GENE CUISINE:
GENETICALLY MODIFIED FOODS

RESEARCH BULLETIN NO 3/97

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BRISBANE
APRIL 1997
ISSN 1324-860X
ISBN 0 7242 7359 X

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ABSTRACT

Genetically manipulated foods are described as "mutant" or "polluted" by some, and a "miraculous" scientific advance by others. Regardless of their description, in 1997 Australians will be eating an expanding array of foods containing genetically manipulated organisms. In December 1996, a cargo of soybeans became the first genetically manipulated food product to be commercially imported into Australia. It is expected the soybeans will enter food production early in 1997. The implications of the presence of these products in Australia are far-reaching. The most significant issues include the regulation and the safety of the technology and the labelling of products. There is currently no specific legislation governing the release of genetically modified organisms in Australia. Australia is not alone in facing these issues; all western countries are struggling to develop policies that will satisfy all interested parties. Debate on the merits of the technology is hampered by a lack of data on the environmental effects of these organisms and the lack of information available to the public. Public debate is largely the preserve of public health and safety officials, scientists, consumer groups and environmentalists. However the commercial release of genetically manipulated foods in Australia is moving the debate from these specialists to the community. This Research Bulletin provides an overview of these issues and a description of some of the genetically modified foods that are currently available or under development.

CONTENTS

1. INTRODUCTION

Genetic manipulation of organisms will have an enormous impact on the entire food chain - from the farmer's paddock to the food on our plates. In August 1996, the federal government announced the first large-scale planting of a genetically engineered crop. That Spring, 30,000 hectares of land in New South Wales and Queensland, about 10 percent of Australia's cotton crop, were sown with a genetically manipulated cotton.[1] Some of the oils from this crop may enter the food chain during 1997. In December 1996, a cargo of soybeans became the first genetically manipulated food product to be commercially imported into Australia. It is expected the soybeans will enter food production early in 1997.[2] Up to 60 percent of all processed foods could eventually contain the altered soybean.[3]

The regulation and release of genetically manipulated organisms is looming as one of the most controversial issues to be debated during 1997. The issue is particularly important as it potentially affects the way every Australian views their food. No one who purchases food will be immune from the changes expected to occur rapidly over the next few years.

The development of biotechnology, of which genetic manipulation techniques are a part, promises to generate a revolution in industrial techniques. Many countries, including Australia, are currently attempting to formulate legal and institutional changes required to cope with the new technology. Many complex issues previously unaddressed need to now be determined, such as the ethical, health, legal and environmental implications of the application of genetic manipulation technologies to develop and use modified organisms.

This Research Bulletin describes the various issues surrounding the development and use of genetically modified food products. Appendices provide a glossary of terms, a chronology of developments, and examples of some of the first foods to be developed and/or released. The Bulletin incorporates information published up to December 1996, unless otherwise indicated.

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1 Communication with Australia New Zealand Food Authority, September 1996.

2 Cathy Bolt, 'Transgenic bean about to land in supermarket', *Australian Financial Review*, 12 November 1996, p 2.

3 Carole Renouf, *Spilling the Gene Beans*, Australian Consumers Association, Media Statement, 12 December 1996.

1.1 DEFINITION OF GENETICALLY MANIPULATED ORGANISMS (GMOS)

The House of Representatives Standing Committee on Industry, Science and Technology defined genetic manipulation as "*altering (adding to, deleting from or re-arranging) the genetic information in an organism*".[4] Changes may include the addition of genes for disease resistance, drought or salinity tolerance, improved growth, flavour, storage or other useful features. The technology allows for the transfer of genetic material between unrelated organisms in ways that could not happen naturally or through traditional agricultural breeding techniques.

Therefore, a **genetically manipulated organism** is one resulting from the use of genetic manipulation techniques. Other terms commonly used are **genetically modified organisms** and **genetically engineered organisms**[5]. But these terms are interchangeable as they refer to the same process.[6] **Genetically manipulated organism**, or its accepted abbreviation **GMO**, will be the preferred term used in this Bulletin. Appendix A contains a glossary of other terms used in this Bulletin.

Genetic manipulation is the subject of ongoing and often acrimonious debate, but there is considerable lack of public awareness about genetic manipulation generally. The aim of this report is to highlight the issues involved in genetic manipulation specifically as they affect food.

Inevitably people who know little about genetic manipulation believe it involves scientists tampering with (their own) human genes.

> *At least 99.9% of medical research on genetic engineering has nothing whatsoever to do with fiddling around with human genes.*[7]

By far the greatest amount of research effort has been into the manipulation of microorganisms and plants, followed by animals. A large proportion of this research is ultimately aimed at improving food resources.

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4 Australia. House of Representatives Standing Committee on Industry, Science and Technology, *Genetic Manipulation: The Threat or the Glory?*, Parliamentary Papers, No 52, February 1992, p 2.

5 House of Representatives Standing Committee on Industry, Science and Technology, p 2.

6 House of Representatives Standing Committee on Industry, Science and Technology, p 3.

7 Gustav Nossal, *Today's Life Sciences*, February 1992, p 10 as quoted in John Herron, 'Genetic Engineering', *Parliamentary Debates: Senate*, Matters of Public Interest, 4 June 1992, p 3512.

2. BACKGROUND

It was not until the 20th century that humans began to understand the origins of biological inheritance. Modern work on genetics began in the middle of the nineteenth century with the work of an Augustine Monk, Gregor Mendel. Working with pea plants, Mendel discovered that some of the characteristics of the offspring were inherited from the parents as discrete units rather than a blend, as traditionally thought. Mendel's Laws of Inheritance were published in 1865 and 1869. Unfortunately his work was not progressed until three botanists independently discovered the publications in 1900.[8]

In 1944, Oswald Avery demonstrated that deoxyribonucleic acid (DNA) was able to transform one strain of bacteria into another. This focussed attention on the role of DNA as the chemical carrier of genetic information. These studies led to James Watson and Francis Crick's discovery in 1953 of the "double helix" nature of DNA, and its mechanism of replication.

Further experimentation in the early 1970s identified enzymes which allowed parts of a DNA sequence to be chemically cut and recombined with other sources. Creation of the first "recombinant" organism became possible with this discovery.

> *It was evident that a very powerful technique had been developed which not only enabled scientists to make many copies of particular genes and move them across species barriers, but also allowed genes to be altered in the laboratory and then returned to the cell where the altered gene could be maintained and possibly expressed as a novel characteristic.*[9]

A simple outline of the fundamentals of genetics is provided in Appendix B and a chronology of significant events in the history of gene technology is described in Appendix C.

2.1 BUT IT'S NOT HAPPENING IN AUSTRALIA YET - IS IT?

According to CSIRO's Dr Phillip Owens,

> *International developments will almost certainly force genetically manipulated organisms into food production systems in* [Australia]. *Between 1986 and 1992,*

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8 House of Representatives Standing Committee on Industry, Science and Technology, p 14.

9 Recombinant DNA Monitoring Committee, *Monitoring Recombinant DNA Technology: A Five Year Review*, quoted in House of Representatives Standing Committee on Industry, Science and Technology, p 15.

> *there were over 850 approvals granted in 15 OECD countries for the release of GMOs for testing in field trials.*[10]

In Australia, after decades of research and development, many genetically modified products are approaching commercial release into the Australian market. Genetically engineered organisms are already being used in food production processes in Australia. Ingard cotton, Roundup Ready soybean and chymosin are currently available in Australia. Chymosin is already on the menu in several brands of cheese. Several other genetically manipulated foods will also soon be on the menu. These include altered tomatoes, transgenic pigs and virus-resistant potatoes. A fuller discussion of the types of genetically altered foods being developed is contained in Appendix D.

In Australia, the Genetic Manipulation Advisory Committee (GMAC) oversees the biosafety of genetic manipulation techniques. GMAC's role is to scrutinise genetic manipulation experiments to ensure they are as safe as possible (see Section 5.1 for further details). Although GMAC may assess projects as safe, concerns remain that these findings may not pass the test of time. Unforseen gaps in knowledge may turn a project currently considered to be minimal risk into a future disaster. Although GMAC is undertaking all possible precautions ensuring the safety of GMOs, there is no guarantee of future safety.

Most Australians would be unaware that between 1981 and June 1996, 66 proposals for the release of genetically modified organisms were assessed by the relevant body at the time. Significantly, three proposals were approved in 1995/96 in Australia for general commercial release to the marketplace.[11] These proposals were for cotton containing insect resistance, and carnations with improved vase-life and altered colours. Also between 1981 and June 1996, a further 28 large scale research proposals were considered, along with 3953 small scale research proposals.[12]

The transgenic cotton, Ingard, is the first large-scale planting (30,000 hectares) of a genetically engineered crop. The cotton plants have in-built protection against the *Heliothis* caterpillar, which is a major pest of Australian cotton. The planting represents about 10 percent of the cotton grown in Australia.[13] Some of the oils from this crop may enter the food chain after the 1997 harvest. In addition to these developments, Australian researchers have virus-resistant potatoes and transgenic

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[10] PC Owens, 'Designer genes: genetic manipulation in food production', *Food Australia,* 47(5), May 1995, pp 201-202.

[11] Genetic Manipulation Advisory Committee, *Annual Report 1995-96*, pp 45-49.

[12] Genetic Manipulation Advisory Committee, *Annual Report 1995-96*, pp 43-44.

[13] Communication with ANZFA, September 1996.

pigs close to commercial release, although the companies involved have not yet applied for permission.[14] The field trials approved in Australia cover a range of crops including transgenic apples, peas and canola seed.

Most of the releases of GMOs in Australia have been geographically located along the eastern coast of Australia in low risk contained environments, such as greenhouses and laboratories. Up until 1991, all release proposals assessed by GMAC were for microorganisms. Since then, the number of proposals has increased significantly, and modified agricultural crops currently form the bulk of the release proposals assessed by GMAC. Only one of the proposals assessed for release until June 1996 involves genetically modified animals.[15]

Australia has a strong and internationally competitive gene technology infrastructure. More than twenty companies are involved in the development and use of the technology.[16] Most of the research capacity is in public institutions, but over the last five years there has been an increase in partnerships formed with private industry. The establishment of the Cooperative Research Centres Scheme and a 150%[17] tax incentive for eligible research and development expenditure have improved Australia's international position.[18]

2.2 The Problem - If Any?

Mostly unknowingly, Australians have been consuming some products produced using genetically modified organisms in the production process since 1988, such as cheese and some brewing and baking products[19]. The scientific community tends to consider these products low risk. So what is the problem - if any?

