was conceived by focus group participants as a 'secret science', characterised by laboratory work that took place behind closed doors. The participants often equated it with the term 'genetic engineering' and a small number of them could not accurately define it. It was found that the term was not part of everyday talk, and was less of a concern than other issues such as access to primary health care, housing, employment and education.

Focus group participants were found to be influenced in their perceptions of biotechnology by a series of underlying attitudes and values that included ethical and moral issues, spirituality, and perceptions of nature. These were not influential in isolation, but interacted with one another in complex ways when it came to making decisions about particular aspects of biotechnology.

The word 'nature' was found to be fundamentally important, referring to competing/overlapping versions of nature as wise, dynamic, competitive, traditional, inclusive of humans and balanced. These conceptions were applied in specific contexts and used to either refute or support the use of novel biotechnologies in New Zealand.

New Zealand's clean green image was seen as a national icon, but one that existed either in the past or was a future utopia that participants strived to reach. This utopia could either be accomplished by steering away from agricultural and environmental genetic engineering or by using it to sweep up the remnants of past mistakes such as pesticide contamination.

The absence of references to spirituality was revealing in itself, suggesting that New Zealanders feel uncomfortable discussing this issue in public. However, among Christians in the focus groups, specific biblical codes of ethics were cited in relationship to their receptivity towards new biotechnologies.

Interpretation

Spirituality, New Zealand's clean green image and conceptions of nature were found to be inextricably linked to one another in the perception of novel biotechnologies. Further, the foundation of New Zealand's clean green image was shown to be based on conceptions of a "traditional nature" and "wise nature". However, at present there is a change and the New Zealand public is starting to view nature as a complex, dynamic ecosystem in which human subjects are entangled and rather than perceiving nature as a machine, it is seen as a dynamic actor in its own evolution. Accordingly it can respond to technological development and if pushed too hard it can be tipped into chaos (bite back). Genetic engineering, xenotransplantation and cloning have muddied the boundaries between human and non-human nature, and nature has also shifted from a physical entity that merely surrounds humans, to one in which humans are corporeally integrated. Such a shift has implications for both how we conceive human nature, our role in nature and our perception of biotechnologies. Overall then, novel biotechnologies have disrupted the naturalised separation between self and non-human other, between human, animal and plant and these identity disturbances forced participants in this study to re-examine their constructions of nature and how they used them to make value judgements about biotechnology.

Policy Implications

To the public, biotechnology has an air of secrecy about it that breeds mistrust. In order for scientific and government institutions to be trusted the research process should be rendered more transparent. One way to achieve this, which was suggested by participants, is to establish biotechnology educational sites, which members of the public and schoolchildren could visit. Participants in this study based their concerns about new products on previous experiences with institutional botches and misnomers. These included perceived cover-ups such as Corngate, in which inconsistencies of behaviour were noted and exemplified. In order for a sense of trust to permeate through to the New Zealand public, a sense of behavioural consistency should be promoted by appropriate government bodies. One of the key themes was the importance of moral issues in judging the acceptability of novel biotechnologies. Participants would like to see more emphasis on bioethics in New Zealand, as promoted by the Bioethics Council. Spiritual values are a deep-rooted part of our cultural heritage and can override even the apparent rationality of the arguments of scientific and commercially-aligned personnel.

Public Understandings of Biotechnology in New Zealand:
Factors Affecting Acceptability Rankings of Five Selected Biotechnologies

Lesley Hunt, John Fairweather and Fiona Coyle (2003)
AERU Research Report No. 266

Research Objectives
The main objective was to identify the factors affecting the acceptability rankings of five biotechnologies and to understand how focus group participants made these decisions.

Methods and Approach
Focus groups were conducted in 11 locations around New Zealand, including the four main centres and three regional centres and included 117 participants. The focus was on the acceptability of specific examples of new medical, agricultural and environmental biotechnologies, and the reasons underlying this. In the course of each focus group the participants were asked to rank five different exemplars of biotechnology for acceptability:

- A treatment of sheep to reduce their methane emission.
- A throat lozenge which placed beneficial bacteria in the mouth.
- A potato that was genetically modified by the addition of a synthetic toad gene to resist potato rot.
- The use of stem cells from embryos to treat Alzheimer's Disease.
- The use of a genetically modified bacterium to break down DDT residue in the soil.

Focus group discussions were transcribed and using NVivo, the transcript data for each exemplar was examined for themes, which were then collated across exemplars. This report focuses on the factors that participants considered when making their acceptability rankings.

Results
The acceptability factors for the five exemplars could be divided into four important generic groupings. Firstly, participants were most concerned about the risks and benefits posed by a particular biotechnology. The discussion of risk brought up related issues such as fear, distrust of the motivations and knowledge of those promoting biotechnology, whether it would affect a lot of people or a few, whether it would benefit the world as a whole or individuals, whether it was it useful and simple, and ethical considerations. Certain biotechnologies were acceptable if specific provisos were attached to their use. They wanted more information. They wanted to know more specific details about the biotechnology. How was it made? What was it made of? Then they wanted to know the reasons for having this biotechnology. Why had the researchers become interested in it? What was its purpose? Who was going to benefit from it? Who was paying for it to be researched and developed? They wanted to know what research had been done on the risks surrounding it and who had done this research. If there were risks to them but commercial benefits to others they were reluctant to support the biotechnology. Participants were very aware of the balance between costs and benefits indicating that they did not see any biotechnology as being risk free. They were ambivalent because they could see the good that would come from a particular biotechnology but were also aware of and concerned about the possible risks it posed.

Secondly, participants considered whether the biotechnology was 'natural', and the implications it had for their sense of place and their feelings about where they as humans fitted in the natural world. Thirdly, participants used their own personal experience and related knowledge of this or similar biotechnologies to interpret its likely impact. Fourthly, they wanted to have a choice about the use of a biotechnology – both at an environmental and

an individual level. The lack of information of the type they wanted played a part in the dominant concern and distrust about the role of business in biotechnology products. Participants wanted to be able to have enough information to make up their own mind about a biotechnology as a citizen, and, where it was possible, to make a choice about using a biotechnology product as a consumer. For example, the results show that biotechnology to be used in the environment was not so well supported because there would be less choice possible over contact with it.

