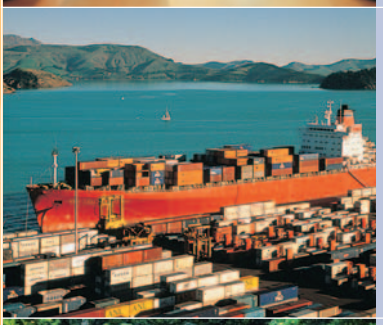
New Zealander Reactions to the use of Biotechnology and Nanotechnology in Medicine, Farming and Food

Andrew Cook
John Fairweather

Research Report No. 287
October 2006



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; business and sustainability, 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

A summary of AERU Research Reports, beginning with #235, are available at the AERU website www.lincoln.ac.nz/aeru

Printed copies of AERU Research Reports are available from the Secretary.

New Zealanders and Biotechnology: Reactions to Novel Developments in Medicine, Farming and Food

Andrew Cook
John Fairweather

October 2006

Research Report No. 287

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

Ph: (64) (3) 325 2811
Fax: (64) (3) 325 3679
www.lincoln.ac.nz/aeru

ISSN 1170-7682
ISBN 0-909042-73-X

Contents

LIST OF TABLES ..... **I**

LIST OF FIGURES ..... **I**

PREFACE ..... **III**

ACKNOWLEDGEMENTS ..... **V**

SUMMARY ..... **VII**

CHAPTER 1 INTRODUCTION **1**

1.1 Introduction 1
1.2 Biotechnology, nanotechnology and nanobiotechnology 1
1.3 The fate of biotechnology 2
1.4 Public reactions to nanotechnology 4
1.5 Aims and objectives 5
1.6 Report structure 5
2.1 Introduction 7
2.2 The theory of planned behaviour 7
2.3 Self identity and planned behaviour 8
2.4 Planned behaviour and biotechnology 9
2.5 A model for biotechnology 10

CHAPTER 3 SURVEY DESIGN **13**

3.1 Introduction 13
3.2 The questionnaire 13
3.2.1 Acceptability of biotechnology items 13
3.2.2 Models of examples of biotechnology 13
3.2.3 Other general attitudes and values 14
3.2.4 Demographic information 15
3.3 Pre-testing 15
3.4 Survey distribution 15
3.5 Response rate 15
3.6 Representativeness of the sample 16

CHAPTER 4 RESULTS **19**

4.1 Introduction 19
4.2 Statistical methods 19
4.3 Acceptability of examples 19
4.4 New medical technology 20
4.5 Bio-pharming 23
4.6 New beef or lamb 26
4.7 Post materialism, technology and nature 29
4.8 Values and the biotechnology examples 31
4.8.1 Values and new medical technology 31
4.8.2 Values and bio-pharming 32
4.8.3 Values and new beef or lamb 33
4.9 Demographics and intention 34

CHAPTER 5 DISCUSSION AND CONCLUSION....39

5.1 Introduction....39
5.2 Representativeness....39
5.3 Acceptability of examples and change over time. 39
5.4 New medical technology....40
5.5 Bio-pharming 42
5.6 New beef or lamb....43
5.7 Implications....45
5.8 Conclusion 46

REFERENCES....47

APPENDIX....51

List of Tables

Table 1: The 2006 sample compared to census data and the 2005 survey 17
Table 2: Acceptability of biotechnology examples 20
Table 3: New medical technology – beliefs 21
Table 4: New medical technology - TPB components 22
Table 5: Correlations between variables – new medical technology 22
Table 6: Regression on intention – new medical technology 23
Table 7: Bio-pharming – beliefs 24
Table 8: Bio-pharming - TPB components 25
Table 9: Correlations between TPB components - bio-pharming 25
Table 10: Regression on intention – bio-pharming 26
Table 11: New beef or lamb – beliefs 27
Table 12: New beef or lamb - TPB components 28
Table 13: Correlations between TPB components – new beef or lamb 28
Table 14: Regression on intention – new beef or lamb 29
Table 15: Level of agreement with post materialist values 29
Table 16: Level of agreement with technology and resource use statements 30
Table 17: Level of agreement with technology and nature statements 31
Table 18: Summary variables 31
Table 19: Correlations between values and self identity – new medical technology 32
Table 20: Regression of values on self identity – new medical technology 32
Table 21: Correlations between values and self identity – bio-pharming 33
Table 22: Regression of values on self identity – bio-pharming 33
Table 23: Correlations between values and self identity – new beef or lamb 33
Table 24: Regression of values on self identity – new beef or lamb 34
Table 25: Demographic variables and intention to support new medical example 35
Table 26: Demographic variables and intention to support bio-pharming 36
Table 27: Demographic variables and intention to buy new beef or lamb 37

List of Figures

Figure 1: The theory of planned behaviour (Ajzen, 1991:182) 8
Figure 2: Model of biotechnology intention 11

Preface

This research report is part of a series that has examined the perceptions and attitudes of the New Zealand public towards biotechnology. The focus of this report is on change in acceptability over time and the investigation of reactions to possible new developments in biotechnology. Given the potential for nanotechnology to enhance biotechnology this research provides a useful view of the near future through an assessment of public reactions to this new technology. The findings are of general interest but should be particularly important to people who have a professional interest in the topic area.

Professor Caroline Saunders
Director
AERU

Acknowledgements

We acknowledge the assistance of those who took the time to complete the questionnaire.

This research was funded by the Foundation for Science and Technology (CINX0204).

Summary

Research aim and 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

- 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.

Representativeness

- As is common for survey research the sample over represented older age groups as well as those with higher incomes and education, though there was no evidence of difference based on gender.

Main 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 a lack of change 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 were subsequently shown to be strongly linked to attitude towards supporting the new treatment.
- 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.

Implications

- 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 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.
- New and positive information about the risks of a biotechnology could improve 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.

Chapter 1
Introduction

1.1 Introduction

Biotechnology is now both a new and old technology. It involves the science of using life forms in the process of making new or improved products and processes. Biotechnology has been an emerging technology since the development of techniques in the 1970s to transfer genetic material from one living thing to another. Biotechnology also has a history that some commentators extend far back in time to the fermenting of yeast for food and drink. Nevertheless, in modern form it is a technology that involves the application of highly specialised scientific techniques and processes. In consequence, to the general public the products and processes of biotechnology may be unwelcome because the technology can seen unfamiliar and unusual, or even strange and threatening. On the other hand, the general public may welcome biotechnologies. Such reactions are the subject of the research presented in this report.

To continue our programme of research this report offers an insight into public reactions to possible developments in biotechnology in the near future. Overseas, traditional farm crops have been modified for the production of chemicals for the pharmaceutical industry, although, as yet, there are few examples of the commercial use of this form of biotechnology. However, there have been a large number of commercially orientated experimental trials conducted on farm land in the US. While regulatory hurdles may yet constrain further development in the US, the level of development and commercial interest may well result in farming for the pharmaceutical industry, commonly termed 'biopharming', becoming a viable option for farmers overseas and possibly in New Zealand. Another possible near future development is the use of nanobiotechnology which is the combination of nanotechnology and biotechnology. Nanotechnology is a very new technology that involves the manipulation of extremely tiny particles or molecules. This new technology, based principally on physics and chemistry, is expected to offer new possibilities for scientific discovery and produce a new wave of novel technologies. For biotechnology, the adding of new techniques and processes of nanotechnology means it can be expected to achieve more than it could do on its own.

The remainder of this introduction comprises an introduction to biotechnology, nanotechnology and bionanotechnology. This is followed by a summary of recent understandings gained during our programme of research on public reactions to biotechnology. The aims and objectives are then presented followed by a summary of the remaining chapters.

1.2 Biotechnology, nanotechnology and nanobiotechnology

Biotechnology is a technology based on biology that involves the manipulation of organisms to do practical things and to provide useful products. It includes a wide range of agricultural, industrial and medical technologies that make use of living organisms such as microbes, plants or animals, or parts of living organisms such as cells or proteins. Biotechnology is often associated with the alteration of genetic material found in microbes, plants and animals but also encompasses, for example, traditional plant breeding and wine making.

Nanotechnology is a very new technology that is based on the development of useful products and processes from science and engineering at an extremely small scale. The term 'nano' is derived from the nanometre which is a measurement of a millionth of a millimetre or about one eighty thousandth the width of a human hair. The new technology involves the scientific study of extremely tiny molecules, compounds or particles so that new ways can be found to use these to make new or improved products and processes. Nanotechnology has involved the development of new materials with some being stronger, lighter, or good conductors of heat or electricity, because of the way their molecules and atoms are assembled. Carbon nanotubes, for example, are made from carbon atoms and have strength characteristics similar to diamonds and, like graphite, are good conductors of electricity. This shows that by controlling the way in which tiny structures are formed, it is possible to design and develop new materials with specified properties.

The use of both biotechnology and nanotechnology is referred to as nanobiotechnology. Nanobiotechnology is an emerging field that is not necessarily as yet well defined. The field in general involves the use or manipulation of non living things and living things at the nano-scale. Nanobiotechnology can therefore be used in areas where living things or their parts are altered, for example, for medical treatment or food production. An example of nanobiotechnology is the use of an extremely tiny particle or filament to penetrate the wall of a living cell. Other recent examples from the Journal of Nanobiotechnology (www.jnanobiotechnology.com, accessed March 2, 2006) include the use of nanoparticles in the human body for identifying tumours, for imaging cancer cells and to enable the high resolution imaging of human sperm. An example of nanobiotechnology in food production is the use of nanotechnology tools and techniques to enable rearrangement of genetic material in rice (ETC, 2004a). Another example is the use of nanotechnology in drinks to change flavour or colour (ETC, 2004b). Other developments from nanotechnology are improved shelf life and improvements are planned for the texture of some foods.

1.3 The fate of biotechnology

In New Zealand there have been a number of different surveys conducted at different times that have had the aim of studying reactions to biotechnology or an example of biotechnology. Each survey, whether an opinion poll or analytical study, has to some lesser or greater extent contributed to knowledge of New Zealand public reactions. Surveys of relevance to our programme have been reviewed in previous reports (see Cook, Fairweather, Satterfield, & Hunt, 2004 and Cook & Fairweather, 2005a). To avoid repetition, further review is not provided in this report. We have previously noted a range of methods that have been used and that this work has concentrated on various facets of reactions towards biotechnology. The projects within our programme have examined talk about biotechnology, Maori viewpoints, consumer reactions, effects on trade, New Zealand values, affective responses and change in reactions over time. To compliment these projects this, our sixth project output, was principally concerned with continuing our programme by investigating near future developments in biotechnology and with providing a detailed prospective assessment of public reactions.

The general aim of the programme conducted over the last four years has been to provide an understanding of New Zealand public reactions to biotechnology. This has been achieved by using qualitative and then quantitative methods of enquiry, while sequentially investigating important aspects of public reactions.

The Fate of Biotechnology research programme began with national focus group research (N = 115, 11 focus groups) which was an extensive and detailed gathering of the views and thoughts of New Zealanders. The extent of the results was such that two separate analyses were performed which resulted in two reports. The first by Coyle, Maslin, Fairweather and Hunt (2003) utilised the transcribed talk of the focus groups to explore attitudes and values about medical, agricultural and environmental biotechnologies. This served to find discussion of the role of nature, New Zealand's 'clean green image' and spirituality to be important to the group participants. It was shown that the general values of New Zealanders regarding the environment and nature were considered relevant when discussing the new technology. Nature was particularly salient to the participants and was discussed in terms of it being dynamic as well as fragile.

The second report (Hunt, Fairweather & Coyle, 2003) further analysed the transcribed focus group discussions. This research centred on discussion of the risks and benefits of five biotechnology examples that were presented to the focus group participants. The examples were: treatment of sheep to reduce methane emissions; a bacteria based throat lozenge; a GM potato; stem cell research and a GM bacterium for contaminated soil remediation. Perceived naturalness was a common point of concern for the groups as well as the general issue of where people fit in the natural world. Challenges to personal ethics were also prevalent and it was generally felt that the degree of personal experience also affected considerations of risk and benefit. Whether particular examples affected adversely many or few people was also a common consideration.

Next, Cook, Fairweather, Satterfield and Hunt (2004) conducted a national survey of public perceptions to biotechnology (N = 701). The survey design incorporated key results from the focus group research. First, one planned comparison found that biotechnology was a public concern but was less of a concern than a number of other public issues. Nevertheless, over half 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 and biotechnologies that involved genetic modification were less acceptable. Those with a positive attitude were found to believe that the New Zealand public would benefit from biotechnology while giving less emphasis to the prospect of benefits to private companies. There was also concern about compliance with rules or regulations and the potential of the technology to create unforeseen problems. Similarly, it was found that nature was considered to have the inherent capacity to react to interference by producing negative consequences. Concerns about genetic modification included concerns about the cross contamination of seeds and possible negative impacts on exports and aligned to this were the beliefs that it is wrong to eat genetically modified food and wrong to mix plant and animal material.

Further work undertaken under the programme has included a study of South Island Maori perceptions of biotechnology. Roberts and Fairweather (2004) reported on focus group work conducted in the South Island that involved 91 individuals. This research project revealed findings similar to those highlighted by Coyle, Maslin, Fairweather and Hunt (2003) regarding risk perceptions and feelings of unnaturalness. However, these findings were supplemented with many rich insights from the Maori participants, as was evident in reports of group discussions on the effects of biotechnology on whakapapa, wairui and mauri.

Another important output was a study of the expected impact on New Zealand of trading in GM food. (Kaye-Blake, Saunders & Fairweather, 2004). This report presented trade projections and was based on willingness to pay data generated in a section of the Cook, Fairweather, Satterfield and Hunt (2004) questionnaire. Interpretation of the modelling of

trade impacts showed that New Zealand could increase trade revenue by four to six per cent through the production of GM food. This would be conditional on limiting the supply of quality enhanced GM products because estimated consumer purchasing was shown to favour niche products of higher price.