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14 Diana Bagnall, 'Gene limbo', *The Bulletin*, 20 August 1996, pp 40-42.

15 Genetic Manipulation Advisory Committee, *Annual Report 1995-96*, p 45. This is BresaGen Ltd's proposal for the planned release of transgenic pigs. GMAC still has this proposal under consideration.

16 Owens, p 201.

17 In the last federal budget, the Coalition Government reduced this tax incentive from 150% to 125%; See Nina Field, 'Democrats threaten to block $1.4Bn in R & D bounty cuts', *Australian Financial Review*, 15 November 1996, p 3; George Megalogenics, 'Coalition's Senate win comes by bizarre route', *Australian*, 14 December 1996, p 2.

18 Owens, p 202.

19 Richard Hindmarsh, 'There's something happening in my burger but I can't tell what', *Consuming Interest*, no 52, July-September 1992, pp 8-12; p 9.

The problem is that there are currently no specific standards for genetically modified foods in Australia.[20] In November 1996, the chairperson of the Australia New Zealand Food Authority, Ms Winsome McCaughey, was reported as saying that the authority was preparing a draft standard but it would be eight to ten months before it passed the required consultation and ministerial approval processes.[21] Meanwhile, genetically modified foods need only meet the same safety and labelling requirements as their conventional counterparts. Some organisations and consumer groups are unhappy with this situation.

The Australian Consumers Association policy officer, Ms Sally Nathan, said the association was going to mount a campaign calling on the Federal Government to ensure foods derived from genetically modified ingredients were appropriately labelled.[22] Numerous studies have shown people are more likely to accept a product produced using gene modification technologies if it is appropriately labelled.[23]

2.3 Traditional Breeding Techniques vs. Genetic Manipulation

Traditionally, humanity has attempted to improve the qualities of various plants and animals to increase food production, improve the taste, colour or storage of a product or to produce it out of normal seasons. These improvements have been achieved through breeding from selected individuals containing the desired characteristics, often over several generations. Selective breeding techniques have resulted in many improvements in animal and plant production contributing to the welfare of mankind.

Unfortunately, selective breeding has several problems. Unwanted characteristics can be produced with the technique. For example, the organisms produced as a result of the technique may contain both desirable and undesirable qualities, possibly making them less useful than the original organism. The process is not always successful and can be very slow, involving several generations of an organism.

Genetic manipulation, on the other hand, differs from traditional biotechnology as the process allows the transfer of genes between totally unrelated species - plants to

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20 Bolt, p 2.

21 Bolt, p 2.

22 Bolt, p 2.

23 Lina Melero Nichele, 'Gene technology and public perceptions', *Rural Research*, vol 167, Winter 1995, pp 5-7; Jonathan Kelley, 'Australian support for genetic engineering', *Search*, 26(5), June 1995, pp 141-144, p 141.

animals, microorganisms to plants, humans to animals - and so on. For example, a gene from a fish living in the cold seas of the North Atlantic could be inserted into a strawberry enabling it to survive a frost. This process would not ordinarily happen in nature.

Compared with traditional agricultural breeding techniques, genetic manipulation of organisms is[24]:

- More specific - scientists can choose with greater accuracy the trait they want to establish, with undesirable traits kept to a minimum;
- Faster - the trait can be established in only one generation compared with many generations often needed for traditional selective breeding;
- More flexible - traits that would ordinarily be unavailable in some plants and animals may be achievable using transgenic techniques; and
- Less costly - much of the cost and labour involved in administering feed supplements or chemical and disease treatments to animals and plants could be avoided.

3. EXISTING AND POTENTIAL THREATS AND BENEFITS OF GENETICALLY MANIPULATED FOODS

Because humanity has had little experience in the environment with genetically altered organisms, diverse views exist on the ecology, genetics, population dynamics, political, social and economic implications, plus the potential environmental and public health risks of these organisms. New applications of technologies to the foods people eat have an explosive potential for controversy. The intended release of novel organisms resulting from genetic manipulation has raised concerns regarding food safety since the beginning of this decade.[25] There are risks and benefits associated with the application of any new technology, and genetic manipulation is no exception.

3.1 ETHICAL AND SOCIAL ISSUES

The main philosophical or ethical concerns for and against the application of GMOs are discussed in this section.

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24 Australian Biotechnology Association Ltd, *Transgenic Animals and Plants*, Deakin University: 16 April 1996 at Internet site http://www.aba.asn.au/leaf9.html

25 Tony Connor, 'Food safety issues relating to genetic engineering of crop plants', *Agricultural Science*, 6(3), 1993, pp 36-41, p 36.

3.1.1 Playing God

One major objection to genetic manipulation is its capacity to intermingle the characteristics of separate species, which challenges some people's religious beliefs. The Judeo-Christian tradition has shaped western civilisation's beliefs on humanity's relationship with nature. Scientists are challenging this view, encouraging GMO opponents to claim scientists are "playing God".

> *It is the simple act of creating new forms of life that changes the world, that puts us forever in the deity business. We will never again be a created being; instead we will be the creators.*[26]

3.1.2 The Human-Nature Relationship

Some critics foresee the process resulting in ecological or epidemic disasters. They consider nature intrinsically benign and wise. The problem with this view is that in nature, genes are being continually reorganised into novel configurations by sexual reproduction. Nature and evolution have given us disasters such as the bubonic plague. Yet even this example highlights that the ecosystem limits a species eventually in time and space. The plague did not destroy humanity.

In addition, the needs of different religious and other minority groups, such as vegetarians, may be overlooked with the creation of transgenic plants, animals and microorganisms. Religious groups could find the transfer of genes between species difficult to accept if one of the organisms involved a dietary taboo.[27]

3.1.3 Simplistic or Reductionist View of the World

Critics of genetic manipulation claim the current approach to biotechnology is too simplistic. Dr Mae Wan Ho of the British Open University believes scientists fail to understand the complexity and interaction of genes.[28] She says they are assuming each gene has a specific effect and that this can be separated from the operations of all the other genes in a sequence. Dr Wan Ho says experience shows that not every cause and effect is isolated, therefore the fundamental premise of genetic manipulation is flawed.

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26 W McKibben, *The End of Nature*, Random House, New York, 1989, p 165.

27 Basma Ellahi, 'Genetic engineering for food production - What is it all about?', *British Food Journal*, 98(8), 1994, pp 13-23, p 16.

28 Janis Robinson, 'Greens and Genes', a BBC report played on *Landline*, Channel 2, 27 October 1996.

3.1.4 Counter Arguments

Some of the counter-arguments to the concerns raised are:

- Selective breeding has long been used, as well as species being crossed before. DNA techniques allow a more controlled means of carrying out genetic manipulation. Therefore, the current practices are an extension of past techniques[29];
- The transfer of some genetic material can not be considered as crossing species as the transfer of genetic material does not alter the nature of the organisms. Despite this claim, it cannot be ignored that the organism produced allows the crossing of species barriers not previously possible.[30] Previously, only closely related species could be crossed; and
- Another counter argument is that there is no such thing as a pre-ordained plan for life on earth which would be disrupted through genetic manipulation.[31] Random breeding and selective adaptation have proceeded in the past on the basis of organisms' ability to survive and reproduce.

3.2 POLITICAL AND SOCIAL ISSUES

3.2.1 Corporate Domination

The political and social criticisms of genetic manipulation are based on a perception that technological change, and reliance on this technology, enhances the power of large commercial organisations to the detriment of individuals and families.[32] In 1995, there were over 2800 biotechnology companies in existence worldwide. By 2000, the present number of companies is expected to be halved by mergers and take-overs.[33] These corporations own 25 to 50 percent of the global commercial

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[29] Jim Peacock, 'The Potential Benefits of Genetically Engineered Products', In *Money & Morals, Mad Cows & Mutants ...are they worth the risk?*, Conference Proceedings, 19-20 September 1996, Australian Institute of Agricultural Science, Sydney.

[30] Law Reform Commission of Victoria, *Genetic Manipulation*, Report No 26, June 1989, p 2.

[31] Law Reform Commission of Victoria, p 3.

[32] House of Representatives Standing Committee on Industry, Science and Technology, p 106.

[33] Richard Hindmarsh, 'Genealogies', *Arena*, no 16, April/ May 1995, pp 8-9.

seeds and plant breeding sector.[34] Linked in with this centralisation of power argument is the perception that commercial interests have immense power to set scientific research priorities[35], particularly concerning the implementation of new technology. This concern is based on the belief that the dominance of commercial interests conflicts with the interests of the society as a whole.

The flaw with this argument is that society as a whole is seen to be disempowered. This is in fact not the case. A product's commercial success depends on consumer acceptance. If consumers have a concern with a product, the market will not carry that product for long before it is removed. Consumer empowerment could be enhanced by increasing public knowledge and understanding of proposals; increasing public input into the developmental and implementation stages of a proposal; and promoting alternative technologies.[36]

3.2.2 Socio-Economic Equity

The plants and animals of many developing countries are providing the raw genetic material for many of these developments. These countries have little technology, but huge genetic diversity. There is a concern that developing nations will gain little or no benefit from the exploitation of their resources.[37] In fact, if they require the new varieties, they could end up purchasing patented genetically improved organisms created from their own resources.

3.2.3 Fear of Frankenstein's Monster

The House of Representatives report into genetic manipulation described a "*fear of Frankenstein's monster*".[38] This fear is that some GMOs will be released for short-term gain, or that some will escape resulting in harmful consequences not anticipated and unable to be controlled. Fears of this kind include concerns about damage to the environment as well as directly to human health.

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[34] Hindmarsh, 'Genealogies', p 8.

[35] Bob Phelps, Australian Conservation Foundation, cited in House of Representatives Standing Committee on Industry, Science and Technology, p 111.

[36] House of Representatives Standing Committee on Industry, Science and Technology, p 106.

[37] 'Gene cuisine', *Choice*, May 1996, pp 7-11, p 10.

[38] House of Representatives Standing Committee on Industry, Science and Technology, p 125.

