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New Zealand Public Acceptance of Biotechnology

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Preface

Biotechnology is the use of living organisms to make products and solve problems. In New Zealand, it has made national headlines through public controversies over genetically modified corn, cloned sheep and the transplantation of animal cells into human bodies. Whilst scientists and government bodies make decisions regarding the applicability and ethical standards of such research, the public are sometimes not given full attention in this decision-making process. The AERU has been conducting a programme of research designed to address this need. The programme includes a number of topics such as public perceptions, socio-cultural determinants of risk assessment and trade modelling. To date, there are three reports on public perceptions and the present one makes a fourth contribution. Readers interested in the public issues associated with biotechnology will find this report of interest, particularly for its coverage public viewpoints.

Professor Caroline Saunders
Director

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Summary

Purpose and overall aim

- The overall aim of this research was to determine and understand public perceptions of biotechnology in New Zealand.

- Key objectives were to identify and determine the relative importance of factors involved in perceptions of biotechnology.

Method

- A questionnaire was designed which included items from risk perception research and items developed from focus group research.

- The questionnaire contained a range of questions investigating issues and topics including concern over biotechnology as a social issue, the acceptability of examples of biotechnology and concerns and worries about genetic modification. Also included were diverse topics generated using focus groups including beliefs about nature, post materialist values and spiritual beliefs.

- Data was gathered by national postal survey through the distribution of 2,000 questionnaires. Seven hundred and one usable responses were received which, accounting for undelivered questionnaires, derived a response rate of 36.3 per cent.

- A variety of statistical methods were used to investigate relationships in the data. Of note, regression analysis was performed on selected data to test two models proposed as explanations of a general attitude towards biotechnology.

Key findings

- Biotechnology is a public concern although of less importance than many other issues. 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 are more acceptable than agricultural uses.

- Biotechnologies that involve genetic modification are less acceptable.

- The use of genetic modification to fix environmental problems is more acceptable than its use in medical treatments or use in agriculture.

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

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

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

- Whether people are familiar with biotechnology has little bearing on their acceptance of, or general attitude towards, biotechnology.

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

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

- The following considerations explain differences in attitude towards biotechnology.

    - Concerns about genetic modification including concerns about cross contamination of seeds and possible negative impacts on exports.
    - Beliefs that genetic modification is wrong including beliefs that it is wrong to eat genetically modified food and wrong to mix plant and animal material.
    - Beliefs that biotechnology will be of general benefit to society.
    - Beliefs that biotechnology can fix problems and that it is natural for people to use biotechnology.

Implications

- The identified importance of views and values reflecting a particular worldview means that attitudes towards biotechnology are more resilient and entrenched than has previously been presumed.

- For many New Zealanders their basic values, beliefs and perceptions mean that biotechnology is not acceptable and there is little prospect for a change in opinion.

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

Chapter 1
Introduction: Definitions, Responses to Biotechnology and Research Aims and Objectives

1.1 Introduction

The research reported here is part of a larger research programme entitled "The fate of biotechnology: Why do some of the public reject novel scientific technologies?" The overall aim of the research reported here was to determine and understand public perceptions of biotechnology in New Zealand. The research involves determining and understanding both perceptions of biotechnology generally as well as the perceptions of a number of specific key biotechnology applications. The study is rooted in social psychology, judgement and decision making, in particular, the established work of Slovic (e.g., 1992; 2000). This work has found that perceptions of technological risks can be predicted on the basis of the perceived attributes of the risk object itself (namely, whether it, for example a disease risk, is perceived as dreaded, controllable, visible, new, etc.). Also included are a number of social factors including, but not limited to, trust invested in risk regulators, the gender and/or the worldview of the perceiver.

This introductory chapter defines biotechnology and then discusses the status of survey research into biotechnology as a social issue. We note that research on public reactions to particular aspects of biotechnology do not necessarily reflect industry or biotechnology research activity. Given our aim to investigate public perceptions, our concern is with those aspects of the technologies that draw public attention and, more broadly, with how these technologies are conceptualised by the general public. As such, we provide here an overview of the social issue of genetic engineering and we review national surveys of this biotechnology. Importantly, the review identifies the need for the research we have undertaken. Our research approach is new to the topic area in New Zealand and its basis in a particular conceptualisation of perceived risk is explained. The chapter closes with a plan of this report.

1.2 Defining biotechnology

Biotechnology is a term used to encompass a vast range of techniques for modifying life forms for research (e.g., medical, environmental, agricultural) and commercial uses. Biotechnology includes genetic modification (GM), which is a method for altering the genetic composition of organisms thereby altering the characteristics and traits of a microorganism, plant or animal. Biotechnology also encompasses, for example, *in vitro* fertilisation, cloning, and fermentation. Although the term is now commonly used to refer to the use of life forms for purposeful research, biotechnology can, through its association with fermentation, be associated with the historic practices of brewing and bread making. The practice of hybridising plants by selective breeding is also an example of biotechnology. Yet biotechnology also has a modern definition that can be characterised by the use of specialised scientific techniques for the development of new processes and novel products.

In modern form, biotechnology has been defined in New Zealand as:

> "The application of scientific and engineering principles to the processing of material by biological agents, and the processing of biological materials to improve quality of

life, by isolating, modifying and synthesising the genetic instructions responsible for biological processes" (Statistics New Zealand, 2001:8).

As this definition implies by its reference to "modifying and synthesizing the genetic instructions", biotechnology is often associated with, but is not limited to, the modern practice of GM.

1.3 The new biotechnology of genetic engineering

Genetic engineering (the manipulation of recombinant DNA) permits the genetic characteristics of a living thing to be manipulated in a comparatively shorter time frame than traditional selective breeding techniques. Critically, it also allows for a myriad manipulations of the kind not otherwise possible "in nature" such as those realized through selective breeding. The new technology also brings with it the capacity to mix gene traits between life forms, including the crossing the species barrier or the mixing of traits between animals and plants. Genetic engineering has its foundation in the discovery of the structure of DNA, through the 1953 Nobel Prize winning work of Watson and Crick. That discovery, in turn, rendered possible the development in the 1970s of techniques to isolate and transfer fragments of genetic material between life forms. The manipulation of DNA is, nevertheless, one of many recent techniques within biotechnology.

1.4 Opposition to biotechnology

These new biotechnologies have attracted commercial and political interest as new sources of wealth. Seemingly in tandem, however, and despite the obvious possible benefits in medicine and agriculture, the development of modern biotechnology has given rise to a good deal of opposition and public concern.

Opposition to genetic engineering is particularly noticeable in reference to agricultural applications and production. In the 1980s, the 'ice-minus' project in the US, which involved the release of modified bacteria to inhibit frost damage, marked the beginnings of opposition to biotechnology and the ensuing litigation slowed down the development of the project. In general, however, organised opposition has had a limited impact. As Hannigan (1995) has observed, the green movement has been impeded by a lack of resources, poor coordination between environmental groups and a lack of full support from grass root members. Nevertheless, despite the promise of prosperity and disorganised formal opposition, the new industry has yet to fully realise the expectations of its proponents.

Overall, research on public opinion shows that, depending upon the particular process and product, many, if not most, people have an unfavourable disposition towards biotechnology. Further, despite the growing popularity of research on the subject, there are no agreed upon conclusions about why many people are averse to biotechnology. Much of this work has focused on the use of genetic engineering in food production. (For reviews of the international literature see: Zechendorf, 1994; Hamstra, 1998; Norton, 1998; Bredahl, Grunert & Frewer, 1998; Campbell, Fitzgerald, Saunders & Slavic, 2000). Among the better studies is Scholderer and Frewer's (2003) recent work in which they stipulate that anti-GE dispositions are associated with a number of factors including, but not limited to, assumptions about risks posed to the environment, concerns about risks to personal and social health as well as ethical and moral concerns.

In the US, initial studies found only low levels of public concern. For example, in a 1987 study of public reactions by the US Office of Technological Assessment (OTA) found that ".... while the majority of the public expresses concern about genetic engineering in the abstract, it approves nearly every environmental or therapeutic application" (OTA, 1987:5 cited in Norton, 1998:175). Similarly, Norton (1998) has pointed out that focus group research conducted in the US also found low levels of concern. Focus group research conducted in New Jersey between 1992 and 1995 found that people were fairly positive towards the use of genetic engineering in agriculture and to its products. This favourability was positively related to the level of knowledge about the technology, an awareness of its potential benefits, confidence in regulatory authorities and trust of information sources (Hoban, 1996). Other focus group research conducted over a number of US states found that while most participants approved of the technology, they still sought assurances that food produced using genetic engineering was safe and requested that more information be made available about the technology (Zimmerman, Kendall, Stone & Hoban, 1995). This research also found that respondents had only moderate trust in the statements made by government agencies and held reservations about the ability of these agencies to ensure adequate safety standards.

In the UK, concern about the possibility of health and environmental risks has been found to be related to concerns about the welfare of others, future generations, and the environment, rather than to the welfare of the respondents themselves (Frewer, Howard & Shepherd, 1996). Interpretation of the Eurobarometer, a longitudinal survey of European attitudes towards genetic engineering, has found that public acceptance has decreased over time, while awareness of the technology has increased (Jank, 1995). In addition, investigations of the attitudes of interested sub-groups within society have found that strong proponents and opponents of the technology have attitudes that are difficult to change (Martin & Tait, 1992). People within these groups were also more likely to seek information to reinforce their existing attitudes, whereas groups with less polarised attitudes were more open to a wider range of information sources. In addition, a difference in acceptance of the technology between countries has been attributed to differences in culture and history, economic conditions, and government response to the possible risks affiliated with the introduction and development of the technology (Hoban, 1997).

In New Zealand, studies based on polling (rather than analytic studies of decision-making processes) was the norm prior to 1995. A review conducted by Cook, Fairweather and Campbell (2000) showed that prior to 1995 the New Zealand public was not predominantly averse to the use of genetic engineering biotechnology in food production. More recently it would seem that aversion has become more prominent.

In a comprehensive New Zealand study conducted over 12 years ago, Coachman and Fink-Jensen (1990; N = 2,048), found that less than one half of the respondents were concerned about eating meat (48 per cent), dairy products (43 per cent) and vegetables (38 per cent) that had been produced using genetic engineering. Similarly, though not with a specific reference to eating, Macer (1994; N = 329) found that 56 per cent of the public indicated that genetic engineering of plants was acceptable and that 29 per cent considered the genetic engineering of animals to be acceptable. A further relevant survey conducted in 1994 by Fitzgerald, Saunders and Wilkinson (1996; N = 1,017) found that, in a measure of the acceptability of the use of genetic engineering in agriculture, 14 per cent found it unacceptable, 18 per cent reported indifference and 65 per cent reported approval. When taken together, these studies show that negative dispositions towards the use of genetic engineering technology in plant-based food production were not predominant prior to 1995.

Research conducted more recently suggests that aversion has become more prominent. Approximately nine years after the Coachman and Fink-Jensen (1990) study, a survey conducted in 1999 found that, of its 908 respondents, 57 to 58 per cent had a negative attitude towards the use of gene technology in food production (Gamble et al., 2000). Similarly, a survey of New Zealanders conducted by the Royal Commission on Genetic Modification, (2001) (N = 1,153) found public disapproval for the use of gene technology in processed foods (73 per cent), farm animals (70 per cent) and crops (58 per cent).

To provide another perspective on possible changes over time several recent investigations have been undertaken. Gamble and Gunson (2002) surveyed the public in May 2001 and again in October 2001. The surveys were undertaken prior to, and after, the Royal Commission on Genetic Modification. The study found less averse reactions to products with consumer benefits and there was more aversion to GM meat than other food types. In addition, more people surveyed in the second part of the study reported checking food labels than in the first group that had been surveyed in May 2001. Overall, however, the study did not conclude that any meaningful change in public opinion had occurred, perhaps due to the relatively short period of time between the surveys. Another study has suggested that the public has become less averse over recent years. For example, an investigation of change in the views of New Zealand farmers and growers over a time period of approximately two years found that the fewer farmers expressed negative intentions to use GMOs, although the proportion of farmers with positive intentions had not increased (Fairweather, Maslin, Gossman & Campbell, 2003).

Recent studies in the US also suggests that aversion to the biotechnology of genetic engineering increased prior to 2000 and has, thereafter, decreased. A recent analysis by Bonny (2003) of survey results in the US shows a similar trend. Bonny (2003) showed that aversion in the US to agricultural produce modified by biotechnology increased in the years preceding 1997, peaked in 2000, and declined on or before in the year 2002. There is no immediate rationale for linking these US data with New Zealand. Bonny (2003) does, however, link the rise of strong opposition in Europe with government debate and government moves to regulate biotechnology activity. Similarly, it is possible that increased aversion in New Zealand may have been prompted by the investigations of the New Zealand Royal Commission of Inquiry into Genetic Modification in 2000 and 2001 and the consequential increase in attention in the popular media. As Downs (1972) has pointed out, seeming intractable public issues often elicit public concern, however, this concern often reduces over time even though the issue is unresolved. Similarly, the public handling of genetic modification likely resulted in increased public concern, which has waned even though many of the issues investigated by the Royal Commission may not have been resolved. For example, the Royal Commission advocated that the introduction of agricultural biotechnology should proceed whereas merely five per cent of public submitters to the Royal Commission argued that genetic modification was safe or posed no risk. The majority (approximately 90 per cent) were of the opinion that genetic modification posed a risk (Royal Commission on Genetic Modification, 2001).

1.5 Public opinion on biotechnology

In general, national opinion polls are useful for the purpose of understanding first-tier or ‘impressionistic’ public concern. Beyond this it cannot be assumed that such polls ‘predict’ responses to future policy debates (e.g., about biotechnology), nor can it be assumed that the opinions expressed in polls can be easily countered with tacit or overt education campaigns based on factual or scientific information. Wansink and Kim (2001) explain that factual information has potential to influence public views where such views already have a basis in

or is consistent with the information provided. More broadly, new studies in judgement and decision making indicate that most risk judgements (and information processing generally) is dependent on both an affect-experiential aspects of cognition as well as an analytic aspect or dimension (e.g., Finucane et al. 2000, Slovic 2001). Further, people can be primed in advance of risk judgements to emphasize either their affective-experiential or analytic processing capacities (Hsee et al., 2004). This and related risk work thus suggests that the presentation of specialised information will most likely be relevant when it addresses both affective and analytic dimensions of a problem. Following this rationale the imperative for effective education is to (a) understand the affective and analytic dimensions of risk judgement including the 'factual' basis of that underpin those judgements, and (b) better design risk communication protocols such that they are both consistent with how that risk is already conceptualised or evaluated.

Wansink and Kim (2001) also found that people more readily accept a biotechnology when they are presented with the outcomes or products of the biotechnology (i.e., its benefits). The researchers point out, however, that necessary attention should be given to providing information about both process and product, because aversion to the process may not necessarily be compensated by a beneficial outcome and vice versa. For example, in keeping with this assumption the simple labelling of a product as "GM" may not raise a negative reaction whereas knowledge of the details of the modification process may well give rise to a different reaction. This suggests that providing information about the process as well as the outcome or product (along with the above considerations) will result in a more informed and balanced judgement. Factual information about the biotechnology may also fail to effect more fundamental concerns, many of which are fairly stable over time (i.e., not subject to change or manipulation). Conversely, recent empirical work undertaken by Scholderer and Frewer (2003), suggests that the reinforcement of general attitudes and values upon introduction of a product or process will occur regardless of the representation of benefits. They too found that it is not the product or process itself that is considered, but rather these things serve as a cue to initiate consideration of the general attitudes and values that have previously been associated with the product or process. In support, Scholderer and Frewer (2003) cite a number of prominent European studies that identified general influences including attitudes towards technological progress, attitudes towards the environment and nature, and trust in regulars of the new biotechnologies. Coyle, Maslin, Fairweather & Hunt, (2003) similarly found that New Zealand focus group participants readily associated their views about biotechnology with their interpretations of nature. The implication here is that views about biotechnology might only change when views about nature also change. Such anchoring to an external value suggests that to be effective the study of public views on biotechnology should attempt to identify and capture views and values that, by association, are necessarily related to biotechnology.

This discussion of the research of public views of biotechnology gives direction to the form, type and style of research that can best lead to further understanding biotechnology as a social issue. In particular, while there is a good deal of aversion to aspects of biotechnology, there is some evidence that the public is becoming more accepting of new technologies. Describing this trend does not, however, equate to understanding why it has occurred and speculating about the effects of media attention, for example, will remain speculation without the necessary empirical work.

A second area in need of development is the investigation of general social attitudes and values and their relationship with concerns more immediate to the target biotechnology. To some degree this attention to what has commonly been regarded as peripheral influences has already been incorporated as additions to the study of attitudes and intentions towards GM

food in New Zealand (e.g., Cook, Kerr & Moore, 2002; Gamble et al., 2000) and overseas (e.g., Bredahl, 2001). The orientation of these research projects has, nevertheless, been towards explaining immediate reactions to the target behaviour of purchasing GM products with social influences posed as mere contextual factors. Clearly, the next step in research into biotechnology as a public issue, as advocated by Scholderer and Frewer (2003), is to consider more fully the seating of public reactions to biotechnology in the social factors that cause biotechnology to be a concern. This step is taken in the research reported in this report through the use of recent work in the social risk perception paradigm.

1.6 Definition of risk

Risk can be defined as being simply the probability of an occurrence and it is most often expressed in terms of expected percentage of mortality or morbidity outcomes. More problematic risk events include occurrences that are fairly unlikely (i.e., low probability events) but involve potentially catastrophic outcomes (such as that associated with nuclear war). More broadly, a technical definition of risk is: 'The chance of an adverse outcome to human health, the quality of life or the environment' (Graham & Wiener, 1995:25). Social science work on risk has attended, primarily, to lay or 'subjective' assessments of risk wherein study participants are asked to evaluate risk objects as presenting a high or low risk, as acceptable or unacceptable. Similarly, the work of Slovic (e.g., 1992; 2000) and others is primarily focused on the understanding of risk although much of their early work focused on the valence assigned to risks and benefits and the different cognitive processes affiliated with risk versus benefit judgements. Cognitively, it appears that we are far more sensitive to risk information (and negative information generally) thus necessitating an emphasis on risk.

Cultural theorists, when examining risk as a cultural phenomenon, also commonly give emphasis to negative outcomes while disregarding the possibility of prospective benefit. This is the case in large part because of the pioneering work of Douglas (1966) who argued that social taboos could be understood as critiques of the social whole. In particular, she has argued that some things are selected as pervasive and ominous risk not because of their attributes per se but because such risk assignations serve to reinforce social solidarity among groups, reinforcing boundaries and assigning blame (Douglas 1992). In addition, Douglas (1992) has also pointed out that risk is most often associated with a negative outcome in both technical assessment and the everyday considerations of lay people. Consistent with this tradition, this research is concerned with risk as a negative outcome with benefits being a secondary concern. The rationale is that any hazard is typically perceived or benchmarked initially as a risk while the benefit is a secondary consideration. Risk is the defining and necessary factor for explaining perceptions of all new technologies subject to public scrutiny.

1.7 Aims and objectives

The overall aim of the research was to determine and understand public perceptions of biotechnology in New Zealand. Key objectives were to identify and determine the relative importance of factors involved in perceptions of biotechnology. The achievement of the aim and objectives involves the use of a quantitative survey and the use of models of dispositions towards of biotechnology. The design incorporates items that are known to have relationships with perceptions of biotechnology. Our design and analysis is also enhanced by means of the incorporation of items developed from focus group research conducted in New Zealand. Also, to gain a broader perspective on perceptions of biotechnology, concern about the technology is compared to a range of public concerns over issues such as public welfare, crime and education. Further, measures of acceptability of a broad range of applications of

biotechnology are also discussed so as to present a rich portrait of the social acceptability of biotechnology.

1.8 Plan of this report

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

Chapter 2 begins with a review of risk perception research. The review gives emphasis to the recent work in the risk perception paradigm, which gives prominence to social factors as explanations for perceptions of risk. The second half of the chapter is concerned with the development of various means for investigating social perceptions of risk to be incorporated in the quantitative survey. These means include perceptions of nature and technological aspects of worldviews; trust in information sources; and aspects of the New Zealand identity.

Chapter 3 describes the construction of the quantitative survey instrument and its development and application to investigate social perceptions of risk.

Chapter 4 presents the survey findings and their analysis. The perceived risk of biotechnology in general and five specific examples of biotechnology are measured and explained. This explanation is then given depth by linking them with measures of trust, sense of New Zealand identity, conceptualisations of nature and measures of spirituality. Comparison is made between the perceived risk of biotechnology and other public concerns.

In Chapter 5 the survey findings are discussed and theoretical and practical implications are then identified. The chapter closes with conclusions and recommendations for further research.

Chapter 2
Risk Perception and Biotechnology

2.1 Introduction

The purpose of this chapter is to explain the modelling of risk perception, introduce recent additions to the model that are useful for researching perceptions of biotechnology, and provide the background for the design of the survey instrument. This development process drew both from other risk perception and attitude research related to the topic area, as well as the focus group research undertaken in phase one of the overall research programme. Consequently factors indicated as useful by other research are presented with reference to the results of the focus group research. Central to meeting the overall aim of this research, to determine and understand risk perceptions, was the modelling of risk perception. This modelling followed the recommendations of Slovic (e.g., 1992; 2000) and concentrated on revealing the underlying factors, such as dread or uncertainty, that are held to underlie and influence perceptions of biotechnology.

