Perceptions are reality: New Zealanders' perceptions of biological hazards.

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Published in *Money & Morals; mad cows and mutants. Are they worth the risk?. Proceedings of a conference*, Sydney, September 1996.

Introduction

A decision on whether to import or release a new biological technology is ultimately a political decision, not a technical one. Politicians make the final decision, not scientists. Part of the decision process of politicians involves considering public opinion. Thus, public perceptions of the technology and its benefits and hazards have a real influence on the decision. Those perceptions may not accord with scientists' understanding and knowledge of the technology but, to all of us, our own perceptions — whatever their basis — are real. Scientists are no exception to this observation.

We have been involved in several studies of public perceptions of biological technologies in recent years, both in New Zealand and other countries. This includes perceptions of genetic engineering and biological control of pests. In this paper we describe how people perceive risks, then share some of the results of our work. We conclude with some suggestions for decision-making and for communicating with the public.

Public perceptions of risk

Social science research on risk has covered a range of areas, including how lay people and experts perceive risks, uncertainty and problem analysis, risk communication, and risk management. The work on hazard or risk perception is particularly relevant to the study of public attitudes to biological technologies.

Risk research has mainly focused on the potential damage or actual effect of events, practices or technologies on people's well-being. In general, risk perception involves "people's beliefs, attitudes, judgements and feelings, as well as the wider social or cultural values and dispositions that people adopt towards hazards" (Pidgeon *et al*. 1992, p. 89). Essentially a hazard is a situation or event that presents a 'threat' to people and what they value (Kates and Kasperson 1983). All risk assessments (the weighing up of the likelihood or potential impact of a hazard), whether done by the public on the basis of attitudes or values or by experts on the basis of the mathematics of probability, involve some subjectivity (Fischhoff 1989).

According to several studies, two key factors describe lay people's ratings of risks: the 'dread risk factor' and the 'unknown risk factor' (Slovic *et al*. 1980). The 'dread factor' is a combination of perceived controllability of the risk, extent of fear evoked, extent of the

impact involving fatality, equity in the distribution of the risk, extent to which the risk extends to future generations, the ease of reducibility of the risk, increased risk in general, the voluntariness of exposure, and the degree of effect on the individual. The 'unknown risk factor' is a combination of the perceived degree of observability of the risk, familiarity to those exposed, delay in time, scientific familiarity and knowledge, and novelty of the risk source.

The acceptability of risks arising from new technologies is central to our interests. Unacceptability (related closely to dread) increases when:

- exposure to the risk is involuntary rather than voluntary;
- the risks are under the control of an external body (e.g. government) rather than under the individual's or community's control;
- the risks are seen to be inequitable (unequal sharing of benefits versus costs);
- the risks are not balanced by benefits;
- risk information is seen to come from untrustworthy or doubtful sources;
- the risks arise from man-made rather than natural sources;
- the risks are considered to be ethically objectionable or challenging;
- the hazard or type of risk is exotic or novel rather than familiar;
- the risks or hazard can be associated with some other memorable events, such as a disaster or public problem (Chess *et al.* 1989).

The likelihood of public concern about the risk increases with the number and seriousness of these factors, regardless of the scientific data (Slovic 1987, Chess *et al*. 1989).

People's perceptions of risks are socially conditioned, and such perceptions should therefore be considered in their social and cultural context (Douglas 1985). People think about risks with reference to significant others (individuals or groups) and receive information about the implications of hazards through various communication channels. These include the media, groups of activists, agencies, politicians, friends, and families, all of which amplify or interpret messages about hazards (Kasperson *et al*. 1988). These channels are also responsible for generating secondary impacts or ripples from the initial impact out to a whole industry, other technologies, or even a whole field of endeavour (Slovic 1987). Examples of these secondary impacts are community opposition, development of regulations, and investor flight.

Public perceptions of genetic engineering

Two significant studies of public perceptions of genetic engineering in New Zealand give us a clear idea of the way in which biological technologies are viewed by the public. In 1990 an interview survey was undertaken by DSIR Crop Research (Couchman & Fink-Jensen 1990). This was followed by a 1993 mail survey (Macer 1994a) which was part of a cross-cultural

study of public perceptions of genetic engineering. A number of issues arise from these studies.

In New Zealand, as in most countries, there is a very positive attitude to science and technology: over 90% of the public believe science makes an important contribution to the quality of life. However, for specific developments of technology and research endeavours, this attitude fails to hold. People's concerns begin to emerge when we look at particular types of science. The scattergram in Fig. 1 shows people express a higher level of worry about biological research than physical research, with both genetic engineering and biological control being perceived as having a high potential for both benefit and risk.