But the risks from GMOs must be seen in perspective, relative to other activities which involve equal or greater risk.[39] Perceived or real risks must be balanced against the benefits gained. It must also be remembered that the risks associated with genetic manipulation must be evaluated on a case by case process. Obviously some procedures and resultant organisms would involve more risk than others. Daily, we accept risks of quite high probability, such as an accident resulting from being in a motor car, but we require far lower probabilities for activities we seldom engage in.[40]

Most concerns about modern gene technology are based on hypothetical scenarios rather than on actual incidences of harm. The historical record is that in the last 20 years of modern gene technology, there is no proof of any harm resulting from the technology.[41] Nevertheless, there has been speculation that harm has occurred.[42]

3.3 AGRICULTURAL ISSUES

As discussed earlier[43], traditional animal and plant breeding programs using genetic selection are imprecise and take time, in some cases several years. Genetic manipulation offers the potential of achieving "*in one year what might have taken*

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39 Professor Phillip Nagley, Department of Biochemistry, Monash University, as cited in House of Representatives Standing Committee on Industry, Science and Technology, p 125.

40 Nancy Millis, 'The Good, the Bad and the Ugly - Can We Tell the Difference?', In *Money & Morals, Mad Cows & Mutants ...are they worth the risk?,* Conference Proceedings, 19-20 September 1996, Australian Institute of Agricultural Science, Sydney.

41 David Tribe, 'An Historical Perspective on Risks due to Gene Technology: Myths about Mutants Muddy the Waters', In *Money & Morals, Mad Cows & Mutants ...are they worth the risk?,* Conference Proceedings, 19-20 September 1996, Australian Institute of Agricultural Science, Sydney.

42 One widely cited example of adverse human health effects resulting from genetic manipulation involved L-tryptophan. In the United States and Europe, reportedly over thirty people died and five thousand contracted a crippling blood disease called EMS, eosinophila-myalgia syndrome. This event coincided with the sale of an amino acid food supplement L-tryptophan produced by a Japanese petrochemical company using genetically engineered microbes. The exact cause of the illness is not determined, and after a three year study the US Food and Drug Administration concluded that "genetic engineering cannot be ruled out as the cause of EMS". See: Hindmarsh, 'Genealogies', p 8.

43 See section 2.3.

30 years to do by normal breeding programs".[44] This allows for improved agricultural production efficiency.

The future challenge for agriculture is to feed twice as many people, twice as well, over the next 40 years without a negative impact on the environment.[45] Currently the world's population is growing at 2 percent annually, yet food production is increasing at only 1 percent. The past Green Revolution allowed production of staples such as wheat and rice to increase at 4 to 5 percent every year for several decades, but it has run out of steam.[46] Genetic manipulation is often offered as one of the major solutions to the world's growing food shortage.[47] This view though is tempered by others:

> *A real agricultural revolution... may not arrive until we give up the view of genetic engineering as a silver bullet to be aimed at every agricultural problem... "Solving the problem rather than worshipping the tool should be the goal". With a silver bullet, after all, it's still possible to shoot yourself in the foot.* [48]

The international group, the United Scientists for Environmental Responsibility and Protection, argue that claims that genetic manipulation would help solve the world food problems are overstated, because proponents overestimate the benefits and underestimate the risks.[49] The United Scientists said similar claims were made about the Green Revolution and pesticides which ended up proving less successful than expected. They claim that the world's food production is adequate, but that distribution is the main cause of malnutrition and hunger. Unfortunately though, the inequitable distribution of food has been well recognised as a problem, but it has proven intractable. The existence of this problem does not preclude the need to improve the efficiency of food production. [50]

Apart from an increase in the amount or efficiency of food production, genetic manipulation has the potential to increase the quality of products. Other factors that

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44 Dr J Wells, Bresatec, as cited in House of Representatives Standing Committee on Industry, Science and Technology, p 59.

45 Graeme Browning, 'Biotech politics', *National Journal*, 29 February 1992, pp 511-514; p 512.

46 Karen Schmidt, 'Whatever happened to the gene revolution?', *New Scientist*, vol 1959, 7 January 1995, pp 21-25; p 23.

47 See Peacock, 'The Potential Benefits of Genetically Engineered Products'.

48 Schmidt, p 25.

49 Dr R Nable, United Scientists for Environmental Responsibility and Protection, as cited in House of Representatives Standing Committee on Industry, Science and Technology, p 65.

50 House of Representatives Standing Committee on Industry, Science and Technology, p 65.

could be improved with genetic manipulation are a reduction of the chemical residues in food. Developments in vaccines and genetically modifying pest and disease resistance into animals and plants has the potential to greatly reduce pesticide use. Already in Australia, the use of biological pesticides is accepted. [51] One current example of the application of this technology in Australia is Ingard cotton. Refer to Appendix D for further discussion.

The nutritional quality of some food could be also be altered making its consumption more beneficial. Genetic manipulation of organisms also has the potential to create new food products and processes. Novel food products currently being investigated include a low carbohydrate beer, different types of cheese made using altered bacterium, a biodegradable plastic and meat substitutes.[52]

3.4 ENVIRONMENTAL ISSUES

3.4.1 Will the Environment be the Winner?

Some scientists think the environment could be a big winner with the use of genetically manipulated organisms. Modified pest and disease resistance of some organisms and the production of new vaccines will benefit the environment through a reduction in the use of hazardous pesticides and drugs. Consequently there could be less chemical residue in the soil, entering watercourses and ultimately the food chain. By contrast, the development of herbicide resistant crops by genetic manipulation could in fact result in increased use of herbicides on those crops, with a consequential increase in environmental damage.[53] Problems such as feral animals could also be addressed through the use of GMOs. Genetic manipulation is playing an important role in measures being developed by CSIRO to control foxes through increased sterility.[54]

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51 A biological pesticide contains an organism that kills pests. For example, Dipel and Thuricide contain the spores of a naturally occurring bacterium which kills caterpillars which eat it.

52 House of Representatives Standing Committee on Industry, Science and Technology, pp 75-77.

53 House of Representatives Standing Committee on Industry, Science and Technology, p 159.

54 Kim Jenkins, ‘Outfoxing the fox’, *Rural Research*, no 167, June 1995, pp 8-11, p 8.

Genetically manipulated organisms pose three potential threats to Australia's native ecosystem[55]:

- Firstly, a specialised GMO may displace an indigenous organism occupying a parallel niche, possibly leading to extinction of the indigenous organism;
- Secondly, a generalist GMO may displace several organisms, directly or indirectly, impacting on the natural ecosystem; and
- Thirdly, a new disease, toxin or parasite may be introduced into an existing community, severely affecting the whole system.

The effects of these events are difficult to predict and test. For example, researchers have shown that about 20 percent of cultivated crops escape and become established as feral populations.[56] Half of these become widespread weeds. Keighery quoted statistics indicating that of the 463 exotic pasture and legume species imported and trialed between 1947 and 1985, only 21 (5%) were useful, while, most significantly, 60 (13%) became weeds.[57] Genetically manipulated organisms could enter the ecosystem through these already established avenues of escape.

3.4.2 Bioremediation

Microorganisms, such as bacteria, are small, genetically diverse and capable of increasing rapidly under the right conditions. These features may make it possible to use microorganisms for bioremediation, which involves the cleaning up of chemical spills or waste products. It may be possible to discover genes which enable certain microorganisms to use noxious chemicals or waste as a food source rendering the chemicals inactive. The efficiency of these processes may be able to be enhanced through genetic manipulation.[58]

Bacteria are already being used to clean up oil spills. In 1980, a genetically modified bacteria was the subject of a landmark court decision regarding patenting. A bacteria had been created containing additional plasmids so that it was able to

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55 Paul Hatchwell, 'Opening Pandora's Box: The risks of releasing genetically engineered organisms', *The Ecologist*, 19(4), 1989, pp 130-136, p 131.

56 Greg Keighery, 'The ecological consequences of genetic engineering', *Search*, 26(9), 1995, pp 274-276.

57 Keighery, p 276.

58 House of Representatives Standing Committee on Industry, Science and Technology, pp 79-80.

break down the components of crude oil. It may also be possible to use modified bacteria to reduce erosion and reclaim degraded land.[59]

3.4.3 Diversity of Species

Critics argue genetic manipulation will promote uniformity of species because only commercially useful characteristics will be enhanced.[60] This argument applies similarly to present agricultural breeding techniques. If correct, biotechnology could contribute to a decline in genetic diversity. Ultimately, this "sameness" could lead to some plants being more vulnerable to disease or insects. Conversely supporters of genetic manipulation say many varied organisms will result from genetic manipulation, particularly as changes are possible with genetic manipulation that are not currently possible in Nature.[61] Therefore more biodiversity will be possible than currently exists.

3.5 Risk Assessment

Ultimately, all activities in life carry a level of risk and the same would be true for the use of genetically modified foods. But there should be some balance in the assessment of the risk posed by GMOs.[62]

A common claim, particularly by environmental groups, is that genetic technology studies should not be commercially applied in the community until there is complete knowledge of the possible consequences. Dr David Tribe, a genetics researcher, considers this statement "*abject nonsense*".[63] He provides other examples of where scientific knowledge is incomplete, such as in ecology and environmental management. Yet, he points out, recommendations of ecologists and environmentalists are ordinarily sought and applied in relation to ecosystem management in many major projects in Australia.

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59 House of Representatives Standing Committee on Industry, Science and Technology, p 80.

60 'Gene cuisine', p 10.

61 Peacock, 'The Potential Benefits of Genetically Engineered Products'.

62 Paul Barnes & Kees Hulsman, 'Ecological risk analysis of transgenic plants', *Search*, 26(9), 1995, pp 277-280.

63 David Tribe, *Position Paper: ACF and the Genetic Engineering Debate*, 4 March 1992, as quoted in Herron, *Parliamentary Debates: Senate*, 4 June 1992, p 3514.

Some researchers suggest a cost-benefit analysis be undertaken to establish the need for genetically engineered plants, and that analysis include impacts on Australia's natural heritage.[64] Other commentators believe the assessment should also include ecological, social, justice, ethical, consumer, animal welfare and other legitimate concerns.[65]

The problem with assessing the risks of the introduction of an organism, is that there may be insufficient knowledge to fully understand the implications of the general release of that GMO.[66] Some submissions to the House of Representatives review of genetic manipulation in 1992 supported this view. They also questioned whether risk assessment was possible or reliable.[67] A lack of comprehensive data about the Australian environment was mentioned as one factor making it difficult to assess risk in any meaningful way.