The research continued with a second national survey of New Zealander reactions (Cook & Fairweather, 2005a; N = 657). This continued the line of research regarding the relationship between values towards nature and the environment and biotechnology. In addition to building upon the 2004 study, this research project incorporated a new line of enquiry that was drawing interest, and fresh empirical work, internationally. This interest centred on explaining the role that affect or emotion had in reactions to a risk or hazard. Subsequently the national survey incorporated an enquiry into the role that emotional reactions played in acceptance or rejection of biotechnology.

This second national survey also had the objective of determining the amount of change over time in attitudes towards biotechnology. The estimation of change over time was based on a comparison with the previous national survey. The main findings were that public reactions to biotechnology involved both affective and rational considerations. It was also found that beliefs about the protection of nature were correspondent with a tendency to reject biotechnology. These two main findings were important because, together with evidence of a small positive shift in public attitude, the findings showed why most New Zealanders have not changed their minds about biotechnology. This was because it was shown that links to values regarding nature, and strong feelings about biotechnology, served to strengthen attitudes towards biotechnology.

1.4 Public reactions to nanotechnology

Unlike research on public reactions to biotechnology there have been few survey based studies of public reactions towards nanotechnology. In 2001 a US internet based survey was conducted which found most respondents were very positive about the new technology (Bainbridge, 2002). A US national phone survey (N = 1,536) found also reactions to nanotechnology were positive and linked these to a positive view of science (Cobb & Macoubrie, 2004). In the UK focus groups (50 participants) and an interview survey (N = 1005) by BMRB (2004) have been conducted. In the focus groups positive interest was found particularly for new medical treatments from nanotechnology, but there also was concern over impacts that the technology could have on employment, social freedom and personal control. Also, long term unintended effects were of concern.

In New Zealand relatively intensive focus group work has been completed which involved four groups each meeting three times to discuss various aspects and examples of nanotechnology (Cook & Fairweather, 2005b). Amongst other important points these groups were concerned about biased information and as well as conflicting public information about new technologies. There was evidence that personal cost was weighed up against social benefit. The possibility of medical advances from nanotechnology was praised but there was caution over possible unknown harmful outcomes. Nano-particles in food to add flavour were considered unusual and it was thought that consumers may not buy the products. In addition, the possibility of harmful consequences to the human body and the environment were raised in response to this example.

1.5 Aims and objectives

The general aims of this project were to predict and understand public reactions to biotechnology. The project therefore draws together a number of the key findings and methods from within the programme, with the general aim of providing a comprehensive assessment of public responses to realisable future developments. These developments are specifically public reactions to (1) using nanoparticles in gene therapy, (2) crop bio-pharming and (3) using nanoparticles in the production of a common food product.

1.6 Report structure

The following is a brief overview of the remaining chapters of this report.

Chapter two is a review and evaluation of current research on psychological modelling. This review is then supplemented by the findings from the research programme. A conceptual model is developed. The chapter concludes with a graphic presentation of the model.

Chapter three details the construction of a quantitative survey to determine public reactions immediate influences on these reactions and their economic impacts.

Chapter four presents the survey results and their analysis.

Chapter five is the concluding chapter which begins with a discussion of the survey findings and closes with general implications and conclusions.

Chapter 2
Investigating Personal Reactions

2.1 Introduction

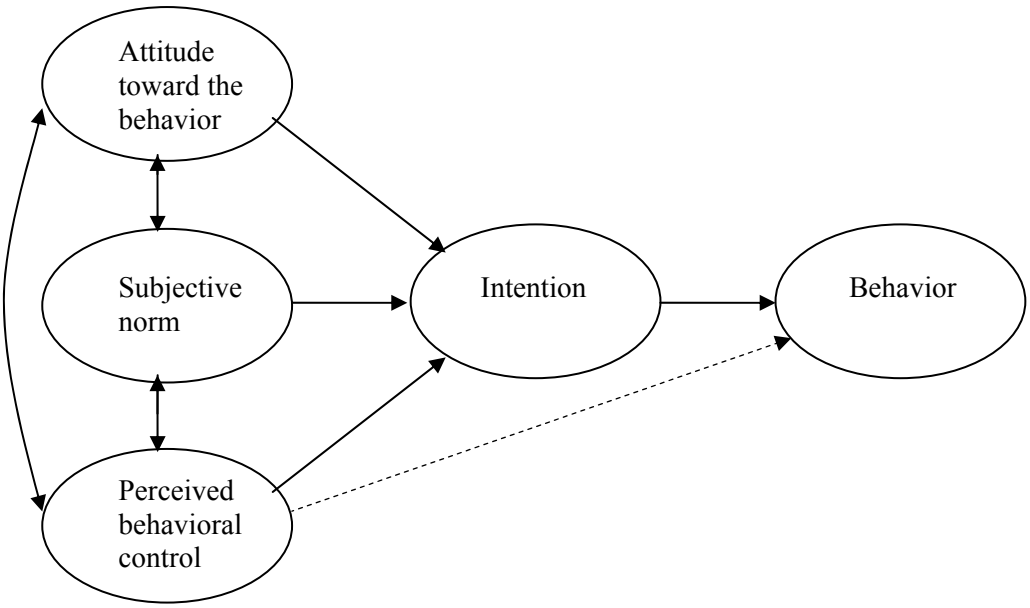
For this investigation a model was used to assist in structuring public reactions. In the various projects within our programme, general views and values, perceptions and beliefs have been identified as important in personal reactions to biotechnology. These findings indicate that personal reactions are shaped by general views of society, nature and the environment and suggest that these personally held factors result in particular public choices. To enable these various factors to be drawn together for an understanding of public reactions the theory of planned behaviour (TPB) (Ajzen 1991), a long standing and parsimonious model of the motivations for personal behaviour, was used to structure this investigation.

The remainder of this chapter provides an explanation of the TPB and explains further the incorporation of the factors of particular interest in explaining reactions to biotechnology. To begin, an explanation of the TPB is provided and it is shown that it is not uncommon for additional factors to be added to the TPB for the purpose of more fully explaining personal reasons or motivations. The chapter therefore culminates with a diagrammatic representation of the revised model for the purpose of representing various important determinant factors in reactions to biotechnology.

2.2 The theory of planned behaviour

The TPB is a model of the relationship between attitudes towards undertaking a behaviour and the act of undertaking a behaviour. As illustrated in Figure 1, attitudes are posed as a determinant of behaviour through their effect on a person's intentions to undertake a particular behaviour. Intentions are also shown to be subject to motivations to comply with pressure from people whose opinion is important to the individual. These perceived social pressures form the subjective norm. A central concept is that attitudes are formed from beliefs regarding the consequences for the individual of performing a particular behaviour. Attitude is held to be subject to pressure from the subjective norm indicating that one should conform to the views of one's peers. Attitude, subjective norm and perceived control are considered to wholly form an intention to perform a behaviour, which is expected to be highly correspondent with the actual performance of a behaviour. Personal control, also termed perceived behavioural control, is a third important influence on intentions which is a measure of a person's perceived ability to perform a behaviour. This measure of perceived ability is intended to incorporate a person's consideration of resources and opportunities that are recognised as conditional for the performance of some behaviours.

Figure 1: The theory of planned behaviour (Ajzen, 1991:182)



The TPB has been applied to the study of a wide variety of behaviours. Ajzen (1991) reviewed a range of these including: voting, playing a video game, losing weight, shop lifting and cheating in an exam. Examples of more recent studies include: the purchase of organic food (Sparks & Shepherd, 1992), newspaper recycling (Boldero, 1995; Cheung, Chan & Wong, 1999) and home composting (Taylor & Todd, 1995). The extent to which the TPB has been used is evident in a number of reviews (Ajzen 1991; Randall & Wolff, 1994; Conner & Armitage, 1998; Armitage & Conner, 2001). In addition, while the TPB has in my cases been found to be useful for explaining intention and behaviour, there have been arguments that the explanation it provides is limited because for some behaviours other factors are likely to be involved (Eagly & Chaiken 1993). In consequence additional variables have been added as further explanations of intention. Examples include self identity, past behaviour, personal morals and self efficacy (Conner & Armitage, 1998)

2.3 Self identity and planned behaviour

Self identity has been a useful addition to the TPB because it has been shown that the self identity can further explain intention. Self-identity can be understood as a label that people use to describe themselves and is generally taken as evident from the personal use of self-referential propositions. Such propositions in simple form can be, for example, 'I am an environmentalist' or 'I am car enthusiast'. Use of such statements suggests identification with a particular identifiable social group or category. In this form self identity can be considered an aspect of self that is derived from, and is a reflection of the view and viewpoints of a social group. As originally proposed by Mead (1934), it is assumed that the self takes on the views and viewpoint of a group through social interaction and the group views and viewpoints are requisitely sustained. Self identity is then also a social identity but because this research was concerned with the individual the former term is the more appropriate term. Self identity is therefore the product of social interaction and more importantly it can be argued that it is the cause of subsequent behaviour (Biddle, Bank, & Slavings, 1987). It has been shown that self identity involves adherence to a social role whereby the individual is

assumed to take on the role of the 'environmentalist', for example. However, this suggests more than simply evidence of an acquired tendency to associate an action with a social view or view point. A social role is ideally identified by a requisite action or set of actions and suggests the individual attempts to match an action to the prescription set by the role. Adherence to a view or viewpoint is less rigid. It is in this manner it is proposed to show whether New Zealander views of nature and post materialism are part of a self identity that relates to examples of biotechnology.

In broader review, self identity became common in explanations of intention in the late 1980s. Charng, Piliavin and Callero (1988), for example, found that an independent measure of self-identity improved predictions of intentions and behaviour in a study of blood donation. Biddle et al. (1987) found that students' intentions to remain at college were influenced by their self-identity. Granberg and Holmberg (1990) found that intentions to vote were subject to the effects of self-identity. Further empirical work on food choice has found a significant effect, independent of TPB components, of self-identity on intention, alongside TPB components. While sceptical of the addition of self-identity, Sparks and Shepherd (1992) nevertheless found support for a measure of a 'green consumer' as an addition to the TPB. Subsequently measures of degrees of health consciousness have been found to be significant independent variables for food choice for a number of TPB studies (Sparks & Guthrie, 1998). Sparks, Shepherd and Frewer (1995) also tested self-identity in a variation of the TPB and found that self-identity made a small independent contribution to explaining differences in expectations to consume genetically modified food. In addition, Sparks and Guthrie (1998) showed that self-identity has also been found to be a useful addition to the TPB in studies of exercise behaviour and household recycling.

2.4 Planned behaviour and biotechnology

In New Zealand in projects undertaken before this research programme the TPB has been shown to be useful for explaining New Zealand public and farmer reactions to the biotechnology of genetic modification (see Cook, Kerr & Moore, 2002; Cook & Fairweather, 2004). Cook, Moore and Kerr (2002) reported on research conducted in 1999 on public attitudes and intentions to purchase GM food. The research used three focus groups (26 participants overall) for the development of a postal questionnaire. The focus group discussions centred on beliefs about the outcomes of using the technology in food production, including risks to the environment, harm to public health and improvements in food quality. The postal survey solicited 266 usable responses. Of the 266, 60 per cent intended not to purchase, ten per cent intended to purchase and ten per cent had no intention to either purchase or not purchase. Beliefs about the outcomes of purchasing, sense of self-identity, personal control over purchasing and the views of family and friends were identified as proximal determinants of intentions to purchase. Relationships were also identified between model components and gender and age. Key implications were that change in purchase intentions would come most readily through a change in attitude, by revision of a range of beliefs about the social and personal consequences of GM food which included beliefs about personal and social risk. Self identity was also found to have a strong relationship with intention. Unlike the prospect of change in beliefs about GM food, self identity is less likely to change. However, it was concluded that self identity could nevertheless change if perceptions of GM food were to change. This was identified as possible if, for example, GM food was considered to be more like other food types.

Cook and Fairweather (2002) reported on surveys of farmers and grower intentions to use genetechnology and purchase GM food which had a basis in the earlier research reported by

Cook, Kerr and Moore (2002). Their first farmer survey was undertaken in 2000 (N = 656) and a second follow up survey was undertaken in 2002 (N = 115) which surveyed for a second time the attitudes of farmers who had replied in 2000. By design this second survey of earlier respondents sought to show more clearly differences over time than would a second survey of other farmers. The main findings of Cook and Fairweather (2002) were that beliefs, attitudes and intentions were invariant or stable over time and that beliefs about the consequences of using genetechnology were important in farmer attitudes and subsequent intentions to use or not use gene technology on their farms. Importantly this work showed that farmers needed convincing that the risks of adoption are acceptable, that the food products were marketable and that improved financial returns would be forthcoming before they would change their views.

