Strategic Issues for GMOs in Primary Production:

Key Economic Drivers and Emerging Issues

CSAFE Discussion Paper No. 1
October 2000

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BACKGROUND:

Since 1995, Dr Hugh Campbell has been the programme leader of a PGSF programme investigating the emergence of environmentally enhanced food exports. This programme has been re-funded four times and each time has increased in size and scope. Through the operation of this research programme, Dr Campbell formed a Cooperating Research Group involving nine researchers with expertise relevant to evaluating the socio-economic dimensions of adopting new agricultural systems.

In 2000, this Co-operating Research Group was recognised by the School of Social Sciences, University of Otago as forming the basis of a new research centre – the Centre for the Study of Agriculture, Food and Environment (CSAFE). CSAFE has a director and three re searchers based at University of Otago, and has five affiliated researchers around New Zealand.

CENTRE RESEARCH SPECIALITIES:

Research undertaken through CSAFE concentrates on the relationships within what is termed the Agri-food system. Agri-food analysis examines the links between different aspects of the production, distribution and consumption of foods, and relates these to particular social, economic and environmental outcomes. While many researchers are concentrating on the regulatory and policy process relating to human/environment interactions, CSAFE represents a group of researchers from different specialisations within both social science and agricultural extension with a common interest in evaluating the influence of changing agricultural systems on environmental sustainability, as well as the counter influence of sustainability, environmental and food safety concerns on agricultural systems. Consequently, CSAFE represents the most specialised body of researchers competent to examine the sustainability claims of different systems of agricultural production.

PUBLICATIONS

CSAFE is responsible for the Studies in Rural Sustainability series, and also a series of Discussion Papers on recent research work undertaken by CSAFE researchers.

RESEARCH REPORTS:

Campbell, H. *Recent developments in organic food production in New Zealand: part 1, organic food exporting in Canterbury.* Studies in Rural Sustainability No. 1 (1996)

Campbell, H., Fairweather, J. and Steven, D. *Recent developments in organic food production in New Zealand: part 2, Kiwifruit in the Bay of Plenty.* Studies in Rural Sustainability No. 2 (1997)

Liepins, R. and Campbell, H. *Men and women as stakeholders in the initiation and implementation of sustainable farm practices: Organic agriculture in Canterbury.* Studies in Rural Sustainability No. 3. (1997)

Coombes, B., Campbell, H., and Fairweather, J. *Recent developments in organic food production in New Zealand: part 3, Exporting of organic produce from Gisborne District.* Studies in Rural Sustainability No. 4 (1998)

Coombes, B. and Campbell H. *Recent developments in organic food production in New Zealand: part 4, The expansion of organic food production in Nelson and Golden Bay.* Studies in Rural Sustainability No. 5, Department of Anthropology, University of Otago. (1998)

McKenna, M. and Campbell. H. *Strategies for Greening the New Zealand Pipfruit Industry: The Development of IFP and Organic Systems.* Studies in Rural Sustainability Research Report No. 6 (1999)

Fairweather, J., Campbell, H. and Manhire, J. *The 'Greening' of the New Zealand Wine Industry; Movement Towards the Use of Sustainable Management Practices.* Studies in Rural Sustainability Research Report No. 7 (1999)

Bourn, D., Newton, B. and Campbell, H. (1999) *Strategies for 'Greening' the New Zealand Honey Industry: An Evaluation of the Development of Organic and Other Standards.* Studies in Rural Sustainability Research Report No. 8 (1999)

ACKNOWLEDGEMENTS

This paper took original shape as a submission by the authors to the Royal Society of New Zealand's ad hoc committee on Social Science Issues and GMOs. The authors of this paper would like to thank the convener of that committee – Rosemary Du Plessis – for agreeing to our publication of this material as a CSAFE Discussion Paper. We would also like to thank the other members of the ad hoc group (and several reviewers) – Keiko Tanaka, Kevin Dew, Fiona Cram, Bevan Tipene Matua, Geoff Lawrence and Anne Murcott for their various helpful comments on the draft of this report.

We would also like to thank Les O'Neill for his assistance in preparing and formatting this Discussion Paper in an extremely short space of time.

This Discussion Paper represents only the views of the four authors.

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Summary

Economic analyses of GMOs, especially those attempting to predict their economic performance in primary production, tend to rely heavily on changing point of production efficiencies or output. A more useful approach to predicting economic performance is to identify key economic drivers that lie outside the point of production.

These key economic drivers are:
- consumer responses
- the length and intensity of the GMO food scare
- trade politics and GMOs
- export performance
- bifurcation of markets

This discussion paper argues that a balanced analysis of the potential economic performance of GMOs must account for all these factors, as well as point of production efficiencies or productivity gains.

1 Consumer responses to GMOs are considered by all parties in the GMO debate to be central to the marketability of the technology. For this reason, the views of consumers on this topic have been investigated repeatedly however with tools of quite varied scope, rigour and suitability (particularly in North America) which makes interpretation of the significance of their responses more complex. It is possible to draw the following conclusions from the published literature:
   - People's responses to GMOs in ALL of the countries sampled (while culturally specific) have been becoming more negative in recent years with the most concern for the technology apparent in Europe and Japan.
   - People have a differential response to GMOs with medical applications being more acceptable than food applications.
   - People are interested in labelling GM food products, are mistrustful of much expert opinion on this topic, and are not as well informed as they would like to be.
   - Some people's opinions on specific biotechnology applications can be influenced by whether or not they perceive some benefit in the product itself

2 While some public discussion has promoted the use of science based public education campaigns as a way of reducing public concerns over the technology, such measures are unlikely to succeed because they presume an unwarranted degree of efficacy in public information campaigns. Parallel campaigns in health promotion have not succeeded to the extent that their proponents might have hoped.

3 The manner in which populations handle concerns over novel foods can be more satisfyingly understood using examples from previous historical scares (for example concerns over margarine and over irradiated food). These incidents provide better models of the complexity of such social phenomena.

   In past food scares, a redefinition of the stigmatised product at a discursive and semiotic level within society does take place in many cases. However, the amount of time which can pass before such a redefined product comes to be accepted by the general public can be extremely lengthy. Evidence to date suggests that GM foods have experienced this kind of stigmatisation and that the GM food scare may, therefore, be quite lengthy.

4 Economic analysis suggests that despite the current commercial release of GM being seen to benefit producers – in reducing costs and/or increasing yields – how far this has actually translated through into increased producer returns is questionable.

5 The influence of consumer shifts away from GM products can be seen in the development of price premiums for GM free; trade diversion away from GM sources to GM free sources (particularly to the Japanese market) and the positioning of key retail outlets in Europe as GM-free.

6 NZ food exports currently comprise 70% of total exports. The main markets for these exports are the developed countries, which have the advantage of being relatively high value secure markets. The proportion spent on food (especially the value of produce at the farm gate) in these developed markets is falling and predicted to fall further. The focus of the growth in these markets is on the attributes associated with food such as quality, safety and environmental attributes.

7 Recent developments in agricultural/food policy stress these changes. For example, the switch in EU policy away from block market support to payments for environmental enhancement, and the changes in UK liability law making retailers responsible for food safety issues, have all had and are predicted to continue to have impact.

8 These regulatory moves have translated into an adoption of the 'precautionary principle' in trade negotiations, and the emergence of 'green protectionism' as some First World markets seek to protect domestic producers through the imposition of increasingly stringent food safety and environmental criteria for imports. Recently, such sanctions have been applied to GM imports.

9 Economists agree that it is important for NZ, as a small player even in agricultural terms on world markets, to target high value markets which, through policy actions and/or market preference, are concerned with how food is produced.

10 A simulation trade model at Lincoln University has been adapted to assess the impact on producers, consumers and trade of various scenarios relating to

production of GM food. The model simulates, against various assumptions of proportions GM/GM free production, the impact of various scenarios relating to preference for or against GM production. The results of this preliminary analysis show the greatest positive impact on New Zealand's farm income occurs under the GM-free strategy where it is assumed that such markets as the EU and Japan experience large switches in preference away from GM food, followed by a 20% preference for GM-free. Other scenarios – including a range of price preferences for and against GM products – achieve variable results. Under several of these scenarios, economic returns decline.

11 The conclusion of the discussion paper is that New Zealand would not experience any adverse economic effects if a moratorium on commercial release of GMOs in primary production was imposed for a period of 3 years. In fact, trade modelling suggests that this would actually increase returns to farming through accessing GM-free markets. Longer term prospects require considerably more analysis which could be undertaken while a moratorium was in force.

Introduction

The Warrant of the Royal Commission of Enquiry into Genetic Modification asks a range of questions about the kinds of consequences (health, environmental, legal, cultural, ethical and economic) that might occur should GM technologies be commercially released in New Zealand. These are important questions, as New Zealand is one of only a few countries that rely on food exports to generate a major proportion of national revenue, but which have not yet released GMOs into commercial production of food, fibre or nutriceuticals.

Focussing specifically on the *economic consequences* of commercial GM production, there is clearly both an opportunity for unique economic outcomes that must be considered, and also a series of major methodological challenges surrounding how we might quantify the nature of these opportunities given that such an exercise is entirely predictive (ie. we have no actual commercial production of GMOs to evaluate).

This difficulty is evidenced by the level of claims-making taking place about the potential economic value to New Zealand of either avoiding or encouraging GM technologies in commercial production of food, fibre and nutriceuticals. There are clearly few certainties in this discussion. The *New York Times* reported in 1999 that even Monsanto had hired a group of independent consultants to try and estimate the nature of the biotechnology landscape in several decades time ('Plotting Corporate Futures: Outlining What Could Go Wrong' New York Times: 24/6/99). The consultants drew up three scenarios – one reasonably positive, one uncertain and contingent on the outcomes of many unpredictable variables, and one primarily negative for GM food. However, they were unable to recommend which one they considered the most likely to happen. Such caution is scarcely reflected in some of the recent claims-making in public fora about the presumed benefits and disadvantages of either a biotechnologically-driven or GM-free economic future for New Zealand.

In order to give a sense of proportion to the extent to which economic realities can live up to the more dramatic claimed scenarios of public debate, it is important to examine some of the key drivers of the future performance of commercial GM. This paper considers the drivers for GM *food* and *fibre* production rather than those for nutriceutical/medical applications of the technology which are likely to be somewhat different in nature and to require separate analysis.