Weighing any risk of harm to the environment will always involve a value judgement about what constitutes "harm". Therefore, evaluating risk is not purely a scientific process. In a discussion paper on risk assessment and management released in 1991, the Australian Quarantine and Inspection Service (AQIS) acknowledged that "*while a professional, scientific and objective approach is essential ... ultimate judgements ... will usually be at least partly subjective*".[68]

Dr David Burch commented that adverse impacts may not be apparent in field or laboratory trials. He added that biotechnologists cannot predict how altered organisms will 'behave' once they are released.[69] However, the best possible safety controls need to be applied. Many scientists will not guarantee that genetically manipulated products are 100 percent safe.[70] The Science Minister Peter McGauran

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64 Keighery, p 276.

65 Bob Phelps, 'Genetic engineering: Time for a long, hard look', *Acres Australia*, no 4, 1991, pp 10-11.

66 Winsome McCaughey, 'The Professional Contract with the Community', In *Money & Morals, Mad Cows & Mutants ...are they worth the risk?,* Conference Proceedings, 19-20 September 1996, Australian Institute of Agricultural Science, Sydney.

67 House of Representatives Standing Committee on Industry, Science and Technology, p 129.

68 Australian Quarantine and Inspection Service, *The Application of Risk Management in Agricultural Quarantine Import Assessment*, Discussion Paper, Canberra, 1991, as cited in House of Representatives Standing Committee on Industry, Science and Technology, p 132.

69 House of Representatives Standing Committee on Industry, Science and Technology, p 130.

70 Pip Courtenay, *Landline*, Channel 2, 27 October 1996.

qualifies this statement though by saying that there are no guarantees for a great many things in life.

> *All we can say is that all products that come under the control of GMAC are very carefully tested before approval.*[71]

Another problem with trying to accurately assess risk with the application of GMOs is that there will never be agreement on the level of acceptable risk.[72] Despite the problems of developing an accurate risk assessment system, there are examples which could be applied in Australia. A United Kingdom Royal Commission into the appraisal of proposals for the release of genetically modified organisms found merit in a formally structured program called GENHAZ. GENHAZ identifies the hazards of a proposal to release a genetically manipulated organism, rather than quantifying the risks.[73] Other schemes may also be available. For example, marker genes, which identify a particular organism, could be used to track the spread of a released GMO.[74]

3.6 Health Issues

There are concerns that eating genetically altered products, or those derived from GMOs, may be dangerous for human health. The unintended health consequences of the past use of some pesticides, hormones and herbicides cautions against automatic acceptance of any new technology that alters food composition.

There are several problems that may arise with the use of genetic manipulation techniques in food. These are:

- Naturally occurring toxins can be injurious to human health if ingested. The substance solanine in potatoes is an example. Modifying food crops to produce greater quantities of toxins in order to combat pests or disease may increase the risk;
- Introducing chemical substances into food products that were not previously present could create health dangers. For example, an overseas study

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[71] Peter McGauran on *Landline*, 27 October 1996.

[72] Millis, 'The Good, the Bad and the Ugly - Can We Tell The Difference?'.

[73] House of Representatives Standing Committee on Industry, Science and Technology, pp 134-136.

[74] Scientists use "marker genes" to tell whether they have succeeded in introducing new genes into a plant, animal or microorganism. These markers are easy to detect. Marker genes though may also remain in the food. See House of Representatives Standing Committee on Industry, Science and Technology, p 143.

inserted a genetic feature of brazil nuts into soybeans. Some people who had an allergy to brazil nuts also exhibited an allergic reaction to the modified soybean[75];

- Altering the current biochemistry of a food product may result in changes in its nutritional value.

The types of effects feared range from allergies to possibly even death.

Consumers want safe high quality products but at a reasonable cost. In the case of food, this often is seen to mean pure, natural, green or wholesome. Consequently, the products of biotechnology maybe seen as flawed because the technology is often considered 'unnatural'.[76] Unfortunately, not all 'pure and natural' products are safe. Many people fail to consider that there are considerable risks to human health from naturally occurring compounds in the diet. Nevertheless, the consumer has the right to be suspicious of claims that a new process, such as genetic manipulation, is 'completely' safe with only benefits to the world, and no detriment.

The potential and perceived hazardous issues relating to food safety of transgenic organisms have been studied by the International Food Biotechnology Council and a Joint FAO/ WHO consultation[77]. These reports concluded that genetic manipulation does not pose any new food safety hazard or risks over those associated with more traditional mechanisms of genetic manipulation used in breeding programs. Nevertheless, the importance of safety assessment was recognised.

3.7 Economic Issues

3.7.1 Money to be Made

Predictions of the size of the worldwide market for biotechnology in agriculture and food processing products range from $10 billion to $100 billion by the year 2000.[78] The food processing industry is Australia's largest industry, with an annual turnover of about $40 billion. Agricultural commodities and their processed food products

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75 Rachel Friend, *A Current Affair*, 10 December 1996.

76 House of Representatives Standing Committee on Industry, Science and Technology, p 197.

77 Connor, p 36.

78 Susan Watts, 'Have we the stomach for engineered food?', *New Scientist*, no 1741, 3 November 1990, pp 12-13.

account for more than 30 percent of Australia's export earnings.[79] Gene technology can present both new opportunities for the industry and threaten its future.

3.7.2 Australia can Participate in this Technology

Genetically engineered organisms have the potential to make the companies that create them a great deal of money. There are no estimates of the financial potential of biotechnology in the agricultural area, as the implications and far-reaching ramifications for the technology have not yet been realised. But there is speculation that the biotechnology industry will have greater revenues than the computer industry within a decade.[80]

Gene technology offers Australia a unique opportunity to be intricately involved in an important technological revolution.[81] This country has the resources, human and industrial, to fully participate and contribute to the field of genetic research, unlike the computer industry where Australia has failed to become a major player.

> *Our challenge is to identify R & D* [Research and Development] *opportunities in genetic engineering that are most likely to bring a commercial return and ensure their development is supported politically as well as financially. Failure to do so places the future of our food export industries at risk.*[82]

An obligatory partnership links science and technology with industry and commerce. The partnership began with the Industrial Revolution, and it has become increasing closer, particularly since the end of the second World War. Nearly all OECD countries are making investments in gene technology. Australia's entry into the field of biotechnology has been described as "*late and somewhat struggling*".[83] During the 1980s, the federal government took several initiatives to support biotechnology research, attract venture capital and provide access to expertise. These steps are having a positive impact.

More recently in Queensland, the state government has given in principle support to the University of Queensland to enable the establishment of a $50 million Institute

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79 ABS, *Yearbook Australia 1997*, AGPS, Canberra, 1997.

80 Browning, p 512.

81 Dr Jim Peacock, quoted in Ian Paterson, 'Genetic engineering: The next farm revolution', *Australian Farm Journal*, February 1994, pp 16-21, p 19.

82 Owens, p 202.

83 G Nossal & R Coppel, *Reshaping Life: Key Issues in Genetic Engineering*, Second Edition, Melbourne University Press, Carlton, 1989, p 118.

for Molecular BioScience which would focus on the application of biotechnology. Minister for Economic Development and Trade and Minister Assisting the Premier, Hon Doug Slack, expected Cabinet to agree to providing a funding commitment of $15 million for the establishment of the centre. A working group was due to report back to Cabinet on the proposal by the end of February 1997.[84]

3.7.3 Intellectual Property Rights or Patenting

One of the most important economic aspects of the biotechnology debate is the issue of patenting. Corporations and governments want to establish industries based on the genetic manipulation of organisms In fact, the European Commission identified biotechnology as one of three key technologies for the future of European economic growth.[85] Corporate interest in genetic manipulation is premised on a company's ability to gain patent ownership over any organisms and products that are created. Patents are needed so companies can recoup their investment, but they could also disadvantage others. As noted earlier, developing countries could be excluded from access to new beneficial technology because of its cost.

The Australian Conservation Foundation opposes the use of patents in relation to genetic manipulation.[86] They argue that selective breeding has occurred successfully for centuries without patent protection to supposedly encourage innovation. The Foundation believes it is unjust that the altering of one gene would enable patent ownership, thus appropriating the work of generations of traditional breeders and the biological resources of the world.[87]

The issue of intellectual property rights, patents, and ownership of genetic resources is far from resolved after a decade of debate.[88] Regardless, some biotechnology companies and developing countries are forming agreements. For example, Monsanto brokered a deal with Kenyan authorities enabling them to engineer a

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84 Minister for Trade and Economic Development and Minister Assisting the Premier, Hon Doug Slack, 'In-principle backing for world leading science institute', *Ministerial Media Statements for the Period 29 December 1996 to 4 January 1997*, 18 December 1996, p 34.

85 Ruth McNally & Peter Wheale, 'Biopatenting and biodiversity: Comparative advantage in the new global order', *The Ecologist*, 26(5), 1996, pp 222-228, p 222.

86 Phelps, 'Genetic engineering: Time for a long, hard look', p 11.

87 Phelps, 'Genetic engineering: Time for a long, hard look', p 11.

88 Schmidt, p 25.

sweet potato with virus-resistance. Monsanto is also helping Brazil and Zimbabwe to genetically alter cotton.[89]

3.7.4 Will Farmers Benefit?

The potential economic effects of genetic manipulation on farmers and their land can not yet be determined. Views proposed differ greatly. Some commentators believe that farmers will be economically better off through increased yields, higher premiums or shorter production periods.[90] However, others believe farmers' profit margins will decline because the cost of the technology will increase input costs.[91] Also, it is suggested that the use of genetic technology to synthetically produce cocoa, coffee and tea extracts may lead to the elimination of these industries in developing countries. This would create obvious economic adjustments, negatively impacting on the technologically poorer countries.

3.7.5 Barriers to International Trade

A significant economic issue Australia has to deal with involves barriers to international trade. Australia is an ardent supporter of free world trade, and has worked hard to increase Australia's access and competitiveness in overseas markets. Uruguay Round agreements on Sanitary and Phytosanitary (SPS) measures and Technical Barriers to Trade (TBT) provide a framework for managing trade in agricultural commodities and food. These agreements are designed to remove non-tariff barriers to trade, and hence improve Australia's access to a range of markets. The agreements enable every country to impose environmental regulations for process and production measures within its own borders.