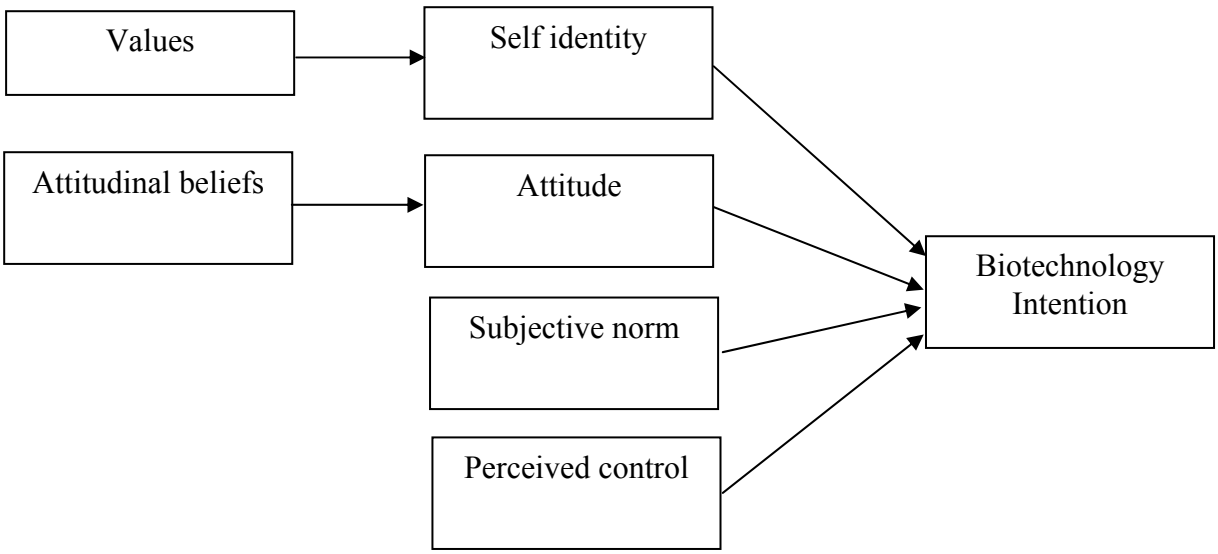
The New Zealand studies have also contributed to the numbers of TPB studies of biotechnology undertaken overseas. For example, Sparks, Shepherd and Frewer (1995) used the model to explain intentions to eat and purchase GM food. Bredahll (2001) used the TPB to explain intentions towards purchasing the GM food products of yoghurt and beer in Europe. Similarly Saba and Vassallo (2002) used the main components of the TPB to explain reactions to the use of GM in tomato production. Most recently, Spence and Townsend (2006) used the TPB to assist in examining consumer behaviour toward GM food in Britain.

2.5 A model for biotechnology

Drawing principally from results of the empirical work undertaken in the previous projects of our research programme and results of TPB work on aspects of biotechnology, a model was proposed to structure enquiry into intentional behaviours associated with biotechnology. The model is shown in Figure 2. The TPB is shown to be the basis for the model with attitude, subjective norm and perceived control proposed to function as they would in the TPB. Beliefs are held to influence attitude which in this case follows the method used by Bredahll (2001) There is also an additional variable with self identity posed as a further determinant of intention. A further variable is also proposed with social values shown as a determinant of self-identity. This measure of social identity is held to represent values regarding nature, materialism and technology which were shown to have been important in reactions to biotechnology first in focus groups (Coyle, Maslin, Fairweather & Hunt, 2003) and subsequently in survey results (Cook, Fairweather, Satterfield, & Hunt, 2004; Cook & Fairweather, 2005a). Specifically, in the 2004 research project, attitude towards nature, the need for people to have a stewardship over the environment, post materialism, optimism about technology and spiritual, but not necessarily religious, beliefs were shown to jointly explain a good deal of public reactions towards biotechnology. Similarly, the results 2005 research project showed conceptions of nature and technology were important influences on reactions to biotechnology.

In the model shown in Figure 2, social values are linked to intention primarily through self identity. This particular sense of self-identity is held by a person who considers themselves to be in agreement or disagreement with values associated with nature, post materialism, technology and nature. In keeping with Chrang et al. (1988), self identity is held to explain the influence of social values on intention over and above positive or negative attitudes that influence behaviour. A person is considered to readily perform or not perform a behaviour because it is in keeping with his or her self identity. The nature of this self identity is assumed to be revealed in their agreement or disagreement with social values.

Figure 2: Model of biotechnology intention



Chapter 3
Survey Design

3.1 Introduction

This chapter presents and explains the questionnaire used to measure public attitudes towards biotechnology and considers the administration of the potential survey, response rate and representativeness. The questionnaire was designed to meet the aim of investigating reactions to a number of possible near future biotechnologies by modelling attitudes and intentions towards (1) supporting the use of nanoparticles in gene therapy (2) supporting the use of crop bio-pharming and (3) purchasing a common food product that involved the use of nanoparticles in its production.

3.2 The questionnaire

Questionnaire items were presented in an A5-size booklet with questions on facing pages. A copy of the questionnaire is provided in Appendix 1. A letter of introduction stating the purpose of the questionnaire, introducing the aim of the research and the topics covered in the questionnaire while also inviting voluntary participation, was included with the booklet. The questionnaire was designed to be limited to approximately 100 measurement items so that length did not deter people from completing the questionnaire. Therefore only 99 separate items formed the questionnaire. Instructions were provided on the front on the questionnaire and a general definition of biotechnology was provided, as well a general definition of nanotechnology. The use of definitions, particularly at the start of a questionnaire, can influence the answering of the questions. However, given the future orientation of the questionnaire it was considered necessary to inform respondents in this manner, otherwise it would be difficult to respond. Apart from demographic measures all measurements were taken on five-point likert type scales.

The following sections explain the question sets used in the questionnaire. The question sets are introduced in the order they were presented in the questionnaire.

3.2.1 Acceptability of biotechnology items

Thirteen examples of the applications of biotechnology were presented to respondents. The examples were designed to gauge the acceptability of a varied range of examples of biotechnology. Twelve of the examples was repeated from the biotechnology survey conducted in 2005 and were derived from examples used in 2004. The remaining example of a GM salmon was additional to these. Because twelve of the examples were identical to those used in the two previous surveys, they enabled comparisons to be made over time.

3.2.2 Models of examples of biotechnology

Next was the main part of the questionnaire which comprised three examples of biotechnology with each having three question sets. Each set had about 18 questions so that each of the three examples had a set of questions and measurements for a model of intentions regarding a biotechnology. Following each example were requisite beliefs about the example followed by measures of intention, self identity, attitude (two measures), subjective norm and

perceived control. Apart from the self identity measure which was derived from Cook, Kerr and Moore (2002), the remaining TPB measures were drawn from Ajzen's recommendations for questionnaire construction (http://people.umass.edu/aizen/pdf/tpb.measurement.pdf. The intention to purchase measure for the food example used a statement and measurement scale recommended by Conner and Sparks (1995).

The set for the new medical technology pertained to the use of nanoparticles as a vector in gene therapy. Of the ten belief statements the statements about the example being unethical, unnatural and having unforeseen harmful outcomes were measures from Slovic (2000) and had been used in the 2004 and 2005 surveys. The statement regarding whether the treatment would actually affect the respondent was derived from a set of questions from the 2005 survey that measured reactions to a medical biotechnology. The remaining five questions were derived from focus group discussions regarding the use of nanoparticles in medical treatment (Cook & Fairweather, 2005b).

The set for bio-pharming began with four belief statements derived from Slovic (2000) and had been used in the 2004 and 2005 surveys. Following these, a further seven belief statements pertaining to bio-pharming were also derived from the 2004 and 2005 surveys. Cross pollination, doing 'unexpected things' and damage to soil ecology were used in the 2004 survey and were derived from our focus group work on biotechnology. 'Money better spent on making substances in factories' was derived from the 2005 survey and was also sourced from our focus group work. Lower costs but not to the consumer was from studies of attitudes towards GM food (Cook, Kerr & Moore, 2002; Cook & Fairweather, 2002). Unlike the other statements which were derived from belief statements used previously in New Zealand surveys, the statements about new health and safety regulations and getting the products mixed up with food plants were from Jaffe (2004) on biopharming. The remaining statement about fewer protests was a new statement to enable comparison with attitudes to GM food farming. Therefore although the belief statements were not derived immediately from pilot work on the specific topic of bio-pharming, they were nevertheless grounded in surveys and focus group work from the general topic area.

The food example was the use of nanoparticles for the GM of farm animals. This example had a consumer benefit of lamb or beef with reduced cholesterol producing fat. It had two belief statements were derived from Slovic (2000), as well as the statements about the product being unethical and unnatural. The statement regarding compliance with rules and regulations and that it was 'more about making money' were used to measure reactions to a GM potato in the 2005 survey. The test of agreement regarding contaminated farm land was a more specific version of the risk perception measures. Easing pressure on health services was included in recognition of the possibility of health benefits, as was the statement regarding improvement of the health of New Zealanders. Reactions by overseas consumers was measured in 2005 and the possibility of food risk has been a common measure in reactions to GM food since the 1999 survey reported by Cook, Kerr and Moore (2002).

3.2.3 Other general attitudes and values

A set of twenty questions was used to measure general views and values that were proposed to be related to a New Zealanders sense of self identity and subsequently to the use of biotechnology.

The set began with five statements selected from the work of Inglehart (1990) designed to measure the emergence and extent of post-materialist values in society. This is a reduced set that had previously been tested against attitudes towards biotechnology in the 2005 survey.

The 2005 results, compared to the extensive work done by Inglehart (1990) in Europe, were very interesting. New Zealanders seemed to mix materialist goals for a strong economy with post materialist values for a more deliberative democracy. While of interest in the context of the New Zealand shift to mixed member proportional (MMP) proportional government, the mix likely confounded evidence of a relationship between these very general measures of materialism/post materialism and attitude towards biotechnology. Consequently to pursue further the enquiry into relations between these very general measures of a social trend and reactions to the new technology of biotechnology a reduced set of five questions was included in the questionnaire.

The next set of six statements was included to measure attitudes towards the use of technology and resource use. These were derived from Seigrist (1999), were rewritten to be more succinct and straightforward for the 2004 survey, and had been found to be useful for representing a general view of technology and society that was associated with attitudes towards biotechnology in both the 2004 and 2005 surveys.

The remaining questions in the set were designed to measure attitudes towards technology and nature. These questions were refined and developed from those used in the 2004 and 2005 survey. Originally, they were derived from our national focus group work. Developed in New Zealand with New Zealanders, the questions are formed to represent local views and values of nature and expectations of how technology reacts with this local view of nature.

3.2.4 Demographic information

Six questions gathered demographic information about the survey respondents. The questions were designed to gather data sufficient for testing for representativeness of the survey sample against New Zealand census data.

3.3 Pre-testing

A draft of the questionnaire was tested on 13 volunteers. The time for completion was approximately 30 minutes and it was generally found to be easy to complete. Only minor adjustments were made to questionnaire items before producing the questionnaire presented in this report.

3.4 Survey distribution

A total of 2,000 questionnaires were distributed to randomly selected addresses in New Zealand. The addresses were provided from a national record of listed and unlisted telephone subscribers. The questionnaire was posted with a freepost return envelope on May 9th, 2006. To encourage further responses a reminder letter was posted on May 24th and a second copy of the questionnaire was posted on June 22nd, 2006 to those who had not replied.

3.5 Response rate

Within five weeks of the second post out 565 questionnaires with usable responses were returned. In addition, 91 had been returned undelivered. Also 42 were returned either uncompleted or without a sufficient number of responses. Within these 42 questionnaires four

indicated they were too old, one had a language difficulty and two indicated they lacked sufficient understanding of the topic. The response rate for usable responses was calculated as the proportion of useable questionnaires (565) over 1909 (2000 minus 91) who had received the questionnaire. The response rate for usable questionnaires was therefore 29.6 per cent.

3.6 Representativeness of the sample

Demographic information (sex, age, income, qualification and religious beliefs) from the questionnaire was coded to enable comparison with the 2005 survey and census data from the 2001 New Zealand census. All data were limited to people over the age of 15 years. Frequencies per category and percentages per category are provided in Table 1.

As shown in Table 1 the survey results compared to the census results show that there was a similar proportion of males to females. Subsequently a test for representativeness showed no significant difference between the survey sample and the census based on gender (Chi Sq. $p < 0.05$). There were, however, more respondents in older age groups. There were also more people with higher incomes and more with higher qualifications in comparison with the census data. There were significant differences for age, income and education (Chi sq. $p > 0.05$).

Overall, the sample was not representative of the New Zealand population which can mean that the survey results do not necessarily apply with accuracy to the population. Following the 2003/04 survey a phone survey or non-respondents led to the conclusion that the results gave more representation to those who positively assessed biotechnology as well as those who negatively assessed biotechnology. This suggests that the descriptive results do not necessarily reflect with accuracy the views of the population as a whole. It is, however, known that this problem may not impact upon associations between responses to survey questions. In social research, surveys that do not accurately represent the population do not necessarily bias relationships between variables (Loon et al., 2003). In keeping with these investigations it can be expected that the 2005 results over represent those who are positive towards biotechnology, as well as those who are negative towards biotechnology. Nevertheless, it can be assumed that explanations for reactions to biotechnology apply to the population.

Table 1 also shows that in terms of responses to the demographic questions the sample was divergent from the 2005 sample (Chi sq. $p < 0.05$). Slightly more men replied in 2006, slightly fewer young people replied and more in higher income and education brackets had replied.

Table 1: The 2006 sample compared to census data and the 2005 survey

Item	Sample frequency	Sample %	2005 survey %	Population %
Gender (n = 646)				
Male	264	47.0	44.9	48.6
Female	298	53.0	55.1	51.4
Age (n = 565)				
15-24 Years	26	4.6	5.3	13.6
25-34 Years	60	10.6	12.0	14.1
35-44 Years	115	20.4	17.9	15.6
45-54 Years	104	18.4	19.3	13.1
55-64 Years	113	20.0	19.2	9.0
65-Years and Over	147	26.0	26.2	12.0
Income (n = 562)				
Less than $15000	85	15.6	19.3	40.0
$15001 to $20000	54	9.9	15.0	10.0
$20001 to $40000	168	30.8	26.4	30.3
$40001 to $60000	112	20.5	18.8	14.3
$60001 to $100000	82	15.0	13.5	2.8
$100001 and above	45	8.2	6.9	2.6
Education (n = 565)				
No qualification	84	14.9	15.0	27.0
Secondary school qualifications	124	21.9	24.0	40.1
Vocational	180	31.9	32.9	20.5
Bachelors	100	17.7	14.9	8.1
Postgraduate	74	13.1	13.2	3.7
Religion (n = 622)				
Agnostic	42	7.4	12.2	
Christian	265	46.9	43.1	
Other	2	0.4	0.1	
Spiritual - not religious	162	28.7	32.5	
Atheist	49	8.7	10.8	

Chapter 4
Results

4.1 Introduction

This chapter presents the results of the analysis of the survey data. The results begin with an explanation of the statistical methods used in this chapter. The first results are measures of the acceptability of various examples of biotechnology. These measures have been taken consecutively in three surveys over approximately three years and consequently comparisons are made over time for these results. Then each of three models of reactions towards a biotechnology example is presented. Results are then presented for measures of self identity and values. The chapter closes with tests for relationships between demographic variables and intentions.