Public perceptions of biological and genetic developments show greater variations *within* cultures than *between* cultures. Macer's 1993 international bioethics survey generally shows strong similarities between cultures as seemingly different as New Zealand, Russia, Israel, Thailand, India and Japan. One of the exceptions noted in this survey was that New Zealanders generally took a much more conservative approach to genetic engineering (Table *I*), with only 41% feeling that it was worthwhile (cf. 62% in Australia and between 57% and 77% in all the other countries surveyed).

Table I. Public perceptions of the benefit of genetic engineering

Do you personally believe genetic engineering is a worthwhile area for scientific research?

	NZ (n=321)	Australia (n=197)
Yes (%)	41	62
No (%)	29	17
Don't know (%)	30	21

Within each country, variations within and between groups are frequently substantial. For example, Couchman & Fink-Jensen found that while 44% of the population didn't worry about genetic engineering, 32% were either very worried or extremely worried. Differences between professional groups can be strong (Table *II*). For example, the same survey shows that most school biology teachers (86%) and scientists (80%) thought that genetic engineering was a worthwhile area for research compared with little more than half of the public (57%). Semi-skilled workers (44%) showed less worry about genetic engineering than professional workers (71%). Smaller differences were seen between age groups, gender and geographic area.

Table II. Perceptions of benefit among occupational groups

NZ (Couchman)	(%)	NZ (Macer)	(%)
Do you personally believe genetic engineering is a worthwhile area for scientific research?			
Biology teachers	86	Biology teachers	92
Scientists	80	Social studies teachers	60
Public	57	Public	41
No qualifications	52	Medical students	76

Public concerns about genetic engineering

Genetic engineering and biological control fit the category 'low familiarity' and 'moderately high dread'. The Couchman & Fink-Jensen (1990) study shows that New Zealanders see greater potential for harm in manipulating the higher forms of life with which they are most familiar (Table *III*). Nearly three quarters (74%) of those who had heard of it considered that genetic engineering of human cells could present serious risks, 67% thought this of the genetic manipulation of microbes, and 58% considered the genetic manipulation of animals could pose serious risks. By contrast only 42% felt there were serious risks presented by the

genetic engineering of plants. Scientists interviewed in the survey were less concerned about the risks.

Table III. Perceptions of risk involved in genetic engineering

NZ (Couchman)	public	scientists	farmers
Which, if any, of the biological methods could present serious risks for New Zealand?			
human cells (%)	74	57	74
microbes (%)	67	56	62
animals (%)	58	43	58
plants (%)	42	39	33

The public and scientists gave similar reasons for these fears, including the notions of uncontrollability, potential future catastrophe, risks to future generations and potential effect on the individual.

For all countries in Macer's 1993 International Bioethics Survey and in the US survey of Hoban and Kendall (1992), plant-to-plant gene transfers were found to be the most acceptable, with animal-to-animal next, then animal-to-plant. Human-to-animal gene transfers were the least acceptable (Table *IV*). Medical students were generally much less conservative about cross species gene transfer.

Table IV. Acceptability of cross-species gene transfer

	% public accepting NZ	% medical students accepting NZ
plant to plant	56	86
animal to plant	19	49
animal to animal	29	50
human to animal	10	20

One of the common features of several surveys (Macer 1992; OTA 1987) is that there is greater approval for specific examples of the use of genetically modified organisms (GMOs) than for generically-described manipulation. Acceptability was shown in the 1993 Macer study to be highly related to perceived benefit. The highest level of acceptance was for the use of bacteria to clean oil spills and for disease-resistant crops; and over half of the respondents supported GMO-derived tomatoes and low-fat meat. There was less support for using genetic manipulation of cows to produce more milk and for the development of larger sporting fish. The higher levels of acceptance of applications of plant genetic engineering is also consistent with studies in New Zealand (Couchman & Fink-Jensen 1990), Australia (Macer 1994a), Europe (Eurobarometer 39.1), USA (Hoban & Kendall 1992), Canada (Macer 1994a), and the Netherlands (Hamstra 1993). From these studies it is relatively easy to predict public perception; widespread approval for the release of the Flavr Savr tomato could be expected in most countries.