The need for this discussion paper is founded upon an imbalance in the consideration to date of the potential economic performance of GMOs in commercial production. This imbalance is caused by the tendency to evaluate productivity gains, or changes to plant or animal specifications as the sole source of evidence required to establish beneficial market outcomes. This kind of reductionist focus on the point of production in primary industries is understandable given the narrow focus of scientific activities directed specifically at developing novel characteristics for goods in primary production. Likewise, it has always been the task of plant and animal scientists to improve the characteristics of plant and animal products, and this forms a crucial and necessary part of our scientific endeavour. However, providing evidence of productivity gains, or novel characteristics as the *sole* body of evidence for impending economic success is deceptive. Such reductionism is fraught with difficulty for many economists and social scientists and ignores those social elements which are likely to provide some of the key drivers of potential economic performance. These are the drivers that lie outside the point of production – in trade politics, generic industry strategies, collective branding initiatives, retailer trends, media coverage, and many other consumer-related phenomena (see Box 1 for a case study revealing the complex interplay of these socio-economic factors).

This discussion paper will address these key drivers. However, the following analysis is severely hampered by the paucity of material originating from countries like New Zealand and Australia. In contrast, more thorough studies from countries like the UK provide a broader understanding of some key drivers of GM performance, but are only partly relevant to the New Zealand situation. This relevance is strongest when market issues and consumption are being addressed as such issues directly impinge on market performance of New Zealand's exports.

The discussion paper addresses the following key drivers:

- hardening consumer responses to GMOs
- the possible longevity of the GMO food scare
- trade politics and GMOs
- export performance as evidenced by preliminary trade modelling
- bifurcation of markets

Having reviewed the current state of knowledge in regard to these drivers, this discussion paper briefly reviews some of the emergent issues that are influencing the economic debate around GM in food and fibre production.

Potential issues arise from the:

- emergence of alternative agriculture strategies
- potential loss of a generic 'GM-free' marketing strategy

The conclusion of this report is that the many claims made about the potential economic performance of GMOs rely on a limited range of information, with both pro and anti groups mobilising selective bodies of information from within this limited range. Our cautious evaluation of available information suggests that a three-year moratorium on commercial production of GM-based food and fibre production in New Zealand would have limited negative economic impacts and would enable more time for in-depth evaluation, clearer emergence of trends behind key drivers, and may even enable the achievement of GM-free branding benefits for a number of sectors.

Box 1 THE GM PAPAYA STORY

The uncertainty associated with the market for GM food is well illustrated by the following report on Papaya production in Hawaii.

In September 1996, SunUp and Rainbow papaya became the first GM fruit crops to have regulatory restrictions lifted by the USDA and thus be cleared for eventual commercial production (McCandless, 1996). Deregulation by APHIS, EPA and FDA followed in 1997 (Zakour and McCandless, 1998a). The two genetically altered lines of papaya, were developed by scientists at Cornell University and the University of Hawaii to resist papaya ringspot virus (PRSV). This virus stunts growth, yellows leaves, damages fruit and eventually kills papaya plants, and had progressively decimated Hawaiian papaya crops following an outbreak on the Big Isle in 1992 (SCIENCE Newsroom, 1998). Papaya production decreased from 58 million pounds in 1993 to 36 million pounds in 1997 (Zakour and McCandless, 1998a) and so, in such a context, researchers in 1996 understandably claimed that, "commercialisation [of virus resistant GM-papaya] could save the entire Hawaiin papaya industry" (McCandless,1996).

Suitably genetically modified papaya seeds were first released to Hawaiian growers in April, 1998, and were distributed free of charge. The growers themselves had helped finance the research, and ownership of the new papaya lines was transferred to the growers' cooperative, the Papaya Administrative Committee (PAC) (APHIS, 1997). The manager of PAC was optimistic that disease-resistant GM papaya would, " lower input costs for producers, provide a better product for consumers, and improve export potential" (Zakour and McCandless, 1998a) and fruit from the GM seeds was anticipated to be available for purchase within a year (Zakour and McCandless, 1998b).

However, by harvest-time 1999, GM papaya was becoming controversial. The new papaya was associated with worries about potential contamination of organic crops and the possible creation of new viruses. Difficulties in accessing international markets, such as Europe, Mexico and Japan, became a major concern, particularly as between 35–40% of Hawaiian papayas were destined for Japan, where GM papayas had not been approved for sale. So, although biologists maintained that genetic engineering had been much more effective than any alternative traditional attempt to prevent or cure the disease, it was recognised that, "ultimately what will determine the success of the new papayas… is whether consumers are interested in eating them" (New York Times, 1999).

By April 2000,the response from consumers was clearer and the Hawaii Tribune-Herald, 2000 was stating that "market economics have forced the papaya industry to rethink its much-vaunted genetically engineered plant strains". The very important Japanese market had rejected the transgenic fruit. Even domestic growers were obtaining a far better price for the older varieties, which were selling for 60 cents per pound compared with 20 cents per pound for the GE variety, 'Rainbow' (Hawaii Tribune-Herald, 2000). The genetically altered papayas, were found to "have a brief shelf life before turning mushy, and they tend to be oversized making them more expensive to ship. To top things off, the Rainbow variety, a hybrid, is showing signs of being less disease-resistant than advertised" (Hawaii Tribune-Herald, 2000).

What is perhaps most interesting about the papaya story is the degree of local goodwill and enthusiasm surrounding the introduction of the GM crop in the first instance. The novel papaya was developed in response to a specific and very real problem, and, "[u]nlike nearly every other genetically modified crop that has been approved for commercial use, the new papaya was not produced by profit-motivated seed companies but by [University] researchers…" (New York Times,1999). Furthermore, seeds were distributed to growers free of charge and even ownership of the new varieties was transferred to growers. And yet, in the final analysis, where consumers and market pressures determine success, genetically engineered papaya failed.

1 Key Drivers: Consumer Responses to GMOs

In a field that is characterised by a general lack of research, undoubtedly the most deeply investigated arena is the responses of 'consumers' to GM foods. The following discussion reviews the main findings of the most prominent contributors to this work – particularly Hoban and Frewer et al. – and then discusses some methodological issues associated with the interpretation of their work.

1.1 literature review

The English language literature on consumer responses to GMOs is derived from a wide range of media (for example internet sites, academic journals, book chapters, technical reports, customer surveys, public opinion polls in newspapers and privately funded consultant's reports). Understandably, then, it includes sources of varying quality and information obtained from a variety of sampling styles. Three broad divisions of information sources emerge from the literature. The largest quantity of material is in the form of marketing style surveys and opinion polls. These sources are of extremely variable quality but can be useful as indications of drifts in public opinion without, however, being able to offer explanations as to why these may occur. There are also psychosocial and quantitative social science surveys, usually more rigorous in design, which examine perceptions and attitudes towards GM food and present the results of surveys of segments of large populations at the level of individual decision making within that population. Such surveys have limitations in that they neglect the broader social dynamics which shape consumer responses and are frequently restricted to a very small geographical area. Finally, there are the more speculative social science pieces which examine larger social trends in an effort to explain their effect on individual and group behaviour but these suffer the drawback of being able to offer little in the way of verifiable evidence of such explanations (Section 2 of this paper is derived from within this third disciplinary perspective but attempts to rectify the lack of evidence so frequently encountered in this style of analysis). There are also noticeable geographical gaps in the published literature with information available predominantly in relation to consumers' opinions in North America, Europe, Australia and New Zealand, and a few studies available on Japan and Brazil.

In general, care should be taken in analysing trends from any *one* of the categories of data previously described and a more reliable picture is likely to emerge from careful consideration of all three categories (this point will be referred to again in Section 2) In addition it is particularly important to source polls and surveys in order to review their construction before uncritically accepting their results as they are likely to have been constructed for marketing analysis which will render them less than reliable for use in the social science arena (see Gofton 1998).

The following literature review focuses mostly on prior reviews to establish the major trends in consumers' perceptions of GMOs in the last ten years and will cover this topic on an area specific basis, it will not include the more speculative social science discussions of the topic which will be referred to briefly again in Section 2.

Writing in 1994, Zechendorf reviewed twenty-four surveys and opinion polls from Japan, Northern Europe, the US and Southern Europe which were conducted over the previous decade and observed (despite the disparity between methodologies) the following common points. First, acceptance of the technology was different for various applications. This was moderated by the individual's level of knowledge of biotechnology (which if increased tended to increase acceptance), their perception of risk, and degree of ethical concern (applications for drug use were preferred over interference with food or animals). In the US and Europe, Zechendorf notes that there was also scepticism of the media and of scientists as knowledge sources.

In 1998, Norton reviewed sixteen surveys and opinion polls from Australia, New Zealand, Northern America and Europe over the preceding eight years and described similar trends, in particular, the tendency to differentiate between the acceptability of certain applications of biotechnology (e.g. there was more distaste for manipulation of human material than for animal material). There was also concern for the unintended consequences which may have been associated with the technology and a lack of confidence in the ability of regulatory bodies to manage these risks. These more recent surveys signal the appearance in the intervening four years of a wish for more public involvement in decision making around these issues and the wish for clear labelling of GM products. These concerns are still present today, most noticeably in Western Europe.

Kamaldeen and Powell (2000) have reviewed polls of quite varied sophistication and rigour to gather North American opinions on biotechnology in relation to recent international opinion polls. They illustrate that concerns over biotechnology and GM food in particular are not as significant for North Americans as they are for Europeans as around 61% of Canadians feel comfortable with biotechnology as a general concept while 38% do not (Pollara and Earnscliffe 1999 cited in Kamaldeen and Powell 2000). However, 59% of the Canadians polled also saw GM *food* as a negative application of the technology in contrast to the 39% cited as being not comfortable with the technology in *general* (Angus Reid 2000 cited in Kamaldeen and Powell 2000), suggesting a similar differential response to applications of the technology as has been noted in other western countries. General levels of awareness of biotechnology for Canadians are quite similar to those levels obtained for France (at 78% of the Canadian respondents) and higher than those levels recorded for the US (66%) and Brazil(39%) (The Economist/Angus Reid Poll, The Globe and Mall 2000 cited in Kamaldeen and Powell [2000]). One should also note that

these are self estimations of awareness level rather than the biotechnology quizzes carried out in the considerably more sophisticated Eurobarometer polls.

The Wirthlin Quorum Poll (http://www.ificinfo.-health.org/foodbiotech/survey.htm) which these authors cite in relation to the US situation provides an excellent example of the inadequate methodology on which so many of these polls have been based. For example, it presents only positively biased applications of biotechnology to assess the acceptance of GM food (eg fresher, tastier vegetables and low fat cooking oils). The response of US subjects to the question "would you be likely to buy this produce?" has remained roughly evenly divided since 1997 (figures for 2000 are 54% 'likely' and 43% 'not likely'). In response to a question aimed at assessing subjects' views of the potential benefit to themselves of biotechnology, attitudes in the US have hardened from 1997. The poll measures a drop in presumed positive effects from 78% to only 58% of respondents by 2000, and there has been a similar increase in negative expectations from 14% in 1997 to 25% in 2000 with 16% not knowing or failing to answer.