4.2 Statistical methods

A variety of statistical methods were employed in the analysis of the survey data. Results are provided with mean and standard deviation for interval or ratio data and frequency of occurrence provided for categorical data. Apart from the demographic measures all items were measured on fully labelled five-point scales. For acceptability the range was from (1) very unacceptable to (5) very acceptable and for the remainder the range was from (1) strongly disagree to (5) strongly agree. In addition, because some respondents did not reply to every question, the number of responses to each item is included.

For the purpose of modelling, in some cases variables were formed by the summation of the responses to a number of questions that pertained to the same topic. Reliability analysis using Cronbach's alpha was performed to test the validity of this procedure. Cronbach's Alpha is commonly used in the estimation of a common factor underlying the answers to a number of questions (Chen & Kraus, 2004). Values above 0.5 are considered acceptable as evidence of a common factor (Nunnally, 1967).

Model analysis was performed using linear regression and all procedures were performed using SPSS version 12.

4.3 Acceptability of examples

The acceptability of 13 examples of biotechnology was measured starting with four environmental examples, followed by four medical examples, and then five agricultural or food examples. The examples had been selected from a range examples tested in the 2003/04 and 2005 survey with the last example of a GM salmon being a recent addition. As shown in, Table 2 the acceptability of the examples in 2006 ranged from 73.8 per cent for the use of GM to grow a crop as an environmentally friendly fuel source to 27.3 per cent who judged the raising of hormone levels in farm animals to be acceptable. Of interest, as had occurred in the 2005 survey, GM received a relatively high level of acceptance for developing a virus to reduce fertility in possums and in making stronger pine trees. All four medical examples and the example of genetic screening for sheep breeding had acceptability percentages of around 40 to 50 per cent. The use of aerial Bt sprays tended to be less acceptable than the medical

examples. Amongst the lowest percentage of acceptability was for the GM apple and for the GM salmon.

In terms of change over time there was evidence of change over time in two items. Tests indicated that genetically modifying a crop to produce a low pollution fuel for cars had become more acceptable in 2006. In addition, although dropping in acceptance in 2005 there was evidence of a rebound for using bacteria from a human being in throat lozenges to prevent serious infections to near 2004/05 acceptance levels.

Table 2: Acceptability of biotechnology examples

	N	Mean 2006	Std. Dev.	Percentage Acceptable	Mean 2005	Mean 2003/04
Genetically modifying a crop to produce a low pollution fuel for cars	564	3.81	1.195	73.8	3.59[1]	3.36[2]
Developing a virus (genetically modified) that reduces fertility in possums	564	3.34	1.328	55.5	3.38	3.34[2]
Use of aerial sprays made from soil bacterium (Bacillis thuringiensis) to control insect pests in urban areas	561	2.87	1.200	36.2	2.94	3.04
Cloning a kakapo to ensure the survival of the species	563	2.98	1.312	42.5	3.01	2.84[2]
Using bacteria from a human being in throat lozenges to prevent serious infections	563	3.34	1.164	54.0	3.17[1]	3.40[2]
Inserting human genes into a cow to produce milk for the treatment of multiple sclerosis	564	3.06	1.279	43.4	3.03	3.08
Preventing stomach cancer by modifying a person's genetic code	561	3.02	1.265	40.6	3.11	3.11
Using new cells (stem cells) from a 5 day old human embryo to treat an Alzheimer sufferer	562	3.19	1.344	48.3	3.34	3.25
Using genetic screening to breed sheep that produce twins or triplets	565	3.08	1.255	43.0	3.08	3.10
Raising hormone levels in farm animals to increase fertility	564	2.69	1.130	27.3	2.70	2.80
Genetically modifying pine trees to produce stronger timber	564	3.43	1.192	59.0	3.42	3.28[2]
Genetically modifying an apple to make it more nutritious	564	2.78	1.257	34.0	2.75	2.52[2]
Genetically modifying salmon to raise levels of omega 3 oils	563	2.69	1.188	29.5		

Note: [1] = significant difference between 2005 and 2006 and [2] = significant difference between 2003/04 and 2005 (paired samples t test, $p < 0.05$).

4.4 New medical technology

The results of the measures of beliefs about using nanotechnology in gene therapy are shown in Table 3. As shown the agreement percentage indicates that approximately one third of the respondents considered the treatment would have unforeseen harmful outcomes. Almost 40 per cent considered the treatment would be preferable to GM techniques that use a virus. Slightly fewer (34 per cent) thought the treatment unlikely to affect them personally. The highest agreement percentage was for agreement with the view that it would be wrong to use the new technique to improve abilities or enhance performance. However, fewer considered it a tool for perfection and beauty. A relatively small proportion considered that it doesn't

matter how the human body is changed because the essence of a person is in their thoughts and only about one third considered the treatment unethical. In comparison, almost twice the proportion thought it unnatural, though only less than one third considered it would feel unnatural to have nanoparticles floating around in your body. Just over one third agreed that this type of treatment that could eventually lead to people becoming artificial and losing the natural qualities of being human.

To form a single component based on the assumption that people summarise beliefs in forming an attitude the beliefs were first shown to be interrelated (Cronbach's alpha = 0.63). The beliefs were then added and averaged to form a single component (mean = 3.13, range 1.42 to 4.50, std dev 0.434, n = 541).

Table 3: New medical technology – beliefs

	N	Mean	Std. Dev.	Agreement percentage
This treatment would result in unforeseen harmful outcomes that can't be reversed	558	3.10	0.974	31.7
This treatment would be preferable to GM that uses viruses	561	3.29	0.828	39.8
The use of this treatment is unlikely to affect me personally	559	3.13	0.964	34.0
It would be wrong to use this treatment to artificially improve human abilities and performance	564	3.65	1.201	62.1
This treatment could eventually become a new tool for striving for beauty and perfection	562	3.13	1.277	43.1
It doesn't matter how the human body is changed because the essence of a person is in their thoughts	563	2.67	1.211	26.3
This treatment would be unethical	561	3.12	1.012	33.2
This treatment would be unnatural	563	3.60	0.997	60.6
It would feel unnatural to have nanoparticles floating around in your body	564	3.06	0.986	31.6
This is the type of treatment that could eventually lead to people becoming artificial and losing the natural qualities of being human	561	3.08	1.110	36.2

As shown in Table 4, in the measure of intention just over one quarter of respondents would definitely support the use of nanoparticles in gene therapy. Though not shown in the table, 35 per cent were opposed to the use of this new treatment. In the measure of self identity a slightly larger proportion indicated they would oppose the use of the treatment. For the two attitude measures almost 23 per cent thought the treatment wise but a larger proportion (27.4 per cent) thought it wrong. When aligned to have a common positive valence and added and averaged, the mean for the attitude measure was 2.93 (std dev. 0.906, range 1 to 5). Only a small proportion of respondents considered they had the support of important others (subjective norm) although most thought that whether or not they used the treatment would be entirely up to them (perceived control).

Table 4: New medical technology - TPB components

	N	Mean	Std. Dev.	Agreement percentage
In a referendum I would definitely support the use of this treatment (Intention)	561	2.73	1.073	25.5
I am the type of person who would oppose the use of this treatment (Self identity)	561	2.92	1.084	29.1
It would be wise for me to support the development and use of this treatment (Attitude)	558	2.83	.950	22.9
It would be wrong for me to support the development and use of this treatment (Attitude)	558	2.97	1.013	27.4
Most people whose views are important to me would approve of my supporting this treatment (Subjective norm)	557	2.86	0.910	20.8
Whether I support or oppose the development and use of this treatment would be entirely up to me (Perceived control)	561	4.04	0.896	79.3

Correlation values representing associations between components are shown in Table 5. As shown, values were generally high between self identity, attitude and intention. Values were not as strong with the subjective norm and the weak or non significant values with perceived control indicate little evidence of this component being related to other components.

Table 5: Correlations between variables – new medical technology

		Self identity	Attitude	Subjective norm	Perceived control
Intention	r n	-0.703** 558	0.778** 554	0.493** 554	0.024 558
Self identity	r n		-0.746** 557	-0.393** 557	-0.083* 558
Attitude	r n			.458** 557	0.040 556
Subjective norm	r n				0.037 556

Note: ** = $p < 0.01$, * = $p < 0.05$

The results of the regression analysis are shown in Table 6. The R^2 value of .66 was quite high indicating the model provided a good explanation of respondent intentions to support the use of nanoparticles in gene therapy. Significant ($p < 0.001$) independent effects were found for three of the four proposed determinants with no evidence found of an interaction between perceived control and intention. Attitude was the most important factor in terms of its relationship with intention followed by self identity and subjective norm. Attitude was also found to be related to attitudinal beliefs ($r = .62$, $p < 0.001$).

Table 6: Regression on intention – new medical technology

$R^2 = 0.66$, n = 544		
Variable	β	**Significance**
Self identity	-0.27	0.000
Attitude	0.51	0.000
Subjective norm	0.16	0.000
Perceived control	-0.02	0.348

The results therefore suggest that people summarise a number of beliefs when forming their attitude and that this attitude towards the use of nanotechnology in gene therapy has a good deal of influence on their decision to support or reject the new technology. The results also show that the type of person they take themselves to be, also termed their self identity, is also important in these decisions. There is also evidence that people's decisions are generally in keeping with the views of others who are important to them.

4.5 Bio-pharming

The results of the enquiry into beliefs about bio-pharming are shown in Table 7. As can be seen the lowest agreement percentage was for the view that money was better spent on making substances in factories. This suggested the new technique was seen as a viable alternative to industrial based processes. Nevertheless, it was recognised by almost 90 per cent that health and safety issues would need to be addressed and there was also recognition by most (78.2 per cent) that new substances in plants could do unexpected things. It was also seen by most as dangerous that the plants would become mixed with food plants and the possibility of cross pollination was also an issue. More than half of the respondents considered this biotechnology to be unnatural. In keeping with concern over the issues of contamination, less than one quarter of the respondents thought unexpected outcomes could be controlled. Almost one third considered it would be unethical and almost one third considered irreversible harmful outcomes would result and approaching 50 per cent were concerned about long term damage to soil ecology. Some were against bio-pharming because of no consumer benefits and only a small proportion considered there would be few protests over bio-pharming.

To form a single component the beliefs were first shown to be interrelated (Cronbach's alpha = 0.83). The beliefs were then added and averaged to form a single component (mean = 2.53, range 1.00 to 4.83, std dev 0.608, n = 552).

Table 7: Bio-pharming – beliefs

	N	Mean	Std. Dev.	Agreement percentage
I am confident that any unexpected outcomes from bio-pharming can be controlled	564	2.49	1.111	23.0
Bio-pharming will result in irreversible harmful outcomes	564	3.10	0.975	31.0
Bio-pharming would be unethical	563	2.98	1.031	30.4
Bio-pharming would be unnatural	563	3.44	1.056	57.4
Bio-pharming could result in contamination of food through cross pollination with food crops	563	3.67	0.935	62.9
New substances in plants could do unexpected things	564	3.90	0.766	78.2
New health and safety regulations would be needed to ensure safe handling of the plants	565	4.23	0.816	87.3
Money would be better spent on making substances in factories	562	2.78	0.857	14.8
There is a danger that bio-pharming plants will get mixed up with food plants	565	3.78	0.879	69.0
Bio-pharming could cause long term damage to soil ecology	565	3.44	0.952	46.5
Bio-pharming will result in lower costs to pharmaceutical companies but not to the consumer	563	3.47	0.885	43.9
Unlike GM food there will be few protests against bio-pharming	564	2.66	0.967	17.4

The results of the measurement of the TPB components are presented in Table 8. As shown, only 26.4 per cent would support the use of bio-pharming in a referendum. Just over 30 per cent indicated that he or she was the type of person who was opposed to bio-pharming. Worse than the intention score only 20 per cent thought it wise to support the new method. More (27.4 per cent) thought it wrong for them to do so. When aligned to have a common positive valence and added and averaged the mean for the attitude measure was 2.87 (std dev. 1.089, range 1 to 5, n = 562). Relatively few felt they had the support of others in their decision to support or reject bio-pharming, but most considered their decision would be entirely up to themselves.

Table 8: Bio-pharming - TPB components

	N	Mean	Std. Dev.	Agreement percentage
n a referendum I would definitely support bio-pharming (Intention)	565	2.78	1.089	26.4
am the type of person who would oppose bio-pharming (Self identity)	563	2.94	1.107	30.6
would be wise for me to support bio-pharming (Attitude)	563	2.74	0.975	20.2
would be wrong for me to support bio-pharming (Attitude)	562	2.99	1.011	27.4
Most people whose views are important to me would approve of my supporting bio-pharming (Subjective norm)	559	2.80	0.902	16.6
Whether I support or oppose bio-pharming would be entirely up to me (Perceived control)	561	4.09	0.862	83.8

Table 9 shows the correlation values between components. These were generally high between self identity, attitude and intention. Values were not as strong with the subjective norm and non significant values with perceived control indicate little evidence of this component being important in decisions regarding bio-pharming.

Table 9: Correlations between TPB components - bio-pharming

		Self identity	Attitude	Subjective norm	Perceived control
Intention	r n	-0.583** 563	0.749** 562	0.521** 559	0.060 561
Self identity	r n		-0.684** 562	-0.351** 558	-0.045 559
Attitude	r n			0.469** 557	0.145 556
Subjective norm	r n				0.050 555

Note: ** = $p < 0.01$, * = $p < 0.05$

The results of the regression analysis for intention to support bio-pharming are provided in Table 10. As is evident from the table, significant independent effects were found for self identity, attitude and subjective norm. As the correlation results suggest independent effects for perceived control on intention were non-significant ($p > 0.05$). Attitude is shown to have the most influence on intention, followed by subjective norm and self identity. This suggests that whether bio-pharming is seen to be wise or wrong determines most of whether one intends to support or reject the new technology. In turn there is also evidence that this attitude is strongly linked to beliefs ($r = 0.71$, $p < 0.001$).