Certain words had special meanings for participants in the focus groups. For example, one such word was 'waste' which was also tied to 'clean'. Many participants did not like to see anything wasted. The way these words were used often related to their sense of national identity as New Zealanders. When the way participants used the words 'we' and 'they' and other associated words such as 'our' was analysed, it was found that participants took ownership of 'the mess the world is in', of New Zealand agriculture in general and of some scientific discoveries. On the other hand, 'they' was used to refer to 'otherness' – those who were not like them or did things outside their control, such as industries using biotechnology to make what they saw as unreasonable profits, regulatory bodies and government.

The participants gave an overall summary of what factors they used when considering the acceptability of biotechnology but when this was compared with the factors they took account of for each exemplar it was clear that they considered each on a case by case basis, and found some exemplars acceptable and others completely unacceptable.

Interpretation

Applications of biotechnology challenge people's ethics because decisions about their use are frequently about finding a balance between the good something may do compared with the process that has been used to get this biotechnology, or the risk that using it may have. Biotechnology also challenges ethics because it asks questions about where we as humans fit in our natural world and for some this has connotations of good and evil and justice and may include a religious and/or spiritual dimension. Who is going to benefit from a biotechnology is at its heart an ethical and juridical question. Biotechnology challenges the sense of understanding that we have of our natural world and where everything fits, and where we fit – our identity in fact.

A most important question for participants was who benefits from the biotechnology. The response to this question could be closely linked to the egalitarian principle of many in New Zealand society, the concern that the less well off in society should be cared for and that there should be free access to health and education. This would also link to the anti-business feeling amongst participants and the perception that New Zealanders should not stand out from each other, 'skite' or make showy demonstrations of their wealth.

Policy Implications

The myths about New Zealand identity and how these tie in with individual identity are challenged by emerging biotechnologies. The major stakeholders in biotechnology development, scientists, companies, regulators and Government members, could moderate this challenge by including the public. Biotechnologies that take account of, incorporate or enhance some of the New Zealand identity myths and meanings may find greater acceptance in New Zealand and contribute something unique to the world.

South Island Maori Perceptions of biotechnology

Mere Roberts and John Fairweather (2004)
AERU Research Report No. 268

Research Objectives

The main objective was to develop an understanding of Maori perceptions of biotechnology by establishing a primary source record of South Island Maori viewpoints on biotechnology.

Methods and Approach

Twenty-two interviews and/or focus groups were conducted around the South Island involving a total of 91 people. Participants were asked to discuss different biotechnologies and their applications. The report focuses on what the participants said about the different biotechnologies with a view to providing a record of these views. In addition, key themes were identified and collated.

Interviews were organised and conducted in a culturally appropriate manner. A draft summary of each interview was sent to individual participants for verification and comment, and verbal and written responses to this request were incorporated into the final draft. The report presents results without going further to provide an extended interpretation.

Results

Almost every person expressed concerns about the potential for negative effects on humans and the environment, especially in the longer term.

Many expressed an opinion that these new technologies (especially GMOs) somehow transgress tikanga, and break the unwritten rules that govern relationships between things. For them, these technologies are “not right” or not tika. The perception was that these new technologies ignore the nature of the relationships and balance between things, and are therefore "disrespectful".

Whakapapa was most frequently invoked especially in the context of its importance and role in ensuring cultural safety, and as a framework for assessing cultural risks. Whakapapa was identified as the touchstone of the culture, which must be protected against interference from transgenics which are perceived as incompatible with whakapapa and contrary to the Ngai Tahu world view. Many also proffered the view that GM will disrupt the mauri of an organism when the DNA is “broken” by the act of inserting a "foreign" gene.

New technologies especially GMOs were seen as merely “quick fixes” or a “fad”. A number of participants argued that new biotechnologies might solve some problems but will create others. There was considerable cynicism and scepticism especially from more informed participants about purported benefits; many opined that they will mainly benefit the multinationals and overseas interests but not ordinary New Zealanders including Maori.

There were a number of underlying causal factors that contribute to the perceptions of risk. These included: (1) a lack of knowledge and information on which to make an informed decision. A majority of participants, including non-scientific academics, emphasised that they felt at a disadvantage in not having a better understanding of the subject matter (genetics, GM, biotechnology) sufficient to engage in informed dialogue and decision making. (2) Distrust of science and scientists. Scientific and medical misadventures/mistakes were frequently raised both in the historical and personal context as a reason for lack of trust in these new biotechnologies. This distrust occasionally manifested in initial hostility towards

the interviewer (a scientist) but most frequently, during recounting of actual scientific/medical misadventures and purported clandestine activities of individual scientists, their institutions, and/or multinationals. (3) Fear of uncertainty and longer term adverse effects. Most participants tended to be risk adverse concerning biotechnology. A need for caution was frequently voiced (although not explicitly, as kia tupato). Most wanted more assurances about safety, and more "proof" that there were no long-term adverse effects on human or environmental health. (4) Perceptions of 'natural' versus 'unnatural'. Views about these two concepts were very frequently cited – explicitly or implicitly - as an important factor in determining the 'rightness' or 'wrongness' of a particular application of biotechnology. (5) Perception of what is 'right' versus 'wrong'. The issue of what is right or tika in each application exercised the minds of most participants. In many participants' minds, this perception was based on judgements concerning the relationships of the organisms involved (e.g. in xenotransplantation, or in a GMO) and whether these imply or will result in or upset the "balance" between things. Implicit in the concept of balanced relationships were a cluster of associated values such as reciprocity and respect. (6). Influence of the media. Several people mentioned the impact of the media on their views about science/scientists and biotechnology. The mouse with the ear on its back was mentioned numerous times, always in a negative context, and it had resulted not only in a specific revulsion to the observed research but also to research involving animals. (7) Concerns for animals. Many also voiced concerns about the health, safety, ethics and intrinsic rights of animals. In some interviews this manifested as opposition to 'factory farming', e.g., pigs farmed for organ transplants, and biopharming of cows and sheep for medically useful proteins.

Interpretation

The research found that Maori attitudes concerning biotechnology fall into two broad categories, one largely pragmatic and the other more subjective and apparently culturally based. Three clear expressions of pragmatism were found to have emerged. One was a general risk adversity to new technologies, particularly those for which there was no apparent need or benefits. This, combined with lack of knowledge and understanding of these things and a general distrust of scientists and of the commercial interests perceived to be behind these technologies, was identified to have led to an unwillingness to trust and accept new technologies. A second example of pragmatism was that despite the risk adversity and general lack of acceptance of most forms of biotechnology, an exception was generally made for those that would save human lives (this is sometimes referred to as the "he tangata, he tangata, he tangata" principle). Finally, it was found that there was general acceptance of the right of the individual to make a choice, particularly for those technologies that affected only the individual and not the population at large or the environment.