2.2 The Perception of risk

The perception of risk has been of interest to researchers and policymakers for some time. As a formal discipline Sjöberg (2000) has noted that risk perception research can be traced back to the late 1960s. In juxtaposition to the more recent risk perception approach, Slovic (2000) has pointed out that Starr (1969) proposed that the social perception of a risky activity altered proportionately with personal benefit. Skiing, for example, while affording a degree of personal danger was judged to be popular because of its personal benefit. Thus a risk-benefit trade-off was held to explain engagement in an activity that was technically assessed as risky, but was socially judged as being 'safe' or acceptable, as evident by participation in the activity. The model proposed by Starr (1969) assumed that acceptable levels of safety were revealed by people's actions.

A number of objections to Starr's (1969) revealed preference approach have been raised. In criticism of this analysis, Slovic (1992) has pointed out that preferences revealed by participation in an activity were less revealing than personal reasons, which provided much less equivocal data. In broader perspective, Sjöberg (2000) pointed out that while Starr's work has been criticised, it served to draw the attention of social scientists towards explaining the interesting phenomenon of perceived risk. This quest for a detailed explanation has involved the investigation of personal dispositions and decision-making processes as they relate to the assessment of risks and hazards.

Initial work on the risk perception area can broadly be termed 'the psychology of risk' because the investigation was of subjective judgements or assessments of risk. In the 1970s this particular treatment of risk perception was initially characterised by the comparison between subjective layperson assessments of risk and objective technical assessments. Heuristics and biases were associated with subjective judgements to show that a small number of definable errors in processing information resulted in consistent and predictable patterns of response (see Kahneman, Slovic & Tversky, 1982). The focus on heuristics and biases was meant to purposefully discern the key factors involved in what could sometimes result in sub-optimal subjective decision-making process. For example, the incorrect assumption that information pertaining to a small sample characterized the population (representativeness), the colouring of the judgement of later findings by presumptions

(anchoring) and the prominence of recent events (availability) were found to be important as measurable biases in studies of lay perceptions of risk. Sometimes a person may be right, but at other times the person will overestimate the possibility of some risks and underestimate others. Regardless, these patterns of judgement can actually serve persons reasonably well in everyday situations (Slovic, 1987, 2000; Kroll-Smith, Couch & Levine, 2002). For example, often initial ill-informed decisions suffice when only limited information is available. In addition, the use of a heuristic or rule of thumb may not necessarily be the best or optimal tactic for a particular situation, but such a tactic may nevertheless function well across a number of risk situations. The problem for research may well be that the study of heuristics and biases looks for the 'error' of human assessments whereas people function adequately in day-to-day decision making in spite of the error. This error is ultimately exposed through comparison with an objective technical assessment and interest in this approach has been to examine and compare the differences between perceptions of risk and technical assessments of risk. In consequence this attention on the error of lay assessments encourages the provision of accurate and understandable information to the public, but at the same time suggests public involvement in issues of social risk should be avoided while technical assessments should be favoured. The counter position is that all assessments are subject to the same errors with the error imbued in the technical assessments themselves as well as colouring the judgement of people making decisions based on these assessments. As Deitz, Frey and Rosa (2002:342) have pointed out, in this roundabout way it can be argued that lay people should be involved in assessing, evaluating and managing risks and hazards. Nevertheless, while it is interesting to study how cognition based on intuitive-like processes fail to correspond with technical probability assessments, studies of heuristics and biases only provide a limited explanation of risk perceptions in applied settings (Sjöberg, 2000).

The most recent and enduring model for studying public perceptions is the psychometric model. The psychometric model was developed in the 1980s to deal explicitly with the meaning of risk by attempting to understand the sources of risk perceptions and determinants involved in subjective risk assessment (see Slovic, 1992). An initial presentation of the model was made in a paper by Fischhoff, Slovic, Lichtenstein, Read and Combes (1978) and while measurement scales and methods of analysis have varied over time the model structure and components have essentially remained unchanged. The model assumes that two broad factors, the dread risk factor and the unknown risk factor are separate, immediate and substantial determinants of perceived risk. The often-cited paper by Slovic (1987) has described the dread factor and uncertainty factors of perceived risk as well as their sub-determinants. The dread risk factor is a combination of the sub factors of: control, dread, catastrophe, potential for fatality, equity, effect on future generations, ease of reduction, variance of risk and voluntariness. The unknown risk factor is a combination of the sub factors of: observability, knowledge of exposure, immediacy, degree of novelty and knowledge of science. To operationalise the model people are asked to rate a particular risk or hazard in terms of the sub factors, which are then combined to form a dread and uncertainty two-factor matrix which is presented using binomial scales. The matrix, which is a hallmark of the approach, is commonly used to make comparisons between a particular class of risk or hazard and other classes of risks or hazards presented in the same dimension. The relative positioning of risks and hazards, such as nuclear power, volcanoes, and genetically modified crops, is then used to make comparisons between such risks and hazards or to estimate the relative perceived risk in comparison with other risk sources. A range of hazards assessed using multiple factors provide the criteria for a comparing the risk of one hazard with another. Hazards like genetic engineering and nuclear power that have tended to be judged high on catastrophic potential, are judged to be unfamiliar and have been associated with new and delayed harmful effects (Siegrist, 2000). In lay terms, these factors suggest that people judge risks on the basis of their attributes, which are explained by way of reference to the above factors derived from this

style of psychometric scaling. The scale ratings assigned to the risk being rated include whether it was perceived as a dreaded, controllable or unknown risk, and so on.

The psychometric approach the measurement of perceived risk has predominantly employed the method of self-completed questionnaires. Slovic (1992:118) explains the advantages of this method which include: the gathering of expressed preferences, the gathering of many aspects of risks beyond the standard use of participation rates in activities and fatality or injury data, the enabling of the study of a large number of risks at one time and the simultaneous examination of multiple influences using statistical techniques. In addition, a further advantage noted by Slovic (1992) has been the ease of integration of the dread and uncertainty measures with other measures of risk such as the trade offs between risk and benefit. Slovic (1992) also pointed out that it has not been uncommon to also incorporate measures of attitude, word association tasks and the use of scenarios to generate reactions.

An important assumption of the psychometric approach is that risk is inherently subjective. This is unlike technical assessments which generally assume that risk is immediately with the modelled probability of an occurrence (where speculation is necessary) or the use of actuarial tables where available. The psychometric approach assumes that risk is a social phenomenon in that people have developed ways of thinking about risks to quickly and easily sort the safe from the harmful and that this is often done through attributions so that make some risks are dreaded and some not (regardless in some cases of their actually propensity to lead to death or morbidity or whichever metric deemed appropriate). This interpretation means that personal perceptions are inextricably imbued with social processes. The nature of, and reactions to, risks and hazards are therefore taken to vary with changes in personal perceptions and social processes and contexts. Hence, explanations or variations in perceived risk are sought in social and cultural differences of the people being studied with the base unit for analysis becoming the worldview, orienting dispositions or demographic variable such as gender or age. In other words, explanation is held to lie in definable points of difference of how aspects of the world are understood either within or between various populations. Risk perception is understood as a complex phenomenon that is socially constructed and is ultimately subjective. As Slovic (2000:xxxvi) has explained, '…risk is not out there, independent of our minds and cultures, waiting to be measured. Instead human beings have invented the concept of risk to help them to understand and cope with the dangers and uncertainties of life. Although these dangers are real, there is no such thing as real risk or objective risk.' This means that for studies of risk perception the imperative of the researcher is to study and explain the perceptions of individuals in terms of social factors and social processes that shape these perceptions.

2.3 Risk perception and biotechnology

By looking across a number of studies of public opinion regarding biotechnology Fischhoff and Fischhoff (2001) were able to draw conclusions of relevance to undertaking a study of perceptions of biotechnology. In their view it would be easy to simply and usefully compare biotechnologies using established measurement scales (dread, familiarity, etc.) as have been used in the psychometric model (see the previous section above). They have, however, pointed out that such a strategy is limited because it uses a limited number of measures with the assumption that these measures are appropriate for the varied range of applications of biotechnology. Following this general observation Fischhoff and Fischhoff (2001) assert that different people have different views about biotechnology. An example, referred to by Fischhoff and Fischhoff (2001:157), is the Grobe, Douthitt and Zepeda (2001) study of perceptions of the health effects of using growth hormone in cows (rBGH). Gender, income, education, age and ethnicity were found to be important factors in relation to awareness of the

technology, future health concerns and concern over immediate health effects. In addition, country of residence has also been found to be a factor in varied reactions to various biotechnologies. Gaskell (2000), for example, in review of the 1996 Eurobarometer, presented differences between European countries regarding the acceptability of a selection of biotechnology applications. Similarly, a survey using questions from the 1996 Eurobarometer found that New Zealanders had a better understanding and awareness of biotechnology than most other countries (Macer, 1998). Accordingly we need to consider a number of measures appropriate to understanding reactions to biotechnology in New Zealand.

2.3.1 Trust

Factors other than demographic information have also been identified as relevant in risk perception studies of biotechnology. Trust, for example, has been recognised for some time as being related to acceptability of new biotechnologies. In a study of the reactions of protesters to the ice-minus experiments, Thompson (1987) discussed the relationship between public opinion of scientists and the acceptability of genetic engineering. In more general comment, Barber (1983) has suggested that a reaction to perceptions of the power to influence social decisions is a key factor in trust in scientists. Sparks, Shepherd and Frewer (1995) extended upon these viewpoints by suggesting that opponents of science would be seen to be more trustworthy because of the belief that they lacked self-interest. Their test of the likelihood of believing statements by different organisations such as environmental groups and government officials supported their hypothesis by showing that trust was related to acceptability. Trust is now well known as a factor in social acceptability of biotechnology in Europe (Barling, et al., 1999). In addition, trust in actors involved in making decisions about biotechnology have been identified in the US as important in gauging support for biotechnology (Priest, Bonfadelli, & Rusanen, 2003). Also, recent work has usefully extended upon risk perception using measures of trust. For example, Siegrist (1999) found strong relationships between trust in scientists and companies and the perceptions of benefits and risks of using genetic engineering in agriculture.

2.3.2 Spirituality

Recent empirical work by Sjoberg and Wahalberg (2002) supported the assertion that spiritual beliefs are involved in the perception of risk. They asked for agreement with personal questions such as “There is meaning in all that happens”, “The soul continues to exist though the body may die” and “We all have a spark of divinity inside us” (Sjoberg & Wahlberg, 2002:760). Nevertheless, Coyle, Maslin, Fairweather & Hunt, (2003) have reported discussions about spirituality in focus groups in New Zealand that suggested that New Zealanders feel uncomfortable discussing such matters in public. There was some discussion arising from talk about scientists ‘playing God’ which arose either spontaneously or after the presentation of a cartoon depicting a scientist ‘playing God’. Nevertheless, the comments made by participants in relation to spirituality were for the most part fleeting and subtle. Although using a different method and target population, reluctance to discuss spiritual values was not found in the study by Sjoberg and Wahlberg (2002). While cultural differences cannot be discounted when comparing this European study to New Zealand it is also possible that reluctance to discuss spirituality in New Zealand was because it was too personal to discuss in a group. This means that the more anonymous survey method is likely to be more suitable for enquiry into spiritual beliefs.

2.3.3 Nature and unnatural

Coyle, Maslin, Fairweather & Hunt, (2003) drew upon arguments informed by social theory (e.g., MacNaghten & Urry, 1998) to design and interpret their focus group research. In particular, following Franklin (2002), the approach was shaped by the interpretation that nature was conceptualised in reflection of how people understand the world around them.

Views of nature were therefore regarded as a part of a particular worldview. Empirical studies, though not necessarily adhering to the same theoretical interpretation, have also found nature to be a useful in studies of reactions to biotechnology. In a recent review, Scholderer and Frewer (2003) identified that attitude towards the environment and nature is well known as an explanatory variable in studies of the risks and benefits of GM products. Similarly, in risk perception it has become common to use value scales in an attempt to capture worldviews associated with nature. Measurement of worldviews have been undertaken using scales such as the New Environmental Paradigm scale (Dunlap & Van Liere, 1978) and Kempton's items that measured American values (Kempton, Boster & Hartley, 1995).

Along with worldview characterizations of nature has been the measurement of the perceived naturalness of the technological processes. Unnatural risk, as Sjoberg (2000) has described it, challenges the purity and "naturalness" of nature. Sjoberg (2000) has also explained that conceptualisations of nature are linked in turn to moral or ethical implications of tampering with nature.

2.3.4 Technology

As well as measuring trust in actors and institutions involved in regulating biotechnology, Siegrist (1999) also measured technology as a substantial component of a technological worldview. In a causal model this worldview was shown to explain perceived benefit, perceived risk and the acceptance of the biotechnology of genetic engineering. The study was somewhat exploratory, as it had only surveyed students, however, it clearly showed acceptance of this application of biotechnology was concordant with a worldview that is sympathetic to technology. This technologically-based worldview was not investigated in, nor extrapolated from, the New Zealand focus group research. Nevertheless, the New Zealand propensity for a more positive view of processes that have useful outcomes was identified (Hunt, Fairweather & Coyle, 2003), which may well be concordant with a technological worldview.

2.4 Summary

This chapter has introduced and explained the modelling of risk perceptions and has also introduced further factors that can usefully extend the model. The risk perception model presents a range of dread and uncertainty factors for consideration as explanatory factors. In addition, other research as well as New Zealand focus group results indicates that the inclusion of demographic variables, measures of trust, spirituality, nature and naturalness would usefully extend upon the perception model to further understanding of perceptions of biotechnology. Also, the apparent usefulness of comparing different applications using the risk perception model has been supported.

In the next chapter the factors identified as important here are formed into survey questions and response scales. In addition, further questions are introduced and explained in order to develop a better understanding of the acceptance of biotechnology than has been achieved to date.

Chapter 3
Questionnaire Development and Survey Administration

3.1 Introduction

The purpose of this chapter is to present and explain the questionnaire used to measure perceptions of the risk of biotechnology. The questionnaire was designed to both test the key findings of the focus group research across the New Zealand population, as well as test for relationships known to be associated with perceptions of risk from overseas research. The questionnaire was therefore intended to add breadth to the in-depth analysis that had already been undertaken and to add further to the investigation by introducing established lines of enquiry from elsewhere.

3.2 The questionnaire

A copy of the questionnaire is provided in Appendix 1. Questionnaire items were presented in an A4-size booklet with questions on facing pages. A separate letter of introduction stating the purpose of the research introducing the topics in the questionnaire and inviting voluntary participation was included at the start of the booklet (also included in Appendix 1). The questionnaire and the research met requirements for ethical research by the Lincoln University Ethics Committee.

The questionnaire contained 199 separate items and was consequently longer than was desirable for encouraging a high response rate. For comparison, other surveys of similar design and subject undertaken by the AERU in recent years have sought approximately 100 responses. On balance, the need to more fully investigate perceptions and proposed associations with worldviews was judged to outweigh the possibility of a lower response rate from a longer questionnaire. In recognition of this likelihood particular attention was given to the time and ease of completion in pre-testing. In addition, the use of a second post out of the questionnaire and openly telling respondents 'it will take some time' in the introductory letter sought to improve the response rate.

Instructions were provided on the front on the questionnaire and a definition of biotechnology was provided as well as the use of the terms 'genetic modification', 'genetic engineering' and 'genetically modified organisms'. It was explained that these terms referred to a particular aspect of biotechnology.

The use of a definition, particularly at the start of a questionnaire, could be interpreted as influencing the answering of the questions presented to respondents. There are two relevant schools of thought to our providing a definition. First, the provision of a definition introduces a bias that influences how respondents reply to the questions. Second, the definition is necessary to make the subject matter and purpose of the questionnaire clear to the respondents. In this case the latter took precedence because it was important that each particular example presented in the questionnaire was recognised as an aspect of biotechnology and that biotechnology was recognised as a covering term for a variety of processes and outcomes. The introduction of examples of biotechnology was intended to facilitate consideration of the various technologies presented as aspects of biotechnology in keeping with the aim of the research. Further, without providing this brief introduction to the topic some respondents might have found the questionnaire illogical, especially in relation to a failure to recognise the items presented as being aspects of biotechnology.

The concern about our approach to influencing respondents reflects an approach to sound social research that is not well grounded in theory and epistemology. It must be remembered that any questionnaire cannot escape providing some framing to the study, and to the questions asked. Consequently, it is not possible to present totally 'unbiased' questions.

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

3.2.1 Issues facing society

This question set was placed first in the questionnaire to provide respondents with a relatively straightforward task of evaluating a variety of issues facing society including biotechnology. The question measured level of concern or unconcern about issues of society. Rather than using a ranking task this use of independent measures was preferred to avoid having respondents make difficult comparisons between issues. The question was designed to gather independent measures of concern for each item with post hoc comparisons enabled by comparison between the measures of concern. A similar question set has been used in national surveys of perceptions of the environment (Hughey, Kerr, Cullen & Cook, 2001; Hughey, Kerr & Cullen, 2003, see also Hughey, Cullen, Kerr, & Cook, 2004). In these surveys the question set enabled a useful comparison between environmental issues and social issues including crime and unemployment. Placing biotechnology in a similar framework was designed to show the relative concern over biotechnology when measured against other social issues.

3.2.2 Acceptability of Biotechnology Items

A range of 22 examples of the applications of biotechnology was presented to respondents under the headings of environmental uses, medical uses and agricultural uses. The range was formed with the intention of gauging the acceptability of a varied range of biotechnology examples. For example, the environmental uses included the examples of the remediation or cleaning of soil, making transport fuel from crops, using a virus for pest control, use of natural toxins in an airborne spray and cloning to prevent species extinction. These represented quite different examples while staying within the environment category.

Along with the biotechnology examples there were also three examples of nanotechnology under the medical uses category. Nanotechnology is similar to biotechnology as it can be used to alter life forms at the cellular level but can also re-arrange non living components at a molecular or atomic level. Nanotechnology differs from biotechnology because it can use non-biochemical techniques to perform these processes. Originally it had been intended to measure the acceptability of nanotechnology examples in a separate question set. In an effort to reduce the size of the questionnaire, a separate question set was not included in the final questionnaire. However, in recognition of the importance of this very new technology, three questions regarding the use of microscopic techniques were included in the acceptability of biotechnology measures. While technically not a biotechnology it was thought that the similarities with biotechnology meant that it was not unreasonable to use these examples in the same set as biotechnology items.

3.2.3 Specific Examples of Biotechnology

The third question set had five parts. Each part included a self-contained set of questions from risk perception research. A sixth question set was an overall assessment of the perceived risk of biotechnology. Each set had seven questions from risk perception modelling (e.g., see

Slovic, 2000) including an acceptability question to enable comparison with the acceptability measures taken in the previous set of questions. The use of the examples and risk perception measures was designed to be keeping with the recommendations of Fischoff and Fischoff (2001) towards capturing diversity in response to different examples of biotechnology. Comparison can be made between biotechnologies within the limits of the examples. In addition, and importantly, the perceived risk of biotechnology as a whole (question 8) was intended to usefully serve as a dependant measure for comparison with other measures related to worldviews.

3.2.4 Views on Biotechnology

The purpose of this set of questions was primarily to test the findings from the focus groups across the New Zealand population. The fourteen questions represent points of discussion from the focus groups concerning nature and the environment as well as outcomes from biotechnology.

3.2.5 Information about biotechnology

This question was designed to measure a key dimension related to trust in sources of information. The measures were of the believability of information from six sources. The six had involvement in either regulating, commenting on, or promoting biotechnology. Each measure of believability was taken separately enabling a comparative analysis between the believability of each actor. A similar question was used in a study of UK attitudes towards gene technology (Sparks, Shepherd & Frewer, 1994). In addition, this list included believing biotechnology companies which was important in explaining attitudes of New Zealanders towards GM food (Cook, Kerr & Moore, 2002).

3.2.6 Who benefits from Biotechnology?

Five questions exploring perceptions of benefits from biotechnology were included. These were conceptualised as being related to the hypothesis that a positive disposition towards biotechnology would be associated with some form of personal benefit. Importantly, three ways in which New Zealand would benefit (public, economy and quality of life) were put forward as questions as well as benefits to private corporations or companies. The personal benefit to oneself or a member of one's family from a medical treatment was also included.

3.2.7 Concerns about biotechnology

This set of seven questions comprised a more specific enquiry about possible adverse consequences of genetic modification. The questions, while drawn from the focus group research, represented a more explicitly 'rational' dimension of the acceptability of biotechnology.

3.2.8 Buying the products of biotechnology

This question set had two parts. The question set measured the intention to purchase six possible products of biotechnology, as well as measuring the amount the respondent would choose to pay given that they did not reject consideration of purchase. The intention to purchase question and measurement scale were recommended by Conner and Sparks (1995). Intentions to purchase have been shown to have reasonable correspondence with actual purchasing behaviour (Conner & Sparks, 1995), although the products presented for consideration were not actually available for purchase they are also not entirely unrealistic. The second part of the question was designed to measure the willingness to pay for the six products. The results of this analysis are not provided in this report but are included in an analysis of the economic impact of commercialising GMOs, including the trade impacts, for different New Zealand scenarios (see Kaye-Blake, Saunders & Fairweather, 2004).

3.2.9 Attitude towards Nature

The questions put forward to directly measure key aspects of worldviews relevant to the acceptability of biotechnology began with the measurement of attitudes towards nature. The proposition was that characterisations of nature (e.g., as pure or as resilient) predisposed consideration of biotechnology. The questions were derived from the focus group research where such matters were explored with the focus group respondents.