There was a high level of awareness (about 80%) in both studies that GMOs were being used to produce food and medicines (Table *V*). When asked about concerns in using them, the highest level of confidence was seen in medicines and vegetables: around 65% of respondents had few or no worries about using them. The level of concern about dairy and meat products was higher but still more than 40% of respondents in the Macer study and over 50% in the Couchman & Fink-Jensen (1990) study had few or no worries about using them. The major concerns cited were that they were interfering with nature or worries about safety for human consumption. Interestingly, scientists and teachers were much less concerned about eating foods developed with GMOs, with no category causing more or less concern than others.

Table V. Concerns about consuming foods made from GMOs

If any of the following were to be produced from GMOs, would you have any concerns about using them?

	Public (%) few or no worries			
	Dairy	Vegetables	Meat	Medicines
NZ (Couchman)	57	61	52	66
NZ (Macer)	49	52	43	61
Australia (Macer)	52	56	57	67

The most recent measure of public perceptions of GMOs in New Zealand comes from a 1994 study (Fitzgerald *et al*. 1996b). There was not much variation in the acceptability of different kinds of use for GMOs. Of the respondents able to give a rating, the majority considered all the listed uses of GMOs to be acceptable, including for controlling animal pests (Table *VI*).

Table VI. Acceptability of uses of genetically modified organisms

Use of GMO	% of public rating as acceptable
Vaccines to prevent animal diseases	78
Production of medical drugs for humans	70
Control of pest plants or weeds	65
Increasing quantity or quality of agricultural products such as meat, milk and vegetables	64
Control of insect pests	64
Control of animal pests	63
Treatment of human diseases	56

Public perceptions of biological controls

Possums and rabbits are both major pests in New Zealand. In late 1994, some of the authors conducted a study of New Zealanders' perceptions of possums and rabbits and their attitude to various methods of controlling these vertebrate pests, with special emphasis on biological control (Fitzgerald *et al*. 1996a, 1996b). The study used both qualitative and quantitative methods, combining 11 focus groups with a geographically stratified national random sample of 1127 people. Although 68% of the respondents said they had heard of "biological control of pests", only one-third of these felt they could explain it to a friend. Awareness of the concept of the "biological control of pests" was not a strong determinant of people's level of acceptance of biological controls.

Of four suggested potential biological means for killing possums, use of a genetically modified organism was considered the most acceptable, being rated acceptable by 50% of respondents. More people rated the use of a parasite, bacteria, or virus unacceptable than acceptable. Of four suggested biological methods for controlling possums, the most acceptable was one that "stops possums breeding" (which would include methods such as immuno-contraception and sterilisation). This was considered acceptable by 85% of the respondents (Table *VII*). The least acceptable method was one which "makes possums more susceptible to natural diseases".

Table VII. Acceptability of specific biological control methods

Method of biological control of possums	% of public rating acceptable
Stops possums breeding	85
Immunises against Bovine Tuberculosis	62
Kills young in the pouch	48
Makes more susceptible to natural diseases	40

Public concerns about biological controls

The main risk domains identified by participants in the Fitzgerald *et al*. focus groups were to the environment, the economy, and people's health. In the survey only about one-quarter to one-third of respondents considered the biological forms of control a high risk in all three risk domains. Within each of the risk domains, a pest-controlling GMO was considered to present the lowest risk.

Most of the respondents rated a GMO-derived biological control as presenting a low risk to the environment, the economy and people's health. The respondents considered an (unspecified) GMO to be less risky than an imported naturally-occurring organism. The closeness of the risk ratings given to imported parasites, bacteria, and viruses suggests that the respondents did not distinguish well between these kinds of organisms, and that the perceived risks were more to do with the origin of the organism than its form. The perceived higher risks of such imported organisms to the environment than to the economy and people's health indicates that the risk issue is that these organisms were seen as yet another unwanted or dangerous introduction to New Zealand. This further suggests that imported organisms are perceived by the public as being potentially less specific to the target pest than a GMO.

A GMO was perceived as presenting much less risk to New Zealand, even though GMOs are probably less well understood by the public, and are therefore more novel. Since a GMO was seen as being potentially more specific, it would therefore be regarded as more controllable and with less potential for catastrophe.

Our focus group discussions showed that the public wanted high levels of guarantee about the specificity of any organisms to be used for biological control, whether the organism would be used directly as a biological control or whether it would be used as a vector to spread a control organism to the target pest. The greatest concerns were that an organism would spread directly or indirectly to the human population, or to native and domestic animals, in particular to livestock. The theme of potential mutation of an introduced or modified organism was encountered consistently, and some focus groups also raised the spectre of a 'time bomb' or delayed effect.