Of what appeared to be culturally based and derived attitudes, two broad categories were discerned: one politically and one spiritually grounded. Concerning the former, for one runaka, participants had a strong sense of their own tino rangatiratanga, which led them to sometimes take their own tribal Trust Board (TRONT) to task over decisions they felt were being made without adequate consultation, as well as making demands for more involvement in and control over these technologies within a Treaty-based framework governing that involvement. The other category found expression in what are clearly culturally derived values and beliefs. In many instances these were overtly explicated, often in considerable detail; but in others they instead found expression in concerns about things being 'unnatural' and/or 'not right.' Those who agreed strongly with statements about the negative impacts of GMOs on spiritual aspects (namely mauri and whakapapa) were also less likely to accept GMOs than those who disagreed with the statements about spiritual aspects.

Policy Implications

The research found that many participants made reference to and suggestions about the need for tikanga based, culturally appropriate risk assessment processes regarding biotechnology developments. It was identified that there was there is a need for:

- More information. All apart from the few experts in this area wanted more information made available about these technologies so that Maori could make informed choices.
- Clarification of purpose and benefits. "*Who benefits?*" is an important issue for Maori. Clearer and more convincing statements of the purpose (kaupapa) and benefits, particularly to New Zealand and to Maori, need to be made in the media and by applicants.
- Identification of "boundaries" or "no go" areas of research. Several participants expressed the need for identification and formal recognition of boundaries or "*no go*" zones that should not be crossed. Such officially sanctioned limits would help allay fears about the "*slippery slope*" or "*thin end of the wedge*" view that all of this technology will inevitably progress beyond legal and moral control and constraints.
- More emphasis on alternatives. Many asked about alternatives to these technologies particularly those involving GM. Many considered that the best alternatives to be '*natural*' ones, e.g., rongoa and organic foods.
- More involvement in and control over the technology and the decision-making processes. Most advocated more involvement by Maori in the biotechnology process, not just in the decision making but in the initial policy setting stage by government bodies (e.g., MoRST) and the pre-application stage (e.g., in research institutions) as illustrated by the view that *"It would be good to know what's planned before it happens"*. Many also wanted involvement in long-term monitoring of biotechnologies so that the kaitiakitanga rights and responsibilities of Maori were acknowledged and recognised. The current perception is of an imbalance of power . This was considered to be too great so that Maori had no real input into the decision making process.
- Development of culturally appropriate risk assessment guidelines and frameworks. Many participants emphasised the need for a proposed cultural risk assessment framework that was grounded in culturally appropriate tikanga, including spiritual beliefs and values as well as actual practices. A purely scientific risk/benefit framework is not sufficient for Maori.

New Zealand Public Acceptance of Biotechnology

Andrew Cook, John Fairweather, Theresa Satterfield and Lesley Hunt (2004)
AERU Research Report No. 269

Research Objectives
The overall aim of this research was to determine and understand public perceptions of biotechnology in New Zealand, in particular to determine the relative importance of factors involved in perceptions of biotechnology.

Method
A questionnaire was designed which included items from risk perception research and items developed from focus group research. Data were gathered by national postal survey through the distribution of 2,000 questionnaires during December and January, 2004. Seven hundred and one usable responses were received which, accounting for undelivered questionnaires, derived a response rate of 36.3 per cent.

Approach
The questionnaire contained a range of questions investigating issues and topics including concern over biotechnology as a social issue, the acceptability of examples of biotechnology and concerns and worries about genetic modification. Also included were diverse topics generated using focus groups including beliefs about nature, post materialist values and spiritual beliefs. These variables were examined by developing two models. A belief model linked affect, risk perception and beliefs to overall reaction to three specific biotechnologies and for an overall assessment of biotechnology. A worldview model linked spirituality, nature, technology and post-materialism responses to reactions to biotechnology.

Results
Biotechnology was found to be a public concern although of less importance than many other issues. Over one half of the respondents were either concerned or very concerned about biotechnology and the use of genetically modified organisms in agriculture. Medical uses of biotechnology were more acceptable than agricultural uses. Biotechnologies that involve genetic modification were less acceptable. The use of genetic modification to fix environmental problems was more acceptable than its use in medical treatments or use in agriculture.

University scientists and crown research institutes were more trusted sources of information about biotechnology than the general news media, politicians or biotechnology companies.

Those with a positive attitude tend to believe that the New Zealand public will benefit from biotechnology while giving less emphasis to the prospect of benefits to private companies.

Specific concerns about genetic modification cause apprehension. Respondents expressed particular concern about compliance with rules or regulations and there were also concerns that while biotechnology may solve a problem it can also create more problems.

Whether people were familiar with biotechnology had little bearing on their acceptance of, or general attitude towards, biotechnology.

The following beliefs explain differences in attitude towards biotechnology.

- Concerns about genetic modification including concerns about cross contamination of seeds and possible negative impacts on exports are negatively related.

- Beliefs that genetic modification is wrong including beliefs that it is wrong to eat genetically modified food and wrong to mix plant and animal material are negatively related.
- Beliefs that biotechnology will be of general benefit to society are positively related.
- Beliefs that biotechnology can fix problems and that it is natural for people to use biotechnology are positively related.

The following general views and values reflect a particular worldview that explains differences in attitude towards biotechnology.

- Nature has the inherent capacity to react to interference by producing negative consequences (negative to biotechnology).
- The way forward for society is through the use of technology (positive to biotechnology).
- People have a God-given stewardship role to care for the environment (negative to biotechnology).
- The holding of spiritual beliefs (negative to biotechnology).
- The holding of post-material values that promote conservation and advocates limited resource use (negative to biotechnology).

Interpretation

Central to this research was the use of risk perception measures in the formation of a dependant variable for a model of immediate beliefs and concerns and biotechnology, and a model of worldviews and biotechnology.

The first model of interrelationships indicated that a tendency for a positive attitude was held by those who believed that the New Zealand public will benefit from biotechnology while there was less emphasis to the prospect of benefits to private companies. Concern about compliance with rules or regulations was also important as well as the potential of the technology to create unforeseen problems.