3.2.10 New Zealand Identity

A second set of questions measured a different dimension of worldviews. Although less readily apparent than talk about nature in the focus groups, the talk of a number of respondents could be characterised in terms of national identity. Some of this talk seemed to involve the consideration of biotechnology as it challenged, or was in keeping with, what respondents thought characterised the national identity. Such indirect comments formed a background to the development of the question set which is consequently more exploratory than the other worldview questions.

Notwithstanding this qualification a second proposition was included in the question set with measurement taken of 'my personal view' and 'what most New Zealanders think'. This comparison was designed to enable investigation of how the self is differentiated from the perceived views of others. It is assumed that there is a perception of an agreed upon standard as well as a personal view and that each view has a different relationship with biotechnology.

3.2.11 Technology

While technology was mentioned in the focus group research the motivation for this question set was investigations conducted overseas. This dimension of worldview was developed from Seigrist (1999) with the five questions of the set reworded to a more simplified form than used in this European study. Like Seigrist (1999), technology was considered an important dimension of biotechnology.

3.2.12 Clean Green New Zealand

A national pride in the 'greenness' of New Zealand was evident in the focus groups. There are, however, contradictions in this use of the term 'clean and green'. A national New Zealand survey has noted that the public has considered New Zealand to be cleaner and greener than other countries while being concerned about its management (Hughey, Kerr, Cullen & Cook, 2001). A Massey University (2001) study, however, suggested that the 'clean and green' image was a myth. In consequence, the questions related to New Zealand being clean and green explored both dimensions with measures of clean and green presented in a factual manner as well as enquiring as to agreement with the concept as a myth.

3.2.13 Spirituality

Although there was some reluctance to discuss or link spiritual beliefs with biotechnology in the focus groups eight questions were included in the questionnaire. A study by Sjoberg and Wahalberg (2002) suggested respondents to a questionnaire may answer spiritual questions more readily than those in a focus group. The line of questioning therefore pursued for the purpose of discerning what could well be an important element in understanding the acceptability of biotechnology.

3.2.14 General Viewpoints

Vulnerability was also measured as another dimension of a worldview about biotechnology. Eight questions measured aspects of vulnerability including fairness, discrimination and fear.

These measures opened the possibility that the risk of biotechnology was for, some people, based on their feelings of being defenceless, of being exposed, or feelings of having some susceptibility to harm. These sentiments are captured by measures drawn from Slovic (2000:402). Two control questions relate to fatalism. 'A fair system' was interpreted as individualism and the 'equal distribution' question was interpreted as egalitarianism. The remaining four questions were designed to capture aspects of a personal sense of vulnerability.

3.2.15 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. The question about religious beliefs departed more than the other questions had from census questions by including 'agnostic', 'atheist' and 'spiritual but not religious'. Of note, this question did not ask for adherence to a particular denomination but was a more general inquiry of religious beliefs.

3.3 Pre-testing

Sixteen people completed a draft of the questionnaire and subsequently provided their thoughts and opinions on the content and structure of the questionnaire. Due to the concern over the length of the questionnaire these respondents were asked to record the time it took them to complete it. The time for completion ranged between 21 minutes and 38 minutes. In comment about the questionnaire five people said they found it easy to complete and three of these people reported it was an enjoyable experience. One person reported being uncomfortable with questions of an affective nature. Another person felt impeded by their lack of familiarity with specific examples of biotechnology. The phase 'based on your current knowledge' was subsequently added to the instructions for assessing the acceptability of examples of biotechnology and other 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 addressed 'to the householder' and the envelope carried large banners that read 'New Zealanders and biotechnology: A nationwide survey of public opinion', 'Important request to the householder' and 'Please tell us what you think about biotechnology. Your opinion matters'. The questionnaire was posted with a freepost return envelope on December 1st, 2003. To encourage further responses a second post out of the questionnaire to those who had not replied was posted on January 19th 2004.

3.5 Response rate

Within six weeks of the second post out 701 questionnaires with usable responses were returned. In addition, 69 had been returned undelivered and 45 were returned either uncompleted or without a sufficient number of responses to the questionnaire items. The response rate for usable responses was calculated as the proportion of useable questionnaires (701) over the 1,931 (2000 minus 69) that had received the questionnaire. The response rate for usable questionnaires was therefore 36.3 per cent.

3.6 Representativeness of the sample

Demographic information (sex, income, qualification and age) from the questionnaire was coded to enable comparison with census information about the New Zealand population. Census information was limited to people over the age of 15 to more closely correspond with the age of survey respondents. Frequencies per category and percentages per category for gender, age, income, qualification and ethnicity are provided in Table 1. A comparison between respondents in terms of gender found no evidence of significant difference (Chi sq. 0.117, df 1, $p > 0.05$). There were, however, differences (Chi sq., $p < 0.05$) between the sample and the census population data in terms of age, income, number of respondents with university qualifications and ethnicity. For example, as can be seen in Table 1 regarding age the sample had proportionately fewer young people and more old people compared to the census. The sample also had fewer respondents with low income, disproportionately more respondents with high income and there were a greater proportion of respondents with bachelors or postgraduate qualifications than recorded in census data. A further comparison of interest is the lack of responses from Maori and Asians with a particularly noticeably poor response from Pacific peoples with only two respondents.

It is well accepted that surveys usually suffer from lack of representation because older and wealthier people are more likely to participate. Other survey research at Lincoln University has experienced the same effect when surveying the public about attitudes towards tourism (e.g., Shone, Simmons & Fairweather, 2003).

Table 1 Representativeness of the sample compared to census data

Item	Sample frequency	Sample %	Population %
Gender (n = 691)			
Male	332	48.0	48.6
Female	359	52.0	51.4
Age (n = 688)			
15-24 Years	45	6.4	13.6
25-34 Years	85	12.1	14.1
35-44 Years	126	18.0	15.6
45-54 Years	133	19.0	13.1
55-64 Years	91	13.0	9.0
65-Years and Over	208	29.7	12.0
Income (n = 653)			
Less than $15000	162	23.1	40.0
$15001 to $20000	77	11.0	10.0
$20001 to $40000	182	26.0	30.3
$40001 to $60000	116	16.5	14.3
$60001 to $100000	81	11.6	2.8
$100001 and above	35	5.0	2.6
Education (n = 693)*			
School certificate	79	11.3	
Sixth form cert and/or UE	60	8.5	
Higher cert	29	4.1	
Diploma or trade cert	203	29.0	
Bachelors	109	15.5	8.1
Postgraduate	90	12.8	3.7
Ethnic group (n = 677)			
European	630	93.1	70.0
Maori	34	5.0	7.9
Pacific peoples	2	0.2	4.5
Asian	11	1.6	5.7
Other	0	0	0.5

* Note: Differences in design between the census and survey meant that comparison could only be provided for higher qualifications.

3.7 The issue of non respondent bias

Surveys based on samples may be subject to non-respondent bias. This bias occurs when the relevant characteristics of the non-respondent are different from respondents. A lack of information about the views of non-respondents means that it cannot be ruled out that disproportionately more replies are received from people with knowledge of, or interest in, the topic of the questionnaire. Indeed, with regard to the topic area of biotechnology it would seem logical to assume bias due to lack of knowledge of novel applications. In addition, for some biotechnologies it is known that some people ardently oppose them while others appear keen to support them. Ultimately this means that when assertions are made about the wider population, the often-invoked maxim of *ceteris paribus* (all other things being equal) does not apply. Plainly, it is likely that other things are not equal and that a survey may have a non-respondent bias. If this is the case then the sample proportions for or against biotechnology are recorded to a greater extent than they exist in the wider population. In the population it would be expected that there would be proportionately fewer people against biotechnology and fewer in support of biotechnology with a larger proportion having less extreme views.

To investigate the accuracy of this expectation we interviewed non-respondents to the biotechnology survey. This was accomplished by obtaining a sample of the phone numbers for the non-respondents. Initially ten non-respondents to the survey were telephoned and an attempt was made to ask why they had not responded, as well as to ask some key questions from the questionnaire and some demographic questions. This approach was abandoned when it was found that people were reluctant to participate by answering any of the questions. A second attempt designed to engage the person in a briefer interview was, however, more successful. During the week of 15-19 March 2004 a total of 46 randomly selected, non-respondent households were telephoned on weekday evenings. Of the 46 there was one disconnection, one person in the process of moving and no longer at the house, and 12 who did not answer the phone. This left 32 households contacted from which only one person was unwilling to participate and two did not wish to answer questions about biotechnology. Nevertheless, while agreeing to answer a few questions, all those that agreed to a brief interview gave the impression that they would not tolerate lengthy or detailed questioning.

For the 32 households contacted there were 13 males (41%) and 19 females (59%). Fifteen respondents (47%) said that they did receive the questionnaire, and the remainder said they did not or were not sure. About one half of the non-respondents were negative about receiving the questionnaire. Three respondents said that they had returned the questionnaire. These three were asked: "How did you find the questionnaire?". Their replies were:

1. "It was OK".
2. "Some questions I was not sure of. It was hard to comprehend. I was not sure what my answer would be."
3. "I had to be careful. The questionnaire was loaded. I had to be careful to make sure what I said was what I thought."

Two of these three respondents found the questionnaire hard going, and this is consistent with our own assessment of it based on the reactions of those who pre-tested it.

For the remaining 29 non-respondents, answers to the question "How important is biotechnology to you?" gave a good indication of their reasons for not replying. For 20 non-respondents, biotechnology was unimportant (two of these non-respondents said they did not really know about biotechnology and two were equivocal – and said that perhaps biotechnology was important). For three non-respondents biotechnology was important but they had good reasons for not replying. These reasons included: self employed and very busy, moving to a rest home, and biotechnology seen as "over my head". One non-respondent was anti research and chose no to give an answer. Finally, five non-respondents said biotechnology was important, but they nevertheless failed to reply to the postal questionnaire.

Overall, the survey of non-respondents showed that biotechnology was not important for 20 of 29 respondents (68.9 per cent) to the brief telephone survey. From the survey results 34.5 per cent neither agreed nor disagreed that biotechnology was acceptable. Given the lack of interest by these non-respondents and the prospect that this lack of interest would be concordant with a neutral response to the acceptability question, it can be assumed that those with an interest in the topic area either positively or negatively were more likely to have responded to the postal questionnaire. Consequently it is expected the survey data contains a larger proportion of those who assess biotechnology positively or negatively than exist in the New Zealand population. However, while survey estimates of prevalence may be overestimated, this does not necessarily mean that associations between variables found in the

sample are biased. Research has shown that non-response bias effected prevalence estimates but did not cause bias in examined associations (Loan et al., 2003).

Chapter 4
Results

4.1 Introduction

This chapter presents the results of statistical analyses of the survey data. The chapter begins by introducing the statistical methods that are employed in this analysis. The first results place concern over biotechnology in relation to concern over other social issues. Descriptive results are then provided for sections of the questionnaire. Then a variable representing a general attitude towards biotechnology is constructed and comparisons between this attitude and the other items is undertaken to investigate relationships between items. For the purpose of explaining attitude towards biotechnology two models are constructed. First, a model is proposed for an explanation based on social views and values, including beliefs about nature and spiritual beliefs. Second, a model is proposed for an explanation that uses the more immediate concerns and beliefs as determinants, including specific concerns about GM. Good support is found for the two models and the models are presented as explanations of a general attitude towards biotechnology.

4.2 Statistical methods

A variety of methods of statistical analysis 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 measured on either nominal or ordinal scales. Because some respondents did not reply to every question the number of responses to each item is included.

Correlation was used to analyse relationships between interval or ratio data. For interpretation of correlation results an r-value less than 0.3 was interpreted as weak, between 0.3 and 0.6 was moderate and above 0.6 was judged to be strong. Comparison between means was analysed using T-tests (unequal variances assumed).

For the purpose of modelling, 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 prior to each summation as an indication of 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 about a particular topic (Chen & Kraus, 2004). Values above 0.5 are considered acceptable as evidence of a common factor (Nunnally, 1967), while values above 0.7 are more definitive (Peterson, 1994).

Model analysis was performed using linear regression.

4.3 Concern over biotechnology in relation to other social issues

Respondents were asked to indicate their level of concern regarding 16 issues facing society so as to juxtapose concern about biotechnology and the use of genetically modified organisms in agriculture against concern about other social issues. Table 2 shows the mean scores for the level of concern for each issue. The mean scores are ranked in the table with the issues of most concern presented at the top of the table and the issue of least concern at the bottom of the table. As shown, social issues of crime and violence, availability of public health care and illegal drug use were of most concern. Resource and pollution issues are shown to comprise

relatively lower concern. The next concerns in terms of the mean score were unemployment, pesticide use, terrorism and motor vehicle accidents, all of which were found to have the very similar levels of concern. The measures of concern for the use of genetically modified organisms in agriculture, and biotechnology, when compared to the other issues, ranked amongst the five of least concern. Natural hazards were the issue of least concern.

Table 2 Concern over issues facing society

Issues	n	Mean	Std. Dev.	Percentage indicating concern
Crime and violence	691	4.54	0.68	93.5
The availability and quality of public health care	693	4.34	0.76	88.5
Illegal drug use	690	4.32	0.88	84.5
Decline in water quality	691	4.21	0.78	84.9
Air pollution	690	4.13	0.72	87.1
Industrial pollution	688	4.12	0.69	86.8
Loss of animal and plant species	689	4.05	0.86	77.9
Unemployment	688	3.78	0.87	67.2
Pesticide use	691	3.70	0.93	68.9
Terrorism	691	3.70	1.07	62.1
Motor vehicle accidents	688	3.70	0.93	62.2
Use of genetically modified organisms in agriculture	693	3.65	1.07	57.6
Climate change	692	3.61	0.92	57.8
Global warming	673	3.58	0.92	57.5
Biotechnology	682	3.51	0.93	51.6
Natural hazards (e.g., earthquake, cyclones, floods, etc)	689	3.09	0.83	30.9

Note: Range for all items 1 = Very unconcerned 5 = Very concerned

To examine concern for biotechnology in detail 51.6 per cent of the respondents were either concerned or very concerned about biotechnology. More concern was expressed for the use of genetically modified organisms in agriculture with 57.6 per cent being either concerned or very concerned. In comparison, 93.5 per cent indicated concern regarding crime and violence and, similarly, 88.5 per cent expressed concern over the availability and quality of public health care.

In summary, biotechnology does not appear to rank amongst the most important issues facing society. Over 50 per cent of the respondents expressed concern over the use of genetically modified organisms in agriculture and biotechnology. However, while of more concern than natural hazards, these issues are not of the greatest concern when compared to, for example, crime and violence and the availability and quality of health care.

4.4 The acceptability of biotechnology examples

The acceptability of 22 examples of environmental uses, medical uses and agricultural uses of biotechnology were measured. Descriptive results for five environmental uses are shown in Table 3. As can be seen, the acceptability of these environmental applications of biotechnology ranged from 34.5 per cent for cloning the kakapo to 55.7 per cent who had indicated the use of genetic modification to grow a crop as an environmentally friendly fuel source was acceptable. Of interest, the use of genetic modification in making a bacterium, making a fuel and developing a virus were more acceptable than the use of a soil bacterium

for pest control and the cloning of the kakapo. However, while useful as a general indicator of relative acceptability, comparisons must be made with some qualification. For example, the use of a soil bacterium for aerial application of pest control has been an issue of public concern which might have caused a higher than otherwise lack of acceptance. In addition, while an endangered species whose preservation would be in the public interest, the cloning of the kakapo may have invoked concern over the tarnishing of a New Zealand icon species.

Table 3 Biotechnology – environmental uses

	N	Mean	Std. Dev.	Agreement percentage
Use of genetically modified bacteria to help clean unwanted toxins in soil	685	3.18	1.11	48.9
Producing a low pollution grain-based fuel for cars by genetically modifying a crop	686	3.36	1.19	55.7
Developing a virus (genetically modified) that reduces fertility in possums	687	3.34	1.30	53.5
Use of aerial sprays made from soil bacterium (Bacillis thuringiensis) to control unwanted insect pests in urban areas	686	3.04	1.19	41.3
Cloning a kakapo to ensure the survival of the species	687	2.84	1.24	34.5

Note: Range for all items 1 = Very unacceptable 5 = Very acceptable.

Many of the medical uses of biotechnology were noticeably more acceptable than were the environmental uses. As can be seen in Table 4 the treatment of Huntington's disease, the use of DNA testing to help convict criminals, the treatment of a brain tumor and the monitoring of blood sugar levels in diabetics all exceeded 60 per cent for acceptance. Only three examples had less than 50 per cent acceptance. Two of these, the inserting of human genes into a cow and the transplanting copies of pancreatic cells from pigs into a person, involved the cross species transfer of genetic traits. The third involved the modification of a person's genetic code. These results suggest the mixing of genetic material or traits between species, or the within species manipulation of traits, were comparatively less acceptable than other forms of medical intervention.

The question set recording the acceptability of agricultural uses also comprised a number of food items. As shown in Table 5, the number of respondents indicating acceptance of genetically modified pine trees was relatively high, as was the numbers accepting the genetic screening of sheep to promote the birth of twins or triplets. In comparison, the numbers accepting of genetic modification of potatoes, kumara and apples was low, as was the number accepting of the use of a device containing bacteria in a sheep's stomach and the modification of hormone levels in sheep.

Table 4 Biotechnology – medical uses

	N	Mean	Std. Dev.	Agreement percentage
Using bacteria in throat lozenges to prevent serious infections	684	3.40	1.10	55.9
Inserting human genes into a cow to produce milk for the treatment of multiple sclerosis	685	3.08	1.28	46.9
Preventing stomach cancer by modifying a person's genetic code	682	3.11	1.19	44.9
Removing, repairing and then reinserting brain stem cells to help a sufferer of Huntington's disease	683	3.69	1.01	68.1
Using new cells (stem cells) from a 5 day old human embryo to treat an Alzheimer sufferer	684	3.25	1.26	50.0
Transplanting copies of pancreatic cells from pigs into a person to help treat diabetes	682	3.18	1.19	46.3
Using DNA (gene) testing to help convict criminals	688	4.52	0.81	92.3
A microscopic device can carry chemotherapy drugs through the blood-brain barrier to treat a brain tumor	682	4.17	0.80	85.6
A miniature biosensor implanted into a human body can be used to monitor blood sugar levels in diabetics	682	3.97	0.89	75.9
Manipulating the molecular structure of sunscreen so that it penetrates the skin to provide greater protection against UV radiation	681	3.50	1.12	54.4

Note: Range for all items 1 = Very unacceptable 5 = Very acceptable.

Table 5 Biotechnology – agricultural uses

	N	Mean	Std. Dev.	Agreement percentage
Using genetic screening to breed sheep that produce twins or triplets	686	3.10	1.11	40.0
Raising hormone levels in farm animals to increase fertility	685	2.80	1.02	26.1
Genetically modifying potatoes to resist common pests or diseases	684	2.91	1.16	35.7
Genetically modifying pine trees to produce stronger timber	688	3.28	1.17	52.9
Genetically modifying kumara to resist common pests or diseases	686	2.86	1.14	33.5
Inserting a plastic device containing bacteria into a sheep's stomach to reduce the production of harmful greenhouse gases	685	2.65	1.11	24.6
Genetically modifying an apple to make it more nutritious	684	2.52	1.16	22.7

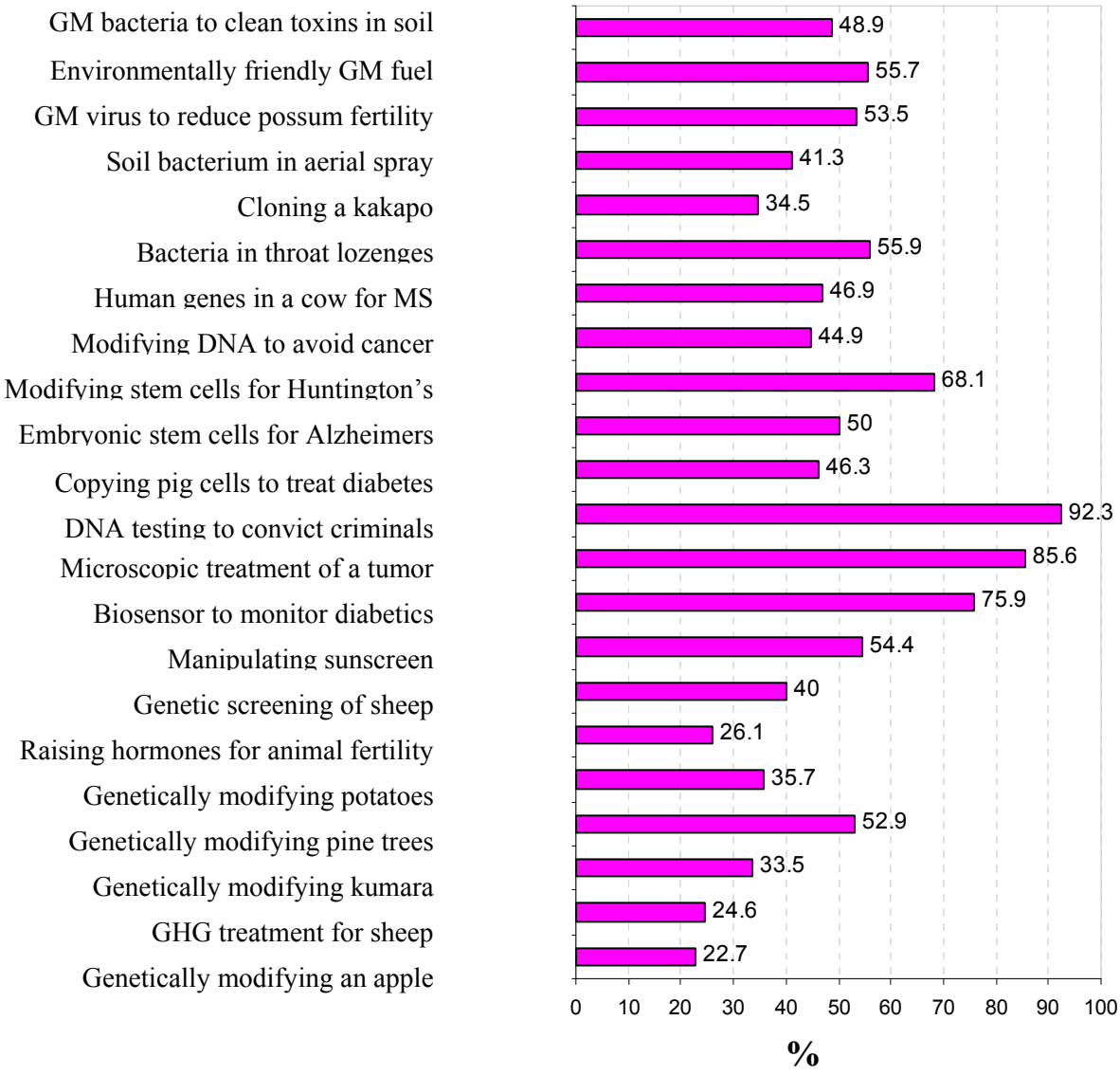
Note: Range for all items 1 = Very unacceptable 5 = Very acceptable.