Consequently, many focus group participants felt that biological control methods should be researched and developed to the point where all doubt or risk was removed. Even then, they believed that science could not necessarily guarantee the ongoing specificity or immutability of a biological control organism. This was further complicated by doubts about the credibility and trustworthiness of scientists and their funding agencies. These themes of the risk of the unknown, fear of catastrophe, and the credibility of science arise commonly in social research on new technologies.

Getting specific: acceptability of RCD as a biological control for rabbits

The myxoma virus (myxomatosis) was introduced to New Zealand as a biological control agent for rabbits in 1952, but there was no suitable vector and the disease could not be sustained in feral rabbit populations. In 1991 a further application was made to introduce myxomatosis and an insect vector, the European rabbit flea, to New Zealand. In 1993 the Minister of Agriculture and the Director General of Agriculture ruled that myxomatosis was "an unacceptable option in the 1990s", due largely to public concerns over the host specificity of the flea vector and the humaneness of the disease (Williams and Munro 1994). On the humaneness issue, government indicated that a potentially more acceptable biological control, Rabbit Calicivirus Disease (RCD), could become available in the future.

In the public debate over the proposed introduction of the myxoma virus and the current use of 1080 poison, perceptions of 'dread' and 'unknown' risks appeared and became socially amplified. These focused on mutation of the virus, uncontrollability, and inhumaneness to the rabbit. Media attention on the escape of RCD from its test site on Wardang Island in 1995 further amplified the public's perception of the risks of biological forms of control for pests, and perhaps reduced the credibility of scientists working in this field.

At the time of our survey in late 1994, RCD was being tested on Wardang Island, but had not yet escaped. Our questions on perceptions of RCD were hypothetical. Since then, RCD has become a more pressing issue in New Zealand, and we are now conducting follow-up research on perceptions of biological control with particular reference to RCD.

The acceptability of a biological control for vertebrate pests, such as RCD, depends on the question being asked and how specifically one asks it. In the 1994 survey RCD and its characteristics were outlined. Just over half (51%) of the respondents thought that RCD should be introduced to control rabbits, just under a quarter (24%) thought it shouldn't, 19%

were undecided (i.e. said "depends"), and 6% did not know (Fitzgerald *et al*. 1996a). However we found that a person's attitudes to RCD or biological control could not be fully ascertained from the response to a single question. For example, over half the respondents in the survey had a different position on the introduction of RCD from that on an unnamed rabbit virus. The number of respondents who favoured the introduction of a virus increased when it was named and its features explained. This effect is similar to that described earlier for different forms of genetic engineering.

When our respondents were asked to explain their position on introducing RCD — that is, when they had to think more about the question — we found their position was multifaceted, and often different from what they said initially. Within each category of response to the introduction of RCD, the types of reasons differed. Those in favour of introducing RCD referred to existing rabbit problems and the need for a solution, though some qualified their acceptance with the requirements that RCD should be specific to rabbits and humane. Those who considered that RCD should not be introduced focused on the risks or problems of introducing a new virus. These respondents also required ethical standards but did not believe they could be met, and were distrusting of information provided by scientists. Those with a 'depends' response raised the risk of new problems arising from the virus, requiring it to be specific and humane. They were also seeking additional information.

Based on the combination of the respondent's initial position on introducing RCD and the reasons given for this position, we then categorised the respondents into six groups: Supporters (22%), Concerned Supporters (13%), Cautious (19%), Undecided (5%), Ethically Concerned (22%) and Rejectors (19%). Just over one third of the population (the supporters and the concerned supporters) expressed straight-forward support for introducing RCD, just over one third were in opposition (the rejectors and the cautious), and one quarter (the undecided and ethically concerned) required more scientific reassurance and information to resolve issues and doubts before they would support the introduction of RCD.

On the basis of these expanded positions, straight-forward support for introducing RCD would most likely come from only about one-third of the population — the 'supporters' and the 'concerned supporters' — compared with the apparent 51% obtained in the initial response. The remaining two-thirds of the population would need sufficient credible information put in front of them to decide whether the proposed biological control complied with their requirements, and to assess the various risks. Even with this information, people may oppose the introduction of RCD. We found, for example, that the 'cautious' (the 19% who focused on the need for more information) closely resembled the 'rejectors' in many of their attitudes to rabbit controls. Their request for more information may therefore have been a way of avoiding taking an overtly negative initial position.

Perceptions are reality: decision-making and public information

Professional agriculturalists should remember that however ill-conceived they believe public perceptions are, the perceptions represent reality to those who hold them. Public perceptions are usually quite stable, though they may change through exposure to information and discussion. Such changes cannot easily be manipulated. The best way for professional agriculturalists to provide constructive influences on public perception is within a consultative framework.