In the second model of worldviews and biotechnology the five worldview items showed that together they were aligned to attitude towards biotechnology. This suggests that, while each worldview item did not refer to biotechnology, each was nevertheless associated with attitude towards biotechnology. This means, for example, that having spiritual beliefs was for many people a conditional factor that goes along with having a negative attitude towards biotechnology. Beliefs about nature, beliefs about technology, spiritual beliefs and post-materialism values can be interpreted as being important as conditional factors with each having independent significance, although each was found to have different degrees of relative importance.

Policy Implications

Endeavouring to understand the views, values and worldviews associated with biotechnology would be a positive step towards reconciling the development and use of biotechnology and public concerns.

The worldview model has shown that factors such as spiritual beliefs and beliefs about the character of nature are linked to a general disposition towards biotechnology. Such factors cannot be immediately regarded as beliefs that can be changed through the provision of new information. Whereas there is potential to change views about the likelihood and consequences of an event, such as a perceived risk to public health, there is little potential to similarly alter a person's spiritual beliefs or their conception of nature. This anchoring effect means that attitudes towards biotechnology were prior to this research found to be likely to be more resilient and entrenched than has previously been presumed.

A further main finding was that it was possible for the general attitude towards biotechnology to be disassociated from the worldview items. For example, the challenge that biotechnology is meddling with nature could possibly be removed if biotechnology is thought of as working with nature. Similarly, biotechnology could make less of a challenge to post materialism if the technology were accepted as a means of reaching post materialist goals. This is inviting a fundamentally different conceptualisation of biotechnology. The implication was that biotechnology must be recast in the minds of the public if it is to become more acceptable.

The finding from this survey research indicated that information about the immediate risks and benefits was unlikely to have an immediate effect because of deep-seated views and values that shaped peoples' views of biotechnology. It was found that this did not mean that trying to inform or educate people about biotechnology is totally pointless, but rather takes issue with the view that the public can be easily informed and educated. Importantly, the findings suggested that endeavouring to understand public views and values would be a useful first step towards reconciling the development and use of biotechnology and public concerns.

Modelling the Trade Impacts of Willingness to Pay for Genetically Modified Food

William Kaye-Blake, Caroline Saunders and John Fairweather (2004)
AERU Research Report No. 270

Research Objectives

The objective of this research was to examine New Zealanders' intentions to purchase and willingness to pay for several specific genetically modified (GM) food products, and to use these results as input for a model of international trade to estimate potential impacts from trade on New Zealand.

Methods and Approach

A nationwide survey was administered and the resultant data were used to estimate consumer and producer impacts of GM crops. Assuming the best adoption rate of GM crops for New Zealand agriculture, these data were used as inputs for the trade model in order to assess the economic impacts of the production and use of genetically modified food.

Results

Different New Zealanders have different willingness to pay for GM food. For all six GM products in the survey, about 30 per cent to 45 per cent of respondents were indifferent to the GM products. These respondents would pay the same price for the GM as for non-GM food. For four of the six GM food products, there were respondents willing to pay a 40 per cent premium for GM food. On the other hand, seven per cent to 27 per cent of respondents, depending on the product, were willing to pay for the GM food but at a discounted price. The proportion of respondents who rejected each product was fairly consistent at about 40 per cent. However, the proportion of respondents who rejected all GM products was lower at 31.4 per cent.

This willingness to pay data was transformed into a demand curve. The raw data and the estimated demand curve were S-shaped (sigmoid) – steeply sloped at both high and low prices and fairly flat in the middle. A sigmoid regression was estimated and fitted the data very well. It showed that, with one exception, the type of GM product offered had little effect on the prices people were willing to pay. This estimated demand curve was used to calculate the optimal uptake of GM crops, which is the percentage of total output that should be GM in order to have the highest industry revenues. This calculation led to the finding that the agricultural sector could maximise its revenue from most products by having 15 per cent of its production in GM products and charging an 11 per cent premium for the products. This would raise sector revenues by 1.6 per cent. If the percentage of consumers willing to pay for GM food increased from the 62 per cent in the survey data to 90 percent of consumers, then the optimal uptake would be 22 per cent, the premium would be 11 per cent, and the increase in agricultural revenues would be 2.4 per cent.

These findings were incorporated into the AERU's model of international agricultural commodity trade. Using the optimal uptake rate, a universal willingness to pay a premium for certain GM crops, and increased productivity of some GM products, the modelling found that New Zealand could increase its agricultural revenues by up to six percent by adopting GM crops. It is further shown that increased productivity not accompanied by consumer premia leads to reduced revenues.

Interpretation

This report went beyond a polarised either-or approach to GM crops and, for the first time, attempted to estimate how much of production would optimally be GM. Using this optimal uptake, the research estimated potential impacts on New Zealand agriculture. Because the analysis attempted to incorporate reactions to GM food from all consumers, it was able to show the importance of the large number of consumers who are either indifferent to GM or who would to reject GM food.

Policy Implications

The existence of consumers indifferent to GM food, or consumers who would to reject GM food, places limits on the profitability of GM food crops. Nevertheless, at the appropriate levels of production, GM food could be sold at a premium and could increase total agricultural sector revenue. However, without limits on production or access to the technology, the sector can expect any excess profits from biotechnology to be squeezed out of the sector rapidly. The uptake rates that lead to increased total revenues are not very high, in fact. The large number of indifferent consumers and the sizeable minority who wish to refuse GM food limit the sector's ability to charge a premium for these products. Finally, increases in productivity that were not accompanied by consumer premiums would lead to reduced producer returns.

Future Research

It was judged that an important area for future research is the demand curve for different countries. It is considered commonplace in consumer research on GM food to have consumers in different countries with different reactions to GM products. The demand estimate used in this research was specific to New Zealand. The general proportions of indifferent and refusing consumers were approximately the same as in some countries, but were likely quite different from others. Given New Zealand's dependence on export markets, more precise estimates of demand for GM food in other countries would be desirable. A second important area identified for future research was the impact of different product enhancements on willingness to pay. In the research, both the product and the enhancement were varied simultaneously. It is therefore unknown whether consumers have different preferences regarding which food is modified, whether they have preferences regarding the modifications themselves, or whether there is some interactive effect between the specific food product and the enhancement.