Figure 1 provides a view of the data for all biotechnology examples so they can be compared. As can be seen, most of the examples of the use of biotechnology in agriculture had the lowest number of respondents indicating that they were acceptable. Of note, three of the four with the lowest percentage of acceptability were GM food examples and amongst these were the use of hormone treatment in sheep and the insertion of a device in sheep to reduce the production of greenhouse gasses. Genetically modifying an apple to make it more nutritious

was the least acceptable of the 22 examples. While these examples are only a few of the many possible examples, the results show that the use of genetic modification in food production was less acceptable than other areas in which biotechnology can be applied.

The more acceptable examples can also be seen in Figure 1. The example with the highest level of acceptability was the use of DNA testing to catch criminals. Recalling the finding from the previous section that crime and violence was the issue of most concern, it is not surprising that the use of biotechnology to help catch criminals had a very large percentage indicating acceptability. These high levels of concern and the acceptability of the technology to assist in crime prevention suggests that acceptability is driven by the importance of crime as a social issue, aided by the fact that it is already in use and involves DNA rather than GMOs.

Figure 1 Percentage indicating acceptance for all examples



Medical uses of biotechnology were also amongst those examples with a high percentage of acceptance. Of note, the second and third most accepted biotechnologies were examples of nanotechnology. The use of an introduced artificial microscopic mechanism appears to be acceptable to more respondents than the examples that used genetic modification. Apart from

the example of treating Huntington's disease, the examples show that a GM manipulation for medical purposes failed to exceed 50 per cent acceptance.

Of further interest, cross tabulation found that only 19 respondents indicated all of the biotechnology examples were acceptable. There were 99 who considered all five of the environmental examples were acceptable, 102 considered all five of the medical examples were acceptable, and 60 considered all five of the environmental examples acceptable.

4.5 Detailed assessment of five examples

Five examples of biotechnology were investigated in more detail. The five had already been assessed briefly in the previous section, but in this section these are explained more fully with seven questions being asked to investigate different aspects of a disposition towards the technology.

4.5.1 Genetically modified bacterium

The first question was headed with the following description. "A genetically modified bacterium can be developed that helps to repair soil damaged by DDE contamination (DDE is a harmful toxin that has remained in the soil from the use of the pesticide DDT)."

Table 6 Genetically modified bacterium

	n	Mean	Std. Dev.	Agreement percentage
This use of biotechnology is acceptable to me	667	2.54	0.96	15.1
I am familiar with this use of biotechnology	673	2.65	1.05	18.8
I feel dread at the thought of this use of biotechnology	678	2.63	1.05	20.9
I am confident that any unexpected outcomes from this biotechnology can be controlled	678	3.11	1.03	34.6
I fear that use of this biotechnology will result in irreversible harmful outcomes	676	2.70	1.02	18.7
I feel that use of this biotechnology would be unethical	678	3.09	1.13	18.7
I feel that use of this biotechnology would be unnatural	667	2.54	0.96	37.0

Note: 1. Range for all items 1 = Strongly disagree 5 = Strongly agree.

Table 6 shows that few respondents agreed that this biotechnology was acceptable and few were familiar with the example. Only a small proportion felt dread at the thought of this technology and just over one third were confident that it could be controlled. Less than 20 per cent feared irreversible harmful outcomes and a similar percentage felt the technology was unethical. A larger proportion of respondents felt that use of this biotechnology would be unnatural.

To investigate associations between items correlation values between the responses are shown in Table 7. Respondents' familiarity with the biotechnology had only a weak relationship with the other measures. This suggests that being familiar with the use of a genetically modified bacterium had little effect on other reactions to this technology. Other correlations showed moderate to strong relationships. For example, respondents with feeling of dread tended to estimate that the technology could not be controlled, that its effects were likely

irreversible, and that it was unethical and unnatural. On the other hand, those with low dread took the opposite view in terms of these characteristics.

Table 7 Relationships between items for GM bacterium

		Familiar	Dread	Control	Irreversible	Unethical	Unnatural
Acceptable	**r**	0.22***	-0.55***	0.56***	-0.47***	-0.59***	-0.52***
	n	665	669	672	673	671	673
Familiar	**r**		n. s.	0.21***	-0.14***	-0.09*	-0.13***
	n			665	665	665	666
Dread	**r**			-0.46***	0.61***	0.67***	0.58***
	n			671	672	672	673
Control	**r**				-0.54***	-0.44***	-0.46***
	n				674	674	675
Irreversible	**r**					0.64***	0.64***
	n					675	676
Unethical	**r**						0.73***
	n						676

Note: Significance level, * = $p < 0.05$¸ *** = $p < 0.001$

4.5.2 Bacteria throat lozenge

The second question set was headed with the following description. “Bacterium found naturally in some people’s saliva can be synthesised and introduced into throat lozenges. A protein produced by these bacteria fights a more harmful form of bacteria that can cause throat infections, rheumatic fever and in some cases rheumatic heart disease.”

As shown in Table 7, more than half of the respondents agreed that the use of a bacterium in throat lozenges was acceptable. Relatively few were familiar with these lozenges and only a few felt dread at the thought of this technology. Less than one-third agreed unexpected outcomes could be controlled and approximately one quarter of the respondents indicated concern over the possibility of irreversible harmful effects. A small proportion felt the technology was unethical and less than one third felt it was unnatural.

Table 8 Bacteria throat lozenge

	n	Mean	Std. Dev.	Agreement percentage
This use of biotechnology is acceptable to me	676	3.39	1.09	57.0
I am familiar with this use of biotechnology	656	2.61	0.98	18.2
I feel dread at the thought of this use of biotechnology	668	2.63	1.01	18.7
I am confident that any unexpected outcomes from this biotechnology can be controlled	670	2.88	1.01	29.1
I fear that use of this biotechnology will result in irreversible harmful outcomes	667	2.88	0.97	24.4
I feel that use of this biotechnology would be unethical	669	2.61	1.00	18.3
I feel that use of this biotechnology would be unnatural	668	2.88	1.10	29.2

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

Correlation values between the measured reactions to the bacteria lozenge are shown in Table 34. Familiarity had weak relationships with the other measures. Other correlations showed

moderate to strong relationships. These results suggest respondents with higher dread tended to estimate that the technology could not be controlled, that its effects were likely irreversible, that was unethical and unnatural. On the other hand those with low dread took the opposite view in terms of these characteristics. Familiarity was not a strong factor in terms of relationships with other measures.

Table 9 Relationships between items for lozenges

		Familiar	Dread	Control	Irreversible	Unethical	Unnatural
Acceptable	**r**	0.26***	-0.56***	0.58***	-0.48***	-0.55***	-0.48***
	n	656	667	668	667	668	667
Familiar	**r**		-0.08*	0.23***	-0.08*	-0.10**	-0.10*
	n		655	655	654	655	655
Dread	**r**			-0.42***	0.68***	0.72***	0.66***
	n			666	666	667	667
Control	**r**				-0.52***	-0.43***	-0.46***
	n				665	667	666
Irreversible	**r**					0.75***	0.71***
	n					666	666
Unethical	**r**						0.79***
	n						667

Note: Significance level, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$

4.5.3 Greenhouse gas sheep

A third question set was headed with the following description. “New Zealand’s main source of Greenhouse gases that can harm the environment come from methane in the stomachs of sheep. A plastic device containing bacteria can be inserted into a sheep’s stomach to reduce the production of methane gas”

In response to this question more than one third of the respondents found this use of biotechnology to be acceptable, though only a small number indicated it was familiar. More than one quarter indicated they felt dread at the thought of this biotechnology and almost 30 per cent agreed that unexpected outcomes could be controlled. More than a quarter indicated concern over the possibility of irreversible harmful effects. More than 30 per cent agreed that the technology was unethical and almost half felt it was unnatural.

Table 10 Greenhouse gas sheep

	n	Mean	Std. Dev.	Agreement percentage
This use of biotechnology is acceptable to me	669	2.84	1.15	34.4
I am familiar with this use of biotechnology	651	2.41	0.91	11.8
I feel dread at the thought of this use of biotechnology	663	2.81	1.07	27.2
I am confident that any unexpected outcomes from this biotechnology can be controlled	665	2.83	1.05	29.2
I fear that use of this biotechnology will result in irreversible harmful outcomes	663	2.89	1.02	26.9
I feel that use of this biotechnology would be unethical	669	2.93	1.10	31.3
I feel that use of this biotechnology would be unnatural	670	3.26	1.18	49.0

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

Correlation values between the measured reactions to this biotechnology are shown in Table 36. Familiarity had weak relationships with the other measures. However, there were correlation values with moderate to strong relationships between the other measures. Like reactions to the previous two examples, these generally strong values suggest interrelations between items. The correlation value between unethical and unnatural was particularly strong. The results show that those who felt dread also judged that the technology could not be controlled, that its effects were likely irreversible, and in particular it is shown that those who thought the technology unethical also judged it to be unnatural.

Table 11 Relationships between items for sheep

		Familiar	Dread	Control	Irreversible	Unethical	Unnatural
Acceptable	**r**	0.20***	-0.48***	0.52***	-0.39***	-0.55***	-0.52***
	n	649	661	663	661	664	664
Familiar	**r**		n. s.	0.15***	n. s.	-0.13***	-0.19***
	n			650		650	649
Dread	**r**			-0.30***	0.60***	0.67***	0.62***
	n			661	660	662	663
Control	**r**				-0.37***	-0.35***	-0.34***
	n				662	663	664
Irreversible	**r**					0.67***	0.59***
	n					662	662
Unethical	**r**						0.80***
	n						666

Note: *** = $p < 0.001$

4.5.4 Modified potato

The fourth example for assessment referred to a GM potato and was headed with the following description. “Using genetic modification a synthetic toad gene can be inserted into a potato in order to increase its resistance to disease.”

Table 12 Modified potato

	n	Mean	Std. Dev.	Agreement percentage
This use of biotechnology is acceptable to me	668	2.59	1.23	28.6
I am familiar with this use of biotechnology	652	2.61	1.05	21.0
I feel dread at the thought of this use of biotechnology	665	3.03	1.19	38.5
I am confident that any unexpected outcomes from this biotechnology can be controlled	666	2.48	1.07	19.1
I fear that use of this biotechnology will result in irreversible harmful outcomes	665	3.21	1.10	42.2
I feel that use of this biotechnology would be unethical	666	3.08	1.16	38.2
I feel that use of this biotechnology would be unnatural	666	3.38	1.21	53.0

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

To summarise the results presented in Table 12, less than 30 percent of the respondents found this technology acceptable. Twenty-one per cent found the example a familiar one, which was more than the level of familiarity for the previous three examples. Dread was felt by more

respondents than was felt for the other examples, and less than 20 per cent agreed that unexpected outcomes could be controlled. More than 38 per cent indicated concern over the possibility of irreversible harmful effects. Thirty eight per cent agreed that the technology was unethical and more than half felt it was unnatural. The example of a GM potato received more negative responses than had the other examples.

Correlation values between the reactions to the GM potato are shown in Table 38. Like the other examples for familiarity there was little evidence of relationships between this variable and the other measures. Also, like the other examples the remaining correlations showed moderate to strong relationships. These results suggest respondents who felt dread tended to estimate that the technology could not be controlled, that its effects were likely irreversible, that was unethical and unnatural. Those with low dread took the opposite view in terms of these characteristics. Like the previous example, unnatural and unethical were almost correspondent. This means that it was likely that a respondent who judged the technology unethical also judged it unnatural.

Table 13 Relationships between items for GM potato

		Familiar	Dread	Control	Irreversible	Unethical	Unnatural
Acceptable	**r**	0.20***	-0.47***	0.65***	-0.49***	-0.55***	-0.50***
	n	652	663	664	663	664	663
Familiar	**r**		n. s.	0.16	n. s.	n. s.	n. s.
	n			651			
Dread	**r**			-0.39***	0.68***	0.67***	0.66***
	n			662	662	663	662
Control	**r**				-0.44***	-0.42***	-0.42***
	n				662	663	662
Irreversible	**r**					0.75***	0.74***
	n					662	661
Unethical	**r**						0.81***
	n						664

Note: *** = $p < 0.001$

4.5.5 Treatment for Alzheimer's disease

The last of the five examples referred to a treatment for Alzheimer's disease and was headed with the following description. "New cells (stem cells) from a 5 day-old human embryo can be inserted into the brain of a person with Alzheimer's disease. This serves to regenerate some of the cells that have been destroyed."

As shown in Table 14 more than half of the respondents found this technology to be acceptable making this example the most acceptable of the five examples. This medical treatment was also the most familiar of the five examples with almost 30 per cent agreeing it was familiar to them. Twenty nine per cent of respondents, however, felt dread at the thought of this treatment, though more than 30 per cent indicated their view that unexpected outcomes could be controlled. More than one quarter indicated concern over the possibility of irreversible harmful effects. More than 31 per cent agreed that the technology was unethical and nearly 37 per cent felt it was unnatural. This medical example was more acceptable and familiar than the other examples, but concerns were also found regarding the other measures that were second only to the GM potato example in terms of the number of negative responses.

Table 14 Treatment for Alzheimer's disease

	n	Mean	Std. Dev.	Agreement percentage
This use of biotechnology is acceptable to me	667	3.27	1.26	53.4
I am familiar with this use of biotechnology	652	2.85	1.04	29.4
I feel dread at the thought of this use of biotechnology	660	2.83	1.16	28.7
I am confident that any unexpected outcomes from this biotechnology can be controlled	664	2.83	1.09	31.2
I fear that use of this biotechnology will result in irreversible harmful outcomes	663	2.92	1.00	26.0
I feel that use of this biotechnology would be unethical	665	2.96	1.17	31.3
I feel that use of this biotechnology would be unnatural	664	3.11	1.19	36.9

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

Table 15 Relationship between items for treatment for Alzheimer's disease

		Familiar	Dread	Control	Irreversible	Unethical	Unnatural
Acceptable	**r**	.20***	-.60***	.57***	-.52***	-.62***	-.53***
	n	650	657	661	660	661	661
Familiar	**r**		-.15***	.19***	-.12**	-.16***	-.12**
	n		648	650	650	651	651
Dread	**r**			-.47***	.64***	.74***	.67***
	n			659	659	659	659
Control	**r**				-.49***	-.44***	-.45***
	n				662	662	662
Irreversible	**r**					.71***	.70***
	n					662	662
Unethical	**r**						.81***
	n						664

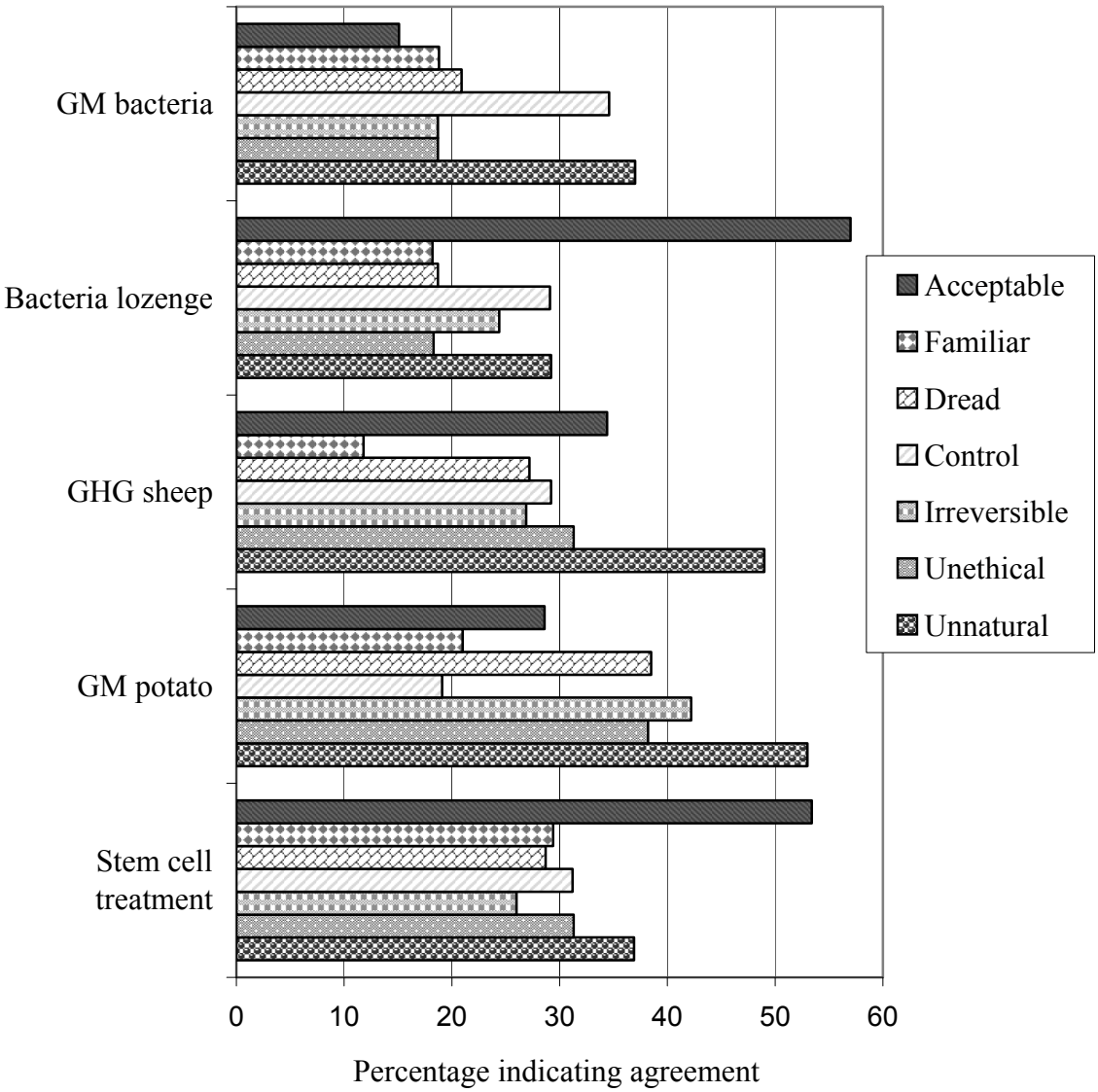
Note: Significance level, ** = $p < 0.01$, *** = $p < 0.001$

Correlation values between the measured reactions to the treatment for Alzheimer's disease are shown in Table 15. Unlike the other examples, there was some weak evidence of relationships with the other measures for correlations with familiarity. The remaining correlations showed moderate to strong relationships. Like the other examples, respondents with more dread tended to estimate that the technology could not be controlled, that its effects were likely irreversible, that was unethical and unnatural. The results also show that those with low dread took the opposite view in terms of these characteristics. Unnatural and unethical were almost correspondent meaning that it was very likely that a respondent who judged the technology unethical also judged it unnatural.

4.5.6 Comparison between examples

For the purpose of comparing the examples of biotechnology, Figure 2 shows the percentage of respondents indicating agreement with the seven statements for each of the five examples. First, in terms of acceptance, the bacteria lozenge and treatment for Alzheimers disease had the highest levels of acceptance. While the GM bacteria treatment of soil had the lowest level of acceptance. Between these extremes were the GHG sheep and GM potato.

Figure 2 Comparison between biotechnology examples



The treatment for Alzheimer's disease was the most familiar example and the GHG sheep was the least familiar. The GM potato gave rise to more dread than the other examples with both the GM bacteria treatment for soil and bacteria lozenge having comparatively low dread. Also regarding the GM potato, when compared to the other examples, fewer respondents thought that unexpected outcomes from this technology could be controlled and there was also more concern that this biotechnology would result in irreversible harmful outcomes. The GM potato was also judged to be unethical and unnatural by more respondents than had the other examples. At the other end of the range the bacteria lozenge was not only the most acceptable example and was also more favourably assessed with low dread, fewer respondents judged it unethical and fewer respondents judged it unnatural.