Table 10: Regression on intention – bio-pharming

$R^2 = 0.59$, n = 548		
Variable	β	**Significance**
Self identity	-0.13	0.002
Attitude	0.57	0.000
Subjective norm	0.17	0.000
Perceived control	0.01	0.849

In summary, the results suggest that a range of beliefs about bio-pharming are important in informing personal decisions regarding bio-pharming. These 'rational' type considerations involve concerns about safety, unexpected or irreversible outcomes as well as more general concerns about ethics and naturalness as well as who stands to benefit from bio-pharming. Alongside these things, self identity and the support of others whose views are important to the individual also have a bearing on the individual's decision.

4.6 New beef or lamb

Thirteen beliefs were measured in assessing beliefs about a new technique that used nano particles to enable genetic material within a cell to be rearranged. This hypothetical example suggested that animals could subsequently be raised that would produce meat with 20 per cent less cholesterol causing fat. As can be seen in Table 11, the belief of particular concern was regarding the worry that people might not comply with rules or regulations in its development. Next in terms of level of concern was the belief that eating the meat would feel unnatural. Most also agreed that animals used to make this product may suffer unforeseen health problems and most agreed that this food example would be unnatural. Almost one half agreed that the development of this product is more about making money than making better food. In addition, nearing one half believed there was a risk that the use of modified animals will result in the contamination of farm land. On the positive side, just under one third of the respondents judged that consuming this lamb or beef would improve the health of New Zealanders and almost 30 per cent considered the product would result in an easing of pressure on health services. Almost 30 per cent judged the product will result in increased overseas demand for lamb and beef. Against the development of the new product, only about one in four respondents were confident unexpected outcomes could be controlled and a similar proportion was concerned about irreversible harmful outcomes. Of note, few were confident there would be no unexpected food risks from the new product.

To form a single component the beliefs about the new beef or lamb were first shown to be interrelated (Cronbach's alpha = 0.92). The beliefs were then added and averaged to form a single component (mean = 2.72, range 1.00 to 4.83, std dev 0.712, n = 553).

Table 11: New beef or lamb – beliefs

	N	Mean	Std. Dev.	Agreement percentage
I am confident that any unexpected outcomes from making this product can be controlled	565	2.63	1.129	26.4
Making this product will result in irreversible harmful outcomes	564	3.00	0.921	26.6
I am confident that there would be no unexpected food risks from this product	565	2.50	0.987	16.8
Consuming this product would improve the health of New Zealanders	565	2.96	0.998	30.3
This product would be unethical	564	2.96	1.027	29.6
This product would be unnatural	564	3.37	1.037	53.0
It's a worry that people may not comply with the rules or regulations that govern the processes used to make product	563	3.86	0.846	73.5
There is a risk that use of modified animals will result in contamination of farm land	565	3.27	1.012	43.4
This product will ease pressure on health services.	564	2.83	0.969	24.8
This product will result in increased overseas demand for NZ lamb and beef	563	2.86	1.060	27.0
The animals used to make this product may suffer unforeseen health problems	563	3.51	0.869	54.0
The development of this product is more about making money than making better food	562	3.36	1.028	46.6
It would feel unnatural to eat this product	562	3.14	1.076	61.2

The results for the measurement of the TPB components presented in Table 12 indicate that just over three quarters of the respondents would buy this new product. Also some contradiction is shown because 49.2 per cent indicated they were the type of person who would avoid buying this product. Nevertheless, just over 80 per cent thought it wise to buy this product and less than one third thought it wrong to buy the new product. When aligned and added and averaged the mean for the attitude measure was 2.93 (std dev. 0.906, range 1 to 5). While positive about the new product, less than 20 per cent judged they would have the approval of people whose views are important to them (subjective norm) and most felt that whether or not they bought this product would be entirely up to themselves (perceived control).

Table 12: New beef or lamb - TPB components

	N	Mean	Std. Dev.	Agreement percentage
If available I would definitely buy this product (Intention)	562	2.65	1.105	76.6
I am the type of person who would avoid buying this product (Self identity)	559	3.13	1.186	49.2
It would be wise for me to buy this product (Attitude)	560	2.66	1.020	80.4
It would be wrong for me to buy this product (Attitude)	560	2.94	1.066	27.1
Most people whose views are important to me would approve of my buying this product (Subjective norm)	558	2.78	0.894	16.5
Whether or not I buy this product would be entirely up to me (Perceived control)	562	4.17	0.797	85.6

A shown in Table 13, like the other models, the correlation values between components were generally high between self identity, attitude and intention. The values were not as strong with the subjective norm and non significant values with perceived control indicate that there was no evidence of this component being important in decisions regarding the purchase of new lamb or beef.

Table 13: Correlations between TPB components – new beef or lamb

		Self identity	Attitude	Subjective norm	Perceived control
Intention	r n	-0.694** 559	0.765** 559	0.549** 557	0.033 561
Self identity	r n		-0.725** 557	-0.498** 554	-0.048 558
Attitude	r n			0.551** 557	0.017 556
Subjective norm	r n				0.054 557

Note: ** = $p < 0.01$, * = $p < 0.05$

The results of the regression analysis on intention to purchase the new beef or lamb are shown in Table 14 and were much like the results for the new medical technology. The model had a quite high R^2 score of 0.64 and attitude can be interpreted as having the most influence on intention to buy the modified beef of lamb. Attitude was strongly linked to the sum of beliefs ($r = 0.79$, $n = 551$). Those who considered themselves the type of person who would not buy this product were against purchasing the product. Like the medical model, the subjective norm was the third most influential variable indicating the views of others were also an important influence on intention to purchase.

Table 14: Regression on intention – new beef or lamb

$R^2 = 0.64$, n = 548		
Variable	β	**Significance**
Self identity	-0.26	0.000
Attitude	0.49	0.000
Subjective norm	0.15	0.000
Perceived control	0.01	0.833

4.7 Post materialism, technology and nature

The results of the enquiry into post materialist values are shown in Table 15. Most respondents agreed that people should have more say in the decisions of government and most agreed efforts should be made to encourage a friendlier, less impersonal society. Just over 60 per cent thought more efforts should be given to making our cities and countryside more beautiful. However, despite more than 80 per cent agreeing we need to develop a society where people count more than money, almost 60 per cent thought government emphasis should be on maintaining a high rate of economic growth.

Table 15: Level of agreement with post materialist values

	N	**Mean**	**Std. Dev.**	**Agreement percentage**
People should have more say in the decisions of government	564	3.98	0.936	78.5
The priority of government should be to maintain a high rate of economic growth	565	3.52	0.994	59.8
More effort should be given to making our cities and countryside more beautiful	564	3.60	0.842	60.5
Efforts should be made to encourage a friendlier, less impersonal society	565	3.89	0.771	76.1
We need to develop a society where people count more than money	564	4.10	0.797	82.1

The results of the enquiry into technology and resource use are shown in Table 16. Just over 35 per cent of respondents agreed that technology had the best chance of eliminating poverty. Similarly, but not with the same level of agreement, it was thought that advances in technology would mean that the goals of society can be realised. Statements against technology received more agreement. Just over two thirds agreed that living a simpler lifestyle is the best way to conserve energy and just over 60 per cent agreed that wealthy nations should consume less and limit their use of resources. A smaller proportion of just over one third agreed that groups that oppose materialistic values deserve support.

Table 16: Level of agreement with technology and resource use statements

	N	Mean	Std. Dev.	Agreement percentage
A technological society has the best chance of eliminating poverty	564	3.13	0.986	37.2
Advances in technology mean that the goals of society can be realised	563	3.07	0.896	33.6
Living a simpler lifestyle is the best way to conserve energy and resources	563	3.63	0.919	67.1
Wealthy nations should consume less and limit their use of resources	565	3.66	0.925	61.4
Groups that oppose materialistic values deserve support	565	3.18	0.932	35.2

There were ten questions measuring technology and nature with the results shown in Table 17. Of note, at the bottom of the table, three quarters thought interference with nature often produces disastrous consequences and more than 80 per cent considered such consequences were unpredictable. Regarding technology, more than two out of three respondents considered it natural to improve their lives using technology, though very few (8.5 per cent) thought science and technology would lead to no need to worry about the future of the human race. Almost 40 per cent were optimistic that technology would lead to the sustainable use of the planets resources and a similar proportion judged that nature would adapt to the effects of progress. Just over 30 per cent were optimistic and agreed that in the future there will be no need to rely on finite natural resources. Rather than being optimistic almost 60 per cent took a different line of thinking and agreed that we need to start thinking about how much we should change the world and ourselves. A few agreed with the positive view that scientists will eventually know enough about nature to be able to control it.

Table 17: Level of agreement with technology and nature statements

	N	Mean	Std. Dev.	Agreement percentage
It is natural for people to improve their lives by using technology	564	3.68	0.781	70.7
Technology is progressing so that in the future there will be no need to rely on finite natural resources	561	2.90	1.040	30.7
New technology will eventually enable sustainable use of the planets natural resources	560	3.17	0.899	38.6
Through science and technology there will eventually be no need to worry about the future of the human race	564	2.16	0.932	8.5
Nature has tremendous capacity to adapt to the effects of human progress	563	2.90	1.068	36.1
Rather than considering more technology, we need start thinking about how much we should change the world and ourselves	562	3.57	0.946	57.3
Scientists will eventually know enough about nature to be able to control it	564	2.15	0.986	10.8
Technology will eventually repair most of the environmental damage that has been done	564	2.15	0.942	9.8
Interference with nature often produces disastrous consequences	564	3.91	0.903	75.0
When we interfere with the nature the consequences are unpredictable	563	4.02	0.828	80.8

To test for the hypothesised relationship between these general views and values and the measured sense of self identity in the TPB models summary variables were constructed and are presented in Table 18. The mean scores show that respondents were quite positive about post materialist values and more neutral in their agreement or disagreement with statements about technology and resource use and technology and nature.

Table 18: Summary variables

	N	Mean	Std. Dev.	Cronbach's Alpha
Post materialism	562	3.82	0.512	0.53
Technology and resource use	561	2.75	0.597	0.64
Technology and nature	555	2.56	0.532	0.77

4.8 Values and the biotechnology examples

4.8.1 Values and new medical technology

Correlation values representing associations between values and self identity are shown in Table 19. As shown, the correlation values were generally moderate between self identity and the three value measures but the relationship was not as strong between post materialism and self identity. Technology and resource use and technology and nature were moderately to strongly related to each other. This suggests that those advocating the general use of

technology over the conservation of resources also favoured environmental sustainability through technology while assuming that this would not damage nature.

Table 19: Correlations between values and self identity – new medical technology

		Post materialism	Technology and resource use	Technology and nature
Self identity	r n	0.20** 558	-0.36** 557	-0.34** 551
Post materialism	r n		-0.12** 559	n.s
Technology and resource use	r n			0.55** 553

Note: ** = $p < 0.01$

The results of the regression on self identity are shown in Table 20. The R^2 value of 0.19 was low indicating that the three values only provided a partial explanation of self identity. Nevertheless, significant ($p < 0.001$) independent effects were found for the three proposed determinants. These results show that the type of person who opposes the new gene replacement therapy tends to hold post materialist values while being against the use of technology generally in society and being against the use of technology for environmental sustainability.

Table 20: Regression of values on self identity – new medical technology

$R^2 = 0.19$, n = 546		
Variable	β	**Significance**
Post materialism	0.17	0.000
Technology and resource use	-0.21	0.000
Technology and nature	-0.23	0.000

4.8.2 Values and bio-pharming

Correlation values representing associations between values and the self identity measure for bio-pharming are shown in Table 21. As shown, like the correlation results for gene replacement therapy values were generally moderate between self identity and the three value measures but the relationship was not as strong between post materialism and self identity.

Table 21: Correlations between values and self identity – bio-pharming

		Post materialism	Technology and resource use	Technology and nature
Self identity	r n	0.12** 560	-0.30** 559	-0.38** 553

Note: ** = $p < 0.01$

The results of the regression on self identity for bio-pharming are shown in Table 22. The R^2 value of 0.17 was low indicating that the three values only provided a partial explanation of self identity. Significant ($p < 0.001$) independent effects were found for the three proposed determinants but, unlike the results for gene replacement therapy, technology and nature are shown to have a greater influence. The results show that those who were not the type of person to support bio-pharming had a weak tendency to hold post materialist values and tended more strongly to be against technology.

Table 22: Regression of values on self identity – bio-pharming

$R^2 = 0.17$, n = 548		
Variable	β	**Significance**
Post materialism	0.11	0.004
Technology and resource use	-0.13	0.005
Technology and nature	-0.31	0.000

4.8.3 Values and new beef or lamb

Correlation values representing associations between values and the self identity measure for the new beef or lamb are shown in Table 23. As shown, unlike the correlation results for the other two biotechnologies, there was no evidence of link a between post materialism and self identity. In addition, the two other value measures are shown to have stronger influences on intention.

Table 23: Correlations between values and self identity – new beef or lamb

		Post materialism	Technology and resource use	Technology and nature
Self identity	r n	n.s.	-0.44** 559	-0.46** 553

Note: ** = $p < 0.01$

The results of the regression on self identity for the new beef or lamb are shown in Table 24. The R^2 value of 0.17 was higher than it was for the new medical technology but was still low indicating that that the values only provided a partial explanation of self identity. Significant

($p < 0.001$) independent effects were found for technology and resource use as well as technology and nature with the latter shown to have slightly more influence on self identity. These results show that those who were not the type of person to purchase new beef or lamb made using nanotechnology, did not hold post materialist values and but tended more strongly to be against technology.