Technology Conflicts in New Zealand Agriculture: Comparing contemporary and historical crises between publics, government, business and science

Annie Stuart and Hugh Campbell (2004)

CSAFE Research Report No. 2.

Research Objectives

The main objective was to construct a narrative of the contested history of New Zealand agriculture. This includes reviewing periods of intense conflict about agricultural technology, consideration of the degree to which GM conflict represents the culmination of two long and opposed trajectories for New Zealand agriculture, and identifying what parallels exist between the earlier crises and contemporary crisis over GM.

Method and Approach

The historical approach used interprets technology development by taking the position that technology crises are not crises about the intrinsic qualities of the technologies themselves but rather are responses to a wider social, historical, and cultural context. Accordingly, historical context can contribute significantly towards understanding contemporary conflicts.

Results

Ten points of similarity were identified across a number of contemporary and historical conflicts in New Zealand agriculture.

- Maori have, since late in the 19th century, contested pakeha approaches to land use.
- Intensification and a spirit of 'technological optimism' form one important trajectory in NZ agriculture.
- Organic agriculture has often been the visible face of opposition to intensive farming practices.
- Highly contested Royal Commissions of Enquiry have played a significant role in the eventual movement towards hegemonic status for intensive agriculture.
- New Zealand's global geo-political commitments were significant in shaping government responses to agricultural conflicts.
- State investment in agricultural science was a decisive factor in creating a hegemonic strategy for agriculture.
- Cultural celebrities like A.R.D. Fairburn played an important part in promoting an alternative vision for New Zealand.
- Science debate and science politics were not separate from cultural, political and economic forces operating through and around agriculture. There was no separation of science activity as an 'apolitical' site of action.
- Within science (and in related political discourse), narratives of technological optimism, discourses about the need to 'feed the world', and a general avoidance of discussion of risk arising from new technologies, characterised the highest hegemonic moments of intensive agriculture. This was especially the case in the years leading up to the DDT crisis and *Silent Spring*.

Industry investment and industry lobbying played an important role in moving intensification into the hegemonic position.

Interpretation

The argument in this report was that the position that conflict over GM was a 'unique challenge' mistakes the long-term character of technology conflicts in New Zealand agriculture. The technology around GM is indeed new and revolutionary, but its intended deployment in agriculture, the institutional setting of the conflict, many of the key players and parties to the dispute, and even much of the public discourse circulating during the conflict, bears a strong resemblance to the earlier agricultural conflicts

By the mid twentieth century, industrial agriculture had become successful at increasing production and assumed the title of 'conventional' agriculture. However the move to industrial agriculture was never wholly embraced and organic production was seen by some as an alternative. Both industrial and organic agriculture drew on traditional farming practice but increasingly resorted to different paradigms of science and a different understanding of the human/nature relations and ultimately diverged and came into conflict.

At no point in the narrative history was there a clear and agreed pathway for strategically shaping New Zealand agriculture. Such a consensus never existed in scientific discourse. Rather, New Zealand has faced a series of sustainability crises which have engaged the attention of the public, politicians, scientists and farmers.

While there are clearly differences between GM in 2000 and the 1940s soil crisis there are also evidently a surprising number of similarities. The general conclusion can be drawn that the GM conflict is not something entirely unique in New Zealand's agricultural history and is actually the latest manifestation of a long running conflict over the future of New Zealand agriculture. Even such a novel technology as GM, once understood in its wider institutional relationships, demonstrates the value of understanding earlier crises in New Zealand agriculture, the historical politics of agricultural science and the broader engagement with public concerns over new technologies in agriculture.

New Zealand and biotechnology: Attitudes, perceptions and affective reactions

Andrew Cook and John Fairweather (2005)
AERU Research Report No. 277

Research Objectives

This research had four research objectives:

- To investigate change over time in public acceptance of various examples of biotechnology.
- Investigate attitudes towards biotechnology generally and specifically towards the treatment of diabetes using cells from a pig, the GM potato and use of GM bacteria to ameliorate the detrimental effects of DDT.
- Identify and determine the role and relative importance of affective responses or feelings towards biotechnology in attitudes towards biotechnology.
- Investigate the relationship between worldviews and attitudes towards biotechnology.

Method and Approach

A national postal survey was used to gather the data in 2005. From 2,000 potential respondents there were 657 usable responses. After accounting for undelivered questionnaires the resulting response rate was 34.3 per cent.

A questionnaire was designed which included: (1) measures of the acceptability of 12 examples of biotechnology, (2) questions sets measured perceptions, beliefs and affective reactions to the treatment of diabetes using cells from a pig, the GM potato, use of GM bacteria to ameliorate the detrimental effects of DDT and biotechnology as a whole and (3) measures of elements of a worldview, including spiritual beliefs, beliefs about nature, attitude towards technology and post-materialist values. Approximately one third of the questions repeated measures taken in 2003/04 to enable investigation of change over time.

Results

The research found different levels of acceptance for 12 examples of biotechnology. Levels of acceptance ranged from 68 per cent who approved the use of genetic modification (GM) to grow a fuel source to 26 per cent for artificially raising hormone levels in farm animals. Four medical examples had similar levels of acceptance of between 44 and 52 per cent. Examples that involved GM had both high and low levels of acceptance. There was a high percentage of acceptance for its use in making a crop to use as a fuel source (68 per cent), developing a GM virus to reduce fertility in possums (58 per cent) and there was a low per cent of acceptance for a GM apple (33 per cent).

Six of the 12 examples had significantly different levels of acceptability in 2005 when compared to 2003/04. Apart from the use of bacteria in throat lozenges these examples had become more acceptable. Of those now more acceptable, four involved GM and one involved cloning.

From the more in-depth analysis of treating diabetes using pig cells, the GM potato, using a GM bacterium to clean toxins from the soil and biotechnology overall, the following results are noteworthy.

- There was particular concern that the treatment for diabetes was unnatural.
- There was little confidence that unexpected outcomes from the GM potato could be controlled and some respondents found the example unethical and some felt dread for this example.

- There was a good deal of concern over lack of compliance with rules and regulations for all examples and for biotechnology as a whole.
- Compared to the other examples more felt worry, unease and apprehension about the GM potato.
- Compared to the other examples more were fascinated or interested by the treatment for diabetes.
- The diabetes treatment was the most acceptable example.
- For each of the examples less than 14 per cent agreed they were safe.