In the New Zealand context, Cook et al (2000) completed a review of seven studies of New Zealand attitudes to GM in food production, including a four-study work by Gamble et al (2000), which were carried out over the period 1990 –2000. These studies show that knowledge of GM has increased over time and that acceptance of the technology has remained rather higher than in other areas of the world until 1998 when it began to diminish (Macer 1994; 1998 cited in Cook et al. 2000). The differential response to the various applications of the technology seen in other parts of the world are also evident here (plant applications being more acceptable than animal or human interventions). Concern for the technology is based on food safety issues, environmental effects and its 'un-natural-ness'.

The situation regarding European perceptions of biotechnology is best understood from the sophisticated Eurobarometer polls (http://www.europa.eu.int/comm/research/pdf/eurobarometer-en.pdf) Eurobarometer 52.1 (carried out in 1999) is the most recent in a series of surveys of around 16,000 people from member states of the EU on the topic of biotechnology. Results show that consumers were concerned about their lack of knowledge of biotechnology and they exhibited a noticeably decreasing trust in all available sources of information on biotechnology although consumer groups (26%), and medical (24%) and environmental organisations (14%) were the least doubtworthy. Differential acceptance of the applications of the technology was still apparent with food applications being least acceptable and disease detection the most acceptable while medical and pharmaceutical applications remained in favour. To compare the Eurobarometer results from 1996 with the present, there has been a noticeable decline in popularity of biotechnology applications generally, although there are regional differences in the degree to which this loss of favour has occurred. For example, Spain is frequently more favourably disposed to these technologies than Greece.

This literature survey also reveals two groups of writers who emerge with a significant depth of publication in the area – Thomas Hoban and Frewer et al., and a discussion of this work follows.

Frewer et al. (1994a, 1994b, 1995, 1996, 1998, 1999) have published consistently in the area of consumer perceptions of GM technology using psychometric surveys of (mostly British) consumer understandings of risk and psychological models of communication in relation to this topic. An underlying theme in their work has been an intention to discover better ways of facilitating informed debate on the topic of biotechnology and to provide information on the most efficacious route for the introduction of this technology into society. Their work also confirms a differential response to the acceptability of GM technology with negative responses to applications involving human and animal DNA while work on plants and micro-organisms was seen more positively. The decision by their subjects to view certain applications as negative was sometimes mediated by the perception of the benefit or need associated with the application. They note significant distrust by their subjects of the government and industry as sources of information on biotechnology and demonstrate that medical doctors and consumer groups as regarded by the UK public as more trustworthy sources (Frewer et al. 1999). They also describe some cultural differences in responses to their surveys on concern over biotechnology with the UK sample expressing concern over the risk associated with the technology whilst for the Italian sample, ethics appeared to be the more problematic aspect to biotechnology (ibid). This finding – highlighting the importance of cultural differences in consumer responses – does indicate the limitations of making cross cultural inferences based on data derived from studies conducted using psychological or psycho-social methodologies. Basically, Frewer's findings provide excellent insights into one specific aspect of consumer responses, but the wider significance of these findings is more accurately achieved by incorporating such findings with the results of other methods of enquiry. These methodological issues regarding Frewer's work are insignificant however, when compared to the questions that are raised about the other prominent researcher in this area – Thomas Hoban.

Hoban (1989, 1994, 1995, 1996, 1997, 1999a, 1999b, 2000, nd a, nd b) is an author who has been quite widely cited in relation to perceptions of biotechnology in the US and has also published interpretations of international (Hoban 2000, 1997) and Japanese (Hoban 1996) perceptions of the technology. His general findings prior to 1997 indicate a lower level of concern over biotechnology in the US than in Europe with people prepared to try varieties of GM food which have been engineered with specific benefits. However, there is still a differential response to the acceptability of certain applications of the technology (medical and crop technology are more popular than animal, food and fish applications). Hoban uses telephone surveys and his frequently less than full disclosure of his research methodology has left his work vulnerable to

critique for biased interviewing techniques (see The Centre for Media and Democracy website [Charman, 1999]). Concern over another aspect of his methodology in relation to his 1994 work on American consumers' awareness of rbGH has been voiced by Grobe, Douthitt and Zepeda (1999). Hoban's work is noticeable for two themes which he has continued to promote throughout his publications. The first has been his strong endorsement of the idea that consumer unease over biotechnology can be corrected by the introduction of public information campaigns about the technology. The other statement he has frequently made is that biased and negative media campaigns about GMOs have caused consumers to develop negative attitudes towards the product, implying that when the media loses interest in the controversy the public will relax and accept the products. Both points require further discussion as they have been powerful shapers of US industry opinion that concerns over biotechnology are likely to be short lived.

1.2 CRITIQUE OF HOBAN'S 'EDUCATION MODEL'

Hoban's oft cited (1997, 1999a, 1999b, 2000, nd a, nd b, Hoban and Katic 1998) assertion that consumer acceptance of biotechnology will increase once consumers have been exposed to science-based educational material is an assumption which is open to critique on several points:

- *Proposals for science based education programs construct consumers of these news campaigns as passive and uncritical recipients of information:*

Social scientists such as Fiske and Hartley (1978) have studied the consumption of media texts and revealed that consumers may actively resist prescriptive interpretations of media texts, preferring instead to elaborate their own local understandings of media information. In other words, when it comes to interpreting information campaigns, research reveals that people do not necessarily soak up this information like sponges. Instead they may ignore the advice, actively disagree with it, or produce their own hybrid version of the information. Thus 'official' information campaigns are not likely to be as efficacious in changing attitudes as their promoters expect them to be.

- *Corollaries in public education from the field of health promotion suggest education campaigns have the least empirical evidence of efficacy of all health promotion interventions*:

The field of accident prevention provides a useful corollary on this point because the orientation of professional health promoters towards 'lay' understandings of accidents (Green, 1995) is similar to the perspective which pro-GM writers such as Hoban hold towards the understandings of the general public on the safety of biotechnology (ie. that lay ideas are irrational beliefs formed without the benefit of scientific explanations of phenomena). The aim in both fields is to influence consumer's behaviour in the light of their perception of risks, with the key strategy being to change their perception of risk through education. The seduction behind education as a strategy in health care (as Green 1995 argues) is that it diverts attention from larger structural barriers to health and welfare which agency workers are unable to tackle due to lack of time and resources. Similarly, in the field of biotechnology the refusal to consider larger society wide influences on consumer concerns with some aspects of the technology ignores obvious cultural differences in acceptability of these techniques (see previous literature review). The response has been to promote a 'quick fix' to complex issues for which independent social science research is required (see comment CEC 2000:55). Education programmes are frequently directed only towards the individual consumer rather than simultaneously engaging with broader complex social processes which also affect behaviours. For all these reasons, public health campaigns based on an 'education' strategy have not proved to be as successful as their promoters had hoped.

- *Science based education solutions propose too narrow an information base to be of effective use in public opinion making:*

Such education proposals also ignore the inability of a scientific paradigm alone to respond to questions of morality, ethics and religious opinion which concerns over the application of GM technologies inevitably raise. These issues arise from within the everyday pursuit of scientific endeavours but pose questions which science no longer has the legitimacy to answer. Such issues have been referred to as trans-science issues by Weinberg (1972) or more recently in the ideas associated with a "risk society" (Adam, Beck and Van Loon 2000).

- *The fallacy of the alleged bias in media coverage of biotechnology and its resulting effect on consumer perceptions (which education campaigns would correct):*

Recently completed research at CSAFE (Sivak et al. *forthcoming)* reveals that the international English language press coverage of genetically modified food issues (as recorded in the Reuters Business Briefing Database over the last nine years) has been remarkably even handed. In fact, in its early years the coverage was biased towards positive reporting. Since food applications have been the most stigmatised application of the new technology, it thus appears reasonable to seriously doubt that Hoban's allegations regarding bias in the media reporting of biotechnology could have been empirically sustained by Hoban in this area.

The second point to note is that these results would then invalidate Hoban's reasons for promoting education campaigns in the first place (independently of the previously addressed concerns over their doubtful efficacy).

2 Key Drivers: The Food Scare as a Recurring Social Phenomenon

The following section reports on ongoing research at CSAFE in the area of food scares[1]. The notion of food scares is currently being developed as an explanatory framework in which to conceptualise the contemporary phenomenon of social concern over GM food in order to make some predictions as to the longevity of the GM food scare. As a methodological approach, this research draws on the disciplines of historical sociology and anthropology and is based on the analysis of primary and secondary literary and electronic texts which make reference to widely publicised and influential concerns over food technologies both now and in the recent historical past. In relation to the literature on consumer concerns over GM food described in Section 1, this work is placed within the third category of literature discussed which deals with social science interpretations of consumers responses in relation to broader changes in the wider society. This research provides an important addition to this literature however by being based (at least in part) on empirical research. As such it provides a necessary adjunct to psychosocial investigations of consumer concerns over GM food by moving beyond simple notions of 'consumer behaviour' as reducible to individual traits. By considering the complexity of social involvement which generally surrounds the social phenomenon of a food scare the idea of the individual as the site of genesis of these concerns is problematised and a credible argument as to why the GM food scare might have an extended rather than a short duration is created.

2.1 Contemporary Manifestations

The concept of a 'food scare' is an idea which has become increasingly familiar in contemporary society. This is illustrated in the figure below which plots the frequency with which the topic of food scares appears in the international English language print media derived from the Reuters Business Briefing database.

The content of these articles and the manner in which they mobilise the idea of a food scare has been subjected to a preliminary analysis at CSAFE and reveals a very wide range of concerns related to food safety, which until the last few years have been derived primarily from Great Britain.

Early references to food scares as represented in this graph frequently refer back to an earlier episode of food tampering in the United States in 1983 when Tylenol tablets were laced with cyanide. The articles deal mostly with concerns about the integrity of foods placed on supermarket shelves and their vulnerability to malicious tampering by other shoppers or disgruntled employees from within the manufacturing process. There are also certain pragmatic concerns, such as worries about radiation levels in various foodstuffs from the fallout of the Chernobyl accident and the infamous salmonella in eggs fiasco of 1988 (see North and Gorman 1990).

1 The term food scare is used with the recognition that it is highly valorised and has been chosen for its high public recognition value which is an asset in a public debate such as the Royal Commission on GMOs. However a more useful and more neutral term in an academic context would be food knowledges and this point has been made in more detail in Fitzgerald and Campbell (2000).