Table 24: Regression of values on self identity – new beef or lamb

$R^2 = 0.26$, n = 544		
Variable	β	**Significance**
Post materialism	0.01	0.760
Technology and resource use	-0.26	0.000
Technology and nature	-0.31	0.000

4.9 Demographics and intention

Tests were undertaken to investigate differences with demographic information and the three measures of intention. These results are shown in Tables 25, 26 and 27. In each case there were differences between males and females with males in general having more positive intentions. The difference between males and females is most noticeable in the medical example. The medical example also most clearly shows those in the highest income groups being positive about this example. There was little evidence of such differences associated with income in the other two examples. In keeping with income, higher education was aligned with positive intentions in the medical example but in the other two examples those without qualifications were the most positive. Also for bio-pharming and intention to buy new beef or lamb, those who were spiritual but not religious were the least positive about these examples.

Table 25: Demographic variables and intention to support new medical example

Item	Frequency	Attitude mean	Significant differences (t-tests, p < 0.05)
Gender (n = 559)			
Male (1)	262	2.97	1-2
Female (2)	297	2.52	
Income (n = 558)			
Less than $15000 (1)	100	3.00	1-6, 2-5, 2-6,
$15001 to $20000 (2)	74	2.83	3-5, 3-6, 4-5,
$20001 to $40000 (3)	137	2.97	4-6,
$40001 to $60000 (4)	104	3.06	
$60001 to $100000 (5)	78	3.33	
$100001 and above (6)	40	3.52	
Education (n = 558)			
Primary school (1)	11	3.09	2-6, 2-7, 3-6,
Secondary - no qualifications (2)	72	2.56	3-7, 4-6, 4-7,
Secondary - with qualifications (3)	124	2.62	5-6, 5-7
Trade tech or similar (4)	91	2.49	
Undergraduate (5)	89	2.56	
Bachelors (6)	98	3.05	
Postgraduate (7)	73	3.10	
Religion (n = 516)			
Agnostic (1)	42	3.00	
Christian (2)	263	2.73	
Atheist (3)	48	2.96	
Spiritual - not religious (4)	161	2.66	
Other (5)	2	3.00	

Table 26: Demographic variables and intention to support bio-pharming

Item	Frequency	Intention mean	Significant differences (t-tests, $p < 0.05$)
Gender (n = 558)			
Male (1)	264	2.95	1-2
Female (2)	298	2.64	
Income (n = 546)			
Less than $15000 (1)	85	2.80	4-6,
$15001 to $20000 (2)	54	2.69	
$20001 to $40000 (3)	168	2.86	
$40001 to $60000 (4)	112	2.64	
$60001 to $100000 (5)	82	2.77	
$100001 and above (6)	45	3.04	
Education (n = 562)			
Primary school (1)	11	3.55	1-4, 1-5, 1-6,
Secondary - no qualifications (2)	73	3.01	1-7, 2-4, 2-5,
Secondary - with qualifications (3)	124	2.88	3-4, 3-6
Trade tech or similar (4)	91	2.55	
Undergraduate (5)	89	2.60	
Bachelors (6)	100	2.84	
Postgraduate (7)	74	2.72	
Religion (n = 520)			
Agnostic (1)	42	2.90	2-4
Christian (2)	265	2.85	
Atheist (3)	49	2.82	
Spiritual - not religious (4)	162	2.59	
Other (5)	2	3.50	

Table 27: Demographic variables and intention to buy new beef or lamb

Item	Frequency	Attitude mean	Significant differences (t-tests, $p < 0.05$)
Gender (n = 559)			
Male (1)	263	2.80	1-2
Female (2)	296	2.52	
Income (n = 543)			
Less than $15000 (1)	85	2.61	2-4, 3-4, 4-5
$15001 to $20000 (2)	52	2.75	
$20001 to $40000 (3)	168	2.77	
$40001 to $60000 (4)	111	2.39	
$60001 to $100000 (5)	82	2.79	
$100001 and above (6)	45	2.69	
Education (n = 559)			
Primary school (1)	11	3.45	1-3, 1-4, 1-5,
Secondary - no qualifications (2)	73	2.88	1-6, 1-7, 2-5,
Secondary - with qualifications (3)	123	2.66	2-6
Trade tech or similar (4)	91	2.76	
Undergraduate (5)	89	2.49	
Bachelors (6)	98	2.51	
Postgraduate (7)	74	2.58	
Religion (n = 520)			
Agnostic (1)	41	2.44	
Christian (2)	264	2.77	2-4
Atheist (3)	49	2.84	
Spiritual - not religious (4)	162	2.49	
Other (5)	2	3.50	

Chapter 5
Discussion and Conclusion

5.1 Introduction

The general purpose of this research was to understand reactions to possible developments in biotechnology. The research set out to investigate change over time in public reactions as well as gauge reactions to the currently hypothetical examples of (1) the use of nanoparticles in gene therapy (2) the use of crop bio-pharming and (3) a common food product that involved the use of nanoparticles in its production. In meeting its aims and objectives the research has identified changes in responses between 2005 and 2006 and has identified key reasons for reactions to its three examples.

This chapter presents and discusses the main findings of this research. The chapter begins with the issue of representativeness. The main findings are then reviewed beginning with 13 examples of biotechnology and change over time. Findings for the three examples are then examined in depth with attention given to change in public reactions over time, should the examples become realised.

5.2 Representativeness

In tests for representativeness the sample was compared to census data and it was found there was evidence of response bias. Although the proportion of males and females were similar to census results there was a greater proportion of older respondents and more respondents with higher levels of income and higher levels of education. These differences are not uncommon for survey research and show that some people with certain demographic characteristics are not well represented. It is also possible that those with stronger views for or against biotechnology were overrepresented. Given these considerations it is expected that New Zealanders hold somewhat less extreme views than those presented in this report. However, the finding of differences with census data does not necessarily affect the study of how people react to biotechnology in terms of the common reasons for their reactions.

A further consideration is the differences with the previous year's sample. Compared to 2005, in 2006 slightly more men replied, slightly fewer young people replied and there were more in higher income and education brackets. Judging by the relationships between intentions and demographic information regarding the three biotechnology examples, the small increase in males may have resulted in a minor more positive response compared to 2005.

5.3 Acceptability of examples and change over time.

Twelve examples of biotechnology were used to investigate acceptability and change in acceptability over time. Each example was different and it was apparent that there were differences in the way the various environmental, medical and agricultural examples were rated. This rating had little to do with whether the example was genetically modified as the GM crop to be used as a fuel source was the most acceptable example and the non GM artificial raising of animal hormone levels was the least acceptable. Also of relatively high acceptability was the GM virus to reduce fertility in possums and stronger GM pine trees. Also of note, the medical examples had similar levels of acceptability. At over 40 per cent,

these levels could be regarded as high for potentially controversial medical interventions involving GM and stem cell research. Of note, amongst these the lowest acceptance was for modifying a person's genetic code whereas the recently controversial stem cell research was more acceptable. It would seem that the more immediate modification of a person was less acceptable than other medical interventions. Nevertheless, the approval level for the medical examples could be judged as high on account of the potential for personal and social benefit.

Another point about the acceptability of examples was the low levels of acceptability for the food examples. The GM apple was the least acceptable example in 2003/04 and was second to least acceptable in 2005. In 2006 it became the third least acceptable when it was replaced by the GM salmon as the second least acceptable. The low level of acceptability for the GM apple, and most recently for the salmon, may suggest a particular dislike of the use of GM in food products, which was not a factor in the other examples. The cloning of the kakapo as the single cloning example also ought to have mention because it failed to gain widespread acceptance.

A further point of interest is the lack of change over time in the examples. Between 2003/04 and 2005 there was a significant difference in responses to four of the 12 examples. Only the example of a GM crop to produce a low pollution fuel for cars showed a continued trend with the example of using human bacteria reverting to previous levels of acceptability. The GM crop example had become more acceptable between 2003/04 and 2005 and has continued to become more acceptable. Previously the GM possum virus, GM pine trees and the GM apple had improved in acceptability, but there was no further evidence of improvement in these examples. As an explanation there is the possibility that the shorter time between the 2005 and 2006 survey was responsible for this lack of change. This was, however, a time period of approximately 12 months and only 4 months shorter than the time span between the first and second survey. A second consideration is the slightly different mix of people answering the questionnaire. This can be discounted as having any significant effect on the acceptability ratings because of two considerations. First the effect of differences in demographics was found to be mixed for the main examples. Apart from males being more positive about the three main examples, the evidence of income and education affects were mixed. Second, the increase in the proportion of males was only two per cent in 2006. Taking these considerations into account means that the differences or lack of differences between 2005 and 2006 are most likely due to change or lack of change in public opinion. The results therefore suggest that there has been a trend for an increase in acceptance of growing a GM crop for a low pollution fuel for cars and a lack of more recent increase in acceptance of the other examples of biotechnology.

5.4 New medical technology

Using nanoparticles for gene replacement therapy was introduced in the survey as a way of replacing the use of a GM technique that used a virus to transfer a gene to deficient cells. Nevertheless, the new technique was not that well received with only about one quarter having a positive intention to support the use of the new treatment. Other medical treatments had been found to have been acceptable to a higher proportion of respondents. The modification of a person's genetic code and the use of stem cells to treat Alzheimer's disease were both acceptable to more than 40 per cent of the survey respondents suggesting people were being more cautious about the new example. The nature of this caution would not, however, seem to be mostly based on the prospect of harmful outcomes. This was not one of the beliefs that had a high percentage agreeing with it. There was more concern that the new technique was unnatural and more that thought it wrong for it to be used as a form of human

enhancement. Of interest, although the technique was judged generally unnatural, only half as many agreed that it would feel unnatural to have nanoparticles 'floating around in your body'. More agreed that it would eventually become a new tool for striving for beauty and perfection and almost as many were concerned about people eventually becoming artificial and losing the natural qualities of being human. This was not so much concern about the immediate effects of the technique on the human body but rather it was concern about what humankind might become through the use of this new type of technology.

Just less than one quarter thought it wise to support the development and use of this treatment which was similar to the measure of intention. Together with a measure of how wrong it was to support the new treatment the subsequent attitude had a similar mean score to the intention mean. At almost 30 per cent the agreement with the type of person who would oppose was a little higher than the positive intention, as was the measure of how wrong it was to support the new treatment. Nevertheless, the mean score was just on the positive side for intention.

Analysis of the model showed that self identity, attitude and the subjective norm provided a good explanation for intention. Of most importance was the influence of attitude on intentions to support this new technique, followed by self identity and then by subjective norm. These are posed as the principle reasons for a person's intention so that people who, for example, support the use of nanoparticles for gene therapy have a positive attitude towards the new medical technique. Those who intend to support the new medical example also tend not to be the type of person to oppose it and believe they have the support of people whose views are important to them such as their family and friends.

The relationship shown between beliefs and attitude supports the view that beliefs are an important determinant of attitude. Those with a positive attitude and intention are shown to be more positive in their beliefs about the use of nanoparticles for gene therapy. This means that the treatment would be considered less unnatural, less likely to be used for human enhancement, would be less likely to be judged unethical and be judged less of a risk of harmful outcomes. For those with a positive attitude the treatment would also be more preferable to the GM alterative and be seen to be less likely to have a personal effect.

Other characteristics of those positive about the technology are that they would have a minor tendency be more materialist than post materialist and to agree that technology is the best means of progress. They also tend to have the view that technology does not conflict with nature as it can, for example, be judged to be able to adapt to the effects of human progress. There was also a tendency for males to be more positive about this example and those with higher income and education.

The results also lend themselves to consideration of change over time. This hypothetical example was generated to enable consideration of reactions to a medical technique that used nanotechnology with biotechnology. The static view of responses can nevertheless be extended upon to enable consideration of change in attitudes and intentions over time. It has been shown that beliefs and attitude towards the technology are most strongly linked to intentions so that change in beliefs can be assumed to effect a requisite change in attitudes and intentions. This means that should the technique be realised and be of low risk then concern over the technique would moderate. The same result can be expected if the technique was not used for human enhancement or failed to lead to people becoming artificial. A relaxing of these challenging beliefs could then ease moral or ethical objections and may also make the technique seem more natural.

Less easy to change are the factors associated with self identity. Post-materialist values are unlikely to change in the short term, though it is possible that technology can be used to help reach its ideals. This could occur if the medical technology was generally available and not associated with use by the wealthy. Similarly technology that does not try and dominate nature may be taken to be more acceptable. The demographic variables are unable to be changed but nevertheless suggest women and those less educated and of lower incomes would be more difficult to convince about the merits of the technology.

5.5 Bio-pharming

Another possible near future development that was the subject of study was reactions towards bio-pharming. This was described as using agricultural land to grow crops that have been genetically modified to produce chemicals or pharmaceuticals. Intentions to support bio-pharming were at a similar level to those that would support the new medical treatment. It was also not that well received with just over one quarter having a positive intention to support bio-pharming. The need for new health and safety regulations was the biggest problem issue along with practical concerns about cross pollination and the danger of mixing the new products up with other food plants. There was also the problem of unexpected consequences in agreement with the belief that new substances in plants could do unexpected things. However, most did not agree that the best place for chemical manufacturing was factories. It would seem that neither factories nor this alternative in agriculture was acceptable to most people.

Bio-pharming was also seen as a problem for public acceptance with few agreeing that there would not be protests about this issue. Lack of consumer benefit and the possibility of damage to soil ecology were further problems of concern. The artificial nature of the activity was the likely reason it was judged by many as being unnatural and it was unethical because GM is still likely to be regarded as a strange and new technology. Finally and of interest, despite there being practical concerns, concern over control of unexpected outcomes and irreversible outcomes were relatively low.