The problem for regulators, particularly of gene technology, is whether a country can impose restrictions on imported commodities. If Australia establishes very strict regulations on genetically altered foods, other countries may challenge the regulations under the General Agreement on Trade and Tariffs on the basis that the regulations constitute an illegal barrier to trade.[92] The treatment of commodities

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89 Schmidt, p 25.

90 Courtenay, *Landline*, 27 October 1996.

91 D Pimentel et al, 'Benefits and risks of genetic engineering in agriculture', *BioScience*, 39(9), 1989, pp 606-614, p 611.

92 Phillipa Rowland, Graeme Evans & George McLean, 'Potential Threats to Trade in Agricultural Products', In *Money & Morals, Mad Cows & Mutants ...are they worth the risk?,*

and foods derived from gene technology will have to conform to World Trade Organisation rules governing trade issues.

4. PUBLIC ATTITUDES TO GENETIC MANIPULATION

> *Never underestimate the public's latent anxiety about biotech - it's a river that runs deep, flows steadily and can rise rapidly at any time.*[93]

The decision to import and release a new technology is ultimately a political decision, not a technical one.[94] Opinion polls on attitudes to technological changes provide information governments value. Biotechnology companies are also interested in this information because their survival depends on providing products the public finds acceptable.[95]

4.1 DO AUSTRALIANS WANT THIS TECHNOLOGY?

CSIRO market research in 1990 showed people perceived scientists as being more concerned with the process of gene technology, whereas the public was concerned with its application.[96] Yet, according to a more recent government survey of public attitudes, Australians have now embraced genetic manipulation.[97] That survey found that a majority of Australians supported the use of genetic manipulation to develop new medical treatments, healthier foods and improved pest-resistant crops. Importantly, the report found that with appropriate labelling, most Australians would welcome the use of gene technology to address current health, agricultural, food and environmental challenges. For example, most would wear clothing made of genetically engineered cotton (77%), eat genetically engineered pork (56%), and

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Conference Proceedings, 19-20 September 1996, Australian Institute of Agricultural Science, Sydney.

93 The Centre for Science Information (San Francisco) as quoted in Browning, p 513.

94 Roger Wilkinson, Howard Bezar, Gerald Fitzgerald & Darryl Macer, 'Perceptions are Reality: New Zealander's Perceptions of Biological Hazards', In *Money & Morals, Mad Cows & Mutants ...are they worth the risk?*, Conference Proceedings, 19-20 September 1996, Australian Institute of Agricultural Science, Sydney.

95 Leo Devin, Simon Brooke-Taylor, Brian Delroy & Keith Bentley, 'The success of biotechnology depends on public approval', *Search*, 24(7), 1993, pp 188-189.

96 Nichele, p 5.

97 Jonathan Kelley, 'Australian support for genetic engineering', *Search*, 26(5), 1995, pp 141-144, p 141.

use genetically engineered cooking oil (60%). Most would also eat modified tomatoes (61%). In summary, over sixty percent of the Australian public thought the benefits of genetic manipulation outweighed the risks.[98]

The results of this survey though have been disputed. The Australian Genethics Network and other commentators consider the study flawed, particularly as it contradicts some findings from overseas research.[99]

4.2 OVERSEAS POLLS

Hindmarsh, Lawrence and Norton summarised the results of several overseas opinion polls. In 1978, the Commission of the European Communities polled attitudes related to scientific and technological developments, including genetic research. Only 33% of respondents thought that genetic research was worthwhile.[100] Results from a recent Eurobarometer survey in 12 European nations using similar questions revealed levels of support varying between 39% and 58% in different nations.[101]

In 1990, a comprehensive survey undertaken by New Zealand's Department of Science and Industrial Research found that while most of the public (73%) was familiar with the term genetic manipulation, only a minority (20%) could explain it.[102] Of those familiar with the term, 57% considered it a worthwhile area for research, but at the same time 56% had concerns about its application. The most recent measure of public perceptions of GMOs in New Zealand comes from a 1994 study. When asked the acceptability of a number of specific uses of genetically modified organisms, the majority of respondents considered them acceptable. The level of acceptability ranged from 56% approval for the use of GMOs to treat human diseases to 78% for the use of vaccines to prevent animal diseases.[103]

A poll conducted in Canada in 1993 concluded that public attitudes to genetic manipulation were still in their early stages of formation, and that largely the public

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98 Kelley, p 141.

99 Richard Hindmarsh, Geoffrey Lawrence & Janet Norton, 'Manipulating genes or public opinion', *Search*, 26(4), 1995, pp 117-121; and I Lowe, 'Was gene survey engineered?', *New Scientist*, 18 February 1995, p 49.

100 Hindmarsh, Lawrence & Norton, p 118.

101 Kelley, p 141.

102 Hindmarsh, Lawrence & Norton, p 118.

103 Wilkinson et al, 'Perceptions are Reality: New Zealander's Perceptions of Biological Hazards'.

was uncertain about what to expect from the technology. This result was confirmed in Britain.[104]

A review of 26 international surveys on biotechnology concluded that knowledge, risk perception and ethical views all influence the acceptability of biotechnology.[105] Other factors which would influence acceptance of the technology include country of origin, sex, educational attainment and religious conviction.[106] Surveys in Europe show that the most educated and best-informed groups of the population show the highest acceptance. Paradoxically, the most active opponents also belong to this segment of the community. Opponents are ordinarily environmentalists, animal rights activists, critics of multi-national companies or religious fundamentalists.[107]

4.3 INTERPRETATION OF OPINION POLLS

Surveys conducted in the United States, Europe and Australia consistently show that the public's understanding of genetic manipulation is very low.[108] This is understandable, because genetic manipulation is a very technical process. Attempts to understand people's views towards the technology demands an understanding of their own level of knowledge concerning the technology.

It was reported in 1995 that "*relatively little effort has been made by media groups, or by relevant industry, government or school organisations, to provide the educational background required for the community to assess* [gene technology]".[109] This assessment is underscored by an OECD survey that in 1992 reported a publicly perceived need for educational programs in gene technology. Such findings seriously question the ability of the average Australian to reach an informed opinion about the benefits or risks of genetic manipulation.[110] Therefore the results of any opinion surveys, positive or otherwise, can be seriously questioned when analysed on this basis.

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104 Hindmarsh, Lawrence & Norton, p 118.

105 Hindmarsh, Lawrence & Norton, p 117.

106 Salomon Wald, 'Biotechnology, agriculture and food', *OECD Observer*, vol 177, August/September 1992, pp 4-8.

107 Wald, p 7.

108 Astrid Gesche, 'Beyond the promises of biotechnology', *Search*, 26(5), 1995, pp 145-147, p 145.

109 D Bittisnich & G Smith, quoted in Hindmarsh, Lawrence & Norton, p 117.

110 Hindmarsh, Lawrence and Norton, p. 117.

Conservation and agricultural agencies and their associated public interest groups need to be aware of each other's needs and aims to prevent the current polarisation of debate. This can only be achieved through education.

The Australian government has recognised the need to better inform the Australian public. The Department of Industry, Science and Technology recently established the Gene Technology Information Unit in order to address this problem. The CSIRO also has a travelling exhibition, called **Will Pigs Fly?**, on genetic manipulation. The exhibition is part of a CSIRO program to increase public education.[111]

4.4 CONSENSUS CONFERENCES

The first consensus conference conducted in New Zealand by the New Zealand Ministry of Agriculture and the Consumers Institute was held in August 1996 on the topic of plant biotechnology.[112] The consensus conference concept is based on Danish precedent where consensus on a technological issue was achieved through a panel of 16 representatives of the community. The panel spent several days over a three month period consulting with experts, and developed a series of recommendations to the community. A consensus conference allows for decision-making which is more likely to be accepted by politicians and the community. In November 1996, the latest consensus conference in Norway decided that genetically engineered food was not needed by Norwegians at present.[113] The panel also demanded the labelling of any genetically engineered foods that did reach Norway's supermarkets.

5. THE MONITORING AND REGULATION OF GENETIC MANIPULATION TECHNOLOGY IN AUSTRALIA

Quite early in the development of genetic manipulation techniques, concerns for the safety of the procedures, and the ethics of undertaking some types of experimentation were raised. In 1975, an international meeting was held in the USA which led to the US National Institute of Health being asked to develop guidelines

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111 Nichele, p 5.

112 Wilkinson et al, 'Perceptions are Reality: New Zealander's Perceptions of Biological Hazards'.

113 'Mutant food', *New Scientist*, 9 November 1996, p 11.

for the conduct of genetic research, and its possible risks.[114] The first guidelines were published in 1976.

5.1 DEVELOPMENT OF GOVERNMENT POLICY AND REGULATION ON BIOTECHNOLOGY ISSUES

Members of the Australian Academy of Science attended the US Conference in 1975, and subsequently appointed the Academy of Science Committee on Recombinant DNA Molecules (ASCORD). ASCORD monitored work, advised on containment procedure, organised training and established guidelines, which were published in 1975. In 1980, the Commonwealth Government established a committee to review the surveillance of biotechnology. This action resulted from the burgeoning scope of genetic manipulation techniques and the number of industrial applications. In response to recommendations of this committee, the Recombinant DNA Monitoring Committee (RDMC) was established in 1981.[115] A voluntary monitoring system was established through the RDMC.

In 1986, RDMC recommended all genetic manipulation technology be monitored, rather than just research involving the breaking and recombining of DNA.[116] The Government accepted the recommendation. To implement this decision, the Genetic Manipulation Advisory Committee (GMAC) was established in 1987 to undertake the recommended responsibilities. GMAC is a non-statutory body established under a Cabinet directive. It is currently administered under the federal Industry, Science and Tourism portfolio. Specifically, GMAC's objectives are:

- *to oversee the development and use of innovative genetic manipulation techniques in Australia so that any biosafety risk factors associated with the novel genetics of manipulated organisms are identified and can be managed; and*
- *to advise the Minister about matters affecting the regulation of innovative genetic manipulative technology.*[117]

The scope of GMAC's objectives are quite wide to include any techniques involving the transfer of genetic material between species which would not normally occur in natural circumstances or traditional gene modifying techniques.

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[114] House of Representatives Standing Committee on Industry, Science and Technology, p 15.

[115] House of Representatives Standing Committee on Industry, Science and Technology, p 16.

[116] House of Representatives Standing Committee on Industry, Science and Technology, p 17.

[117] Genetic Manipulation Advisory Committee, *Annual Report 1995-96*, p 38.