Reactions to biotechnology and the three examples were explained well by the summary variables representing affect, risk perceptions and beliefs. Study of the relationship between worldviews and biotechnology found summary variables representing beliefs about nature and beliefs about technology were important in explaining reactions to biotechnology. Spiritual beliefs and post-materialism values were related to the reaction, but their alignment with beliefs about nature and beliefs about technology meant they did not contribute further to the explanation of reactions to biotechnology. The relationships between these items and attitude towards biotechnology were not as strong as in 2003/04.

Theoretical Implications

Reactions to biotechnology involved both affective and 'rational' risk perception and belief considerations. Further, reactions to biotechnology were linked to a worldview characterised by beliefs about nature and ideas associated with technological progress. Both sets of findings mean that attitudes towards biotechnology are resilient and resistant to change.

The use of GM had become slightly more acceptable by 2005, which was most likely a recovery from a period prior to and during the Royal Commission on Genetic Modification when there was an increased level of public concern. There was a weaker relationship between reactions to biotechnology and worldviews than previously in 2003/04, which was predicted to be a factor in a shift to more acceptance of GM. However, recent changes in acceptance of GM were judged to not necessarily signify a trend. All else being equal, acceptance may have improved slightly over time, but substantial improvement was judged very unlikely given the identified resistance to change.

Policy Implications

Overall, this report showed that in future, attitudes towards biotechnology may slowly become more positive but, nevertheless, these attitudes are resilient and resistant to significant change. There appeared to be limited scope to change public opinion. The interpretation showed that the public handling of GM issues was damaging to its proponents because this led to heightened concern. Accordingly, positive attempts to engage the public were considered likely to be unrewarding. The high level of affective response to the xenotransplantation example suggested that the public has yet to decide about this issue.

Super Salmon: The Industrialisation of Fish Farming and the Drive Towards GM Technologies in Salmon Production

Carmen McLeod, Janet Grice, Hugh Campbell and Teresa Herleth (2006)
CSAFE Discussion Paper No. 5

Research Objectives
The main objective was to use New Zealand as a case study of salmon aquaculture to explore some of the issues raised by Power's 'Lots of Fish in the Sea: Salmon aquaculture, genomics and ethics'.

Method and Approach
This discussion paper uses the case study method to review fish farming, the cultural history of salmon, and the history of salmon farming. It takes a commodity approach, showing how salmon farming is subject to the forces of the technological treadmill, including the use of GM techniques. It focuses on the New Zealand King Salmon Company.

Results
Salmon are important culturally and economically. It has been an important food in many cultures but extensive fishing has lead to declines in fish numbers. Salmon farming was established by the late 19th century and in the last few decades has become a major activity. Salmon have become a commodity in part due to its palatability, the wide contemporary range of products, its prestige and virtue as a food, and technological developments which had aided commoditisation.

There is now an industrialised, Fordist system of production with high levels of inputs and outputs with controversy over environment impacts. Problems with intensified salmon farming include: the high use of pesticides and antibiotics, waste products, the impact of escaped fish on wild fish, and the amount of low value fish needed to provide feed.

GM salmon, to modify a number of salmon attributes and make them more suited to aquaculture, have been developed internationally but not applied in New Zealand. In parallel, there is opposition to salmon farming, focused on health, economic, cultural and spiritual, and environmental concerns.

The New Zealand case study focuses on the New Zealand King Salmon Company. In 1994 it began trials with GM salmon but debate about deformed fish led to the end of the trial in 2000. While there is developing knowledge about the New Zealand public's view of GM food there is no research to date on views of eating fresh GM fish.

Interpretation
Salmon is a cultural touchstone for many people and the introduction of GM salmon raises many issues particularly because GM salmon is unusual in that it is a food compared to a pharmaceutical product.

Policy Implications
Research is needed on the New Zealand public's views about GM fish.

New Zealander Reactions to the use of Biotechnology and Nanotechnology in Medicine, Farming and Food

Andrew Cook and John Fairweather (2006)
AERU Research Report No. 287

Research Objectives

The general aim was to predict and understand public reactions to biotechnology. A primary objective was to estimate recent change over time in acceptability of examples of biotechnology. A further objective was to assess public reactions to realisable future developments in biotechnology. These developments were: using nanoparticles in gene replacement therapy, bio-pharming and using nanoparticles in the production of lamb or beef.

Method and Approach

A questionnaire was designed which included 13 examples of biotechnology of which 12 were repeated from previous surveys in 2003/04 and 2005 to enable comparison over time. To assess reactions to the three future biotechnology developments a model of reactions to biotechnology was designed based on the theory of planned behaviour. To test the model questionnaire items were generated from previous surveys of biotechnology, recent focus group research on nanotechnology and those prescribed for the model. The resulting questionnaire containing measures for the models, questions to compare change over time, five demographic measures and comprised 99 items. The questionnaire was randomly distributed in a national postal survey. From 2,000 potential respondents there were 565 usable responses. After accounting for those undelivered there was a 30 per cent response rate.

Results

Of the 13 examples there were differences for the various environmental, medical and agricultural or food examples. These results prompted the following observations:

- Genetic modification (GM) alone did not affect acceptability.
- Medical examples all had similar moderate levels of acceptability.
- Food examples had low levels of acceptability.

There was only a slight improvement in acceptability over the 12 months since the previous survey. Unlike changes between 2003/04 and 2005, only the example of a GM crop to produce car fuel had continued a trend of increased acceptability.

Of ten belief statements about the use of nanoparticles in gene replacement therapy there was the most agreement with the following:

- It would be wrong for it to be used as a form of human enhancement.
- The new technique was unnatural.
- The treatment would be preferable to a GM technique.
- It would eventually become a new tool for striving for beauty and perfection.
- People eventually becoming artificial and lose the natural qualities of being human.

Of 12 belief statements about bio-pharming there was the most agreement with the following:

- New health and safety regulations would be needed to ensure safe handling of the plants.
- There is a danger that bio-pharming plants will get mixed up with food plants.
- Bio-pharming could result in contamination of food through cross pollination with food crops.
- Bio-pharming would be unnatural.

- Bio-pharming could cause long term damage to soil ecology.