Along with the just over one quarter who had positive intention scores fewer agreed it was wise to support bio-pharming and a greater percentage judged that supporting it would be wrong. This resulted in a slightly more negative attitude and a smaller proportion agreed that the views of important people, such as family or friends, would be supportive of them. At almost one third those who thought they were the type of person to oppose this technology was more than those who thought it was wrong to support it.

Analysis of this model showed that self-identity, attitude and the subjective norm provided a good explanation for intention. Like the model for the use of nanotechnology in the medical example, attitude had the strongest relationship with intention. Unlike the previous model, second to attitude in terms of strength was the subjective norm because the perceived views of other people whose views were important and was more important than self identity. This is possibly because, unlike the nanotechnology example, GM technology is more widely known and discussed. It is then more likely that the views of others are known and the relative position of the individuals view is also known.

Like the previous model there was evidence of a strong effect for attitude on intention and in turn there was evidence of a strong effect of beliefs on attitudes. This means that those positive about bio-pharming would hold negative beliefs less strongly and be more likely to more strongly hold positive beliefs. These people who are more positive would, for example,

tend to give less weight to the practical problems associated with this new technology. On the other hand, those who hold negative beliefs are likely to hold a negative attitude and intention. Being against bio-pharming they are likely to express concern about issues such as damage to soil ecology, health and safety issues or cross pollination.

Those with a positive intention to support bio-pharming had a minor tendency to think they were the type of person who would not support it. This type of person was partly explained by their adherence to post materialist values, lack of support for technology and concern about technology damaging nature. There was also a tendency for males to be more positive about this technology and for those without higher qualifications to be supportive of bio-pharming.

While a static view of opinion about bio-pharming there is the possibility that beliefs and attitudes could change. Attitudes were strongly linked to intentions and the link between attitudes and beliefs provides evidence that a change in beliefs would result in a change in attitudes and intentions. This would occur if apprehension about bio-pharming was reduced and could be achieved if a number of practical concerns were adequately addressed and there was an appreciation of benefits of the new technology. Most immediately this would likely occur with satisfying the need to address health and safety issues and addressing a number of risks that people associate with the technology. These risks would include risk of having plants mixed up with food crops and risk of contamination of other crops through cross pollination.

There is some anchoring of intentions to support bio-pharming in post materialist values and some rejection of technology but in this case these influences are likely to be largely ineffectual on intention. Of more importance was the subjective norm. This means that the views of people such as family and friends are influencing the decision of the individual on this issue. This influence could change if the beliefs of important others change. For example, if the risks of bio-pharming are realised then there could be more pressure on the individual from others to reject the technology.

5.6 New beef or lamb

A novel example of a new food with consumer benefit was used as the third example. This example also involved nanotechnology to gauge general reactions to this new technology in GM food. Unlike the previous examples, most people were positive about this example and intended to buy this product if it was available. This acceptance is higher than that recorded for the GM apple or the GM salmon and suggests the new meat was perceived to be different from other GM products. The GM salmon had a consumer benefit of higher omega three oils, but was still not acceptable to most. This suggests nanotechnology was more acceptable and was seen to be replacing GM.

Despite nanotechnology seeming to be favoured over GM there was a good deal of concern regarding compliance with regulations. It would seem that there is little trust in those involved in developing and implementing nanotechnology in this example. There was also a practical concern over the welfare of animals developed using this technology. The product was also seen to be unnatural due to changes made to the animals. Another practical concern was that the development of the technology was more about making money than making better food and there was the fear that farm land would somehow become contaminated. Despite the large proportion intending to purchase this product the concern about unexpected food risks was not discounted by most people. There were some that saw benefits for the new

technology. These included trade, personal improvement of health and an easing of pressure on health services.

Intentions were generally positive. Most judged it wise to purchase the new product and just under one third thought it wrong to buy the product. When added together the wise and whether it was wrong measures produced an attitude that was more negative than intentions to purchase. Of further interest, those who indicated they were the type of person who would not purchase was greater than those who did not intend to purchase. Some people were intending to purchase food they would usually object to and this raises the likelihood that it was the prospect of health benefit that was altering their decision.

The results of the modelling showed that together self-identity, attitude and subjective norm provided a good explanation of intention. Attitude had the strongest link to intention suggesting that a change in attitude would provide a requisite change in intention. Self-identity had a stronger role than it had in explaining intentions to support bio-pharming, but was similar in importance to its role in explaining intentions to support the new medical example. Like the other examples there was a strong link between beliefs and attitude this suggests that attitude was formed from the considerations encapsulated by the beliefs.

The views of important others, also termed the subjective norm, was also shown to have an effect on intention. This means that those who intended to purchase tended to feel they had the support of others whose views were important to them.

Like the other models the belief-attitude-intention sequence supports the view that beliefs are a determinant of attitude and that attitude influences intention to purchase. Those who intend to purchase are therefore likely to rate negative aspects of the product more moderately and give more prominence to benefits. These people would likely be less concerned about issues involving compliance with regulations, health problems for animals or contamination of farm land. They would also be more likely to emphasise health and trade benefits.

Those positive about the technology would be also very likely to have a sense of self-identity that supports their intentions to purchase the new beef or lamb. They would favour the use of resources and technology generally and likely consider nature to be adaptive to changes brought about through technology. Those with a negative self identity would tend to see themselves as being against progress through technology and this progress would be seen to damage nature and invite disaster.

Beliefs about the new product can change so that it could become on the one hand more favourable, or on the other, less favourable. Trust in compliance with regulations, for example, could be fostered over time and result in a more favourable attitude and more positive intention. Conversely, a less favourable attitude and intention would result if problems eventuated over compliance with rules or regulations. Similarly, if the benefits of the new product are realised then attitudes and intentions would likely improve. Also amenable to change is the subjective norm. This could occur if the views of important others change or if there is a change in the perceived importance of these views. It is conceivable that should this product reach the marketplace then it would become a social issue and the views of others could change or be more strongly voiced. Adherence with these views would change intention to purchase.

Like the other models there would be some anchoring of intention in self identity. Unlike the other two examples this would not involve post materialist values. It would, however, more strongly involve relationships with views of technology, resource use and nature. Such views

and values are less dynamic than beliefs and would tend to moderate the effects of changes in beliefs and attitude or the subjective norm on intention.

5.7 Implications

Concentrating on those variables that are more dynamic than others can lead to an understanding of how intentions can change over time.

First to consider recent changes in reactions, the comparisons of acceptability showed that reactions to biotechnology are largely invariant over time. This suggests that public concern does not vary a great deal in the short term. There had been some improvement recorded earlier but the most recent comparison merely showed that an example associated with fuel had become more acceptable, which may have been a reaction to higher fuel costs. Given results in the earlier survey it is apparent that 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.

Factors that moderate change are the views and values related to post materialism, technology and nature. To a degree, a person's sense of self identity which conflicts with the three examples of biotechnology in this study is associated with these views and values. This means that a change in acceptance may be slowed down or held up because there are deep-seated views or values that are against this form of progress. Unlike beliefs which can be changed with new information, basic views and values are less easy to shift. It could be that, for example, post materialism brings pressure for social projects to be prioritised over technological development. This could then result in novel forms of biotechnology and nanotechnology not receiving as much support for research and development. Some would also likely be resistant of 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. In ways such as these, new biotechnologies are likely to be resisted should they challenge current views and values held by some New Zealanders.

Nevertheless, while post materialism and views of technology and nature are likely to impede acceptance of some new biotechnologies there is still potential for change in beliefs. New positive information about the risks of the technology could improve concerns over risks to people or the environment. In addition, finding that benefits are real and not simply speculative should increase their importance and produce a more favourable attitude and intention.

The consideration of future public reactions has been provided by the hypothetical examples. There are likely to be many more new developments in technology, and as biotechnology has done, each is likely to present new challenges to public opinion. Nanotechnology has the potential to be used in food and medicine in combination with biotechnology and there are already some new developments using this technology in rice and in assisting medical diagnosis. Nanotechnology is a new challenge that is likely to raise new objections, for example, its suggested use in gene therapy raised concerns about it being used for improvement in human ability and beauty. However, using the new technology for lowering harmful fat in meat produced a product that most people would buy when GM food examples were clearly rejected. This could suggest that GM is stigmatised and that GM has become socially unacceptable. The non GM alternative would then fare better because it has not been similarly discredited. This suggests that unlike this aspect of biotechnology there is still an

opportunity for nanotechnology to avoid problems of public acceptance, even where nanotechnology is being used instead of a GM technique.

5.8 Conclusion

The general aim of this research was to predict and understand reactions to biotechnology. In a new initiative for the research programme this investigation was directed at currently hypothetical examples of biotechnology. Included in these was the use of the very novel nanotechnology. There was also an estimate of change in acceptability over time and it was subsequently shown that for most of a range of examples that there had been no change in acceptance over the recent 12 months. For the hypothetical examples, a medical example and the example of bio-pharming did not receive a good deal of support but most would buy a food example with consumer benefit. Importantly, these results have been linked to views and values and beliefs with the latter being amenable to change so it has been shown how the realisation of benefits and evidence of low or acceptable risk will modify New Zealander reactions.

References

Ajzen, I. (1991). The theory of planned behaviour. *Organisational Behaviour and Human Decision Processes, 50,* 179-211.

Armitage, C. J. & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology, 40,* 471-499.

Bainbridge, W.S. (2002). Public attitudes toward nanotechnology. *Journal of Nanoparticle Research*, 4, 561-570.

Biddle, B. J., Bank, B. J. & Slavings, R. R. L. (1987). Norms, preferences, identities and retention decisions. *Social Psychology Quarterly*, 50, 4, 322-337.

BMPR (2004). *Nanotechnology: Views of the Public.* Report prepared for the Royal Society and Royal Society of Engineers Working Group.

Boldero, J. (1995). The production of household recycling of newspapers: The role of attitudes, intentions and situational factors. *Journal of Applied Social Psychology*, 25, 440-462.

Bredahl, L. (2001). Determinants of consumer attitudes and purchase intentions with regard to genetically modified foods: Results of a cross-national survey. *Journal of Consumer Policy*, *24,* 23-61.

Chen, P. Y. & Kraus, A. D. (2004). Cronbach's alpha. In M. S. Lewis-Beck, A. Bryman, T. Futing Liao (Eds.). *The Sage encyclopaedia of social science research methods* (Volume one) (pp. 225- 226). Thousand Oaks, Calif.: Sage.

Cheung, S. F., Chan, D. K. & Wong, Z. (1999). Re-examining the theory of planned behavior in understanding wastepaper recycling. *Environment and Behavior,* 31, 5, 587-612

Charng, H., Piliavin, J. A. & Callero, P. J. (1988). Role identity and reasoned action in the prediction of repeated behaviour. *Social Psychology Quarterly*, 51, 4, 303-317.

Cobb, M. D. & Macoubrie, J. (2004). Public perceptions about nanotechnology: Risk, benefits and trust. *Journal of Nanoparticle Research*, 6, 395-495.

Conner, M. & Armitage, C. J. (1998). Extending the theory of planned behaviour: A review and avenues for further research. *Journal of Applied Social Psychology*, *28,* 15, 1429-1464.

Conner, M. & Sparks, P. (1995). The theory of planned behaviour and health behaviours. In M. Conner & P. Norman (Eds.), *Predicting health behaviour* (pp. 121-163). Buckingham: Open Court Press.

Cook, A. J. & Fairweather, J. R. (2004). Change in New Zealand farmer and grower attitudes towards gene technology: Results from a follow up survey. *Agbioforum,* 6, 3, 9-16.

Cook, A. J. & Fairweather, J. R. (2005a). *New Zealanders and biotechnology: Attitudes perceptions and affective responses.* Research Report, Agribusiness and Economics Research Unit, Lincoln University.

Cook, A. J. & Fairweather, J. R. (2005b). *Nanotechnology – Ethical and social issues: Results from New Zealand focus groups.* Research Report, Agribusiness and Economics Research Unit, Lincoln University.

Cook, A. J, Fairweather, J. R., Satterfield, T. & Hunt, L. M. (2004), *New Zealand public acceptance of biotechnology.* Agribusiness and Economics Research Unit, Research Report No. 269, Lincoln University.

Cook, A. J., Kerr, G.N. & Moore, K. (2002). Attitudes and intentions towards purchasing GM food. *Journal of Economic Psychology*, 23, 557-572.

Coyle, F. J., Maslin, C., Fairweather. J. R. & Hunt, L. M. (2003), *Public understandings of Biotechnology in New Zealand: Nature, Clean Green Image and Spirituality.* Agribusiness and Economics Research Unit, Research Report No. 265, Lincoln University.

Eagly, A. H. & Chaiken, S. (1993). *The Psychology of Attitudes.* Fort Worth: Harcourt Brace Jovanovich.

ETC, (2004a). Jazzing up Jasmine: Anatomically Modified Rice in Asia. (http://www.etcgroup.org/documents/NRatomrice1.pdf - accessed March 2, 2006)

ETC, (2004b). The Precautionary Principle 2. (http://www.etcgroup.org/documents/princenanoprecaution.pdf - accessed March 2, 2006)

Granberg, D. & Holmberg, S. (1990). The intention-behaviour relationship among U.S. and Swedish voters. *Social Psychology Quarterly*, 53, 1, 44 –54.

Inglehart, R. (1990). *Culture Shift in Advanced Industrial Society*. Princeton, N.J.: Princeton University Press.

Hunt, L. M., Fairweather, J. R. & Coyle, F. J. (2003). *Public Understandings of Biotechnology in New Zealand: Factors Affecting Acceptability Rankings of Five Selected Biotechnologies.* Agribusiness and Economics Research Unit, Research Report No. 266, Lincoln University.

Jaffe, G. (2004). *Sowing secrecy: The biotech industry, USDA and America's secret pharm belt.* Centre for science in the public interest.

Kaye-Blake, W., Saunders, C. & Fairweather, J. R. (2004). *Modelling the Trade Impacts of Willingness to Pay for Genetically Modified Food.* Agribusiness and Economics Research Unit, Research Report No 270, Lincoln University.