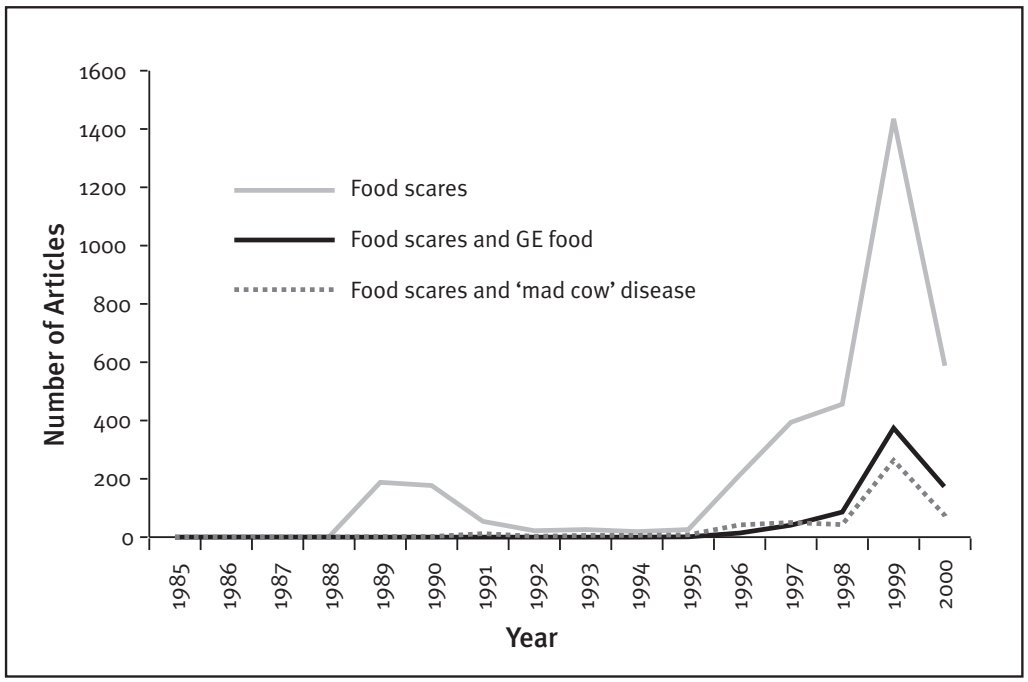

Figure 1 Media coverage of concern and panic over food consumption and production which makes use of the term 'food scares', Reuters Business Briefing Data Base (English language articles only).

However, by 1989 the topics covered by the term 'food scare' widen to include concerns over the safety of microwave ovens, listeria in chilled foods such as pate, soft cheese and fish meals, glass and screws in baby food, complaints about the injection of bovine growth hormone into dairy cows. There are also the beginnings of doubt about the veracity of government denials of the ability of BSE (still at that time referred to as mad cow disease) to jump across species.

By the end of the same year, some of the news sources such as The Grocer are documenting the cost to British food industries of these scares and the results are clearly damaging – loss of sales amounting to as much as £100M for the beef industry, £40M for cooked chicken manufacturers, £33M for the egg industry, a £20M loss for Perrier water (which had traces of benzene in it from a faulty manufacturing process), £15M for the live poultry industry, £15M for the yoghurt industry and £14M for cooked meat (Source: *GROCER 13/10/90 P5).*

By 1996 the term is being used in relation to genetically modified food, and by 1998 food scares begin to be mentioned in other locations apart from Britain such as France, Belgium, the US and Japan and the number of articles which invoke the idea of scares began to dramatically escalate.

2.2 HISTORICAL EVIDENCE

In many of the excerpts discussed in the prior section it is possible to recognise a lament for times prior to the Tylenol lacings when people, it is suggested, were able to eat their food in safety, free from the fear of its malicious adulteration or the potentially lethal side effects of its ingestion. To a large degree however, these halcyon days of food safety are fairly fictitious. To find a period of time when food was relatively safe from adulteration we would need to go back at least to the period prior to the industrial revolution; because it was during this period of upheaval and change in domestic provisioning that for the first time, large sections of the general populations around the world were separated from the means of growing their own food and came to be dependant upon the uncertain honesty of middle men for the quality of their provisions.

Tannahill (1988: 293) and Burnett (1989:86-103) give us lengthy descriptions of the adulteration to food which was so common during this period such as the addition of brick dust to cocoa, the use of copper to colour pickles green, the use of alum in bread. They also describe a thriving back door trade in used tea leaves which were collected by parlour maids from their wealthy employers and then sold to merchants who would dry them out, stiffen them up again with gum recolour them with black lead and sell them once again to unwitting consumers. Contemporary cartoons, snidely referring to these practises as "London Improvements", in Burnett (1989: Plate 2b) leave us in no doubt that the British public were at least partially aware and disapproving of some of these practises.

In anthropological terms there has always been a double edge to the act of eating which while it may not always have been as risky as in historical accounts of the post industrial days, certainly has always given it an edge of ambivalence. For example, the contamination of grain with ergot from the times that it first came to be stored for later use and the potential ingestion of poisonous and spoiled wild foods are hazards which have always been with us. Beardsworth and Keil have spoken about this as the 'omnivores paradox' building on the work of Rozin (1976) and Fischler (1980) (cited in Beardsworth and Keil 1997:51).

The current wave of concern over genetically modified food should be understood then within a historical context of continued anxiety surrounding the ingestion of new foods. An examination of the historical record provides several examples of food technologies which when initially introduced led to widespread consumer concerns and as such provide an informative parallel with the current debates surrounding GM food. So far, CSAFE has investigated two significant food scares from the past which were related to innovative technology – the introduction of margarine and the introduction of food irradiation. Profiles of these scares are set out below in Boxes 2 and 3 but the salient point of the literature search on these topics has been the quite extraordinary length of time for which concerns about these technologies have existed – 60 years in the case of margarine in the US and around 50 years (and still not resolved) for food irradiation.

2.3 DIMENSIONS OF FOOD SCARES

A small literature already exists from social scientists and food scientists who have taken a general interest in the social phenomenon of group anxiety over various types of food. Goodman (1999) is an example of such a theorist. In his analysis of the controversy surrounding BSE and nvCJD (new variant Creutzfeldt-Jacob Disease), he observes that these scares disrupt the taken for granted character of eating and do so on the "material, political-economic, social, discursive and semiotic levels". In simpler language, Goodman is saying that while food scares may manifest initially at the level of an individual as they decide whether or not to place an object in their mouth, eventually their effect becomes much larger. An example of this is the manner in which rbGH in dairy herds caused some people to re-examine the "naturalness" of cow's milk which (prior to the scare) was presumed by them to have been self evident. Such a re-evaluation has subsequent effects at many levels - from the broadest international levels of the food system causing economic disruptions and temporary material shortages of alternative "safe" supplies of the stigmatised product, to the localised responses of retailers repositioning themselves to recover market share. Thus a food scare is not merely the effect of consumer purchasing decisions, but rather a dynamic and complex social event which creates feedback between consumers, retailers, producers, media and scientists.

Box 2 **PROFILE OF MARGARINE AS A FOOD TECHNOLOGY SCARE:**

Duration of Scare in the US = 60 years (Ball and Lilly 1982)

Although it was first introduced at a time when concern with food adulteration was very high in the United States, for all of its history, US margarine has had a safer record from adulteration than butter. Even so, soon after it was first produced commercially in 1875, US margarine was declared to be a dangerous, fraudulent substance and a moral outrage. The state of Missouri prohibited the substance in 1881 banning manufacture, sale and possession of margarine with intent to sell and by 1886 24 states had passed restrictive laws and fines with imprisonment as the result of non-payment.

Dairy interests gathered together to recommend regulation to restrict margarine at the federal level –a tax was introduced on it and annual license fees were introduced for manufacturers, retailers and wholesalers. Next came laws to restrict the use of colouring with five states requiring it to be coloured pink. By 1900, 80% of the population of the US lived in states where the colouring of margarine yellow was prohibited rendering it a stigmatising white. It was not until 1950 that all legal restrictions concerning the sale and production of margarine were finally repealed.

Ball and Lilly (1982) describe the following reasons behind the restrictions:

- the butter lobby saw margarine (incorrectly as the historical record reveals) as a threat
- margarine was viewed as an imposter, a fraud, and a counterfeit product. Mark Twain (cited in Ball and Lilly 1982:492) said it was indicative of the "artificiality of modern life" while others (ibid) called it a "mechanical mixture" created by "the ingenuity of depraved human genius".
- it was viewed as a product of the new mechanical age while butter was symbolic of "the way we were" (a romanticised pastoral past).
- margarine was also stigmatised on two counts - first, for its association with the meat industry (it was initially produced from beef fat) and also because only the poor ate it (serving it in middle class houses was said to "cheapen" the meal).

The final acceptance of margarine is partly, according to Ball and Lilly (1982), due to the austerities of two World Wars and also to do with the manner in which people could perceive or make sense of the substance as having changed. In the 1940's and 50's, its qualities, which were previously viewed as fraudulent, could now be viewed positively in the modern era of scientific housework. For example, consider such aspects such as its ease of storage, its versatility, its standardisation, and its exact nutritional content.

There are some important common factors that suggest that margarine and GE food can be compared. The two most significant factors are:

- the fact that margarine was most despised because of the technological basis of its production.
- butter was viewed as 'natural' while margarine was an industrially engineered product.
- the inability to easily identify margarine from butter
- butter and margarine had a similar appearance and taste that far from easing consumer concerns served to fuel them, similarly reassurances that GE food is indistinguishable from non-GM food may not be helpful.

Using Goodman's suggestions for levels at which the meaning of food is disrupted during a food scare, in addition to the historical examples of significant food scares already collated, the following descriptive model illustrates the social complexity which is involved in these phenomena:

LOCAL LEVEL – the appearance of concerned citizen meetings, numerous marketing style surveys indicating degrees of concern over the technology

REGULATORY LEVEL – the move towards labelling of products as an indicator of their stigmatised status and legislation to contain the distribution of commercial products from the technology

NATIONAL/POLITICAL LEVEL – the formation of lobby groups and the appearance of radical and conservative spokes-people on the issue

Box 3 PROFILE OF FOOD IRRADIATION AS A FOOD TECHNOLOGY SCARE

Duration of Scare = 50 years and still currently unresolved (Ten Eyck 1999)

The technology of food irradiation is a process that has been approved in more than 30 countries (in 1995) and has been endorsed by such bodies as the WHO and the US Drug and Food Administration (Diehl 1995). Its mechanism of action is to expose foods to ionising radiation in order to prolong its shelf life and/or destroy harmful bacteria and pests. On this basis it offers significant gains to consumers, producers and retailers in food hazard reduction particularly where the alternative treatment would be fumigation of the product as, for example, occurs in the dried spice and vegetable trade (Bruhn 1995). The first patent for food irradiation was issued in Britain in 1905 but was not taken up at a sustained commercial level until after WW2 as an "Atoms for Peace" project (Boisseau 1994).