In September 1987, as a result of a Commonwealth Government Cabinet decision, the Group of Officials on Biotechnology Regulation (GOBR) was formed. Its role is to complement GMAC, and establish a national approach to biotechnology regulation throughout Australia.[118]

In March 1988, the Law Reform Commission of Victoria released its discussion paper on genetic manipulation[119], with a report[120] released the following year. A special Premier's Conference was held in October 1990 which agreed to the development of a national approach for the assessment and control of GMOs.[121]

In June 1990, the House of Representative Standing Committee on Industry, Science and Technology was given the terms of reference for an inquiry into the effects of the development, use and release into the environment of genetically modified organisms.[122] The Committee's report, *Genetic Manipulation: the Threat or the Glory?*, was tabled in February 1992. The Government accepted the Committee's recommendations, which were to give legal force to guidelines and procedures for contained research work, and to establish a legal framework for the assessment of all proposals for the release of GMOs into the environment. It was agreed that the existing Genetic Manipulation Advisory Committee (GMAC) would continue to administer the guidelines until new arrangements, such as legislation, were implemented.[123] The Federal Government is currently reviewing the proposal that GMAC become an agency operating under legislation.[124] No legislation has been implemented at this stage.[125]

In Australia, there are several systems currently regulating the research, use and application of GMOs and foods derived from them. Controls include administrative guidelines such as codes, legislation and common law. The next section contains a

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118 House of Representatives Standing Committee on Industry, Science and Technology, pp 21-22.

119 Law Reform Commission of Victoria, *Genetic Manipulation*, Discussion Paper No. 11, March 1988.

120 Law Reform Commission of Victoria, *Genetic Manipulation*, Report No. 26, June 1989.

121 House of Representatives Standing Committee on Industry, Science and Technology, p 2.

122 House of Representatives Standing Committee on Industry, Science and Technology, p xii.

123 Genetic Manipulation Advisory Committee, p 52.

124 Genetic Manipulation Advisory Committee, p 2.

125 Personal communication from Mrs Julia Rymer, Secretariat, Genetic Manipulation Advisory Committee, 12 November 1996.

general explanation of the regulation of the research, release and commercial use of genetically manipulated organisms in Australia. The following section will specifically discuss the regulation of foods derived from genetically manipulated organisms

5.2 Regulation of Genetically Manipulated Organisms in Australia

Statutory responsibility for regulation of the products of genetic manipulation technologies at present rests with the State and Commonwealth agencies, depending on the end use of the product. These agencies include the Australia New Zealand Food Authority, the National Registration Authority for Agricultural and Veterinary Chemicals and the Therapeutic Goods Administration. This publication discusses only the implications of the technology as it relates to food, therefore only the procedures of the Australia New Zealand Food Authority (ANZFA) are considered in detail (see Section 5.2.2).

Skene observed that there are two levels of control over the release of GMOs in Australia. These are:

- administrative guidelines; and
- environmental protection and other types of legislation.[126]

First, at the administrative level, GMAC has established guidelines for the research and release of GMOs in Australia. At the second level of control, each Australian jurisdiction has environmental legislation. But there is no uniform system of environmental law, and more significantly there is no legislation specifically dealing with GMOs.[127] This remains the current situation.

5.2.1 Administrative Guidelines

GMAC Guidelines

Since its creation, GMAC has been solely responsible for the regulation of genetic manipulation technology. The release of genetically modified organisms to the market or environment requires cooperation between State and Commonwealth agencies. GMAC's role is to assess proposals and provide technical advice to

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[126] L Skene, 'The release of genetically manipulated organisms into the environment', *Law Institute Journal*, 62(4), 1988, pp 278-281, p 279.

[127] Skene, p 279.

investigators and to the authorities administering the legislation relevant to the use of the organism. The Committee regulates GMOs through the application of guidelines and supervisory work undertaken at the institutions where research is performed. The Committee administers three sets of guidelines for small scale[128], large scale[129] and planned release work[130]. These guidelines specify the roles of the various players in the system, physical standards for containment, and proper procedures, supervisory practices and record keeping.

Submissions to the House of Representatives inquiry into genetic manipulation suggested that evidence existed of a lack of stringent adherence to the GMAC or animal welfare guidelines, although this point was disputed.[131] There have been two unauthorised releases of GMOs. Several years ago, 53 transgenic pigs were slaughtered and sold, and a soil bacterium was released without authorisation.[132]

Adherence to the guidelines is voluntary, although there are sanctions for non-compliance.[133] The sanctions are more punitive for publicly funded institutions than for privately funded research bodies. Sanctions include the withdrawal of government funding for research and development, and withdrawal of tax concessions. In the case of commercial operations, there is the threat of unfavourable publicity resulting from public disclosure by the Minister that the company was not complying with the guidelines. Continual breaches of the substantive requirements of the guidelines could result in an inquiry under public health and workplace health and safety legislation.[134] The provisions of common law and workplace health and safety legislation apply to laboratories, as to all workplaces.

The Australian Conservation Foundation believes the current regulatory scheme of guidelines and voluntary compliance over genetic manipulation is "*weak and*

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128 Genetic Manipulation Advisory Committee, *Guidelines for Small Scale Genetic Manipulation Work*, AGPS, Canberra, April 1995.

129 Genetic Manipulation Advisory Committee, *Guidelines for Large Scale Genetic Manipulation Work*, AGPS, Canberra, December 1994.

130 Genetic Manipulation Advisory Committee, *Guidelines for the Planned Release of Genetically Manipulated Organisms*, AGPS, Canberra, January 1993.

131 House of Representatives Standing Committee on Industry, Science and Technology, p 181. Pages 182-193 detail three cases where there was concern with the application of guidelines.

132 Courtenay, *Landline*, 27 October 1996.

133 Genetic Manipulation Advisory Committee, Appendix 7, p 53.

134 House of Representatives Standing Committee on Industry, Science and Technology, p 43.

unenforceable".[135] The House of Representatives Committee[136] and the Victorian Law Reform Commission[137] recommended that despite evidence that many research companies are prepared to follow voluntary guidelines, legal force should be given to guidelines. One possibility was that the guidelines be expressed in regulations under an Act of Parliament. The Committee said this would allow for the regulations to be amended keeping up with technology, while also allowing the use of sanctions to act as a deterrent to breaches of the guidelines.

Other Guidelines

Guidelines for genetic manipulation experiments of animals are also contained in the *Australian Code of Practice for the Care and Use of Animals for Scientific Purposes.* This Code was produced by a joint working party of the National Health and Medical Research Council (NHMRC), CSIRO and the Australian Agriculture Council together with representatives of various state and federal organisations.[138]

5.2.2 Legislation Regulating Genetically Manipulated Organisms

The House of Representatives committee found three main reasons why legislative action was needed to manage genetic manipulation techniques:

- To ensure there are adequate controls to protect the environment from accidental or intentional release of genetically modified organisms;
- To fill any gaps in existing legislation governing the clearance and registration of products which may contain genetically modified organisms; and
- To clarify the administration of any mandatory adherence to current voluntary guidelines.[139]

A central criticism of the Australian government's approach to genetic manipulation is that it has not yet instituted a statutory framework for regulating releases, despite

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[135] Phelps, 'Genetic engineering: Time for a long, hard look', p 11.

[136] House of Representatives Standing Committee on Industry, Science and Technology, p 45.

[137] Law Reform Commission of Victoria, 1989, p 35.

[138] National Health & Medical Research Council, Commonwealth Scientific and Industrial research Council and the Australian Agricultural Council, *Australian Code of Practice for the Care and Use of Animals for Scientific Purposes*, sections 3.3.54-3.3.57.

[139] House of Representatives Standing Committee on Industry, Science and Technology, p 260.

declared intentions to do so.[140] However the House of Representatives report on genetic manipulation identified Commonwealth legislation which could be invoked to control the release of genetically modified organisms.[141] The provisions of the *Environment Protection (Impact of Proposals) Act 1974*, the *Wildlife Protection (Regulation of Exports and Imports) Act 1982*, the *Quarantine Act 1908*, and the *Biological Control Act 1984* were mentioned.

The *Biological Control Act 1984* could be the most useful legislation as complementary legislation was introduced in the States to overcome a 1980 injunction preventing the release of a biological control agent to combat Paterson's curse.[142] Apart from specific criticisms of the use of these Acts to control the release of GMOs, there was additional criticism the Acts were not designed to deal with the release or application of genetically modified organisms.[143]

In relation to State and Territory legislation, environmental assessment legislation and procedures vary between jurisdictions. Apart from legislation designed to assess and limit the environmental impact of a proposal, each jurisdiction also has a range of 'nuisance' offences under public health, local government or water and air pollution management legislation. In addition, States and territories typically have legislation which enables the control of plants and animals declared as 'pests' or 'noxious'.

> *The discussion about Australian environmental law suggests an inadequate system for the regulation of genetic engineering. The coverage of existing laws is limited and legislation varies from State to State. As micro-organisms know no boundaries, it is necessary to enact a more effective means to monitor the biological advances.*[144]

This situation has not changed since this statement was written in 1988. However, some commentators believe existing legislation is adequate, and that common law remedies, trespass, negligence and nuisance in particular, may be used to control the

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140 This was reported in the House of Representatives Standing Committee Report, p 163, and the situation has not changed since that time.

141 House of Representatives Standing Committee on Industry, Science and Technology, pp 163-169.

142 Kevin Andrews, 'Australian controls on the environmental application of biotechnology', *Environmental and Planning Law Journal*, vol 5, 1988, pp 194-205, p 203.

143 Andrews, p 203.

144 Andrews, p 203.

release of GMOs to the environment.[145] The application of common law is not entirely clear. Concern is expressed about the ability of common law to redress damage caused by GMOs.[146]

5.3 THE REGULATION OF GENETICALLY MANIPULATED FOODS

Food safety is becoming an increasingly important issue worldwide, and in Australia. The *Salmonella* scare in Australian peanuts in 1996, coupled with the BSE or 'mad cow' crisis in England, has heightened media and consumer attention on food safety issues. Closer to home, in Victoria recently and in Queensland there have been examples of large numbers of people affected by food poisoning.[147] According to press reports, the Australia New Zealand Food Authority (ANZFA) estimates that up to two million Australians are affected by food-related illnesses each year, costing the community more than $1 billion.[148] Until now, none of these problems have resulted from genetically manipulated foods.