4.6 Beliefs about biotechnology

Fourteen questions measured a variety of beliefs about biotechnology. The results of these questions are shown in Table 12. To summarise these results by beginning at the top of the table, it is evident that in keeping with the view that biotechnology is about fixing things, almost half the respondents agreed that the technology can improve on the imperfections of nature. In keeping with this response, slightly more than half agreed that biotechnology could be used to fix environmental problems caused by humans. In answer to a question from a different viewpoint just over 30 per cent of the respondents agreed that animals and plants that have been genetically modified have a right to live and reproduce. A larger proportion (42 per cent) judged that genetic modification was a major step, while recognising that nature has not done this before. In contrast, few agreed that biotechnology simply harnesses and uses natural processes. However, more agreed (44 per cent) that it is part of natural evolution for people to start to play with genes. One third of respondents agreed that the genetic make up of humans and other animals is very similar.

In different line of questioning three questions referred to God in relation to biotechnology. With reference to the sanctity of the human body, approximately one third of the respondents agreed that we are made in the image of god and should not destroy this. The majority of the respondents (64.4 per cent) agreed that the purposeful activity of playing God brought with it the possibility of making mistakes. In addition, a sizeable proportion of the respondents (44.4 per cent) agreed that God had given people the responsibility to care for the welfare of other living things.

Three further questions of this set made specific reference to genetic modification. In relation to the mixing of genetic material from plants and animals, just over half of the respondents agreed this was wrong. Fewer respondents (40.7 per cent) were concerned about the lifting of the moratorium on genetic modification, though almost half agreed that it is worrying that the food we eat might have been produced using genetic modification. In addition, there was a resounding majority of respondents who agreed that the use of biotechnology needs to be transparent.

In summary, the first two questions of the set show that there was positive agreement by about half of the respondents that biotechnology could usefully improve on the imperfections of nature or fix problems. There were also calls for caution, which are particularly noticeable in the level of agreement with the statement that “When we try and play God we make mistakes”. In addition, the results showed that there was concern expressed by half the respondents about the use of GM in food production.

Table 16 Views on biotechnology

	n	Mean	Std. Dev.	Agreement percentage
Biotechnology can improve on the imperfections of nature	684	3.23	1.05	48.3
Biotechnology can fix environmental problems that have been caused by humans	680	3.38	0.96	51.8
Animals and plants that have been genetically modified have a right to live and reproduce	681	2.90	1.06	30.1
Genetic modification is a major step because nature hasn't done anything like this before	682	3.08	1.20	42.0
Biotechnology simply harnesses and uses natural processes	681	2.74	1.00	23.2
Part of natural evolution is that people will start to play with genes	684	3.08	1.17	44.4
The genetic make up of humans and other animals is very similar	675	3.10	0.95	33.9
We are made in the image of God and shouldn't destroy this	679	2.94	1.33	35.1
When we try to play God we make mistakes	680	3.67	1.12	64.4
God made people responsible for the welfare of other living things	683	3.18	1.27	44.4
It feels wrong to mix genetic material from plants and animals	686	3.47	1.11	53.4
It was wrong to lift the moratorium on field trials of genetically modified plants	684	3.23	1.19	40.7
It is worrying that the food we eat might have been produced using genetic modification	686	3.37	1.18	49.7
The use of biotechnology needs to be transparent	686	4.41	0.76	90.1

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree

4.7 Believing different sources of information about biotechnology

Measurement was taken regarding the believability of statements made by six actors involved in biotechnology. As shown in Table 17, university scientists and crown research institutes were judged more trustworthy than the other actors in terms of the believability of the statements they made about biotechnology. Fewer respondents agreed they believed statements by regulatory agencies. Still fewer (13.8 per cent) believed statements made by the popular media and only a small proportion believed companies involved in biotechnology. Very few of the respondents believed statements about biotechnology made by politicians.

Table 17 Believing statements about biotechnology

	n	Mean	Std. Dev.	Agreement percentage	Disagreement percentage
I usually believe statements by regulatory agencies	686	2.96	0.91	31.8	31.0
I usually believe statements by university scientists	686	3.26	0.84	44.9	18.1
I usually believe reports in newspapers and on the radio or TV	688	2.56	0.89	13.8	48.0
I usually believe statements made by crown research institutes	687	3.24	0.87	43.9	16.9
I usually believe statements made by politicians	686	1.92	0.84	3.1	43.7
I usually believe statements by biotech companies	686	2.35	0.88	7.3	78.0

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

4.8 Who benefits from biotechnology?

Five enquires were made regarding who respondents considered would benefit from biotechnology. The results presented in Table 18 show that the majority of respondents (80.3 per cent) agreed that private corporations or companies would benefit from biotechnology. In comparison, less than 40 per cent considered that the public or the economy would benefit and less than 30 per cent agreed it would improve the quality of life for new Zealanders. More agreed (35 per cent) that himself or herself or an immediate family member would benefit from a medical application of biotechnology.

Table 18 Who benefits from biotechnology?

	n	Mean	Std. Dev.	Agreement percentage
Biotechnology will benefit private corporations or companies	689	4.03	0.75	80.3
Biotechnology will benefit the New Zealand public	689	3.10	0.96	37.5
Biotechnology will benefit the New Zealand economy	687	3.19	0.96	31.0
Biotechnology will improve the quality of life for all New Zealanders	690	2.91	0.96	27.5
Myself or a member of my immediate family would benefit from a medical treatment developed using biotechnology	686	3.04	1.04	35.0

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

4.9 Concerns about GM and biotechnology

A question set of seven questions measured concerns about GM. The results presented in Table 19 show a good proportion of the survey respondents agreed with these concerns. Just under two thirds agreed that the use of GM in plants will result in cross contamination and a similarly just over one third agreed that GMOs would spread to places we do not want them.

There was a good deal of concern expressed about compliance with rules or regulations governing the development or release of GMOs. More than 80 percent agreed that compliance was a problem. However, a smaller percentage (44.1 per cent) agreed that GMOs will mutate into something dangerous. Risk to the public or the environment was nevertheless a concern for more than 50 per cent of the respondents and a greater proportion agreed that GMOs would damage exports by tarnishing New Zealand's clean green image. Finally, and in keeping with the concerns of the respondents, three quarters of the respondents agreed that biotechnology may solve a problem but that it can also create more problems.

Table 19 Concerns about GM and biotechnology

	n	Mean	Std. Dev.	Agreement percentage
The use of genetically modified plants will result in the cross contamination of non-GM seeds	686	3.75	0.87	64.7
Genetically modified organisms will spread into places we do not want them	686	3.80	0.85	66.1
People will not always comply with rules or regulations governing the development and release of genetically modified organisms	686	4.07	0.84	83.7
Genetically modified organisms will mutate into something dangerous	685	3.30	0.89	44.1
The commercialisation of biotechnology will result in more risk to the public or the environment	686	3.52	0.97	52.9
The release of genetically modified organisms will damage exports by tarnishing New Zealand's image of being clean and green	686	3.71	1.04	59.0
Biotechnology may solve a problem but it can also create more problems	686	3.97	0.85	75.0

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

4.10 General attitude towards biotechnology

Seven questions were used to gauge the general attitude towards biotechnology. Descriptive results for the seven items are shown in Table 20. Almost one half of the respondents indicated that biotechnology was acceptable. Less than one third agreed they were familiar with the technology and less than one-quarter felt dread at the thought of biotechnology. Less than one quarter of the respondents were confident the technology could be controlled and 21 percent feared it would result in irreversible harmful outcomes. Just over one half felt biotechnology was unethical and 42 per cent felt that use of the technology would be unnatural. The results show that a sizable proportion of the respondents found biotechnology to be acceptable, but only a relatively small proportion were confident that the technology could be controlled.

Table 20 General attitude towards biotechnology

	n	Mean	Std. Dev.	Agreement percentage
Biotechnology is acceptable to me	681	3.26	1.01	45.6
I am familiar with biotechnology	670	2.94	0.92	29.3
I feel dread at the thought of biotechnology	681	2.78	1.03	23.5
I am confident that any unexpected outcomes from biotechnology can be controlled	684	2.60	1.01	23.5
I fear that the use of biotechnology will result in irreversible harmful outcomes	683	3.23	1.04	20.8
I feel that use biotechnology would be unethical	680	2.89	1.02	51.9
I feel that use of biotechnology would be unnatural	681	3.16	1.12	42.0

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree

4.11 Intention to purchase

While the questionnaire investigated in a general way the views and beliefs about biotechnology, reactions to a number of specific GM food products was also measured. The results of this investigation into intentions to purchase are presented in Table 21. The lowest percentage agreeing to purchase the products was 22.7 per cent for the purchase of milk from cows that are grown on pastures containing genetically modified clover. The highest percentage was 32.5 per cent who intended to purchase apples genetically modified to produce twice as much antioxidants, which may help prevent cancer. The next highest number intending to purchase (30.4 per cent) was for sweet corn that has been genetically modified to resist insects so that it requires 50 per cent less than the usual application of pesticides. Of interest, the milk example had no mention of a consumer benefit, whereas the apple and sweet corn examples had consumer benefits with the former offering resistance to cancer and the latter offering the potential for reduced pesticide residues. Although the examples are for different products, meaning that it cannot be assumed that intentions to purchase would be the same, the results suggest that GM products with consumer benefit have an advantage in the marketplace over other GM products.

Overall the percentage of respondents intending to purchase was low. Of interest, 13 per cent of the respondents had a positive intention to purchase all of the products. There were also 27.1 per cent who did not intend to purchase any of the products and 14.6 per cent who neither intended to purchase or avoid purchasing the six products. Together these percentages show that 40.1 percent of the respondents had given the same response to each purchase item.

Table 21 Intention to purchase

	n	Mean	Std. Dev.	Agreement percentage
Butter from cows genetically modified to produce 50% less cholesterol in their milk	685	2.71	1.13	26.6
Meat from sheep genetically modified for 'double-muscling', producing more meat and less fat per animal	686	2.65	1.14	26.6
Bread made from genetically modified wheat that is 25% cheaper to grow	686	2.67	1.10	25.2
Apples genetically modified to produce twice as much antioxidants, which may help prevent cancer	688	2.83	1.17	32.5
Milk from cows that are grown on pastures containing genetically modified clover	687	2.71	1.06	22.7
Sweetcorn that has been genetically modified to resist insects so that it requires 50% less than the usual application of pesticides	687	2.80	1.13	30.4

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

4.12 Beliefs about nature

Beliefs comprising attitude towards nature were surveyed extensively using 20 questions. The results of these questions are shown in Table 22.

In summary, beginning at the top of the table, there were two questions regarding interference with nature. A large proportion of the respondents (77.1 per cent) agreed that interfering with nature would result in unpredictable consequences. Similarly, though not with the same level of agreement (52.4 percent), just over half agreed that descendants would pay for interference. Only a quarter of the respondents agreed that nature could adapt to the products of genetic engineering, but more agreed (52.6 per cent) that nature had a tremendous ability to recover from abuse. These responses suggest that there is concern regarding the consequences of interfering with nature, but it is also recognised that nature has some capacity to recover from abuse or damage. To add further to these results many respondents (75.3 per cent) recognised that people have a special position in nature perhaps implying a guardian or stewardship role. Along with this special position it is nevertheless recognised by many of the respondents that people have a natural desire for self-improvement otherwise they would still be in the caves. The responses show that the use of biotechnology may be part of a natural process, but it is also recognised that technology must be used wisely given the view that interference with nature will result in unpredictable consequences. This section of the nature results was perhaps best summed up with the prompt that "It is wrong to play God with living things" to which almost half the respondents agreed.

Five questions dealt with different, but complimentary dimensions of the concept of nature. Not dissimilar proportions responded with agreement to the statements "Nature knows best" (47.9 per cent) "Nature is morally good" (43 per cent) and "Nature is pure and wild" (51.6 per cent) and "Nature is dynamic". Answers to the three questions were very similar (Cronbach's alpha = 0.84) suggesting that each represents an aspect of a conception of nature. Agreement with the view that nature is dynamic received noticeably more agreement (74.1 per cent) than the previous three items. However, the responses to this question were in keeping with the responses to the previous three questions (Cronbach's alpha = 0.80 for the four questions). Given the attribution of sentience in agreement that nature knows best and is morally good, an interpretation of dynamic as meaning self-motivated and forceful would clarify the

association between these responses. The further consideration of agreement with the statement that "Nature exists in a state of ecological harmony" was also aligned well with the other four responses (Cronbach's Alpha = 0.83).

Table 22 Beliefs about Nature

	n	Mean	Std. Dev.	Agreement percentage
When we interfere with nature the consequences are unpredictable	682	3.93	0.84	77.1
If we interfere with nature our descendants will pay for it	681	3.57	0.96	52.4
Nature can adapt to the products of genetic engineering	677	2.94	0.87	26.1
The environment may have been abused but it has tremendous ability to recover	681	3.30	1.00	52.6
We have a special position in nature	680	3.87	.88	75.3
If we didn't have a natural desire to improve the world, we'd still be back in the caves	679	3.42	1.09	58.2
It is wrong to play God with living things	677	3.34	1.12	47.7
Nature knows best	680	3.44	0.98	47.9
Nature is morally good	675	3.28	1.03	43.0
Nature is pure and wild	678	3.48	0.93	51.6
Nature is dynamic	679	3.90	0.76	74.1
Nature exists in a state of ecological harmony	675	3.47	0.93	51.9
At least once in my life, I have felt a deep connection with nature	677	3.94	0.82	75.3
I remember when the environment was more natural	682	3.76	0.86	68.5
The environment probably doesn't need as much protection as we imagine	681	2.64	1.09	26.8
Nature may be resilient but can only absorb a very limited amount of damage	677	3.74	0.81	71.2
Nature is essentially a very fragile thing. It cannot withstand what has been done to it thus far.	681	3.25	0.91	40.3
Nature is made up of complex interdependencies. Human meddling of the kind introduced by genetic modification will cause a chain reaction with unanticipated effects	680	3.56	0.99	53.4
We shouldn't be too worried about environmental damage. Technology is developing so quickly that in the future people will be able to repair most of the environmental damage that has been done	679	2.31	0.98	12.6

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

Three quarters of the respondents agreed that they had at some time felt a deep connection with nature and almost the same proportion indicated that they could remember when the environment was more natural.

Four further items made reference to resilience or fragility. Only a small proportion of the respondents (26.8 per cent) agreed that the environment probably doesn't need as much protection as we imagine. Many agreed (71.2 per cent) that, while resilient, the environment could only absorb a very limited amount of damage. Although fewer agreed (40.3 per cent) with the description of nature as being fragile to the extent that it could not recover from what has occurred thus far. While recognising nature was made up of complex interdependencies,

just over half agreed that meddling of the kind introduced by genetic modification will cause a chain reaction with unanticipated effects. Finally only a small proportion of the respondents (12.6 per cent) agreed that we should not be too worried about environmental damage with more respondents disagreeing with the view that technological innovation could repair the damage already done to the environment.

4.13 New Zealand identity

Ten statements were used as prompts to measure key aspects of the New Zealand identity. The statements were used to assess both a personal view and a subjective view of what New Zealanders believe.

First to discuss the personal view, many of the responses shown in Table 23 varied little in terms of differences in agreement as shown by the generally low measures of standard deviation. The majority of respondents agreed that "New Zealand is clean and green" and a larger proportion agreed with the statement that "Agriculture is an important part of New Zealand identity". Most agreed that sheep were important, sport and the kiwi were important. Many agreed in valuing something if it was useful. There was comparatively less agreement with the view that New Zealanders are in touch with the land. More agreed that New Zealanders value business success. Less than half agreed that New Zealanders value science and a similar proportion judged that New Zealanders valued arts and crafts.

The view of what New Zealanders believe (Table 24) had some minor differences in comparison with the personal view. The standard deviation measures were a little more constrained indicating a little less variance or variety in the responses. There were also some minor differences in mean scores and the proportion of agreement with the statements.

Table 23 New Zealand Identity (personal view)

	n	Mean	Std. Dev.	Agreement percentage
New Zealand is clean and green	679	3.34	0.99	55.7
Agriculture is an important part of New Zealand identity	684	4.31	0.60	95.0
Sheep are an important part of New Zealand identity	684	4.04	0.79	83.6
Winning at sport is an important part of New Zealand identity	685	3.58	1.01	61.6
The kiwi is an important part of New Zealand identity	685	4.24	0.75	88.8
New Zealanders value something if it is useful	685	3.87	0.73	76.6
New Zealanders are in touch with the land	683	3.28	0.94	76.9
New Zealanders value business success	682	3.76	0.77	71.1
New Zealanders value science and research	683	3.59	0.89	63.5
New Zealanders value arts and crafts	685	3.41	0.91	52.1

Note: Range for all items 1 = Strongly agree 5 = Strongly disagree.

Table 24 New Zealand Identity (what most NZers believe)

	n	Mean	Std. Dev.	Agreement percentage
New Zealand is clean and green	660	3.96	0.64	86.4
Agriculture is an important part of New Zealand identity	661	4.15	0.65	89.3
Sheep are an important part of New Zealand identity	659	4.03	0.70	83.3
Winning at sport is an important part of New Zealand identity	659	4.33	0.68	91.5
The kiwi is an important part of New Zealand identity	659	4.34	0.63	92.7
New Zealanders value something if it is useful	655	3.88	0.66	77.6
New Zealanders are in touch with the land	656	3.54	0.79	58.1
New Zealanders value business success	655	3.72	0.81	67.0
New Zealanders value science and research	656	3.33	0.82	43.0
New Zealanders value arts and crafts	655	3.35	0.84	45.0

Note: Range for all items 1 = Strongly agree 5 = Strongly disagree.

Differences between the personal view and what respondents considered most New Zealanders believe is shown in Table 25. As shown fewer respondents personally considered the country to be clean and green when compared to their view of what other New Zealanders believed. Personally the respondents felt more personally positive about the importance of agriculture than they considered others to be. Fewer of them agreed sport was important while judging it to be more important for other New Zealanders. It was also personally felt that it was more important to be in touch with the land when compared to the respondent views of others. Finally science and research was more important to the individual when compared to their views of the preferences of other new Zealanders.

Table 25 Percentage differences between the personal view and the view of others

	Percentage agreeing: Personal view	Percentage agreeing: View of others	Percentage difference
New Zealand is clean and green	55.7	86.4	+30.7*
Agriculture is an important part of New Zealand identity	95.0	89.3	-5.7*
Sheep are an important part of New Zealand identity	83.6	83.3	n.s.
Winning at sport is an important part of New Zealand identity	61.6	91.5	+29.9*
The kiwi is an important part of New Zealand identity	88.8	92.7	+3.8*
New Zealanders value something if it is useful	76.6	77.6	n.s.
New Zealanders are in touch with the land	76.9	58.1	18.8*
New Zealanders value business success	71.1	67.0	n.s.
New Zealanders value science and research	63.5	43.0	-20.5*
New Zealanders value arts and crafts	52.1	45.0	n.s.

Note: * = significant difference ($p > 0.05$) in paired sample t-test.

4.14 Technological world view

The results of the measurement of items related to a technology and resource use are shown in Table 26. Approximately 40 per cent of the respondents identified with the view that a technological society could eliminate poverty and a similar proportion considered that it would mean social goals could be realised. Alternatively, more than 60 per cent agreed that a simpler lifestyle was the best way of conserving energy and resources and a similar percentage agreed that wealthier nations should consume less and limit their use of resources. A smaller proportion (40.8 per cent) agreed that groups opposing materialistic values deserve support. The results therefore suggest that the respondents tended to favour limiting the use of resources although it is not clear whether respondents included New Zealand in their idea of wealthier nations.

Table 26 Technology

	n	Mean	Std. Dev.	Agreement percentage
A technological society has the best chance of eliminating poverty	681	3.15	0.97	40.1
Advances in technology mean that the goals of society can be realised	679	3.21	0.89	41.4
Living a simpler lifestyle is the best way to conserve energy and resources	680	3.62	0.88	64.1
Wealthy nations should consume less and limit their use of resources	681	3.70	0.91	63.9
Groups that oppose the emphasis on materialistic values deserve support	683	3.28	0.91	40.8

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

4.15 Clean and green

The results of the question set that investigated beliefs about New Zealand being clean and green are shown in Table 28. First, the results about clean green New Zealand are given international context with the predominant agreement (73.2 per cent) that New Zealand is more clean and green than other countries. However, fewer respondents agreed (36.4 per cent) that agricultural production in New Zealand has few adverse effects on the environment. There was optimism that the country could one day become clean and green and many agreed that they were proud of our current international status as a clean and green country. However, many agreed (79.9 per cent) that New Zealand used to be more clean and green than it is now. Few agreed with the statement that clean green New Zealand is a myth, but in summary these results do show that there is a realisation that New Zealand is not as clean and green as it was. There was also an indication that agricultural production may adversely impact on this clean green status. Further, the different statements show complex beliefs that have a contradictory element to them.

In terms of relationships with attitude towards biotechnology, there was some evidence of a relationship with agreement with the statement that New Zealand used to be more clean and green than it is now. Those who agreed with this statement tended to have a negative attitude towards biotechnology.

Table 27 Clean and green New Zealand

	n	Mean	Std. Dev.	Agreement percentage
New Zealand's natural environment is more clean and green than other countries	680	3.73	0.81	73.2
Agricultural production in New Zealand has few adverse effects on the environment	681	2.98	1.01	36.4
I think that New Zealand could one day become clean and green	678	3.60	0.81	60.3
I am proud of our current international status as a clean and green country	677	3.82	0.75	72.7
New Zealand used to be more clean and green than it is now	678	3.97	0.84	79.9
Clean green New Zealand is a myth	681	2.84	1.00	26.6

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

4.16 Spirituality

The results of the enquiry into spiritual beliefs are shown in Table 29. Just over one half of the respondents agreed that they often thought about the meaning of life. Few respondents (7.4 per cent) reported having the feeling that life is meaningless. Less than 20 per cent attended religious services on a regular basis, though about twice this percentage (41 per cent) believed in a personal God. Even more of the respondents (52.2 per cent) believed there is some sort of life force or spirit, not a person. The statement that received the most agreement was "I believe that people have a soul" and "I believe that sin exists" received a slightly lower proportion of agreement. There was, however, somewhat less agreement (41.8 per cent) with a personal belief in life after death.