Controversy surrounding the technology in the United States first occurred in 1951 when researchers at Massachusetts Institute of Technology argued that the radioactive material used to kill the bacteria was also able to kill people if it leaked from its containment site. In addition, it was noted that the technology was also not always 100% effective in killing harmful organisms (Proctor and Goldblith (1951) cited in Ten Eyck 1999). This debate continued in the US newspapers through the 60s and 70s and Goresline (1982) cited in Boisseau's (1994) discussion of the history of food irradiation in France, notes that concerns over the public acceptance of food irradiation were sufficient to discourage private firms from engaging in R&D during this period. Concern over the technology in the US has continued in the media of the 80s and in the 90's although the first commercial food irradiation plant in the US was opened in 1992 in Mulberry, Florida. Commercial and governmental endorsement of this process has not, however, been sufficient to reduce public concern as can be seen by the strong public opposition to a proposed food irradiation plant to be constructed in Hawaii in 1998 (Ten Eyck 1999).

This interim research has yet to reveal a thorough historical-sociological analysis of the reasons which underlay the development of the irradiated food scare, however the eclectic collection of material currently sourced allows for some commonalities to be observed between the irradiated food scare and the situation of GE foods as follows:

- The concern about the technology which produces the food. Jack and Sanderson (1995) in a survey of 200 Scottish shoppers were able to demonstrate a clear 'radiophobia' in their informants ie the informants were concerned about the technology of irradiation. (In their survey although 31% of consumers could conceive of benefits of irradiated food, only 19% were willing to buy it).

MORAL AND PHILOSOPHICAL LEVEL – a plethora of publications, conferences, and articles on the issue

ECONOMIC LEVEL – the appearance and importance in trading transactions of specific references to and demarcation of the technology

NEWS MEDIA LEVEL – international and local interest in the technology as a newsworthy item

SEMIOTIC AND DISCURSIVE LEVEL – the meanings associated with the technology become a site of contestation

2.4 LIKELY DURATION OF CONTINUED CONSUMER ANXIETY OVER GM FOOD

Appendix 2 contains the partial results of CSAFE research which has been cataloguing media reports of GM food using the previously described conceptual categories and which strongly indicates that the contemporary concerns over GM food have become as complex as earlier food scares. In addition, the frequent reference by anti GM protestors to such food as 'franken-food' has clearly drawn GM food into the deeply ambivalent discourse surrounding the self, science and biology which is exhibited in the Frankenstein myth of contemporary popular culture. (See Turney [1998] for an extended discussion of this idea).

While all these dimensions may emerge in relation to any food product from time to time, the phenomenon of

a food scare emerges when various factors begin to interact and 'lock in' concern over the food product. Campbell and Fitzgerald (2000: 76) emphasise the role of legislation in this process:

> "The intriguing quality of food scares is that once legislative and institutional lock-in has occurred, it is very hard to shift. The political gains of stigmatising a food product through legislation are high, while the political costs of retracting that legislation are also high".

It is this quality to food scares that makes this idea important for understanding the GM food scare – particularly in trying to estimate the possible duration of the GM food scare.

It would be inappropriate to draw too directly from events in another historical context to estimate the duration of contemporary anxiety over GM food. However, in view of how closely current concern over GM food approximates the general forms of previous food scares it is reasonable to suggest that such concerns are likely to be long lived rather than short lived. The contemporary trade barriers erected against the food in Europe and Japan and the moratorium in New Zealand are indicators that the potential introduction of restrictive legislation around the technology may not be as far fetched an idea as it would have seemed even only one year ago. In a range of countries labelling regimes have been proposed, these may act as long term stigmatising mechanisms against GM foods in the same way that editors on the webpage for the Foundation for Food Irradiation Education (Marcotte 1999 @www.food-irradiation.com) have voiced the concern that labelling could be expected to disadvantage irradiated foods.

In conclusion, while it is premature to suggest a definite time span that might be encompassed by the GM food scare, it is clear that there is significant evidence to suggest that optimistic scenarios – which propose a rapid turnaround in the confidence of individual consumers in GM foods – are not founded on a sound evaluation of historical precedent or on an awareness of the complex socio-economic factors which influence food production and consumption that are already emerging to lock in the GM food scare and which operate at a level of complexity far beyond that of the individual citizen's perception of either risk or benefit.

3 Key Drivers: Economic Studies of GMOs in New Zealand Agriculture

Economic analysis of the performance of GMOs in primary production cannot be carried out directly for New Zealand as they have not been released commercially. Therefore this section examines evidence of the impact of commercially releasing GM from overseas studies and then presents preliminary results of a simulation exercise of the potential costs and benefits to New Zealand.

The economic/financial impact of the commercial release of GM depends upon the interaction between and the responses of both producers and consumers to GM within the international trading environment. To determine this requires the simultaneous analysis of supply and demand in its international context through a globalised trade model (which will be discussed later). Initially, however, this section assesses the impact of GMOs on producers and consumers in isolation using evidence from overseas followed by the impact on producer returns, consumer expenditure and trade.

3.1 impact of gm on producers

The current commercial release of GM affects the production system not the product itself directly; the main GM crops being insect repellent maize, herbicide tolerant soyabeans and canola. Thus, most of the benefits of GM can be expected to come from the supply side and relate to potential increases in yield and/or reduction in costs. To assess the impact of these, firstly, the benefits of improved productivity have to be determined, the impact on producer returns (assuming no market impacts) and then the market impacts of that improved technology. However, the evidence so far on the impact of GM production techniques can only be treated as preliminary as the crops have not been grown commercially over a long period.

The impact of GM production on yields varies according to crop type, with soyabeans and canola showing little impact on yield, in fact in the case of soyabeans there have actually been recorded falls in yield of GM compared to GM free. This is perhaps not surprising as these GM released products are not targeted at the productivity of the plant but rather at input use, so expected gains should be from savings in input costs. Thus for maize there are reported increases in yield which vary according to insect infestation in the particular year. These gains in yield have been estimated to range from 0.26 tonne per hectare to 1.88 depending upon degree of infestation and the study, (Furman and Selz 1998, cited in CEC 2000; Gianessi and Carpenter 1999; and Duffy et al 1999, cited in CEC 2000).

In the case of the impact on costs, the evidence does show a reduction in costs of herbicides used in GM production for soyabeans and canola, for example of up to 30% for soyabean. All GM products had, as expected, an increase in the cost of seed. Producers have also reported the benefit of increasing the flexibility of production using GM - a fact which made it attractive to some producers. For example, it was found that 12% of farmers listed increased flexibility as a reason for going GM (Duffy et al. 1999, cited in CEC 2000). This increased flexibility may lead to lower costs but these are difficult to quantify.

The impact of increased yield and changes in cost on gross margins (assuming no impact on demand and therefore prices) has been indeterminate. For GM soyabeans the fall in herbicide costs were reported to be offset by rises in seed costs with the return to land and labour being slightly more for GM free, (Duffy et al 1999 cited in CEC 2000). This is supported by a USDA study which reported that while there was some impact on yield and reductions in herbicide use, net returns did not change, (Ferandez-Cornejo and McBride 2000). It is more difficult to assess the impact on gross margins for GM corn given it is highly dependent on the level of insect infestation, and thus the potential losses in yield against the higher price for GM insect resistant seed. A study by Furman and Selz (1998) reported in CEC (2000) shows a gain from using GM corn especially under heavy infestation. However, Gianessi and Carpenter (1999) found mixed results with a gain in returns in 1997 but a loss from using GM corn in 1998. Whereas Duffy et al. (1999, cited in CEC 2000) found a small gain. In the case of canola, results are again mixed with Fulton and Keyowski (1999) reporting lower returns under GM canola whereas the results from a study in Alberta in 1999 found that for one type of soils GM gave lower return but a higher return on another (CEC 2000).

The overall conclusions that can be drawn from the preliminary studies is that the results of applying GM technologies in farm production have been very mixed.

3.2 consumer impacts of gm

The potential economic impact of consumers' responses to the commercial release of GM is of course important and has not been positive. As the first wave of commercially released GM has only affected the production process this is maybe not surprising. Moreover, given recent history relating to food scares as reviewed in the earlier section it is also not surprising that there is a negative preference for GM with price premiums emerging for GM-free and trade diversion away from countries producing GM products. In addition, countries are developing varying regulations regarding the production and marketing of GM foods. Other market influences include major supermarket chains in Europe positioning themselves as selling only GM free products, (CEC 2000, Datamonitor 1999, Woodward-Clyde 1999).

Price premiums for GM-free products are beginning to appear with two tiered pricing structures developing in some markets such as Japan and Korea, as well as in Europe. The introduction of labelling laws has also encouraged markets to source GM-free food. In Japan, for example, GM-free sources are being targeted for future

supply in anticipation of labelling laws being introduced leading to a potential boost for EU and Australian exports.

The results of this are that any potential benefits from planting the current commercially released GM products are further reduced when differential prices are included in the analysis. Even a ten percent premium for GM free reduces further the incentives to produce GM food. Moreover, if substantial markets begin to ban the use of GM the negative impacts would be much larger.

3.3 TRADE IMPACTS OF GM

The trade impacts of GM reflect the discussion above and relate to the interaction of supply and demand in an international context. Currently, given low or negative benefits from growing GM products, the price premium for GM free, and reported trade diversion away from GM in the main developed country markets, trading in GM commodities does not look positive. This section reviews the current and potential trading opportunities for New Zealand, the trade policy issues and then reports on a trade model which simulates the impact on producer returns of various scenarios relating to trade in GM and GM-free products for New Zealand.

The market for New Zealand agricultural produce has changed over the last few decades; in particular, away from the UK and towards other markets. However, the developed country markets are still by far the most important markets for New Zealand, even with their considerable restrictions on market access. This is illustrated in Figure 2 which shows the percentages of the main agricultural exports from New Zealand in 2000 to the main developed country markets. Thus, apart from milk exports, the developed countries are still the most important markets although much of this trade is in bulk commodities.