5.3.1 Food Standards Code

The food and beverage industry in Australia is "*subject to a complex web of State and Commonwealth legislation and regulation.*"[149] The National Food Standards Code prescribes quality and labelling requirements. The contents of the code are implemented and regulated by the states and territories. Until recently, the code was established by the National Food Authority (NFA) which was a commonwealth statutory body. The NFA was established under agreement between the Commonwealth and the States and Territories to consolidate the responsibility for food standards in one specialist agency and to ensure their uniformity in the States and Territories.

As of 1st July 1996, the Australia New Zealand Food Authority (ANZFA) replaced the NFA. The new joint authority resulted from an agreement Australia and New Zealand signed in December 1995. The aim of the agreement is to extend the

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145 M Barker, *The Recombinant DNA Technique and the Law: A Review of Australian Law which may be relevant to the Regulation of Recombinant DNA Research and Applications*, cited in House of Representatives Standing Committee on Industry, Science and Technology, p 177.

146 Andrews, p 203.

147 Neale Maynard, 'Food poisoning hits 488 tourists', *Courier Mail*, 15 November 1996, p 6.

148 A Marx, 'Standards set for clean, healthy food', *Courier Mail*, 1 October 1996, p 5.

149 House of Representatives Standing Committee on Industry, Science and Technology, p 206.

Australian food regulation system to include New Zealand. The establishment of a bilateral authority between Australia and New Zealand was achieved under the Australia New Zealand Closer Economic Relations Trade Agreement.[150]

State food legislation requires that a food be fit for human consumption and that it be of "*a nature and quality demanded by the purchaser*".[151] Foods generally do not require pre-market approval, and this currently also applies to foods derived from gene technology.[152] Neither the Food Standards Code nor state and territory food legislation currently prohibits the sale of foods derived from gene technology.

Existing regulatory procedures, to some degree, provide for the process of manufacture of a product to be taken into account when considering whether the sale of a product should be authorised.[153] For example, food irradiated to remove pests is currently not acceptable. Although significant, the process of manufacture itself may not be a good indication of any possible inherent dangers of a product. Other factors such as any subsequent impact of the food are just as important, as in the example of allergy to brazil nuts expressed with soybeans containing brazil nut genes.[154] Although the process of manufacture was no different to that used for many other GMOs, the effect in the environment of this organism was negative. Therefore, regulatory procedures need to incorporate many more factors than currently considered.

In June 1993, the National Food Authority prepared a proposal, P97, to regulate foods produced with the use of recombinant DNA technology. The original intent of P97 was to ensure that genetically manipulated foods were referred to the Authority for public health and safety assessment before they were released onto the market. This proposal did not proceed as it was decided that the National Food Standards Code required reviewing first.[155] This process began in 1994, and is continuing at the time of writing.

The review involves a comprehensive examination of all standards in the Code. There are currently some 600 pages in the Code covering over 90 separate

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150 National Food Authority, *Annual Report 1995-96*, AGPS, Canberra, p 3.

151 ANZFA, *Information on the Australia New Zealand Food Authority and the Regulation of Foods Derived from Gene Technology*, 1996.

152 National Food Authority, p 19.

153 House of Representatives Standing Committee on Industry, Science and Technology, p 243; Law Reform Commission of Victoria, 1989, pp vii, 37, 38.

154 Rachel Friend, *A Current Affair*, 10 December 1996.

155 National Food Authority, pp 14-15.

standards. The review is not expected to be completed until 1999, although some standards will be completed before this time.[156]

The process of establishing a standard for GMOs has become the focus for a wider range of issues than would normally be considered when establishing a food standard. Some sections of the community have expressed concerns relating to the environmental, social, ethical and religious issues, plus the possible long-term health and environmental effects of the technology.[157]

5.3.2 Inclusion of GMOs in the Food Code

In order to address these issues, a public forum was convened in August 1996. Representatives from industry, consumer, community, religious, ethical and government groups attended the forum, *Gene Technology and Food - The Challenge Ahead*. Six guiding principles were agreed at this forum. In summary, these were:

1. Gene technology is a global technology from which Australia and New Zealand will not be quarantined.

2. There are significant opportunities from the use of gene technology, but there are also concerns with the safety and possible long-term effects.

3. The advent of gene technology raises substantial long term issues for Australia and New Zealand, which have application across a range of sectors including chemicals, pharmaceuticals, primary production, food processing, bioremediation, mining and natural resource management. Therefore, there is a need for one system of management by a broadly based body, such as the proposed Gene Technology Authority. Currently GMAC fulfils a number of these functions in an advisory capacity. The new authority's functions would be to evaluate the social, ethical and environmental issues surrounding genetic research, set policy directions and guidelines, determine safety and biosafety assessment principles and coordinate the roles of the different sector-based regulatory agencies.

4. ANZFA should retain its role in relation to foods derived from gene technology, and GMAC should maintain its role of examining and assessing the risks related to recombinant DNA technology and the release into the environment of genetically modified organisms.

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[156] National Food Authority, p 14.

[157] National Food Authority, p 19.

5. ANZFA should develop a standard to regulate food derived from gene technology as soon as possible, with food and food products assessed on a case-by-case basis, so that:
   - the community can be assured of the safety of genetically modified foods;
   - food industries can be confident there is a clear, certain regulatory framework enabling them to be innovative and competitive; and
   - consumers can have access to accurate information on the use of foods developed using the technology, including provisions to ensure appropriate labelling.
6. Extensive community consultation should be undertaken to enable ongoing public discussion and debate about the uses of gene technology and food derived from the technology. [158]

There was general agreement on the part of the forum participants that a standard to regulate food derived from gene technologies is needed. The proposed Standard A18 would require GMOs and their products to be approved for inclusion in the Food Standards Code before they could be used as food. Inclusion would only occur after safety assessment by ANZFA, which would then determine consumer information and labelling requirements.

A discussion paper containing a draft standard (A18: Food Derived From Gene Technology) was released by ANZFA in February 1997. After a period of consultation and allowing for the Authority's statutory processes, it is anticipated that the standard will be finalised in the second half of 1997.[159]

Key features of the draft standard are:

- a general prohibition on the sale of foods and food ingredients derived from gene technology;
- exemption from the general prohibition will be available for specific foods or food ingredients, which will be listed in a table to the standard,
- exemptions, and any associated conditions in relation to safety, labelling and sale of the food or ingredient, will be determined by ANZFA on a case-by-

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[158] 'Gene technology in food - the challenge ahead', *The Food Standard*, ANZFA, Issue 22, December 1996, pp 4-5.

[159] Communication from ANZFA, September 1996.

> case basis according to established criteria, and will be listed in the standard[160]

On 28 April it was reported that draft new laws are expected to be presented to health ministers in July 1997. "*Under the ANZFA plan, regulators would examine genetically altered foods on a case-by-case basis before granting approval for use. Manufacturers would also be forced to place labels on all products containing more than 5 percent of the gene-enhanced product*."[161]

In December 1996, Science Minister Peter McGauran said the federal government is moving to establish a new gene technology authority.[162] It would be a broadly based body with scientific and community representatives, and would compliment the current activities of GMAC. There is general agreement on the need for such an authority. ANZFA chair Winsome McCaughey said a gene authority is needed because decisions on genetically manipulated organisms are currently made in isolation of one another. ANZFA is only responsible for food products, while the NHMRC is responsible for therapeutic products and the National Registration Authority is responsible for the safety of agricultural and veterinary chemicals.[163] State, Territory and local governments also make agricultural and health decisions which may impact on aspects of gene technology.

By the time the Authority is established, genetically manipulated food will be part of every Australian's diet.[164] Although this may pose no significant risk, it is considered an unfortunate situation for the Australian public due to the current lack of information on the effects of these products.[165]

5.3.3 Labelling of GMOs

The labelling of foods in Australia is regulated under the Food Standards Code. Products are normally labelled according to their contents and country of origin. The process of manufacture, such as the use of genetic manipulation to derive ingredients, is not required to be specified. The use of genetically modified

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160 ANZFA, *Explanatory Notes, Proposal P97: Food Derived from Gene Technology*, February 1997, p 2.

161 Anthony Marx, 'Push to regulate genetic foods', *Courier Mail*, 28 April 1997, p 5.

162 Ray Moynihan, *7.30 Report*, Channel 2, 4 December 1996.

163 McCaughey, 'The Professional Contract with the Community'.

164 Moynihan, *7.30 Report*, 4 December 1996.

165 Moynihan, *7.30 Report*, 4 December 1996.

organisms in the production of commercial products, or as products themselves, raises the issue of whether special product labelling requirements should be introduced. It has been stated that the successful adoption of GMOs in foods will require the establishment of adequate labelling requirements, the dissemination of information and public education on the issues involved in gene technology.[166]

Consumer organisations worldwide are demanding compulsory labelling of all genetically engineered foods.[167] The Australian Consumers Association has long called for labelling of products resulting from biotechnology.[168] The issue is based on an individual's right to know and to choose. A second argument in favour of labelling which identifies the product as one resulting from genetic technology is to enable those with particular medical problems to avoid certain foods. People with allergies might not be able to avoid the allergens if they are added to another food through genetic manipulation.

Industry, on the other hand, expresses concerns with labelling requirements, particularly the practicality of labelling where manufacturers do not solely use genetically engineered products.[169] Industry is concerned that consumers might view their products negatively if they are labelled. The Australian Supermarket Institute would like labelling of genetically altered foods where cross species manipulation has occurred.[170] On the other hand the Australian Food Council, a body representing major food manufacturers, argues that labelling is unnecessary.[171]

Authorities in France, Italy and Ireland support the position that the labelling of genetically altered foods is unnecessary where there is no significant difference with food derived from unmodified organisms. Yet, the European Community is struggling to agree on a common position on legislation for novel foods. Austria, Germany and Denmark support legislation passed in the European Parliament in March 1996 which calls for comprehensive labelling requirements.[172]

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166 Ellahi, p 19.

167 Rowland, Evans & McLean, 'Potential Threats to Trade in Agricultural Products'.

168 'Gene cuisine', p 7.

169 Courtenay, 27 October 1996.

170 Bruce Bevan, 'Safety from Seed to the Supermarket - and Beyond', In *Money & Morals, Mad Cows & Mutants ...are they worth the risk?,* Conference Proceedings, 19-20 September 1996, Australian Institute of Agricultural Science, Sydney.