Table 28 Spirituality

	n	Mean	Std. Dev.	Agreement percentage
I often think about the meaning of life	675	3.42	1.01	54.1
I often have the feeling that life is meaningless	673	2.12	0.86	7.4
I attend religious services on a regular basis	667	2.26	1.21	17.7
I believe there is a personal God	669	3.07	1.33	41.0
I believe there is some sort of life force or spirit, not a person	671	3.29	1.18	52.2
I believe that people have a soul	675	3.73	1.08	68.9
I believe that sin exists	676	3.59	1.17	62.7
I believe in life after death	674	3.19	1.28	41.8

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

4.17 Vulnerability

The results of eight questions that measured aspects of vulnerability including fairness, discrimination and fear are shown in Table 30. The results show that the New Zealand respondents tended not to agree with most of these questions. A good proportion of the respondents (67.7 per cent) did favour a fair system where people who try harder should be rewarded financially. In addition, a similar proportion (66.6 per cent) agreed that "The world needs a more equal distribution of wealth".

Table 29 Vulnerability

	n	Mean	Std. Dev.	Agreement percentage
I often feel discriminated against	678	2.47	0.98	16.4
In a fair system, people who try harder should be rewarded financially	680	3.70	0.82	67.6
The government should strictly limit people's personal risk-taking activities	678	2.27	0.96	10.2
My whole life feels like it's falling apart	678	1.75	0.79	3.1
It is OK for society to impose a small amount of risk on individuals without their consent	677	2.27	0.99	13.0
The world needs a more equal distribution of wealth	680	3.70	0.96	66.6
Life's ups and downs are mostly a matter of fate or divine will, not personal control	678	2.48	0.98	17.3
I have very little control over risks to my health	682	2.40	0.98	17.3

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

4.18 Modelling attitude towards biotechnology using single variables

This part of the results explains the construction of a single item for the purpose of representing a general attitude towards biotechnology. The results of an investigation of associations between attitude and other items is then provided with the tests undertaken using correlation analysis.

4.18.1 Construction of the attitude variable

A single variable was formed from the analysis of the responses to seven questions to form a general attitude towards biotechnology. Descriptive results for the seven items, previously described in Section 4.10, are shown in Table 30.

Table 30 General attitude towards biotechnology

	n	Mean	Std. Dev.	Agreement percentage
Biotechnology is acceptable to me	681	3.26	1.01	45.6
I am familiar with biotechnology	670	2.94	0.92	29.3
I feel dread at the thought of biotechnology	681	2.78	1.03	23.5
I am confident that any unexpected outcomes from biotechnology can be controlled	684	2.60	1.01	23.5
I fear that the use of biotechnology will result in irreversible harmful outcomes	683	3.23	1.04	20.8
I feel that use biotechnology would be unethical	680	2.89	1.02	51.9
I feel that use of biotechnology would be unnatural	681	3.16	1.12	42.0

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree

As planned, Cronbach's alpha was used to measure the internal reliability or consistency of the items presented in Table 26. An adequate measure of reliability was achieved when responses to the first two questions (acceptable and familiar) were omitted (Cronbach's alpha = .62). The remaining five questions were recoded into a common range (i.e. 1 = negative response to 5 = positive response) then added and averaged to form a single attitude towards biotechnology item (n = 679, mean 2.91, s.d. 0.87).

4.18.2 Demographic variables and attitude towards biotechnology

Tests were undertaken to investigate differences with demographic information and attitude towards biotechnology. The results of these tests are shown in Table 31. There were differences between males and females with males having, in general, a more positive attitude towards biotechnology. Those in higher income groups and with higher educational qualifications also had a more positive attitude. Christians and those who had selected spiritual as their preferred religion had a less positive attitude than agnostics and atheists. Agnostics had the most positive attitude towards biotechnology.

Table 31 Demographic variables and attitude towards biotechnology

Item	Sample frequency	Attitude mean	Attitude Std. Dev.	Means with significant differences (t-tests, $p < 0.05$)
Gender				
Male (1)	323	2.21	0.61	1-2
Female (2)	347	1.95	0.67	
Income				
Less than $15000 (1)	159	1.97	0.64	1-3, 1-5,
$15001 to $20000 (2)	74	1.89	0.61	1-6, 2-3,
$20001 to $40000 (3)	176	2.34	0.67	2-5, 2-6,
$40001 to $60000 (4)	115	2.06	0.66	3-6, 4-6,
$60001 to $100000 (5)	80	2.37	0.61	5-6
$100001 and above (6)	33	2.60	0.52	
Education				
Attended primary (1)	16	2.15	0.60	2-5, 2-8,
Attended secondary (2)	104	2.00	0.71	3-5, 3-8,
School certificate (3)	78	1.95	0.70	3-9, 5-7,
Sixth form cert (4)	28	2.08	0.42	6-7, 7-8,
UE (5)	31	2.31	0.57	7-9
Higher cert (6)	27	2.24	0.52	
Diploma or trade cert (7)	199	1.97	0.60	
Bachelors (8)	104	2.23	0.64	
Postgraduate (9)	87	2.18	0.73	
Ethnic group				
European (1)	615	2.09	0.65	
Maori (2)	24	2.00	0.84	
Pacific peoples (3)	2	1.30	0.42	
Asian (4)	8	2.03	0.57	
Religion				
Christian (1)	339	2.00	0.60	1-2, 1-3,
Agnostic (2)	49	2.51	0.60	2-3, 2-4,
Atheist (3)	70	2.27	0.68	2-5, 3-4
Spiritual (4)	152	2.02	0.71	
Other (5)	11	1.96	0.83	

4.18.3 Correlations between general attitude and biotechnology examples

As shown in Table 32, regarding associations between attitude and environmental uses of biotechnology there were weak to moderate correlation values. The environmental use of genetically modified bacteria to help clean unwanted toxins in soil ($r = 0.53$) and the genetic

modification of a crop for car fuel (r = 0.55) and developing a virus to reduce possum fertility were more aligned with the attitude towards biotechnology than the other environmental examples. The use of aerial sprays made from soil bacterium to control unwanted insect pests in urban areas and cloning the Kakapo did not align as well with attitude towards biotechnology.

Table 32 Correlation with environmental uses

	n	Correlation
Use of genetically modified bacteria to help clean unwanted toxins in soil	669	0.53***
Producing a low pollution grain-based fuel for cars by genetically modifying a crop	669	0.55***
Developing a virus (genetically modified) that reduces fertility in possums	672	0.52***
Use of aerial sprays made from soil bacterium (Bacillis thuringiensis) to control unwanted insect pests in urban areas	670	0.38***
Cloning a kakapo to ensure the survival of the species	671	0.39***

Note: *** = p < 0.001.

All of the medical examples, except for the use DNA (gene) testing to help convict criminals, were aligned with attitude towards biotechnology. However, the low correlation between attitude and DNA testing suggests the acceptability of this use of biotechnology is influenced more by its use to catch criminals than the acceptability of the use of biotechnology. Also of note are the lower correlation values for the examples of nanotechnology. These low values might suggest that nanotechnology is less well-known than the other biotechnology examples, or is not widely recognised as a standard example of biotechnology.

Table 33 Correlation with biotechnology – medical uses

	n	Correlation
Using bacteria in throat lozenges to prevent serious infections	679	0.42***
Inserting human genes into a cow to produce milk for the treatment of multiple sclerosis	669	0.57***
Preventing stomach cancer by modifying a person's genetic code	667	0.46***
Removing, repairing and then reinserting brain stem cells to help a sufferer of Huntington's disease	668	0.35***
Using new cells (stem cells) from a 5 day old human embryo to treat an Alzheimer sufferer	669	0.46***
Transplanting copies of pancreatic cells from pigs into a person to help treat diabetes	682	0.44***
Using DNA (gene) testing to help convict criminals	688	0.10**
A microscopic device can carry chemotherapy drugs through the blood-brain barrier to treat a brain tumor	682	0.24***
A miniature biosensor implanted into a human body can be used to monitor blood sugar levels in diabetics	682	0.31***
Manipulating the molecular structure of sunscreen so that it penetrates the skin to provide greater protection against UV radiation	681	0.32***

Note: ** = p < 0.01, *** = p < 0.001.

Table 34 Correlation with biotechnology – agricultural uses

	n	Correlation
Using genetic screening to breed sheep that produce twins or triplets	669	0.42***
Raising hormone levels in farm animals to increase fertility	669	0.45***
Genetically modifying potatoes to resist common pests or diseases	668	0.66***
Genetically modifying pine trees to produce stronger timber	668	0.57***
Genetically modifying kumara to resist common pests or diseases	672	0.64***
Inserting a plastic device containing bacteria into a sheep's stomach to reduce the production of harmful greenhouse gases	670	0.40***
Genetically modifying an apple to make it more nutritious	668	0.59***

Note: *** = $p < 0.001$.

In consideration of the correlation results for agricultural uses the food examples were more aligned to attitude than were other examples. The stronger correlation values indicate that those who have a negative or positive attitude towards biotechnology similarly found these food examples respectively unacceptable or acceptable. Because these values are strong it cannot be readily discounted that the personal consideration of biotechnology involves the implicit or explicit consideration of the use of genetic engineering in food production.

4.18.4 Correlations between general attitude towards biotechnology and views on biotechnology

The correlation results presented in Table 35 between attitude towards biotechnology and beliefs about biotechnology show the strongest values between attitude and most of the beliefs about genetic modification. This suggests that when answering questions about biotechnology respondents may well be have been more mindful of GM than they were with other examples of biotechnology. Further, the stronger correlation values for come comparisons suggest that concerns about mixing genetic material between plants and animals, the lifting of the moratorium and the use of GM in food production were key concerns that influenced attitude towards biotechnology.

Table 35 Correlation with views on biotechnology

	n	Correlation
Biotechnology can improve on the imperfections of nature	671	0.52***
Biotechnology can fix environmental problems that have been caused by humans	669	0.50***
Animals and plants that have been genetically modified have a right to live and reproduce	669	0.46***
Genetic modification is a major step because nature hasn't done anything like this before	669	0.09***
Biotechnology simply harnesses and uses natural processes	670	0.57***
Part of natural evolution is that people will start to play with genes	671	0.30***
The genetic make up of humans and other animals is very similar	665	0.23***
We are made in the image of God and shouldn't destroy this	668	-0.41***
When we try to play God we make mistakes	668	-0.54***
God made people responsible for the welfare of other living things	669	-0.27***
It feels wrong to mix genetic material from plants and animals	674	-0.69***
It was wrong to lift the moratorium on field trials of genetically modified plants	672	-0.64***
It is worrying that the food we eat might have been produced using genetic modification	674	-0.73***
The use of biotechnology needs to be transparent	673	-0.21***

Note: *** = $p < 0.001$

4.18.5 Correlations between general attitude towards biotechnology and believing different sources of information about biotechnology

In consideration of the correlation results shown in Table 36, there is some evidence of positive relationships between believing different sources of information and attitude towards biotechnology. Where statistically significant this evidence suggests the believability of some actors involved in biotechnology has a bearing on attitude towards biotechnology. However, these correlation values are not strong suggesting that the believability of, or trust, in these actors has only a small influence on attitude.

Table 36 Correlation with believing statements about biotechnology

	n	Correlation
I usually believe statements by regulatory agencies	674	0.27***
I usually believe statements by university scientists	674	0.30***
I usually believe reports in newspapers and on the radio or TV	672	n. s.
I usually believe statements made by crown research institutes	673	0.25*
I usually believe statements made by politicians	673	0.08*
I usually believe statements by biotech companies	674	0.30***

Note: * = $p < 0.05$, *** = $p < 0.001$

4.18.6 Correlations between general attitude towards biotechnology and who benefits from biotechnology

As shown in Table 37 positive relationships were found between attitude towards biotechnology and benefits to the public, the economy, quality of life for New Zealanders and benefit from medical treatment. These relationships suggest the belief that biotechnology will bring more benefits would result in a more positive attitude towards biotechnology. Of interest, counter to this result is the finding that the more it is thought that biotechnology will benefit private corporations or companies the less positive is the attitude towards biotechnology. This may well be evidence of resentment towards biotechnology companies. Indeed, a comparison between benefit for private corporations or companies and benefit to the New Zealand public also found a negative relationship ($n = 688$, $r = -0.20$, $p < 0.001$). This suggests a disapproving expectation that private benefits increase at the expense of public benefits.

Table 37 Correlation with who benefits from biotechnology?

	n	Correlation
Biotechnology will benefit private corporations or companies	677	-0.19*
Biotechnology will benefit the New Zealand public	676	0.65***
Biotechnology will benefit the New Zealand economy	675	0.53***
Biotechnology will improve the quality of life for all New Zealanders	676	0.64***
Myself or a member of my immediate family would benefit from a medical treatment developed using biotechnology	673	0.41***

Note: * = $p < 0.05$, *** = $p < 0.001$

4.18.7 Correlations between general attitude towards biotechnology and concerns about GM

There were correlation values of a moderate strength between concerns about GM and attitude towards biotechnology. It is readily apparent that those who tend to have concerns about GM also tended to have a negative attitude towards biotechnology. On the other hand these results also show that those who tend not to agree with these concerns about the use of GM tended to favour biotechnology.

Table 38 Correlation with concerns about biotechnology and GM

	n	Correlation
The use of genetically modified plants will result in the cross contamination of non-GM seeds	678	-0.53***
Genetically modified organisms will spread into places we do not want them	679	-0.61***
People will not always comply with rules or regulations governing the development and release of genetically modified organisms	679	-0.41***
Genetically modified organisms will mutate into something dangerous	678	-0.64***
The commercialisation of biotechnology will result in more risk to the public or the environment	679	-0.66***
The release of genetically modified organisms will damage exports by tarnishing New Zealand's image of being clean and green	678	-0.62***
Biotechnology may solve a problem but it can also create more problems	678	-0.64***

Note: *** = $p < 0.001$

4.18.8 Correlations between general attitude towards biotechnology and intention to purchase

With regard to intentions to purchase in terms of differences in attitude towards biotechnology between these three intention groups those who had a negative intention scored lower on attitude (mean = 2.17) than those with a neutral intention (mean = 2.98) and those with a positive intention (mean = 3.67). The differences between each of the scores are statistically significant (t-test, $p < 0.001$).

The relationships between attitude towards biotechnology and the intentions to purchase each of the products show a similar trend to the differences between intention groups. The reasonably strong r-values (see Table 39) support the view that intentions to purchase are aligned with the general attitude towards biotechnology. Like the other results of relevance to purchasing GM food, GM food appears to be more closely related than many other items to attitude towards biotechnology.

Table 39 Correlation with intention to purchase

	n	Correlation
Butter from cows genetically modified to produce 50% less cholesterol in their milk	675	0.61***
Meat from sheep genetically modified for 'double-muscling', producing more meat and less fat per animal	675	0.63***
Bread made from genetically modified wheat that is 25% cheaper to grow	676	0.63***
Apples genetically modified to produce twice as much antioxidants, which may help prevent cancer	677	0.63***
Milk from cows that are grown on pastures containing genetically modified clover	677	0.65***
Sweetcorn that has been genetically modified to resist insects so that it requires 50% less than the usual application of pesticides	677	0.64***

Note: *** = $p < 0.001$

4.18.9 Correlations between general attitude towards biotechnology and attitude towards nature

In terms of relationships between responses to statements about nature and attitude towards biotechnology it was evident that concern about nature was related to this attitude (Table 40). First, with regard to the interference with nature and its ability to adapt and recover there was a moderate tendency for those who had a positive attitude towards biotechnology to deny that these negative effects would occur. In particular, those with a positive attitude tended to hold the view that nature could adapt to the products of genetic engineering whereas it is suggested that those with a negative attitude tended to agree that it was wrong to play God with living things. While agreement with the view that nature knows best was associated with a negative attitude towards biotechnology, the investigation of dimensions of a conception of nature were significantly related to attitude but were less strongly related than other items. A strong tendency was for those who had a negative attitude towards biotechnology to considered nature to be a complex interdependency that was threatened by chain reactions and unanticipated effects brought about by interventions such as genetic engineering.

Table 40 Correlation with beliefs about nature

	n	Correlation
When we interfere with nature the consequences are unpredictable	670	-0.59***
If we interfere with nature our descendants will pay for it	670	-0.65***
Nature can adapt to the products of genetic engineering	667	0.45***
The environment may have been abused but it has tremendous ability to recover	670	0.24***
We have a special position in nature	670	-0.15***
If we didn't have a natural desire to improve the world, we'd still be back in the caves	668	0.33***
It is wrong to play God with living things	667	-0.61***
Nature knows best	669	-0.46***
Nature is morally good	664	-0.31***
Nature is pure and wild	667	-0.33***
Nature is dynamic	669	-0.22***
Nature exists in a state of ecological harmony	665	-0.22***
At least once in my life, I have felt a deep connection with nature	667	-0.24***
I remember when the environment was more natural	668	-0.32***
The environment probably doesn't need as much protection as we imagine	668	0.10***
Nature may be resilient but can only absorb a very limited amount of damage	670	-0.24***
Nature is essentially a very fragile thing. It cannot withstand what has been done to it thus far.	668	-0.30***
Nature is made up of complex interdependencies. Human meddling of the kind introduced by genetic modification will cause a chain reaction with unanticipated effects	669	-0.68***
We shouldn't be too worried about environmental damage. Technology is developing so quickly that in the future people will be able to repair most of the environmental damage that has been done	668	0.36***

Note: *** = $p < 0.001$

4.18.10 Correlations between general attitude towards biotechnology and New Zealand identity

The correlations with attitude towards biotechnology for both the personal and subjective results found little or no evidence of relationships between respondent answers to these questions and attitude.

4.18.11 Correlations between general attitude towards biotechnology and technology

There were weak to moderate correlation values between technological worldview items and attitude towards biotechnology. The results suggest that those who tend to advocate a simpler lifestyle, less use of resources and were against materialism also tended to have a negative attitude towards biotechnology. On the other hand these results also show that those who favour technology as a means of improving society also tended to favour biotechnology.

Table 41 Correlation with technology

	n	Correlation
A technological society has the best chance of eliminating poverty	669	0.38**
Advances in technology mean that the goals of society can be realised	668	0.38*
Living a simpler lifestyle is the best way to conserve energy and resources	669	-0.32**
Wealthy nations should consume less and limit their use of resources	669	-0.22**
Groups that oppose the emphasis on materialistic values deserve support	669	-0.31**

Note: * = p <0.05, ** = p < 0.001

4.18.12 Correlations between general attitude towards biotechnology and clean and green

In terms of relationships with attitude towards biotechnology, there was some evidence of a relationship with agreement with the statement that New Zealand used to be more clean and green than it is now. Those who agreed with this statement tended to have a negative attitude towards biotechnology.

Table 42 Correlation with clean and green New Zealand

	n	Correlation
New Zealand's natural environment is more clean and green than other countries	665	n.s.
Agricultural production in New Zealand has few adverse effects on the environment	664	0.09*
I think that New Zealand could one day become clean and green		-0.16**
I am proud of our current international status as a clean and green country	669	n.s.
New Zealand used to be more clean and green than it is now	669	-0.22***
Clean green New Zealand is a myth	667	n.s.

Note: * = p <0.05, ** = p <0.01, ***= p < 0.001

4.18.13 Correlations between general attitude towards biotechnology and spirituality

Although spirituality would appear to have little to do with biotechnology there is some evidence of relationships between spirituality and attitude towards biotechnology. Of more relevance in terms of strength of the relationship, the correlation results indicate that those with a negative attitude tend to believe that people have a soul and that there is life after death, whereas those with a positive attitude tend not to hold these beliefs.

Table 43 Correlation with spirituality

	n	Correlation
I often think about the meaning of life	663	-0.18***
I often have the feeling that life is meaningless	664	n.s.
I attend religious services on a regular basis	656	-0.09*
I believe there is a personal God	657	-0.17***
I believe there is some sort of life force or spirit, not a person	660	-0.11**
I believe that people have a soul	661	-0.23***
I believe that sin exists	661	-0.11***
I believe in life after death	661	-0.20***

Note: * = p <0.05¸ ** = p <0.05¸ *** = p < 0.001

4.18.14 Correlations between general attitude towards biotechnology and vulnerability

As shown in Table 44 except for the view that it is OK for society to impose a small amount of risk on individuals without their consent, there was only weak evidence that a few of the measures were related to attitude towards biotechnology. Those who had a positive attitude towards biotechnology tended to adhere to the view that the uninformed imposition of a small risk was acceptable.

Table 44 Correlation with vulnerability

	n	Correlation
I often feel discriminated against	664	n.s.
In a fair system, people who try harder should be rewarded financially	667	0.10**
The government should strictly limit people's personal risk-taking activities	658	n.s.
My whole life feels like it's falling apart	656	n.s.
It is OK for society to impose a small amount of risk on individuals without their consent	665	0.28*
The world needs a more equal distribution of wealth	666	-0.10*
Life's ups and downs are mostly a matter of fate or divine will, not personal control	678	-0.11*
I have very little control over risks to my health	682	n.s.