Lower own price and income elasticities of demand for these basic commodities and the higher elasticities for commodities with attributes such as perceived quality, safety and environmental enhancement, (Lamont and Ritson 1995) mean that to maintain and enhance producer access and returns to high value markets these attributes are becoming more important. Moreover, any benefits from increased production are likely to be small or even negative if these attributes are absent given the low own price elasticity of demand for basic commodities. This means an increase in production leads to falls in producer returns (that is the rise in revenue from increased sales is offset by the fall in revenue caused by the reduction in overall market price). It may also be worth noting here that countries such as the EU - which have in the past supported farmers through minimum prices - will not experience this effect. The same, of course, is not the case for NZ.

Therefore, it is difficult for NZ to isolate itself from trends in the developed country markets which tend to be relatively secure and higher value markets. Moreover, as these markets move, albeit slowly, towards further liberalisation, opportunities for access will increase. It is also the case that emerging developed country markets such as Korea are also exhibiting signs of stressing the quality, safety and environmental attributes associated with food production even in relation to GM. For example, the introduction of labelling for GM foods in Korea. These

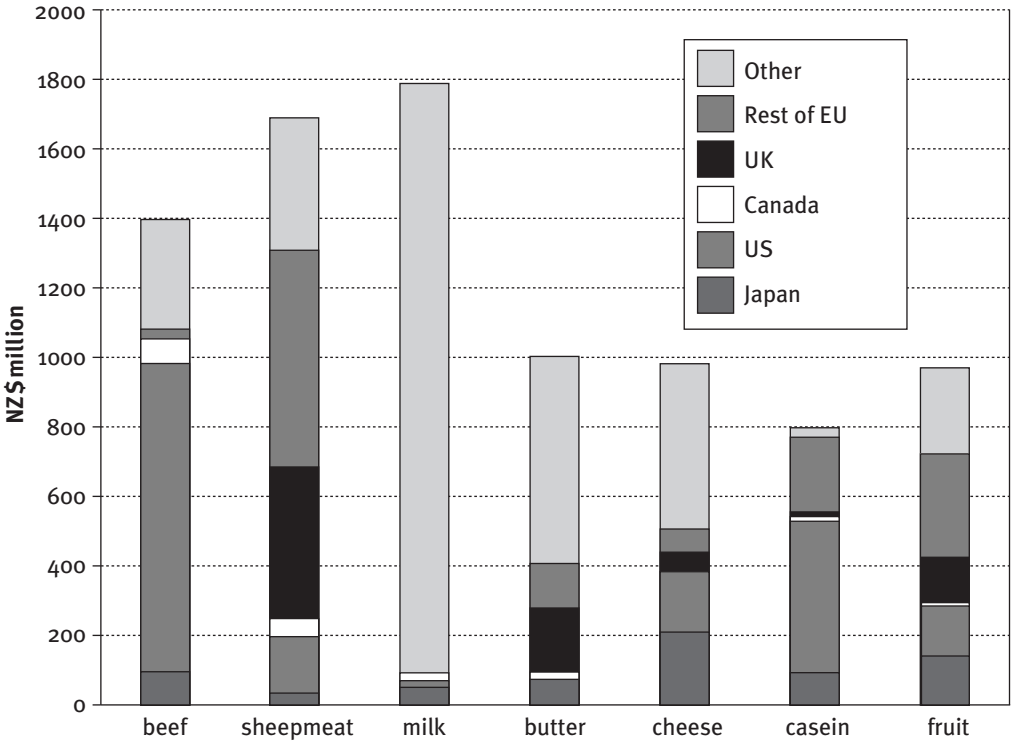

Figure 2. Main Agricultural NZ Exports by Destination, 2000. Source: MFAT (2000): NZ External Trade Statistics, Wellington

developments in markets and trade policy are reviewed below.

3.4 BIFURCATION OF WORLD MARKETS

The global market for food is currently bifurcating with bulk commodities providing inputs to processed foods, while niche retail markets are increasingly auditing and demarcating product lines. It is currently unlikely that the valuable niche markets for food will open to GM product lines in the medium term. The prospects for GM food exports seem more viable in the lower-value bulk commodity trade. This has potentially important implications for the future development and growth of New Zealand. New Zealand currently relies heavily on the exports of primary products, which accounted for 70% of exports last year (MFAT, 2000). However, the terms of trade for primary products have been, on average, falling in real terms since the 1950's, (Statistics NZ). This reflects the fact that as incomes rise internationally the proportion spent on food falls and, in particular, the proportion of expenditure returning to the farm gate declines. Moreover, as incomes rise the attributes of food become more important in maintaining both market access and value and those attributes which are growing in importance include food safety and quality as well as indirect attributes such as animal welfare and environmental consequences of food production. This has already been the case for New Zealand in maintaining its access into high value markets such as Japan and the UK where buyers are concerned with traceability and ensuring producers meet their requirements in terms of production standards as well as quality. Clearly, maintaining access into these markets might be compromised by a GMO-based food exporting strategy unless there is a startling turnaround in consumer perceptions of the acceptability of GM foods at the niche end of the market.

3.5 DEVELOPMENTS IN TRADE POLITICS

Since the completion of the Uruguay Round Agricultural Agreement and the establishment of the WTO, there have been a number of issues relating to food trade and environment/food safety issues that relate to GM food. Campbell and Coombes (1999) and also Campbell and Fitzgerald (2000) and Campbell (2000a) outline the debate that occurred during the formation of the WTO, and predicted the contradictions that would emerge at Seattle.

The argument that is being mobilised in these analyses is that key First World markets are increasingly adopting the 'precautionary principle' in relation to the environmental and food safety attributes of food imports. The result is 'green protectionism' – in which these concerns are mobilised against food imports, and afford some degree of protection to local food producers. In Europe, Japan, and numerous other countries, barriers to the importing of GM foods are being erected (see Box 4). At the same time, subsidisation of local producers in trading blocks like the EU is shifting from price support to more direct subsidisation of environmental initiatives and systems like organic agriculture (Saunders 2000a, 2000b, 2000c, 2000d). These local-level initiatives suggest that markets like the EU are positioning themselves for a long term commitment to the precautionary principle and more subsidised forms of environmental agriculture.

These broad trade trends have significant implications for the potential of GM food exports from New Zealand (Saunders 2000b). The power of market access to influence the economic performance of a product is underlined in the following analysis of trade modelling.

3.6 TRADE MODELLING

Given the lack of actual GMOs in primary production, it is impossible to currently assess the market performance of real goods produced in New Zealand. This is critical in assessing the possible economic performance of products produced using GM technologies. One solution is to attempt to model market performance for goods using a range of possible outcomes to develop likely performance scenarios (see Saunders et al. 2000). To determine the implications for New Zealand of trends in overseas markets a trade model is being developed at Lincoln University. This model shows the impact on New Zealand trade, output, and producer returns for the major agricultural commodities that accrue from various scenarios associated with the trade in GM/GM-free food. These scenarios include the effect of trading partners banning exports from New Zealand, expanded market opportunities elsewhere, changes in consumer preference in both domestic and overseas markets, reduction in producer costs and the effect of New Zealand's major competitors following various strategies relating to the market for GM food.

Provisional simulations from the trade model include, the impact of:

- a 20% price premium for GM-free food,
- a 20% price premium for GM food,
- a large shift in preference from Japan and the EU away from GM food, and
- a 10% reduction in producer costs of GM food.

These four scenarios have been simulated against different assumptions regarding the proportion of GM/GM-free food produced in the countries modelled. These assumptions being:

1 GM/GM-free proportions similar to at present, or
2 an increase in the projected amount of GM food being produced to 75% in the US and Canada, 20 % in New Zealand and 26% in Australia (in line with current survey results as to the likely proportions of farmers who would convert to GM production), or
3 a high uptake of GM food with New Zealand 50% GM and Japan and the EU 20%.

While many more scenarios need to be constructed to enable sound interpretation of this modelling, preliminary findings suggest that economic returns in the trial scenarios would not be favourable and that trade sanctions have the most significant bearing on the

Box 4

COUNTRIES THAT BAN GM FOODS

MORATORIA

The European Union has effectively established a 'de facto moratorium' for three years by halting the approval of new GMOs for cultivation (Marian Burros, Reuters News Service, 14 July 1999). Norway has banned comercialization of GMOs, and France, Denmark, Luxemburg and Greece have all banned GMO production (See: 'UK Brewers Say No GM Maize in British Beer', 24 September 1999). Sri Lanka does not produce GM food at all, and has recently banned GM imports (See: 'Sri Lanka Bans Imports of Genetically Modified Food', Reuters, 10 April 2000). Wales's assembly voted unanimously for a ban on GM crops throughout Wales (See: EU Commission's Agri-Biotech newsletter, Economic Aspects No.25, 20-30 May 2000).

GM-FREE ZONES

Thailand and Italy have both established GM-free agricultural zones, and Thailand intends to progressively become fully GM-free (Kyodo, 27 Sep 1999), while Paraguay's Biosafety Commission called for GM-free production (See: Cummins and Lilliston, Campaign for Food Safety News #22, 21 Oct 1999).

BAN GROWING:

As well as nations moving toward GM-free, there are countries that ban the production of specific crops. Portugal banned production of GM maize because of market pressures and the inability to monitor impacts of release (See: 'Margarida Silva, Quercus, 28 Dec 1999). Brazil, the second-largest producer of soybeans, banned production of GM soy varieties and even offered farmers financial incentive to remove illegal GM varieties and replant non-GM soybeans (See: 'Brazil State Pays Farmers to Rip Out GM Soybeans', Reuters, 7 Dec 1999).

Australia is also hesitant about growing GM crops, with cotton being the only GM crop produced on a large-scale, and commercialization of crops such as canola and sugar cane being prohibited (See: Reuters, 15 Oct 1999). India has decided to stop field trials of Monsanto's GM cotton, and is also pushing for a 3–5 year moratorium on GM field releases (See: Environmental News Service, 23 Feb 1999). Similarly, Italy blocked three GM crops (maize, chicory, and soya) that had completed field testing from being planted as well as halting new GM testing (See: Xinhua, 5 Nov 1999) and suspending the use of GM food products (Reuters World Report, 17 Dec 1999).

BAN IMPORTS

A number of countries have banned imports of various GMOs. Sri Lanka has banned all imports of GM foods (See: 'Sri Lanka Bans Imports of GM Foods', Reuters, 10 April 1999), as has Saudi Arabia ('Tuna Firms Say Certification Could Help End Ban by Saudi Arabia', Bangkok Post, April 2000). Thailand only allows GM plants to be imported for research purposes and has halted imports of GM seeds (AP, 18 October 1999). Austria has banned GM maize imports (See: 'Austria to Ban Aventis GM Maize', Reuters, 2 May 2000).