In August 1996 the Ministry of Agriculture and the Consumers Institute held the first consensus conference in New Zealand. The consensus conference concept was developed in Denmark to develop a consensus on technological issues through a panel of 16 people representative of the community. The panel spent three weekends over three months consulting with experts such as scientists, environmentalists, policy-makers and representatives of cultural groups, and developed a series of recommendations to the community. The first topic debated in New Zealand was 'Plant biotechnology'. The report from this conference demonstrated that a consensus approach to opinion-forming can result in a well considered, balanced view which is more likely to be accepted by politicians and the community.

Erroneous perceptions of risk may occur because people lack information. For people to understand the relative risks of, say, a biological control, they need to know the present and likely future impacts of the pest (on the environment, farming productivity, and the ratepayer or taxpayer), the impacts and risks of current control technologies, and the potential risks of introducing the control organism. The consensus conference panel commented on the problem of inaccessability of scientific, educational and mass media information about biotechnology.

Although the lay public's perceptions may be technically incomplete, their understanding of risk can sometimes be richer than that of experts. In focus groups, we have found that this is mainly because the public tends not to pre-filter the issues for consideration. Although risk experts or scientists may think the public's perceptions are inaccurate or clouded by irrelevant issues in some situations, such perceptions are real. For this reason, public and interest-group perceptions of biological control technologies, their acceptability, their potential risks, and the management of these risks need to be understood.

While it is tempting to say we need to know how to change those perceptions which are unfavourable to a particular position, a more professional approach is to understand how attitudes will be formed in the future and who is likely to influence the formation of the attitudes. Martin and Tait (1992) made the observations that:

- groups with an identifiable interest in genetic engineering will have a fairly stable attitude;
- such groups will seek advice from the group most likely to reinforce their existing attitudes;
- once formed such attitudes are difficult to change;
- the groups with the least polarised attitudes are the most open to a wide range of sources of influence and advice.

Although perceptions appear not to vary greatly between countries, it is important that professionals are aware of cultural sensitivities. The consensus conference helped to identify several key issues relating to Maori perceptions of genetic engineering. These included the pending legal claim on the ownership of all indigenous fauna and flora, which could mean that scientists must seek permission from Maori before commencing genetic work on these plants. Professionals should also understand the 'world' view of Maori in which everything is connected, as being different from the western 'compartmental' view; and a special view that any human DNA should be treated with respect because of the spirituality of ancestors.

Formal or expert probability-based assessments alone are unlikely to meet the public's needs when it comes to making a decision on the introduction of a biological technology. As Chess *et al*. (1989) advise in the resolution of risk problems, "merely hammering away at the scientific information will rarely help". A carefully devised two-way communication process and participatory decision-making approach would therefore be appropriate when the introduction of new organisms is being proposed. Chess *et al*. (1989) and Slovic (1986) have provided useful guidelines for communication and decision making in situations in which questions of risk feature. The Chess risk list can be used as a predictive tool to assess possible public perceptions of biological technologies. People do have the ability to differentiate between specific applications of biotechnology, something which Macer (1994b) has called the 'bioethical maturity' of a society.

Media reporting could inform the public about the technology (thereby reducing some of the 'unknown' risks); it could also amplify the perceived risks. In the case of rabbits and the myxoma virus, the New Zealand public has already been presented with graphic, negative television images of a powerful and novel biotechnology at work, combining larger-than-life images of dead and dying animals, commentary evoking the 'unknown' and 'dread' risks, and doom-laden background music. Such media portrayals can potentially overshadow any images or information about the rabbit's current and future impact on the environment and the economy.

Science is unlikely to be able or willing to provide the levels of certainty that eliminate public dread of the uncontrollability of new organisms, potentially calling into question the public credibility of the scientists and experts providing the information on which the decisions will be made. The design of public information and consultation programs will therefore need to be sensitive to these issues.

The communication process itself is risky. As Morgan *et al*. (1992) have noted, "one should no more release an untested communication, than an untested product". Ideally, a communication program on the introduction of a biological technology should itself be developed in participation with the public and key interest groups. As Couchman & Fink-Jensen (1990) comment, professionals should not seek to manipulate public opinion according to the needs of the regulators or industry. Any hint of such manipulation would merely invoke the stigma of social engineering, to the detriment of the image of genetic engineering. This would amplify the public's views of the risks and further politicise the decision process.

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