Of 13 belief statements about using nanoparticles to produce genetically modified beef or lamb that has less cholesterol causing fat there was the most agreement with the following:

- It's a worry that people may not comply with the rules or regulations that govern the processes used to make product.
- It would feel unnatural to eat this product.
- The animals used to make this product may suffer unforeseen health problems.
- This product would be unnatural.
- This development is more about making money than making better food.

For each of the three examples, beliefs and values were subsequently shown to be strongly linked to attitude towards supporting the new technology. Analysis for each example then showed that those who more positively rate associated beliefs have a more positive attitude and intend to support the new biotechnology. Those who have favourable intentions tend not to be the type of person to oppose it and believe they have the support of people, such as their family and friends, whose views are important to them. Apart from the new food example those who are the type of person to oppose these biotechnologies can be expected to hold post materialist values and for all three examples they can be expected to favour a simpler lifestyle over the use of technology to conserve resources and be against environmental sustainability using technology which would tend to be viewed as damaging to nature.

Interpretation

There has been some improvement in reactions towards biotechnology but it is also apparent that reactions have only slowly improved. Reactions are therefore likely to continue to slowly improve over time given that no adverse events occur that would produce a negative public reaction. Acceptance of biotechnology may be slowed down or held up because there are deep seated views or values that are against biotechnology. Some would likely be resistant to new commodities that seem to drain resources to satisfy consumerism. Further, there are those who see progress through technology as inevitably harming nature and the environment.

Policy Implications

New and positive information about the risks of a biotechnology could allay concerns over risks to people or the environment. Finding that benefits are real and not simply speculative should increase their importance and produce a more favourable attitude and intention.

The Influence of Perceptions of New Zealand Identity on Attitudes to Biotechnology

Lesley Hunt and John Fairweather (2006)
AERU Research Report No. 286

Research Objectives
The objective of this research was to examine possible links between national identity and response to biotechnology.

Methods and Approach
The focus group research showed that people interpreted the biotechnology examples by making reference to concepts of national identity. These results were used to craft some identity questions for use in a subsequent national survey.

Data from the 2004 national survey (N=660) were examined using factor analysis and cluster analysis to identify five clusters among the national identity variables. The clusters were characterised using other survey data and then it was predicted what the attitudes of the different groups would be to biotechnology. These predictions were tested against the survey data.

Results
There are some common elements to national identity. Over 90 per cent of the sample agreed that agriculture and the kiwi have meaning as symbols of New Zealand, and over 80 per cent agreed that sheep are also an important part of this identity. Beneath this broad agreement there were different senses of identity as shown in the clusters.

The five clusters, with a general indication of response to biotechnology, were:

Cluster 1: **The gentle dreamers** (anti biotechnology) (17%) – not into sporting competitiveness and less likely to value things for their usefulness.
Cluster 2: **The classy materialists** (pro biotechnology) (21%) - pro materialistic and pro technology.
Cluster 3: **The sceptical environmentalists** (anti biotechnology) (18%) – sceptical about clean green image and the likelihood that technology will be able to fix everything.
Cluster 4: **The accepting traditionalists** (pro biotechnology) (28%) – see good in most things, concerned about social issues such as unemployment.
Cluster 5: **The happy as they are sports enthusiasts** (pro biotechnology) (16%) – passionate about sport but do not value business success or scientific research.

The basic hypothesis was that the 'Sceptical Environmentalists' would find the most problems with biotechnology and be the least accepting, with the 'Accepting Traditionalists' having the least problems and being the most accepting. The other clusters were expected to fit somewhere in between these views. These predictions proved well founded. The 'Sceptical Environmentalists' were least accepting of environmental and medical uses of biotechnology, the 'Accepting Traditionalists' the most accepting. Other clusters did fit somewhere in between. The 'Gentle Dreamers' aligned themselves with the 'Sceptical Environmentalists' as the least accepting of agricultural uses of biotechnology, while the 'Classy Materialists' aligned themselves with the 'Accepting Traditionalists' as the most accepting. When it came to 'buying products of biotechnology, the 'Sceptical Environmentalists' were the least likely to buy and the 'Accepting Traditionalists' were the most likely to buy these products.

Survey respondents were presented with five biotechnology scenarios: repairing DDE contamination with GM bacterium, an antibacterial throat lozenge made from bacteria in saliva, bacteria in a sheep's stomach to reduce greenhouse gases, a GM potato, and the use of embryo stem cells for the treatment of Alzheimer's Disease. Responses to these generally fell in line with the summary above except the throat lozenge was least acceptable to the 'Gentle Dreamers' and the 'Accepting Traditionalists' and most acceptable to the 'Happy as they are Sports Enthusiasts'. The 'Sceptical Environmentalists' were the most likely to feel dread about the use of biotechnology, lacked confidence that unexpected outcomes could be controlled, felt that use of the biotechnologies would result in harmful outcomes and that these biotechnologies were unnatural. However, the 'Accepting Traditionalists' were not always more supportive of the biotechnologies depicted in the scenarios for these aspects.

Overall, the 'Gentle Dreamers', 'Sceptical Environmentalists' and 'Happy as they are Sports Enthusiasts' were most sceptical about the different sources of information on biotechnology, and who benefited from it, and were more concerned about biotechnology, than the 'Classy Materialists' and the 'Accepting Traditionalists'.

Other data showed that those who agreed that New Zealand was clean and green were more likely to have a positive attitude towards biotechnology than those who disagreed. On first appearance this seems to be a strange result. However, further exploration revealed that those who did not believe New Zealand was clean and green were the most questioning about biotechnology and its supposed benefits.

Overall, there was no unified view of biotechnology but different groupings in New Zealand society had varying appraisals of biotechnology.

Interpretation

Overall, there appear to be few biotechnologies that would be acceptable to all New Zealanders. There are several groups in New Zealand society with differing views about the acceptable use of different biotechnologies.

Policy Implications

Biotechnologies that take account of, incorporate or enhance some of the New Zealand identity myths and meanings may find greater acceptance in New Zealand. What technologies gain ascendance will tell what and who is important to us and what it means to be a citizen of New Zealand.