As well as these specific bans on imports, some countries are legislating for import restrictions. A group of African nations led by Ethiopia have been, 'drafting legislation that would make it illegal to export GE foods or crops to their countries without prior country approval' (Nature, 5 August 1999). The government in Ghana is working to limit the influx of GM foods onto its market, and has wholly rejected GM terminator technology (See: 'Ghana Checks Influx of Genetically Modified Food', Xinhau News Agency, 15 January 2000). Japan has banned imports of unapproved GMOs (See: 'Japan to Tighten GMO Approval Procedures', Reuters, 14 Dec 1999), and has introduced stringent safety screening of potential GM imports (See:'Japan to Screen GM Produce', Financial Times/London, 26 April 2000).

LABELLING

Many countries have been demanding labelling of GM foods, including: South Africa, Czech Republic, Hong Kong, Israel, Japan, Mexico, New Zealand, Philippines, Australia, Russia, Thailand, the European Union, and the USA.

potential performance of products.

Consequently, there is an insignificant impact on New Zealand producer returns if *current* consumer and producer conditions are assumed to exist, under all of the scenarios relating to the uptake of GM production, apart from a small predicted loss in total producer returns to New Zealand if it has a high uptake of GM. Under the assumption of a *20% preference for GM-free* products there is a rise in producer returns, under all GM uptake scenarios, except where New Zealand has 50% GM. Not surprisingly the rise in producer returns are greatest when New Zealand has low or zero GM production. This is replicated under the scenario where *preferences in Japan and the EU* appreciably shift away from GM consumption, with the predicted rises in income being much more significant. The scenario simulating a *10% reduction in GM production cost*s has little impact on producer returns, except when New Zealand is projected to have 50% GM production (although this increase is well below the rises in producer returns reported earlier). Surprisingly, a 20% preference for GM again has less impact on income even under scenarios where GM production is relatively high.

The results of most of these preliminary scenarios are consistent with theory and expectations. It is not surprising that markets such as Japan and the EU have such influence on world trade (and New Zealand) moreover it is also not surprising that reduction in costs does not flow through in the same proportion to increases in producer returns. Of greater concern is the relatively little impact simulated preference *for* GM will have on returns.

3.7 OTHER ECONOMIC CONCERNS

Clearly there are a number of other economic issues relating to the commercial release of GM. Key beneficiaries from GM are the input providers such as the seed companies and technology providers. The extent of these benefits will, of course, depend upon producer uptake of GM production. While uptake initially was high in the US for soyabean, canola and maize, there are suggestions that this may have been encouraged or subsidised through policy actions and clearly further analysis would be necessary to determine the distorting effect of these policy actions (CEC 2000). However, there are signs that the uptake is slowing down as market trends move away from GM production, increasing the risk of returns to these input industries.

Other economic impacts include the vertical integration of technology providers and input industries. These will increase benefits to input industries as they can potentially exert oligopolistic behaviour in relation to the market, raising prices and their returns. Whether this is a benefit to New Zealand or not depends upon whether these technologies and companies are based in New Zealand or not.

There are important economic issues relating to the establishment and maintenance of property rights for the developers of the technology. These are expensive to obtain especially given the expected log-jam through key countries' patent offices such as the US. This problem was outlined by Lindener (2000).

4. Emerging Issues: Alternative Agriculture and a GM-Free Branding Option

4.1 alternative agriculture strategies

One area where a considerable body of research has been conducted in New Zealand, is into the emergence of alternative agriculture strategies in food export industries, and in the alternative agriculture social movement more generally. These are important for understanding the situation of GM food, as this social movement, and related industries, have provided an important base of resistance to the release of GMOs into agricultural production.

The main agricultural social movement to mobilise in resistance to GMOs in agriculture is the organic agriculture movement. Organic agriculture has recently expanded in New Zealand. Campbell (2000) and Campbell and Fitzgerald (2000) outline this growth in organic agriculture, reporting that in the 2000 harvest, organic exports reached an FOB value of NZ$60 million – primarily in fruit production with some fresh and processed vegetables. Campbell and Fitzgerald (2000) report that combining all forms of 'environmentally-enhanced' agriculture totalled just under NZ$1 billion in 2000 exports (FOB). This represents a significant shifting of the export strategy of the horticultural sector in New Zealand. Such a shift has not occurred in the pastoral industries. Most industries participating in these novel forms of crop management report a combination of market demand and potential regulatory sanctions (green protectionism) as forcing such industries towards novel environmental production systems (Campbell and Fairweather 1998).

Given that such exports did not exist in 1990, this industry is a recent phenomenon and is not well integrated with traditional tertiary education providers or state science institutions. This may provide one reason why the organic agriculture industry's opposition took many agricultural scientists by surprise in both its intensity and tenacity. This resistance has come from three sources. First, the professionalisation of the organic agriculture social movement has provided a group of professionals who have participated in public debate and discussion about GMOs. Second, the actual industries involved in organic agriculture – like the kiwifruit industry – have publicly advocated against a GM strategy that might undermine their own investment in 'environmental' agriculture. Finally, the growing profile of organic agriculture (and food) in New Zealand has encouraged an increasing number of consumers to purchase organic food (see Ritchie et al. 2000), and these consumers have assisted in amplifying consumer concerns about GM foods. The combined activities of these different parties have succeeded in positioning organic agriculture as being potentially disadvantaged or undermined by commercial deployment of GMOs (through pollen pollution, increased testing costs, and impaired market image).

The irony here is that in economic terms, significant impacts would be experienced in other environmental strategies like Integrated Pest Management (IPM). The absence of any social or consumer movement behind IPM has effectively left no 'voice' to speak for the potential economic impacts of GMOs on IPM systems. Likewise, IBAC (1999) argues that there has been insufficient attention paid to the potential value to conventional agricultural producers if they were able to access a GM-free branding strategy. This possible strategy will now be discussed.

4.2 the significance of a gm-free trading strategy

There are a variety of potential disadvantages for industries that do not employ genetic modification, but operate in an environment in which it is used by other producers. Those likely to be affected by the use of GM are:

- Industries, like organic and IPM production of foods, where pollen pollution, reduced effectiveness of pest control strategies, and increased compliance/testing costs, may lead to reduced economic performance (Campbell, 2000a, 2000b, 2000c).
- Industries which do not deploy GMOs may experience reduced producer control over IP and other aspects of on-farm production (Goodman et al., 1987).

However, there is a much wider risk to the food sector overall in New Zealand which relates to the growing preference for GM-free. Already there is trade diversion away from countries which are producing GM food to those which don't; such as a rise in GM-free imports into Japan from the EU and Australia and away from the US. In addition, many of the main markets for New Zealand products are stating that GM food or even animal products using GM feed are not acceptable. New Zealand has a unique position in being an island nation which does not have the potential for cross pollination from GM crops and therefore can maintain a GM-free status; unlike many other continental countries. Even countries like the UK have problems of cross pollination of rapeseed and other crops. This means New Zealand is uniquely placed to take advantage of any preference for switching towards GM-free. Thus the greater risk of going GM is losing this status, especially given that New Zealand needs to target high value developed markets.

In addition New Zealand has been successful in developing a marketing strategy of 'clean and green' in international markets. This has enabled New Zealand to target, maintain, and grow market share. The production of GM food, given current attitudes, may well not be compatible with these markets and this image. This broader branding of New Zealand as clean and green provides benefits across a range of industries. While it is certainly possible that individual food production sectors could position themselves as GM or GM-free (with appropriate regulatory protocols to separate the two), this 'mixed marketing' strategy would not work as well for other industries outside agriculture.

In essence, one GM crop of canola does not compromise the ability of many other crops like kiwifruit to audit and declare *GM-free* status. However, the single GM crop does eliminate the possibility that tourism, wine, honey and many other sectors could participate in a generic '*GM-free New Zealand*' strategy. The question therefore becomes whether the potential uptake of GM crops in New Zealand would be large enough to offset the negative impacts on other sectors. Recently, Cook et al. (2000) surveyed the intentions of farmers and growers and concluded that 21% of primary producers intended to use GM technologies in the next ten years, if they became available, while 44% definitely did not. This study suggests that the GM sector will probably only become a minority arena of production in New Zealand – raising questions at to whether the potential gains from this sector outweigh the costs and lost opportunities to other sectors. There is, of course, insufficient research to date which can conclusively calculate relative gains and losses.

5. Conclusion: GM as an Agricultural Development Strategy

In conclusion, there are clearly some highly contestable claims being made in the public arena about the potential economic contribution of GMOs in primary production. However, many of these claims are emanating from the only sectors certain to profit from GMO production – technology and science providers – and some caution is needed in accepting these claims at face value. These claims usually also rely entirely on evidence of production-level product enhancement as sufficient evidence that these products will be economically beneficial. The evidence reviewed in this discussion paper suggests some caution about making such claims. It is actually the market, trade and consumer drivers of the GM market that currently most strongly affect the economic benefits for New Zealand producers.

The current body of economic analysis of the potential deployment of GMOs in commercial land-based production of food and fibre suggest that there will be potential benefits if New Zealand delays a decision on first release for a period of time. Foster (2000) makes the same case for delaying further commercialisation of GMOs in Australia. The first wave of GM food products are performing very poorly in global markets and are unlikely to improve in the medium term. Similarly, they are not suited to production within New Zealand. The development trajectory of commercial quantities of potentially consumer-friendly GM products will take many years. A three-year moratorium on commercial first release in food and fibre would enable a more coherent economic picture of global markets to be compiled. At the same time, other countries would bear the economic and environmental risks of broad release of GMOs during a time when New Zealand would not forfeit any economic advantages. The most likely sector to suffer economic constraints through such a moratorium would be the science sector associated with technology provision to land-based production. This scenario has no implications for medical development of GMOs, and does not suggest the elimination of investment into GM in primary production. It merely suggests that we need vastly better information before definitively closing off the GM-free option for New Zealand's exports.