Note: * = p <0.05¸ ** = p <0.01

4.19 Models of general attitude using composite variables

Two models of a general attitude towards biotechnology were constructed. The first model was designed to explain attitude towards biotechnology using the more general items drawn principally from section B of the questionnaire. The second model was designed to explain attitude towards biotechnology using the more immediate concerns and beliefs about biotechnology from section A of the questionnaire.

For both models the dependant variable was attitude towards biotechnology. Determinant variables were constructed using the criteria that each be constructed from responses to a question set where it can be argued that they are about a common topic or theme. As well as this logical argument, the correlation results presented in the previous section between items and attitude towards biotechnology served as a preliminary test. In addition, reliability analysis (Cronbach's Alpha) was used to inform the selection of items.

4.19.1 Model 1: Worldviews and general attitude towards biotechnology

The descriptive results for the constructed determinant variables for the model of worldviews and attitude are shown in Table 46. The items used in the construction of these variables are shown in Tables 45 to 50.

Table 45 Worldview determinant variables

	n	Mean	Std. Dev.
NATURE'S REVENGE	666	3.60	0.83
God stewardship	675	3.29	1.04
Post materialism	680	3.53	0.72
Tech optimism	675	3.58	0.65
Spirituality	656	3.21	0.89

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

To explain each of the variables, the items used to form 'nature's revenge' (see Table 45) suggest it is wrong to meddle with, interfere with, or play god with nature with the suggestion of negative consequences.

Table 46 Items comprising nature revenge

Item	Reliability
If we interfere with nature our descendants will pay for it.	**Alpha = 0.86**
Nature is made up of complex interdependencies. Human meddling of the kind introduced by genetic modification will cause a chain reaction with unanticipated effects.	
When we interfere with nature the consequences are unpredictable.	
It is wrong to play God with living things.	

A variable called 'god stewardship' was formed from the responses to three items that had made reference to God. The items in this set differ from each other to a greater extent than the items comprising the other variables. There is reference to the sanctity of the human body, a God given role of stewardship and the limitations of people compared when compared to God. However, like the construction of the other variables, support for combining these items is provided by the reliability score (Cronbach's Alpha = 0.80).

Table 47 Items comprising god stewardship

Item	Reliability
We are made in the image of God and shouldn't destroy this	**Alpha = 0.80**
God made people responsible for the welfare of other living things	
When we try to play God we make mistakes	

A variable representing post materialism was formed from the responses to three items from the technology question set. The items shown in Table 48 referred to conservation of energy and resources, limited use of resources and the denial of materialistic values.

A forth variable labelled 'Tech optimism' was made from two further questions from the same question set as post materialism. Unlike post materialism these gave emphasis to the merits of a technological society. In addition, a 'spirituality' variable (see Table 50) was constructed using six of the eight items that measured aspects of spirituality.

Table 48 Items comprising post materialism

Item	Reliability
Wealthy nations should consume less and limit their use of resources.	**Alpha = 0.72**
Groups that oppose the emphasis on materialistic values deserve support.	
Living a simpler lifestyle is the best way to conserve energy and resources.	

Table 49 Items comprising tech optimism

Item	Reliability
A technological society has the best chance of eliminating poverty.	**Alpha = 0.85**
Advances in technology mean that the goals of society can be realised.	

Table 50 Items comprising spirituality

Item	Reliability
I believe there is a personal God.	**Alpha = 0.85**
I believe that people have a soul.	
I believe in life after death.	
I attend religious services on a regular basis.	
I believe that sin exists.	
I often think about the meaning of life	

Table 51 Correlations between worldview items

		Nature revenge	God stewardship	Post materialism	Tech optimism	Spirituality
Attitude towards biotechnology	**r**	-0.69***	-0.47***	-0.35***	0.41***	-0.21***
	n	659	664	669	668	646
Nature revenge	**r**		0.51***	0.37***	-0.27***	0.25***
	n		654	661	660	638
God stewardship	**r**			0.27***	-0.13***	0.66***
	n			662	661	645
Post materialism	**r**				-0.16***	0.25***
	n				679	645
Tech optimist	**r**					-0.09*
	n					644

Note: * = p <0.05¸ ***= p < 0.001

Correlations between model components are provided in Table 51. As is evident from the table, most of the components of the model correlated significantly ($p < 0.05$ or better) with other components of the model. These results suggest relationships between the proposed determinant variables and attitude as well as interrelationships between the determinants.

The results of the regression analysis for the first model are provided in Table 52. The R^2 value shows that the model provided a good explanation of attitude towards biotechnology. Significant ($p < 0.05$) independent effects were found for all the proposed determinants. These results show that respondents who have a positive attitude towards biotechnology tend not to believe that meddling with nature will result in negative consequences, they also tend to deny that people have a stewardship role with nature. Although shown to be only a minor factor, those with a positive attitude also tended not to hold post materialist values, were positively influenced by the ideas of technological progress encapsulated by tech optimism and tended to hold spiritual beliefs.

Table 52 Regression of worldview items on attitude towards biotechnology

R^2 0.63, df 5, F = 210.8, Sig of F = 0.0000, n = 618			
Variable	β	**T**	**Sig T**
Nature's revenge	-0.614	-19.083	0.000
God stewardship	-0.171	-4.512	0.000
Post materialism	-0.061	-2.259	0.024
Tech optimism	0.192	7.369	0.000
Spirituality	-0.098	2.919	0.004

4.19.2 Model 2: Beliefs about biotechnology and attitude towards biotechnology

The descriptive results for the constructed determinant variables for the model of beliefs and attitude are shown in Table 53. To explain each of the variables used in this model, the first variable (see Table 54) was labelled 'GM wrong'. This variable was made from three items that referred to outcomes of GM as being worrying or wrong.

Table 53 Belief determinant variables

	n	**Mean**	**Std. Dev.**
GM WRONG	681	3.35	1.03
GM concern	682	3.73	0.74
Techfix	675	3.11	0.71
Believe	682	2.71	0.81
Benefit	684	3.25	0.79

Note: Range for all items 1 = Strongly disagree 5 = Strongly agree.

Table 54 Items comprising GM wrong

Item	**Reliability**
It is worrying that the food we eat might have been produced using genetic modification	**Alpha = 0.86**
It was wrong to lift the moratorium on field trials of genetically modified plants	
It feels wrong to mix genetic material from plants and animals	

The second variable 'GM concern' contained all of the responses to all of the items in the question set headed 'Concerns about biotechnology' (see Table 55). Some items referred to possible immediate effects of genetic modification. There were also items about general concerns such as the risk of biotechnology, damage to trade and the clean green image and the possibility of more problems. The set nevertheless formed a single index of concern with a particularly strong alpha score.

Table 55 Items comprising GM concern

Item	Reliability
The use of genetically modified plants will result in the cross contamination of non-GM seeds	**Alpha = 0.92**
Genetically modified organisms will spread into places we do not want them	
People will not always comply with rules or regulations governing the development and release of genetically modified organisms	
Genetically modified organisms will mutate into something dangerous	
The commercialisation of biotechnology will result in more risk to the public or the environment	
The release of genetically modified organisms will damage exports by tarnishing New Zealand's image of being clean and green	
Biotechnology may solve a problem but it can also create more problems	

The third variable called 'Techfix' (Table 56) gave voice to positive aspects of biotechnology with the items referring to fixing or making improvements. Two of the items suggested biotechnology was a part of a natural process.

Table 56 Items comprising techfix

Item	Reliability
Biotechnology simply harnesses and uses natural processes.	**Alpha =0 .72**
Biotechnology can fix environmental problems that have been caused by humans.	
Biotechnology can improve on the imperfections of nature.	
Part of natural evolution is that people will start to play with genes.	

A further variable was constructed from items about belief instatements made by various actors and information sources involved in biotechnology (see Table 57). This variable functions as a global measure of the believability of, or trust in, sources of information about biotechnology.

Finally, a variable was constructed form the items regarding who benefits from biotechnology (see Table 58). The variable serves to measure an overall judgement of the benefits that private corporations or companies, the public, the economy, quality of life and personal medical benefits that are believed to result from biotechnology.

Table 57 Items comprising believe statements

Item	Reliability
I usually believe statements by regulatory agencies	Alpha = 0.83
I usually believe statements by university scientists	
I usually believe reports in newspapers and on the radio or TV	
I usually believe statements made by crown research institutes	
I usually believe statements made by politicians	
I usually believe statements by biotech companies	

Table 58 Items comprising who benefits

Item	Reliability
Biotechnology will benefit private corporations or companies	Alpha = 0.71
Biotechnology will benefit the New Zealand public	
Biotechnology will benefit the New Zealand economy	
Biotechnology will improve the quality of life for all New Zealanders	
Myself or a member of my immediate family would benefit from a medical treatment developed using biotechnology	

Table 59 Correlation between items

		GM wrong	Techfix	GM concern	Believe	Benefit
Attitude towards biotechnology	r	-0.77***	0.63***	-0.72***	0.28***	0.64***
	n	670	665	676	670	672
GM wrong	r		-0.58***	0.77***	-0.28***	-0.63***
	n		673	673	674	675
Techfix	r			-0.50***	0.29***	0.64***
	n			669	670	672
GM concern	r				-0.30***	-0.51***
	n				673	674
Believe	r					0.32***
	n					676

Note: *** = $p < 0.001$

Correlations between model components are provided in Table 59. As shown, model components that were proposed as having a direct relationship with attitude towards biotechnology are all correlated significantly ($p < 0.001$ or better) with each other. The results suggest relationships between the proposed determinant variables and attitude, as well as interrelationships between these determinants.

Table 60 Regression of beliefs on attitude towards biotechnology

R^2 0.70, df 5, F = 296.9, Sig of F = 0.0000, n = 650			
Variable	β	**T**	**Sig T**
GM wrong	-0.315	-8.181	0.000
Tech fix	0.162	5.421	0.000
GM concern	-0.321	-9.423	0.000
Believe	-0.011	-0.485	0.628
Benefit	0.183	5.795	0.000

The result of the regression analysis for the second model is provided in Table 60. The high R^2 value shows that the model provides a good explanation of attitude towards biotechnology. As is evident from the table, with the exception of believing statements about biotechnology, significant ($p < 0.001$) independent effects were found for all the proposed determinants. This indicates that people who have a positive attitude tend not to hold beliefs that GM is wrong and also have few concerns about GM. These people also tend to agree that biotechnology is a natural process and that the technology is useful for improving nature's imperfections and fixing environmental problems. Respondents with a positive attitude also tended to agree that biotechnology would benefit private corporations or companies, the public, the economy, the quality of life and result in personal medical benefit.

Chapter 5
Discussion and Conclusion

5.1 Introduction

This study set out to determine and understand public perceptions of biotechnology in New Zealand. Through developing and applying models of a general attitude towards biotechnology important factors associated with this general attitude have been identified. The research has also involved determining and understanding both perceptions of biotechnology and a number of biotechnology applications that have been shown to constitute biotechnology. Overall, our aims have been achieved and in this chapter the findings and their implications are explained and discussed.

The chapter begins with a discussion of representativeness and the issue of non-response bias. Then findings that have a bearing on determining and understanding public perceptions, and the implications of these findings, are discussed. More general, though no less important, observations across the overall survey results are also made.

5.2 Representativeness and non-response bias

An important necessary consideration is the qualification of the results in terms of the validity of claims that can be made about the New Zealand public from the survey results. Tests for representativeness found evidence of response bias. While there was no evidence of a gender bias, there were disproportionately more older respondents and those with higher levels of income, education and ethnicity. This is not uncommon with survey research. It means it is possible that some people with particular characteristics and different views were not surveyed. Our investigation of non-response bias sought to clarify this issue by assessing whether non-respondents had different views than the survey respondents. Results suggest that non-respondents held somewhat different views compared to the respondents. It was apparent that more replies were received from people with knowledge of, or interest in, biotechnology. It is possible that those with stronger views about biotechnology were represented to a greater extent than they exist in the wider population. While a precise estimate cannot be made from our investigation, it can be expected that in the wider population there would be somewhat fewer people against biotechnology, fewer in support of biotechnology and more people with less extreme views than is reported in our survey results.

5.3 Discussion of the results

In this section the main findings of the survey are reviewed and discussed. It includes both descriptive findings and those that relate to relationships between items.

The examination of the relative concern over biotechnology, when measured against other social issues, showed that biotechnology and the use of genetically modified organisms in agriculture were issues of concern. More than half of the respondents indicated they were either concerned or very concerned. However, the levels of concern were not as high as concern for other issues. Almost all respondents indicated concern regarding crime and violence, and there was concern over the availability and quality of public health care, and illegal drug use. This is not unexpected because in other surveys there has been a strong message from the public to better resource crime prevention and health care. Whereas other

issues such as the degradation of the environment have been found to be of less concern (Hughey, Cullen, Kerr, & Cook, 2004).

The use of 22 examples of biotechnology to investigate differences in acceptance was useful. While the examples were different, and should be regarded as individual examples, it was apparent that there were differences between the sets of environmental, medical and agricultural examples. The medical examples were more acceptable and the agricultural examples were less acceptable. In addition, examples that involved the use of genetic modification were noticeably less acceptable than other examples. Despite the prospect of benefit it was apparent that the use of GM lowered the acceptability of the use of biotechnology for the medical examples and the agricultural or food examples. In some contrast, the use of GM in the environmental examples did not appear to lower acceptance. It is possible that the immediacy to the individual of eating GM food or receiving GM medical treatments caused the lower levels of acceptance whereas the use of GM to fix environmental problems was more acceptable because of the potential for little immediate contact with the individual. The single cloning example also deserves mention with the cloning of the kakapo failing to gain widespread acceptance.

The examination in more depth of five examples of biotechnology gave further support to findings from, and adds more depth to, the briefer comparison of the acceptability of biotechnology examples. There appeared to be a unique pattern for each example in terms of the mean scores for the measures adapted from risk perception research. Of note, the examples involving GM were less acceptable. In particular, the example of the GM potato, when assessed using measures from risk perception research, received a more averse response. Also of note was the high correlation values between unethical and unnatural for each of the examples ($r = 0.73$ to 0.80) indicating a strong link between these concepts across the examples. A further point was that there was only poor, if any, evidence of relationships between familiarity and other risk perception measures.

There were a variety of beliefs about biotechnology that had either negative or positive connotations. Approximately half of the respondents had agreed that biotechnology could fix problems. Less than one quarter indicated it was a natural process but the reasonably strong correlation with attitude suggests this is important for those favouring biotechnology. Items with reference to genetic modification elicited concern from approximately half of the respondents. In the correlation analysis the responses to these GM items were more aligned to the general attitude measure suggesting that people are mindful of GM when considering biotechnology.

University scientists and Crown Research Institutes were deemed more trustworthy than other sources of information though trust was only weakly linked to attitudes towards biotechnology. There was some indication that those with a positive attitude tended to be less suspicious of statements made about biotechnology but, as shall be explained in discussion of the modelling results, trust is not a significant factor in comparison to other considerations about biotechnology.

About one third agreed that the public would benefit from biotechnology though most agreed that biotechnology companies would primarily benefit. Nevertheless, the correlation results with attitude showed that the prospect of benefit to the public was more strongly aligned to attitude than the prospect of private company benefits. The possible resentment of biotechnology appears to be less strong than recognition that biotechnology holds the prospect of social benefits.

Concerns about GM were generally reasonably strongly held, in particular the concern about compliance with regulations and the prospect of harm to New Zealand's clean green image. Like other items referring to GM, concerns about GM were reasonably strongly related to the general attitude towards biotechnology.

The construction of a composite measure of a general attitude towards biotechnology used risk perception measures that are designed to measure underlying factors involved in perceptions of risk. Our method for forming the general attitude variable from these measures involved the straightforward adding of variables. This method was appropriate because of the interrelated nature of these variables. The interrelationships indicate that the variables are strongly linked to each other suggesting they signify a single structure which we assume is an underlying disposition. This disposition we termed a 'general attitude towards biotechnology'. It is therefore assumed that questions about dread, control, and irreversibility, unethical or unnatural are measuring aspects of a general disposition. This assumption is supported by the results of modelling attitude towards biotechnology in that each of the two models provided for a good understanding of attitudes towards biotechnology.

For the model of worldviews and biotechnology the five worldview items together accounted for a good proportion of the variation in attitude thus showing that together they were aligned to attitude towards biotechnology. This suggests that, while each worldview item did not refer to biotechnology, each was nevertheless associated with attitude towards biotechnology. This means, for example, that having spiritual beliefs was for many people a conditional factor that goes along with having a negative attitude towards biotechnology. All of the five hypothesised worldview items can be interpreted as being important as conditional factors with each having independent significance, although each was found to have different degrees of relative importance.

The most important factor in the worldview model, in terms of relative importance, was the constructed variable representing nature's revenge. There is a logic to the relationship between nature's revenge and attitude. The variable refers to the negative consequences of interference with nature as well as a caution against 'playing God'. Similarly, attitude was constructed using the notions of 'unexpected outcomes' and 'irreversible harmful outcomes' that are central to two of its measures. The idea that nature will bite back those who interfere with it is important in the model because of concerns that biotechnology will have damaging consequences. The presence of such concerns within attitude and the strong relationship with nature's revenge, which is predominantly about this concern, shows that concern over damaging consequences is an important factor in a general attitude towards biotechnology.

Second in importance was tech optimism. This worldview item was positively associated with attitude and by means of two questions appeared to capture the idea that the way forward for society was through the use of technology. Alignment between attitude towards biotechnology and this worldview item can be readily understood with biotechnology being seen as a technology for doing useful things, which ultimately means the advancement of society.

God stewardship had some diversity of meaning in the items that were used in its construction but appeared to represent the idea of stewardship where people were given a role of responsibility to care for the welfare of living things. The clash with biotechnology, shown by its negative relationship with attitude, can be understood because biotechnology is involved in the transformation of living things.

Of lesser importance, though also a significant factor, was spirituality. Unlike the other factors spirituality seems remote from the general attitude towards biotechnology, yet the model shows that those with spiritual beliefs have a tendency to have a negative attitude towards biotechnology. Perhaps of relevance, spirituality was reasonably strongly linked to God stewardship in the correlation results and this may partly explain the link with attitude. God stewardship implies that people have a God-given role to protect living things. Having spiritual beliefs can be interpreted as giving warrant to perform this role. This means that as a general stance having spiritual beliefs effectively means having concern for maintaining God's order of things.

Of least importance, though still a significant factor, was the measure of post materialism. To a minor degree, in comparison with the other four factors, the general attitude towards biotechnology can be explained by adherence, or lack of adherence for those with a positive attitude, with post-materialist views. Post materialism is generally against the thrust of technology to transform the world by artificial means. Post materialism promotes conservation over transformation and advocates limiting resource use. However, this view is not necessarily in direct conflict with biotechnology, which involves useful transformation rather then use of resources. Nevertheless, when classed as a means associated with materialism the clash with biotechnology can be understood.

The model of beliefs and attitude hypothesised more immediate beliefs as being associated with attitude towards biotechnology. Unlike the worldview model, these beliefs made reference to biotechnology and were more readily able to be associated with the measure of attitude. It is then likely that the good measure of explanatory value was achieved partly because the beliefs and the attitude measure both referred to biotechnology.

Unlike the items in the worldview model, which were interpreted as underlying factors, the belief items present themselves as somewhat more 'rational' considerations. The beliefs were not about the character of nature or a spiritually-based viewpoint as found in the worldview model. In contrast, the beliefs were about practical matters, such as the consequences of mixing genetic material, the fixing of environmental problems or believing statements by scientists. The second model referred to a number of specific beliefs about biotechnology that were shown to be associated with a general attitude towards biotechnology.

In the belief model four of the five hypothesised factors associated with biotechnology were significant. The most important of these was concern over genetic modification. This factor was comprised of items that made reference to both specific (e.g., the cross contamination of seeds) and comparatively more remote consequences (e.g., impact on exports) of biotechnology and the use of GM. Concern over these possible negative consequences can be likened to the unease about irreversible consequences and apprehension regarding control of biotechnology encapsulated by attitude towards biotechnology.

GM wrong was of only slightly lesser importance in its relationship to attitude than GM concern. Although similar to GM concern, this factor more simply stated that aspects of genetic modification were wrong. These aspects included the eating of GM food, the lifting of the GM moratorium, and the mixing of plant and animal material. Although the objections are similar to the GM concerns, the use of the term 'worrying' and 'it feels wrong' for two items suggests an ethical imperative. As well as suggesting links to irreversible consequences and apprehension regarding control, GM concern could also be linked to attitude through concern over the ethics of biotechnology.

The prospect of benefits from biotechnology was also important and was positively related to the general attitude towards biotechnology. Of similar importance was the prospect of technological fixes to environmental problems and the suggestion that the use of biotechnology was natural for humans.

Of no significant importance in the belief model was the proposed relationship between believing statements about biotechnology and attitude. Despite other research finding trust to be an important factor in perceptions of biotechnology (e.g., Siegrist, 1999; Priest, Bonfadelli, & Rusanen, 2003), such a relationship was not important in our model. Unlike other factors in the model, believability summarised reactions to many sources of information. This would differ from testing the believability of a particular source. Nevertheless, the modelling showed that, in general, the believability of information sources about biotechnology was not a factor in attitudes towards biotechnology.

Further points of interest arising from the modelling of attitude were the exclusion of acceptability and familiarity from the models. The two items were not aligned enough with the other items to warrant their inclusion as parts of the general attitude towards biotechnology. As an explanation, for the acceptability item it is possible that this lack of alignment may have been due to it being a more pointed question that required a decision involving the summarising of the other somewhat diverse considerations. Indeed, the novelty of the topic may have meant that many had not previously considered the acceptability of biotechnology making the task difficult and the response somewhat unreliable. The exclusion of familiarity is also of interest. Familiarity was found to have little or no importance in the assessment of the five examples of biotechnology and was excluded from consideration for the general attitude towards biotechnology measure. This means that whether people have heard of, or are familiar with, biotechnology per se, or a particular application of biotechnology, has little bearing or no bearing on their disposition towards these targets.