Loon, A. J. M., Jijhuis, M., Picaret, H. S. J., Surtees, P. J. & Ormel, J. (2003). Survey of non response in the Netherlands: Effect on prevalence estimates and associations. *Annals of Epistomology,* 3, 2, 105-110.

Mead, G. H. (1934). *Mind, Self and Society.* Chicago: University of Chicago Press.

Nunnally, J.C. (1967). *Psychometric Theory*. McGraw-Hill, New York.

Randall, D. M. & Wolff, J. A. (1994). The time interval in the intention-behaviour relationship: Meta-analysis. *British Journal of Social Psychology, 33,* 4, 405-418.

Roberts, M. & Fairweather, J. R. (2004), *South Island Maori perceptions of biotechnology.* Agribusiness and Economics Research Unit, Research Report No. 268, Lincoln University.

Saba, A. & Vassallo, M. (2002). Consumer attitudes toward the use of gene technology in tomato production. *Food Quality Preference*, 13, 13-21.

Siegrist, M. (1999). A causal model explaining the perception and acceptance of gene technology. *Journal of Applied Social Psychology*, 29, 10, 2093-2106.

Slovic, P. (2000). *The perception of risk*. London: Earthscan publications.

Sparks, P. & Guthrie, C. A. (1998). Self-identity and the theory of planned behaviour: A useful addition or an unhelpful artifice? *Journal of Applied Social Psychology, 28,* 15, 1393-1410.

Sparks, P. & Shepherd, R. (1992). Self-identity and the theory of planned behaviour: Assessing the role of identification with "Green consumerism". *Social Psychology Quarterly*, *55,* 4, 388-399.

Sparks, P., Shepherd, R. & Frewer, L. J. (1995). Assessing and structuring attitudes toward the use of gene technology in food production: The role of ethical obligation. *Basic and Applied Social Psychology*, 16, 3, 267-285.

Spence, A. & Townsend, E. (2006). Examining consumer behaviour toward genetically modified food in Britain. *Risk Analysis*, 26, 3, 657-670.

Taylor, S. & Todd, P. (1995). An integrated model of waste management behavior: A test of household recycling and composting intentions. *Environment and Behavior*, 27, 603-630.

Appendix

Public Attitudes Towards Biotechnology: A Nationwide Survey 2006

What is Biotechnology?

Biotechnology is the use of living things, or their parts, to make products. A traditional biotechnology is using yeast to make beer or traditional plant breeding. A new biotechnology is genetic modification (GM), which may involve using foreign genetic material from a plant or animal to alter the genetic material in another plant or animal. By altering genetic material a new plant or animal can be raised with new characteristics. You may have heard of this technology being called genetic engineering, or of it being used to make GM food. While there are benefits from using GM, some people are concerned that their use has risks.

What is Nanotechnology?

You may not have heard of nanotechnology. Nanotechnology is a new development in science that involves the use of materials of an extremely small size, often less than a billionth of a metre. At this scale specialised instruments are being used to construct new materials often called nanoparticles. Overseas, nanoparticles have been used to develop clothing with stain-resistant fibres and formulate more effective sun-screen lotions. Nanoparticles are also helping to deliver drugs to targeted tissues within the body affected by cancer. Nanoparticles are also being used the automotive industry, and in electronics, computers and communication. As these examples show nanoparticles can be useful. However, scientists have also found that some particles can be poisonous or toxic. This has led to calls to avoid the possibility of nanoparticles becoming hazardous to people or the environment.

Please turn the page

Instructions: For <u>each</u> question, please select the number for the option that best indicates your response and write it in the box provided on the right hand side of the page.

Please note that we are interested in your personal opinion and that there are no wrong or right answers.

1. Acceptability of Biotechnology Items

The following are actual or possible examples of biotechnology. Based on your current knowledge, please indicate your opinion about the acceptability or unacceptability of <u>each</u> example.

Very unacceptable	Unacceptable	Neither acceptable nor unacceptable	Acceptable	Very acceptable
1	**2**	**3**	**4**	**5**

Environmental examples:

Genetically modifying a crop to produce a low pollution fuel for cars.	
Developing a virus (genetically modified) that reduces fertility in possums.	
Use of aerial sprays made from soil bacterium (Bacillis thuringiensis) to control insect pests in urban areas.	
Cloning a kakapo to ensure the survival of the species.	

Medical examples:

Using human bacteria in the preparation of throat lozenges to prevent serious infections.	
Inserting human genes into a cow to produce milk for the treatment of multiple sclerosis.	
Preventing stomach cancer by modifying a person's genetic code.	
Using new cells (stem cells) from a 5 day old human embryo to treat an Alzheimer sufferer.	

Agricultural examples:

Using genetic screening to breed sheep that produce twins or triplets.	
Raising hormone levels in farm animals to increase fertility.	
Genetically modifying pine trees to produce stronger timber.	
Genetically modifying an apple to make it more nutritious.	
Genetically modifying salmon to raise levels of omega 3 oils.	

2. New Medical Technology

Gene replacement therapy is designed to replace missing genes which cause serious health problems. The therapy uses a GM technique involving a virus to transfer the needed gene. However, a new technique is being researched that uses nanoparticles to carry and insert a gene into deficient cells.

What is your opinion about using nanoparticles in gene therapy? Please indicate your level of agreement or disagreement with each of the following statements.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	**2**	**3**	**4**	**5**

This treatment would result in unforeseen harmful outcomes that can't be reversed.	
This treatment would be preferable to GM that uses viruses.	
The use of this treatment is unlikely to affect me personally.	
It would be wrong to use this treatment to artificially improve human abilities and performance.	
This treatment could eventually become a new tool for striving for beauty and perfection.	
It doesn't matter how the human body is changed because the essence of a person is in their thoughts.	
This treatment would be unethical.	
This treatment would be unnatural.	
It would feel unnatural to have nanoparticles floating around in your body.	
This is the type of treatment that could eventually lead to people becoming artificial and losing the natural qualities of being human.	
In a referendum I would definitely support the use of this treatment.	
I am the type of person who would oppose the use of this treatment.	
It would be wise for me to support the development and use of this treatment.	
It would be wrong for me to support the development and use of this treatment.	
Most people whose views are important to me would approve of my supporting this treatment.	
Whether I support or oppose the development and use of this treatment would be entirely up to me.	

3. Farming

Bio-pharming is the farming of GM plants or animals to produce new substances such as proteins or chemicals. Bio-pharming often involves GM which inserts foreign genes into a plant, such as corn or barley, so the new substance can be grown. In experimental trials conducted overseas, bio-pharming has been shown to be useful for making, for example, contraceptives, growth hormones, and a blood clotting agent.

What is your opinion about bio-pharming? Please indicate your level of agreement or disagreement with <u>each</u> of the following statements.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	**2**	**3**	**4**	**5**

I am confident that any unexpected outcomes from bio-pharming can be controlled.	
Bio-pharming will result in irreversible harmful outcomes.	
Bio-pharming would be unethical.	
Bio-pharming would be unnatural.	
Bio-pharming could result in contamination of food through cross pollination with food crops.	
New substances in plants could do unexpected things.	
New health and safety regulations would be needed to ensure safe handling of the plants.	
Money would be better spent on making substances in factories.	
There is a danger that bio-pharming plants will get mixed up with food plants.	
Bio-pharming could cause long term damage to soil ecology.	
Bio-pharming will result in lower costs to pharmaceutical companies but not to the consumer.	
Unlike GM food there will be few protests against bio-pharming.	
In a referendum I would definitely support bio-pharming.	
I am the type of person who would oppose bio-pharming.	
It would be wise for me to support bio-pharming.	
It would be wrong for me to support bio-pharming.	
Most people whose views are important to me would approve of my supporting bio-pharming.	
Whether I support or oppose bio-pharming would be entirely up to me.	

4. Food

GM has been used in New Zealand to modify the cells of animals and plants by using genetic material from other plants or animals. With the development of nanotechnology a possible new method uses nanoparticles to penetrate the wall of a cell and enable the genetic material within the cell to be rearranged. The new method would avoid using genetic material from other plants or animals because it would only alter the genetic material within the cell.

Using the new method it could be possible to raise farm animals that would produce lamb or beef with 20% less cholesterol-causing fat.

What is your opinion about this new type of lamb or beef? Please indicate your level of agreement or disagreement with <u>each</u> of the following statements.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	**2**	**3**	**4**	**5**

I am confident that any unexpected outcomes from making this product can be controlled.	
Making this product will result in irreversible harmful outcomes.	
I am confident that there would be no unexpected food risks from this product.	
Consuming this product would improve the health of New Zealanders.	
This product would be unethical.	
This product would be unnatural.	
It's a worry that people may not comply with the rules or regulations that govern the processes used to make product.	
There is a risk that use of modified animals will result in contamination of farm land.	
This product will ease pressure on health services.	
This product will result in increased overseas demand for NZ lamb and beef.	
The animals used to make this product may suffer unforeseen health problems.	
The development of this product is more about making money than making better food.	
It would feel unnatural to eat this product.	
If available I would definitely buy this product.	
I am the type of person who would avoid buying this product.	
It would be wise for me to buy this product.	

It would be wrong for me to buy this product.	
Most people whose views are important to me would approve of my buying this product.	
Whether or not I buy this product would be entirely up to me.	

5. Payment for new lamb or beef

We are also interested in whether you would buy the new lamb or beef with 20% less cholesterol-causing fat and how much you would pay for it. Using the scale below please indicate the most you would be willing to pay for the new lamb or beef. You may be willing to pay more or only consider purchasing if it cost less. If you do not wish to purchase please write an X in the box.

Pay 40% less **1**	Pay 30% less **2**	Pay 20% less **3**	Pay 10% less **4**	Pay no more or no less **5**	Pay 10% more **6**	Pay 20% more **7**	Pay 30% more **8**	Pay 40% more **9**

6. Other general attitudes

We are also interested in your general views of society and technology. Please indicate your level of agreement or disagreement with each of the following statements.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	**2**	**3**	**4**	**5**

People should have more say in the decisions of government.	
The priority of government should be to maintain a high rate of economic growth.	
More effort should be given to making our cities and countryside more beautiful.	
Efforts should be made to encourage a friendlier, less impersonal society.	
We need to develop a society where people count more than money.	
A technological society has the best chance of eliminating poverty.	
Advances in technology mean that the goals of society can be realised.	
Living a simpler lifestyle is the best way to conserve energy and resources.	
Wealthy nations should consume less and limit their use of resources.	
Groups that oppose materialistic values deserve support.	
It is natural for people to improve their lives by using technology.	
Technology is progressing so that in the future there will be no need to rely on finite natural resources.	
New technology will eventually enable sustainable use of the planets natural resources.	
Through science and technology there will eventually be no need to worry about the future of the human race.	
Nature has tremendous capacity to adapt to the effects of human progress.	
Rather than considering more technology, we need start thinking about how much we should change the world and ourselves.	
Scientists will eventually know enough about nature to be able to control it.	
Technology will eventually repair most of the environmental damage that has been done.	
Interference with nature often produces disastrous consequences.	
When we interfere with the nature the consequences are unpredictable.	

Please provide some information about yourself. We need this information to check whether our sample is representative

1. Please provide your age (Years) ☐

2. Please indicate your gender (1) Male (2) Female ☐

3. What was your personal income over the past 12 months?

(1) Less than $15,000 (2) $15,001 - $20,000 (3) $20,001 - $40,000
(4) $40,001 - $60,000 (5) $60,001 - $100,000 (6) $100,001 and above ☐

4. What is your highest level of education completed?

(1) Attended primary school
(2) Attended secondary school, without qualifications
(3) Attended secondary school, with qualifications
(4) Trade technical qualification or similar
(5) Undergraduate diploma or certificate
(6) Bachelors degree
(7) Postgraduate ☐

5. Which of the following best describes your religious beliefs?

(1) Agnostic
(2) Christian
(3) Atheist
(4) Spiritual but not religious
(5) Other - Please specify _____ ☐

6. Which, if any, of the following people live with you in your household?

	(1) Yes	(2) No
Husband, wife or partner	☐	
Mother or father	☐	
Son(s) or daughter(s)	☐	
Sister(s) or brother(s)	☐	
Girlfriend or boyfriend	☐	
Flatmate(s)	☐	

RESEARCH REPORTS

266 Public Understandings of Biotechnology in New Zealand: Factors Affecting Acceptability Rankings of Five Selected Biotechnologies
Hunt, Lesley M., Featherweather, John R. and Coyle, Fiona, J. 2003

267 Trade and the Environment: Economic and Environmental Impacts of Global Dairy Trade Liberalisation
Saunders, C.M., Cagatay, S. and Moxey, A.P. 2004

268 South Island Maori Perceptions of Biotechnology.
Roberts, Mere and Fairweather, John R. 2004.

269 New Zealand Public Acceptance of Biotechnology.
Cook, A.J., Fairweather, J.R., Sattersfield, T. and Hunt, L.M. 2004

270 Modelling the Trade Impacts of Willingness to Pay for Genetically Modified Food.
Kaye-Blake, William., Saunders, Caroline and Fairweather, J. 2004.

271 Selwyn District Council.
Cross, Tracey-Anne, Dalziel, Paul and Saunders, Caroline 2004

272 Instream Water Values: Canterbury's Rakaia and Waimakariri Rivers.
Kerr, Geoffrey N., Sharp, Basil M.H., and Leathers, Kenneth L. 2004

273 Public Perceptions of Outstanding Natural Landscapes in the Auckland Region.
Fairweather, John R. and Swaffield, Simon R. 2004

274 The Costs of Footrot and the Impact of the Footrot Gene-Market Test in New Zealand.
Greer, Glen 2005

275 Forecast of Skills Demand in the High Tech Sector in Canterbury.
Dalziel, Paul, Saunders, Caroline and Taylor, Greg 2005

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

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