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Appendices:

Appendix 1

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APPENDIX 2

	LOCAL	NATIONAL / POLITICAL		REGULATORY			ECONOMIC
	Survey/ Poll Results	**Protest**	**Pro-GM Groups**	**Introduction of Product**	**Legislation/ Regulations**	**Labeling**	**Trade Agreements**
Event	>85% health >45% environment ~92.5% labels	Greenpeace protest over proposed GM maize authorization	Zeneca introduced first GM-food crop in US market: incr. pectin tomato	First GM cell–1982, first US government approved: 96, others since	Code of practice in GE: US 1972, research guidelines NZ 1975	Colza (early name for canola) labelling strife	Cartagena Protocol rejected by Miami Group: precaut. principle
Date	Oct.1996	Jun. 1996	1994	1982	1972, 1975	Dec. 1995	Feb. 1999
Country	Japan	Luxembourg	UK, US	USA	USA, NZ	EU	Colombia
Reference	Reuters* #1119	Reuters #1249	CEC** (p.99)	Reuters #589	Reuters #1139	Reuters #1276	Reuters #756
Event	80% consumers anti-GM food – call for referendum on GM?	opposition to first US shipment GM soya to Europe	Novartis will invest US$600 million in plant genomics	Tomato approved	EP vote on draft regulations for novel food	Mandatory labeling proposed by NZ & Aus. only	G-8 summit US trade in biotech encouraged
Date	Dec. 1996	Late 1996	Oct. 1998	Jan. 1995	Jan. 1997	Aug. 1996	18-20 Jun 1999
Country	Austria	Europe	Switzerland, USA	UK	Eur Parliament	NZ, Australia	USA
Reference	Reuters #1230	Reuters #705	CEC (p.98)	Reuters #1322	Reuters #1217	Reuters #1241	Reuters #608
Event	59% anti-GM food: Swe, Ita, Den, Fra, UK	Nude protest about GM soybeans	AgrEvo: 20% of R&D from sales revenue spent on biotechnology	Corn registered for commercial use by EPA	Ban on biotech research: vote rejected – 67%	Manufacturers vs retailers re-labeling soya	
Date	Jan. 1997	Nov. 1996	--	Aug. 1995	Jun. 1998	Aug. 1996	
Country	Europe	Italy	Germany	USA	Switzerland	UK	
Reference	Reuters #1217	Reuters #1293	CEC (p.98)	Reuters #1285	Reuters #1085	Reuters #1240	
Event	Consumers prefer GM for health & med cf food	Protest over GM maize (day after permitted by EU)		Rapeseed oil approved by UK MAFF	European Commission international submissions on environmental release	92.5% Japanese consumers want labelling	
Date	Mar. 2000	Dec. 1996		Jan. 1996	Jan. 1999	Oct. 1996	
Country	Australia	UK		UK	Europe	Japan	
Reference	Reuters #80	Reuters #1224		Reuters #1271	Reuters #821	Reuters #1119	
Event		Protest: anti GM canola–health, environment		Japan approved imports GM soy, rape, corn, potato	Ecuador: refuse biotech til Cartagena Protocol & nat. legislation	Conference called for comprehensive labelling	
Date		Dec. 1996		Jul. 1996	Feb. 1999	Mar. 1999	
Country		New Zealand		Japan	Colombia conf	Australia	
Reference		Reuters #1226		Reuters #1244	Reuters #756	Reuters #717	
Event		Greenpeace/ Europe 3 country protest over GM feed grains		GM corn approved for import by EU	European consumers get ban on transcrops & antibiotic marker genes		
Date		Dec. 1996		Dec. 1996	Feb. 1999		
Country		Germ, Netherl		EU (from USA)	Fr, Gre, UK, Nor, Lu		
Reference		Reuters #1227		Reuters #1223	Reuters #756		
Event		Greenpeace protest in 9 countries Unilever office anti-GM food		Ecuador: refuse biotech til Cartagena Protocol & national legislation			
Date		Jan. 1997		Feb. 1999			
Country		Belgium, etc.		Colombia conf			
Reference		Reuters #1212		Reuters #756			
Event		Monsanto soy, maize destroyed		Ban enviro release of maize, potato			
Date		Sep. 1998		Apr. 1999			
Country		France		Switzerland			
Reference		Reuters #950		Reuters #650			
Event		GM cotton crop destroyed: dug, burnt					
Date		Nov. 1998					
Country		India					
Reference		Reuters #896					
Event		Naked protest about Monsanto					
Date		Oct. 1997					
Country		UK					
Reference		Reuters #1121					

* This database is the subject of ongoing research at the University of Otago
** CEC refers to Commission of the European Communities, September 2000, Reuters refers to Reuters Business Briefing database

Table 1. Partially Constructed Table for Timeline of GM Events Using the Food Scare Template

APPENDIX 3

SOCIOLOGICAL STUDIES OF GMO'S IN AGRICULTURE

3.1 Introduction

The examination of GMOs in primary production by agricultural sociologists and economists is significant in its attempts to re-embed technologies into their actual social and economic contexts as possible products being deployed by industries. To date, there are no GMOs in commercial deployment which is problematic for enabling an examination of the possible outcomes from these novel technologies. Adam and van Loon (2000) identify the same tendency for many new technologies. They suggest that the outcomes of new technologies are ultimately uncertain and indeterminate:

> "The products of Big Science are a case in point. Created for specific functions and without cognizance of the networked interconnectivity of life, technological products enter the living world as 'foreign bodies'… Once inserted into the ecology of life, they begin to interact with their networked environments and from that point onwards scientists and engineers have inescapably lost control over the effects of their creations." (Adam and van Loon, 2000: 6).

Certainly, previous rounds of deployment of novel technologies in agriculture (particularly the 'green revolution') have often revealed the same tendency – leading to a 'reality gap' between the claims of the proponents of the technology and actual outcomes once deployed. Consequently, recent work by some social scientists and economists has tried to overcome this reality gap by examining how novel technologies might perform in real-world situations.

3.2 Biotechnology and Third World Development:

In a field of enquiry characterised by a general lack of comprehensive studies, one of the main areas to receive attention was the potential impact of biotechnologies as a transformative technology in agricultural production both in Western societies and in the Third World (Goodman and Redclift 1991).

In the context of Third World development, a group of scholars who had longstanding interests in Third World development and the outcomes of the 'green revolution', turned their attention to the claims of biotechnology proponents. Particularly, the claim that this new technology could overcome the persistent problems of Third World development. This debate took place between 1985 and 1990. Kenney and Buttel (1985), Sorj and Wilkinson (1985), Barlow (1988), Molnar and Kinnucan (1989), and Buttel (1990) evaluated the prospects for biotechnology providing solutions to enduring problems like food deficits, sustainable development technologies, and environmental remediation. The conclusions reached by all these scholars was that:

- biotechnology benefits were likely to be very unevenly spread, with general advantage accruing to those countries or regions where agriculture was already heavily intensified.
- serious intellectual property rights issues were inherent in the development of biotechnologies in the Third World context, and could only be protected under a very strong mantle of international treaty obligations and enforcement.
- biotechnologies address few of the underlying problems of Third World hunger which are generally seen to be associated with a lack of entitlements, resources, and access to land, rather than simply the underproduction of food.
- biotechnologies that were developed in the Third World context would most likely be deployed in cash crop-based development rather than providing food crops, thereby advantaging Third World economic and professional (science) elites rather than those sectors of the Third World population experiencing dire poverty.

This debate formed a postscript to the discussion of the effects of the Green Revolution, with more outspoken academics like Lappe and Collins (1988) receiving broad attention. These insights from social scientists - about the expected difficulties of turning the abstract promise of biotechnology into concrete humanitarian outcomes in the Third World - returned to prominence in the late 90s, and were widely cited by those contesting the claims of the proponents of the biotechnology (see esp. Lappe and Bailey 1998). The most comprehensive evaluation of the use of GMOs for achieving better economic and environmental outcomes for Third World producers has been conducted by Pretty (1999). This work reviews over 300 examples of 'sustainable' development strategy, and concludes that in the absence of GM technologies, even modest deployment of more institutionally appropriate sustainability strategies had an extremely positive impact on productivity levels and environmental outcomes. Pretty (1999) concludes that even though GM technologies might provide benefits for development strategies, they are currently institutionally configured in inappropriate ways. His review suggests that GMOs are already being outperformed by less costly technologies.

3.3 Biotechnology and First World Agriculture:

This emerged as a serious focus for study in the late-80s among rural sociologists and geographers. Goodman et al. (1987) wrote the classic work *From Farming to Biotechnology* which identified two mechanisms – appropriationism and substitutionism – by which biotechnologies might reconfigure the social and economic structure of farms in the First World. This work has been highly influential with many subsequent studies tracing these two tendencies through US farming (eg. Buck et al. 1997). One key area of analysis is the contested relationship between farm-level producers and off-farm business (like farm technology suppliers). Initially it was suggested that

biotechnology was 'business as usual' in enabling off-farm business to control an increasing range of on-farm activities, extending legal control over crops, and de-skilling farm producers. More recently, Goodman (1999) has used this body of research to examine the transformation of the capital/nature relationship in farming. Biotechnology overcomes some of the biological constraints to the further industrialisation of farming, but has experienced unexpected setbacks. More specifically, biotechnology is seen as a novel technology which has experienced such a high public profile that it has alerted consumers about a range of contemporary on-farm practices, and helped trigger a consumer backlash against 'un-natural' foods (see Murdoch and Miele 1999).

The biotechnology debate in First World agriculture was paralleled by a similar discussion of the role of agricultural science and sustainable agriculture (Kloppenburg 1991, 1992; Molnar et al. 1992; Hassanein and Kloppenburg 1995). These authors criticised the ability of 'generic' agricultural technologies to provide better solutions for sustainable agricultural systems compared to 'indigenous knowledge' accumulated by farm producers (First and Third World) within particular growing regions and ecosystems. By implication, biotechnology was positioned as a recent initiative of 'big science' to de-legitimise local knowledge in claims-making about sustainability and agricultural production.

3.4 Sociological Studies of Biotechnology in Australia and New Zealand

The sociological or geographical study of biotechnology in New Zealand agriculture is highly limited as there are no actual food crops being produced. Campbell (2000b, 2000c) has predicted certain outcomes for other production systems like organic or Integrated Pest Management systems should rDNA technologies be deployed in pest control strategies in New Zealand horticulture (for Australia see Salleh [1998]). Recently, Cook et al. (2000) surveyed the intentions of farmers and growers and concluded that 21% of primary producers intended to use GM technologies in the next ten years, if they became available, while 44% definitely did not.

In Australia a much larger body of research exists on the possible outcomes for Australian agriculture of adopting biotechnologies. Hindmarsh et al. (1998) review many of these studies. Specifically concerning agriculture, Lawrence and Vanclay (1998) argue that the prima facie evidence that supports the productivity and efficiency gains in production must be offset against threats to biodiversity, the increasing scale of intensive agriculture, ongoing loss of farm-level control over production, and very uncertain markets for GM goods. They argue that a total evaluation of the socio-economic benefits of biotechnology for Australian agriculture is not as positive as some supporters of the technology might suggest.