A further finding was that while the there were differences in the acceptability of the 22 examples each was found to have a moderate to strong relationship with general attitude towards biotechnology. Of note, there was evidence of somewhat stronger relationships with the agricultural examples and the suggestion of stronger relationships with GM examples. This suggests that the general attitude is more readily associated with GM or that in responding to the items that were used to form the general attitude that people were mindful of GM. The lower strength of relationship with the medical examples may well reflect their lack of immediacy. Huntington's disease, Alzheimer disease and diabetes are less likely to be personally experienced whereas possible contact with GM through eating food would arguably make it more salient to respondents.

A final finding of interest was that the relationship between attitude and intentions to purchase was strong for all of the six retail products. These results suggest that the general attitude towards biotechnology and the items it summarises are involved in purchase decisions regarding GM food. This gives further support to using the general attitude towards biotechnology as a measure of a general disposition towards biotechnology. In addition, the findings suggest that use of the general attitude measure in explanatory models of intentions to purchase would be rewarding.

5.4 Theoretical implications

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

construction of models that could be used to meet our aim of understanding public views and reactions to biotechnology. This involved using elements from risk perception modelling for the purpose of doing the empirical work at hand. This adaptation enabled the modelling and testing of variables generated from focus group research alongside other factors drawn from elsewhere. As well as usefully enabling our empirical work, the models and the techniques we have employed should be useful for informing the use of models in other related research areas.

Of relevance to other research, the use in risk perception modelling of a combination of risk perception measures (e.g., dread, familiarity, acceptance) to explain reactions to a risk or hazard was, in our research, taken to suggest their use in the formation of a dependant variable. The risk perception measures have been described as factors involved in the acceptance of risks and hazards, and it has been known for some time that the measures are highly interrelated (Slovic, 1992:121). In our study the finding that these items are highly interrelated is interpreted as meaning that the measures are different measures of same thing, which we have called a 'general attitude towards biotechnology'. This arrangement was found to have sound empirical support and should be of interest to those involved in modelling risk perception.

A second area of relevance to other research stems from the use of views and values that signify a worldview in our first model of general attitude. It has not been uncommon to model issues such as risks, benefits or trust in scientists that are immediately associated with a technological risk. It also can be considered unrevealing that such items are found to be associated with perceptions about a risk or hazard because they make reference to the risk or hazard. Comparatively more revealing are our findings of relationships between views and values and attitude towards biotechnology that apparently have no such direct relationship with biotechnology. Such findings should be of interest to researchers who wish to consider viewpoints and values involved in dispositions towards biotechnology.

A further point is that this research was largely enabled by extensive qualitative work undertaken in focus groups, which allowed detailed discussion of issues as perceived by members of the public, and which then facilitated the exploration of ideas developed from social theory. In this way what might appear to be seemingly remote factors had grounds for formal testing in our research. The research has demonstrated the benefits of building upon qualitative work.

5.5 General implications

One of the most important implications from this research stems from the novel contribution that is made to understanding the nature of dispositions towards biotechnology. In particular the model of worldviews was novel in its operationisation of the findings of focus group work and its testing of factors which were seemingly unrelated to biotechnology. Previous work in New Zealand has established that attitudes towards GM have involved a rational form of decision-making and has assumed that the introduction of new information would alter such decisions (e.g., Cook, Kerr & Moore, 2002; Cook & Fairweather, 2003). This previous work utilised prescribed models not unlike the model of beliefs and general attitude used in this research. The new dimension introduced in this research is the modelling of factors we have associated with worldviews. The worldview model has shown that factors such as spiritual beliefs and beliefs about the character of nature are linked to a general disposition towards biotechnology. Such factors cannot be immediately regarded as beliefs that can be changed through the provision of new information. Whereas there is potential to change views about the likelihood and consequences of an event, such as a perceived risk to public health, there is

little potential to similarly alter a person's spiritual beliefs or their conception of nature. This anchoring effect means that attitudes towards biotechnology are likely to be more resilient and entrenched than has previously been presumed. Indeed, such entrenchment may well explain research findings of a lack of significant change in attitudes towards GM over time (Fairweather, Maslin, Gossman & Campbell, 2003; Cook & Fairweather, 2003).

It can now be plainly understood that dispositions towards biotechnology are resilient and relatively unresponsive to new information about the immediate concerns and consequences of biotechnology. There is, however, a crack in this presumption. Given the findings, it is still possible for the general attitude towards biotechnology to be disassociated from the worldview items. For example, the challenge that biotechnology is meddling with nature could possibly be removed if biotechnology is thought of as working with nature. Similarly biotechnology could make less of a challenge to post materialism if the technology were accepted as a means of reaching post materialist goals. This is inviting a fundamentally different conceptualisation of biotechnology. The implication is that biotechnology must be recast in the minds of the public if it is to become more acceptable.

Our research makes it clear that for many New Zealanders their basic values, beliefs and perceptions mean that biotechnology is not acceptable and there is little prospect for a change in opinion. Our findings indicate that information about the immediate risks and benefits is unlikely to have an immediate effect because of deep-seated views and values that shape peoples' views of biotechnology. This does not mean that trying to inform or educate people about biotechnology is totally pointless, but rather takes issue with the view that the public can be easily informed and educated. Importantly, our findings suggest endeavouring to understand public views and values would be a useful first step towards reconciling the development and use of biotechnology and public concerns.

5.6 Conclusion

The overall aim of this research was to determine and understand public perceptions of biotechnology in New Zealand. The research has involved determining and understanding both perceptions to biotechnology and gauging the acceptability of a number of key biotechnology applications that constitute biotechnology. The research took a new approach to the topic area in New Zealand, and its design drew upon overseas research as well as focus group research conducted in New Zealand. The research identified the relative importance of biotechnology as a social issue and showed that different applications of biotechnology drew different reactions from the public. Of importance, the research has identified that views and values we have associated with worldviews are associated with a general attitude towards biotechnology. The identification of these factors means that dispositions towards biotechnology are more resilient and less responsive to new information than has been previously presumed.

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Appendix 1
The Questionnaire

LINCOLN
UNIVERSITY
Te Whare Wānaka O Aoraki

NEW ZEALANDERS AND BIOTECHNOLOGY:

A NATIONWIDE SURVEY OF PUBLIC OPINION

November, 2003

Definition of Biotechnology

"BIOTECHNOLOGY IS A BROAD TERM FOR A GROUP OF TECHNOLOGIES THAT ARE BASED ON APPLYING BIOLOGICAL PROCESSES. IT INVOLVES THE USE OF LIVING THINGS OR THEIR DERIVATIVES TO SOLVE PROBLEMS AND MAKE PRODUCTS" (MINISTRY OF RESEARCH, SCIENCE AND TECHNOLOGY).

Biotechnologies have been used for a long time. For instance, traditional biotechnologies include fermentation for beer, bread-making, and animal and plant breeding techniques. There are now many environmental, agricultural and medical biotechnologies. Some of these include the use of genetic modification, or genetic engineering, to produce genetically modified organisms.

New Zealanders and Biotechnology

Instructions: For each 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.

Section A

1. Issues facing society

When asked to think broadly about the kind of issues facing society today, some people mention the following items. Please indicate how concerned or unconcerned you are about each of the following.

Very unconcerned	Unconcerned	Neither concerned nor unconcerned	Concerned	Very concerned
1	**2**	**3**	**4**	**5**

Industrial pollution	
Unemployment	
Air pollution	
Climate change	
Loss of animal and plant species	
Crime and violence	
Biotechnology	
Illegal drug use	
Decline in water quality	
Natural hazards (e.g., earthquake, cyclones, floods, etc)	
Use of genetically modified organisms in agriculture	
Pesticide use	
The availability and quality of public health care	
Terrorism	
Motor vehicle accidents	
Global warming	

2. Acceptability of Biotechnology Items

The following are a number of environmental, agricultural and medical examples of biotechnology. Based on your current knowledge, please indicate your opinion about the acceptability or unacceptability of each example.

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

(a) Environmental uses:

Use of genetically modified bacteria to help clean unwanted toxins in soil	
Producing a low pollution grain-based fuel for cars by genetically modifying a crop	
Developing a virus (genetically modified) that reduces fertility in possums	
Use of aerial sprays made from soil bacterium (Bacillis thuringiensis) to control unwanted insect pests in urban areas	
Cloning a kakapo to ensure the survival of the species	

(b) Medical uses:

Using bacteria in 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	
Removing, repairing and then reinserting brain stem cells to help a sufferer of Huntington's disease	
Using new cells (stem cells) from a 5 day old human embryo to treat an Alzheimer sufferer	
Transplanting copies of pancreatic cells from pigs into a person to help treat diabetes	
Using DNA (gene) testing to help convict criminals	
Using a microscopic device to carry chemotherapy drugs through the blood-brain barrier to treat a brain tumor	
Using a miniature biosensor implanted into a human body to monitor blood sugar levels in diabetics	
Manipulating the molecular structure of sunscreen so that it penetrates the skin to provide greater protection against UV radiation	

(c) Agricultural uses:

Using genetic screening to breed sheep that produce twins or triplets	
Raising hormone levels in farm animals to increase fertility	
Genetically modifying potatoes to resist common pests or diseases	
Genetically modifying pine trees to produce stronger timber	
Genetically modifying kumara to resist common pests or diseases	
Inserting a plastic device containing bacteria into a sheep's stomach to reduce the production of harmful greenhouse gases	
Genetically modifying an apple to make it more nutritious	

3. Specific Examples of Biotechnology

Next, you will find descriptions of five biotechnologies. Based on your current knowledge, please indicate your level of agreement or disagreement with the statements following each example.

(a) A genetically modified bacterium can be developed that helps to repair soil damaged by DDE contamination (DDE is a harmful toxin that has remained in the soil from the use of the pesticide DDT).

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

This use of biotechnology is acceptable to me	
I am familiar with this use of biotechnology	
I feel dread at the thought of this use of biotechnology	
I am confident that any unexpected outcomes from this biotechnology can be controlled	
I fear that use of this biotechnology will result in irreversible harmful outcomes	
I feel that use of this biotechnology would be unethical	
I feel that use of this biotechnology would be unnatural	

(b) Bacterium found naturally in some people's saliva can be manufactured and introduced into throat lozenges. A protein produced by these bacteria fights a more harmful form of bacteria that can cause throat infections, rheumatic fever and in some cases rheumatic heart disease.

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

This use of biotechnology is acceptable to me	
I am familiar with this use of biotechnology	
I feel dread at the thought of this use of biotechnology	
I am confident that any unexpected outcomes from this biotechnology can be controlled	
I fear that use of this biotechnology will result in irreversible harmful outcomes	
I feel that use of this biotechnology would be unethical	
I feel that use of this biotechnology would be unnatural	

(c) New Zealand's main source of Greenhouse gases that can harm the environment come from methane in the stomachs of sheep. A plastic device containing bacteria can be inserted into a sheep's stomach to reduce the production of methane gas

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

This use of biotechnology is acceptable to me	
I am familiar with this use of biotechnology	
I feel dread at the thought of this use of biotechnology	
I am confident that any unexpected outcomes from this biotechnology can be controlled	
I fear that use of this biotechnology will result in irreversible harmful outcomes	
I feel that use of this biotechnology would be unethical	
I feel that use of this biotechnology would be unnatural	

(d) Using genetic modification a synthetic toad gene can be inserted into a potato in order to increase its resistance to disease.

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

This use of biotechnology is acceptable to me	
I am familiar with this use of biotechnology	
I feel dread at the thought of this use of biotechnology	
I am confident that any unexpected outcomes from this biotechnology can be controlled	
I fear that use of this biotechnology will result in irreversible harmful outcomes	
I feel that use of this biotechnology would be unethical	
I feel that use of this biotechnology would be unnatural	

(e) New cells (stem cells) from a 5 day-old human embryo can be inserted into the brain of a person with Alzheimer's disease. This serves to regenerate some of the brain cells that have been destroyed and therefore slow down or even reverse the disease's progression.

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

This use of biotechnology is acceptable to me	
I am familiar with this use of biotechnology	
I feel dread at the thought of this use of biotechnology	
I am confident that any unexpected outcomes from this biotechnology can be controlled	
I fear that use of this biotechnology will result in irreversible harmful outcomes	
I feel that use of this biotechnology would be unethical	
I feel that use of this biotechnology would be unnatural	

4. Views on Biotechnology

Some people said the following when we invited them to talk about biotechnology. 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**

Biotechnology can improve on the imperfections of nature	
Biotechnology can fix environmental problems that have been caused by humans	
Animals and plants that have been genetically modified have a right to live and reproduce	
Genetic modification is a major step because nature hasn't done anything like this before	
Biotechnology simply harnesses and uses natural processes	
Part of natural evolution is that people will start to play with genes	
The genetic make up of humans and other animals is very similar	
We are made in the image of God and shouldn't destroy this	
When we try to play God we make mistakes	
God made people responsible for the welfare of other living things	
It feels wrong to mix genetic material from plants and animals	
It was wrong to lift the moratorium on field trials of genetically modified plants	
It is worrying that the food we eat might have been produced using genetic modification	
The use of biotechnology needs to be transparent, so that we all know about what is being developed	

5. Information about biotechnology

Please indicate your agreement or disagreement with information from each of the following sources of information about biotechnology.

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

I usually believe statements by regulatory agencies	
I usually believe statements by university scientists	
I usually believe reports in newspapers and on the radio or TV	
I usually believe statements made by crown research institutes	
I usually believe statements made by politicians	
I usually believe statements by biotech companies	

6. Who benefits from Biotechnology?

Some people express concern about who benefits from biotechnology. Based on your current knowledge, please indicate your level of agreement or disagreement with each of the following statements about who benefits from biotechnology.

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

Biotechnology will benefit private corporations or companies	
Biotechnology will benefit the New Zealand public	
Biotechnology will benefit the New Zealand economy	
Biotechnology will improve the quality of life for all New Zealanders	
Myself or a member of my immediate family would benefit from a medical treatment developed using biotechnology	

7. Concerns about biotechnology

Some people we have interviewed mentioned the following concerns about biotechnology. Please indicate your level of agreement or disagreement with <u>each</u> of the following concerns about biotechnology.

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

The use of genetically modified plants will result in the cross contamination of non-GM seeds	
Genetically modified organisms will spread into places we do not want them	
People will not always comply with rules or regulations governing the development and release of genetically modified organisms	
Genetically modified organisms will mutate into something dangerous	
The commercialisation of biotechnology will result in more risk to the public or the environment	
The release of genetically modified organisms will damage exports by tarnishing New Zealand's image of being clean and green	
Biotechnology may solve a problem but it can also create more problems	

8. Overall Attitude to Biotechnology

Please provide your view of biotechnology as a whole given that it means the use of living things to solve problems and make products. Based on your current knowledge, 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**

Biotechnology is acceptable to me	
I am familiar with biotechnology	
I feel dread at the thought of biotechnology	
I am confident that any unexpected outcomes from biotechnology can be controlled	
I fear that the use of biotechnology will result in irreversible harmful outcomes	
I feel that use of biotechnology would be unethical	
I feel that use of biotechnology would be unnatural	

9. Buying the products of biotechnology

(a) As well as gauging the acceptability of biotechnology we are interested in whether you would purchase products made using biotechnology. Please indicate whether or not you intend to purchase the following products.

Definitely intend not to purchase	Intend not to purchase	No intention to either purchase or not purchase	Intend to purchase	Definitely intend to purchase
1	**2**	**3**	**4**	**5**

Butter from cows genetically modified to produce 50% less cholesterol in their milk	
Meat from sheep genetically modified for 'double-muscling', producing more meat and less fat per animal	
Bread made from genetically modified wheat that is 25% cheaper to grow	
Apples genetically modified to produce twice as much antioxidants, which may help prevent cancer	
Milk from cows that are grown on pastures containing genetically modified clover	
Sweetcorn that has been genetically modified to resist insects so that it requires 50% less than the usual application of pesticides	

(B) NOW PLEASE INDICATE THE MOST YOU WOULD PAY FOR EACH OF THE FOLLOWING PRODUCTS. FOR SOME PRODUCTS YOU MAY BE WILLING TO PAY MORE OR ONLY CONSIDER PURCHASING IF THEY COST LESS. FOR THE PRODUCTS YOU DO NOT WISH TO PURCHASE PLEASE WRITE AN X IN THE BOX.

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

Butter from cows genetically modified to produce 50% less cholesterol in their milk	
Meat from sheep genetically modified for 'double-muscling', producing more meat and less fat per animal	
Bread made from genetically modified wheat that is 25% cheaper to grow	
Apples genetically modified to produce twice as much antioxidants, which may help prevent cancer	
Milk from cows that are grown on pastures containing genetically modified clover	
Sweetcorn that has been genetically modified to resist insects so that it requires 50% less than the usual application of pesticides	

Section B

1. Attitudes Toward Nature

When people talk about biotechnology they often mention nature. Please indicate your level of agreement or disagreement with each of the following statements about nature.

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

When we interfere with nature the consequences are unpredictable	
If we interfere with nature our descendants will pay for it	
Nature can adapt to the products of genetic engineering	
The environment may have been abused but it has tremendous ability to recover	
We have a special position in nature	
If we didn't have a natural desire to improve the world, we'd still be back in the caves	
It is wrong to play God with living things	
Nature knows best	
Nature is morally good	
Nature is pure and wild	
Nature is dynamic	
Nature exists in a state of ecological harmony	
At least once in my life, I have felt a deep connection with nature	
I remember when the environment was more natural	
The environment probably doesn't need as much protection as we imagine	
Nature may be resilient but can only absorb a very limited amount of damage	
Nature is essentially a very fragile thing. It cannot withstand what has been done to it thus far.	
Nature is made up of complex interdependencies. Human meddling of the kind introduced by genetic modification will cause a chain reaction with unanticipated effects	
We shouldn't be too worried about environmental damage. Technology is developing so quickly that in the future people will be able to repair most of the environmental damage that has been done	

2. New Zealand Identity

Please indicate your level of agreement or disagreement with the following aspects of New Zealand identity. For each aspect please indicate your own personal opinion as well as your opinion about what you think most New Zealanders believe.

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

	My personal view	**What most New Zealanders believe**
New Zealand is clean and green		
Agriculture is an important part of New Zealand identity		
Sheep are an important part of New Zealand identity		
Winning at international sport is an important part of New Zealand identity		
The kiwi is an important part of New Zealand identity		
New Zealanders value something if it is useful		
New Zealanders are in touch with the land		
New Zealanders value business success		
New Zealanders value science and research		
New Zealanders value arts and craft		

3. Technology

Please indicate your level of agreement or disagreement with each of the following statements about technology and resource use.

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

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 the emphasis on materialistic values deserve support	

4. Clean Green New Zealand

New Zealand is often described as being clean and green. 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**

New Zealand's natural environment is more clean and green than other countries	
Agricultural production in New Zealand has few adverse effects on the environment	
I think that New Zealand could one day become clean and green	
I am proud of our current international status as a clean and green country	
New Zealand used to be more clean and green than it is now	
Clean green New Zealand is a myth	

5. Spirituality

Some of the people we talked to about biotechnology also mentioned their spiritual beliefs. Please indicate your level of agreement or disagreement with each of the following statements about spiritual beliefs.

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

I often think about the meaning of life	
I often have the feeling that life is meaningless	
I attend religious services on a regular basis	
I believe there is a personal God	
I believe there is some sort of life force or spirit, not a person	
I believe that people have a soul	
I believe that sin exists	
I believe in life after death	

6. General Viewpoints

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 often feel discriminated against	
In a fair system, people who try harder should be rewarded financially	
The government should strictly limit people's personal risk-taking activities	
My whole life feels like it's falling apart	
It is OK for society to impose a small amount of risk on individuals without their consent	
The world needs a more equal distribution of wealth	
Life's ups and downs are mostly a matter of fate or divine will, not personal control	
I have very little control over risks to my health	

Section C

Please provide some information about yourself. We need this information to check whether this survey is representative of your local community.

Please tick a box to indicate your response to each question

1. Sex: ☐ Male ☐ Female

2. Age: _____ years

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

☐ Less than $15,000 ☐ $20,001 - $40,000 ☐ $60,001 - $100,000
☐ $15,001 - $20,000 ☐ $40,001 - $60,000 ☐ $100,001 and above

4. Which ethnic group do you belong to?

☐ NZ Maori ☐ Tongan ☐ Indian
☐ NZ European ☐ Samoan ☐ Chinese
☐ European ☐ Other Pacific Island ☐ Other Asian
☐ Other - Please specify _____

5. Tick the box or boxes to indicate which of the following you have completed.

☐ Attended primary school
☐ Attended secondary school
☐ School Certificate in one or more subjects
☐ Sixth Form Certificate in one or more subjects
☐ University Entrance before 1986 in one or more subjects
☐ Higher School Certificate or Higher Leaving Certificate
☐ Diploma or trade certificate qualification resulting from at least three months full time, or part time equivalent, study
☐ Bachelors Degree
☐ Postgraduate qualification

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

☐ Buddhist ☐ Agnostic
☐ Christian ☐ Atheist
☐ Hindu ☐ Spiritual but not religious
☐ Islam/Moslem ☐ Other - Please specify _____
☐ Jewish