Evaluating the Social and Cultural Implications of GM Technologies in New Zealand Primary Production: A Case Study of Salmon and Other Aquaculture Applications

Janet Grice, Carmen McLeod and Hugh Campbell (2007)

CSAFE Research Report No. 3

Background

Varieties of the salmonidae family have important cultural connections in many cultures. Salmon was an important food source in traditional hunter-gatherer societies throughout northern Europe and North America. Today, commercial salmon aquaculture is a key export industry for nations such as Norway, the United Kingdom, Canada, and Chile – and to a lesser degree, New Zealand. The historical changes that have seen salmon change from primarily being a hunted to a farmed resource exemplifies the development of an industrialised food system and the industrial relationship that Western consumers have with their food.

Modern salmon aquaculture systems are 'Fordist' in nature: they require high inputs and production techniques and operate as highly mechanised assembly lines producing standardised products. The ownership of these farms is often under the control of agribusiness corporations (as is the case in New Zealand). There is currently a great deal of controversy about the environmental impacts of intensive salmon aquaculture.

In the past two decades, laboratory experiments have successfully genetically modified (GM) salmon to grow much faster providing an even more efficient method of producing plentiful, cheaper fish. But this new technology has yet to be approved anywhere for commercial aquaculture production despite predictions in 2000 that GM salmon would soon be commercially available and widely distributed.

In the wake of these experiments there has been opposition in some countries to the commercialisation of GM salmon and moves to have this fish banned. Those opposing the GM salmon include environmental and consumer groups, but also some commercial salmon farm producers as well.

Method and Results

A case study from New Zealand illustrates some of the difficulties related to the production of GM salmon for food. The New Zealand King Salmon Company began trials of GM salmon in 1994, but this research was abandoned in 2000 – probably because of negative public opinion about these experiments, but the tightening of government controls cannot be completely disregarded. There is currently no evidence that GM salmon will be commercially developed in this country in the near future.

Quantitative research in New Zealand in 2006 showed that only 30 per cent of New Zealanders found the genetic modification of salmon to produce more omega 3 oils acceptable. Statistically significant differences were found for only two variables – age and gender. On balance, men were more supportive of the application than women ($\alpha = 0.01$) and older people were more supportive than younger people ($\alpha = 0.05$). Qualitative research conducted to explain this result showed that participants were not concerned about the technology, *per se*. Instead they questioned the need to use the technology, arguing that a more holistic approach to agriculture and food consumption would achieve better results.

Participants were ambivalent about whether they would eat the resultant salmon. A common response was that while they may eat it, they would not feed it to their children. In addition, it appears from the data that genetic engineering – particularly of food – has become a symbol of economic and cultural inequities. These arguments have nothing to do with health or environmental safety or even the science behind genetic engineering.

Interviews with salmon and abalone farmers showed that they were reluctant to move to genetically modified animals as they were aiming their products at what they considered to be an elite, discerning market that would not accept GM foods. This was their main reason for not moving to GM animals rather than having a personal opposition to GM. On the issue of GM feeds, there were no such concerns. They would be willing to use them if they provided an advantage. This did, however, have to be weighed against (economic) advantages of possible organic status.

Conclusion

The New Zealand public does not, at present, appear to be willing to embrace genetically modified food products. The acceptance of the actual technology, however, means that this may alter in the future if the ecological concerns, as well as the economic and cultural inequities commented on by participants can be addressed.

RESEARCH REPORTS

276 Management of Himalayan Tahr in New Zealand. High Country Farmer Perspectives and Implications.
Hughey, Kenneth F.D. and Wason, Karen M. 2005

277 New Zealanders and Biotechnology: Attitudes, Perceptions and Affective Reactions
Cook, Andrew and Fairweather, J.R. 2005

278 Characteristics of Smallholdings in New Zealand: Results from a Nationwide Survey
Cook, Andrew and Fairweather, J.R. 2005

279 The Economic contribution of Four Biotechnologies to New Zealand's Primary Sector
Kaye-Blake, William, Saunders, Caroline, Emanuelsson, Martin, Dalziel, Paul, and Wreford, Anita 2005

280 Smallholding in the Selwyn District
Cook, Andrew J. and Fairweather, J.R. 2005

281 Nanotechnology – ethical and social issues: Results from New Zealand Focus Groups
Cook, Andrew and Fairweather, John R. 2006

282 The Economic Benefits of the Possum Control Area Programme
Greer, Glen 2006

283 Maramataka: the Maori Moon Calendar
Roberts, Mere, Frank, Wero, and Clarke, Liliana 2006

284 Agricultural Sector Adjustment Following Removal of Government Subsidies in New Zealand
Gouin, Daniel-M 2006

285 Food Miles – Comparative Energy/Emissions Performance of New Zealand's Agriculture Industry
Saunders, Caroline, Barber, Andrew, and Taylor, Greg 2006

286 The Influence of Perceptions of New Zealand Identity on Attitudes to Biotechnology
Hunt, Lesley and Fairweather, John 2006

287 New Zealander Reactions to the use of Biotechnology and Nanotechnology in Medicine, Farming and Food
Cook, Andrew and Fairweather, John 2006

288 Forecast of Skills Demand in the High Tech Sector in Canterbury: Phase Two
Dalziel, Paul, Saunders, Caroline and Zellman, Eva 2006

289 Nanotechnology – Ethical and Social Issues: Results from a New Zealand Survey
Cook, Andrew and Fairweather, John 2006

290 Single Farm Payment in the European Union and its Implications on New Zealand Dairy and Beef Trade
Kogler, Klaus 2006

291 Organic Certification Systems and Farmers' Livelihoods in New Zealand
Herberg, L.A. 2007

292 Operations at Risk: 2006 Findings from a Survey of Enterprise Risk in Australia and New Zealand
Smallman, Clive 2007

293 Growing Organically? Human Networks and the Quest to Expand Organic Agriculture in New Zealand
Reider, Rebecca 2007

294 EU Positions in WTO Impact on the EU, New Zealand and Australian Livestock Sectors
Santiago Albuquerque, J.D. and Saunders, C.S. 2007

DISCUSSION PAPERS

145 Papers Presented at the 4th Annual Conference of the NZ Agricultural Economics Society. Blenheim 1997

146 Papers Presented at the 5th Annual Conference of the NZ Agricultural Economics Society. Blenheim 1998

147 Papers Presented at the 6th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2000

148 Papers Presented at the 7th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2001

149 Papers Presented at the 8th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2002

150 Papers Presented at the 9th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2003

151 Papers Presented at the 10th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2004

152 Papers Presented at the 11th Annual Conference of the NZ Agricultural Economics Society. Blenheim 2005