171 Renouf, *Spilling the Gene Beans*.

172 Rowland, Evans & McLean, 'Potential Threats to Trade in Agricultural Products'.

Consumers expect labels on food to provide information which is useful and informative. Product labelling is at the interface point where biotechnology meets the public. Public acceptance is vital for the biotechnology industry to continue. The labelling issue involves the right of consumers to know balanced with the practicality and value of providing the required information. This debate is very sensitive because genetically modified food may be seen as a marketing negative. The House of Representatives report on genetic manipulation recommended that the decision to label a GMO or a product of a GMO should be decided on a case-by-case basis.[173] This may be the most reasoned approach to such a sensitive problem.

Industry has identified a number of problems that would occur if labelling of genetically manipulated foods was made compulsory. These include:

- **Practical difficulties:**

If the manufacturing process is required to be identified on a label, records would need to be kept so that the source of a material could be traced.[174] This could only be achieved where the production process is simple. Difficulties would arise where the product is made from a variety of ingredients. The cost of keeping records would be passed on to the consumers. Consumers may or may not be willing to pay a premium to receive this information;

- **The problem of identity:**

Problems will arise where the product of genetic manipulation is physically and chemically identical to one coming from a non-modified organism.[175] Distinguishing between manipulated and non-manipulated organisms may be impossible and laborious. The issue becomes even more complicated if the modified organism is used as a source of food for animals which then provide products for human consumption. For example, modified rumen bacteria in cattle may increase feed efficiency. The milk and meat from this cattle would then enter the human food chain. Would labelling of the resultant product be required?

- **The problem of ingredients:**

Even if the products of genetic manipulation can be identified and tracked through the production process, problems would arise where the raw materials were available from both genetically modified and traditional sources.[176] Production

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[173] House of Representatives Standing Committee on Industry, Science and Technology, p 254.

[174] House of Representatives Standing Committee on Industry, Science and Technology, p 249.

[175] House of Representatives Standing Committee on Industry, Science and Technology, p 249.

[176] House of Representatives Standing Committee on Industry, Science and Technology, p 250.

processes would be complicated as manufacturers may need to specify on identical products that they were produced using genetically modified raw materials, traditional ingredients or a mixture of both. Also for some items, such as clothing, the choice may be irrelevant. If it was considered that identifying a GMO ingredient on a label would result in market disadvantage, secrecy and deceptive labels could result. Therefore there would need to be enforcement. Proving an infringement would be difficult. Again, these additional costs would have to be ultimately met by the consumer.

- **Singling out the genetic manipulation industry:**

The requirement for genetically manipulated products to be identified via a label would single out an industry 'unfairly' and act as a disincentive to development.[177] Few people would disagree that the safety of consumers is always paramount. The inequity would be most acute where the product is identical to traditional products and/or is assessed as safe. An alternative would be to require all manufacturing methods to be identified on the label. However, this may stimulate a plethora of information, resulting in the consumer being confused.

- **The problem of consistency:**

If Australia adopted a labelling policy which was inconsistent with overseas practices, problems could arise if imports did not comply with the labelling standards and were embargoed. Australia could be accused of erecting barriers to trade.[178] The problem could even be more acute if the labelling requirements were only applied to produce manufactured locally, with traditional labelling requirements applying to imported food. The domestic economic impact of such a decision would be enormous, quite apart from the political and social implications.

Labelling in Overseas Countries

In the United Kingdom there are no mandatory requirements for labelling, yet a number of supermarkets are using labels which identify products of genetic manipulation. This is not the case with manufacturers or supermarkets in Australia.[179] Sainsbury's supermarket chain was one of the British companies that established a protocol for the labelling of genetically modified products.

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177 Dr J Friend, Technical and Research, Food and Fermentation Division, Burns Philp & Co., as cited in House of Representatives Standing Committee on Industry, Science and Technology, p 250.

178 Dr F Peters, Australian Federation of Consumer Organisations, as cited in House of Representatives Standing Committee on Industry, Science and Technology, p 251.

179 'Gene cuisine', p 10.

Specifically, they label their home-brand tomato puree made from genetically modified tomatoes. According to several media reports, when genetically manipulated tomatoes were introduced earlier this year, retailers were adamant that labelling was required.[180]

The Roundup ready soybean is also entering the British food chain. Despite earlier assertions that they were committed to labelling, retailers are now saying labelling is not required.[181] This is partly because the genetically modified soybean forms only part of the product, unlike the tomato puree.[182] This has raised concerns over the potential power of larger corporations over the food chain.

Recent Australian Developments

In June 1996, Queensland Senator John Woodley introduced the Labelling of Genetically Manipulated and Other Foods Bill 1996 into Federal Parliament.[183] This Bill aims to ensure that all genetically modified food is clearly labelled. Debate on the Bill had not proceeded at December 1996. In August, Senator Woodley also tabled two petitions supporting the principles of the Bill.[184]

In December 1995, the Australian Capital Territory considered a private member's Bill requiring the mandatory labelling of genetically altered food products at the point of sale.[185] The Assembly postponed consideration of the Bill pending the development by ANZFA of a set of national guidelines.[186] Although draft guidelines have been released, the ACT Bill is likely to lapse because the Member that sponsored its introduction has since resigned.

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180 Courtenay, *Landline*, 27 October 1996.

181 Courtenay, *Landline*, 27 October 1996.

182 Robinson, *Landline*, 27 October 1996.

183 Senator John Woodley, Second reading speech, Labelling of Genetically Manipulated and Other Foods Bill 1996, *Senate Weekly Hansard*, no 6, 1996, 27 June 1996, p 2335.

184 The petitions were signed by 321 people. *Senate Weekly Hansard*, no 7, 1996, 21 August 1996, p 2745.

185 Food (Amendment) Bill 1995, 13 December 1995, ACT Legislative Assembly.

186 'Eco-Consumer "good" news', *Eco-Consumer*, February 1996, p 5.

5.4 STRENGTHS AND WEAKNESSES OF AUSTRALIA'S CURRENT CONTROL PROGRAM

The current strengths and weaknesses of Australia and New Zealand's present system of management of the use of foods derived from gene technology were identified at the gene technology forum held in August 1996. [187]

Identified strengths included:

- A system 'of sorts' is already in place involving GMAC, ANZFA, the National Registration Authority, environmental protection agencies, the Australian Quarantine and Inspection Service and the Therapeutic Goods Administration, plus state and territory legislation;
- The system addresses human health, food safety, environmental concerns, ethics, commerce, science and world issues such as trade and the environment;
- Governments are keen to consult widely;
- There is a general willingness to cooperate and comply with the system already in place; and
- The present system and process is the basis upon which increased consumer awareness and commercial application can be built.

Weaknesses the forum identified include:

- A basic weakness of the current system is a lack of trust in new technologies, particularly their long term impacts and how to keep pace with changes. This distrust of science and its regulation is broader than gene technology;
- Currently, there are problems for consumers with respect to them having confidence in their choice, plus an awareness and understanding of the issues;
- The current system is fragmented, which leads to uncertainty and inconsistency in the decision-making process; and
- There is no legislative framework for GMAC's operations.

These weaknesses impact negatively on both consumers and the gene technology industry in Australia and New Zealand.

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[187] ANZFA, *Forum on Gene Technology in Food*, Report of the Working Party's Proceedings, September 1996.

Has the Australian government been caught "with their pants down[188]"?

According to Carole Renouf, policy officer for the Australian Consumers Association (ACA), the importation of the Roundup Ready soybean has caught the Australian government with its guard down. The ACA believes Australia is not ready for the Roundup Ready soybean. They are asking that its release be stopped until Australia's regulatory procedures be established and consumers are informed "*before two thirds of our shopping trolleys are filled with gene cuisine*".[189] Industry disagrees, calling this response unrealistic, resulting only in procrastination.[190] If this principle was applied to all innovations, then polio and smallpox vaccines would not have been as successful as they were.[191]

> *Modern Gene Technology is arguably a safer and more efficient way of carrying out many tasks in society than the alternatives.*[192]

In an interview in October 1996, the Minister responsible for biotechnology, McGauran said Australian authorities have spent at least three years attempting to establish regulations for genetically manipulated organisms. Currently the government is working towards commonwealth only legislation supported by memorandum of understandings signed by each of the states.[193] Mr McGauran said this approach is endorsed by the various Australian jurisdictions, and can be implemented fairly quickly.

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188 *Consumers, Food Chiefs at Loggerheads over Gene*, e-mail via Agnet sponsored by the Ontario Ministry of Agriculture, Food and Rural Affairs, 12 December 1996 (dpowell@uoguelph.ca)

189 Renouf, *Spilling the Gene Beans*.

190 Tribe, 'An Historical Perspective on Risks due to Gene Technology: Myths about Mutants Muddy The Waters', p 3.

191 Tribe, 'An Historical Perspective on Risks due to Gene Technology: Myths about Mutants Muddy The Waters', p 3.

192 Tribe, 'An Historical Perspective on Risks due to Gene Technology: Myths about Mutants Muddy The Waters', p 3.

193 Science Minister, Peter McGauran, *Landline*, Channel 2, 27 October 1996.

6. BIOTECHNOLOGY: THE WAY OF THE FUTURE?

> *Genetic engineering is more significant than splitting the atom.*[194]

At this stage, its future is not clear, although we know its implications will be widespread. As is common when there is insufficient evidence or data, wide-ranging speculation and misconceptions occur. Even though our current knowledge of genetics is substantial, the modern image of DNA is still in a flux. New developments are being made almost daily, extending our knowledge of genetics. Therefore, it would be foolish to attempt to predict the future applications and implications of this technology.

No one knows the extent to which genetic manipulation of organisms is going to affect humanity's future. The reality is that the issues surrounding the use and application of genetic manipulation are quite complex, and will need to be assessed on a case-by case approach to ensure beneficial developments are not encompassed with unsafe practices. GMOs will have to compete in the market place with currently available alternatives proving their superiority, if they possess it. They do not have a magical property that will enable them to swamp the market.

Widespread publicity about genetic manipulation has achieved a worthwhile raising of public consciousness about commercial possibilities and concerns. The important action for the immediate and more distant future will be to engage in meticulous and realistic case-by-case analysis of opportunities.[195]

The mad cow problem in the United Kingdom could not have come at a worse time for genetic manipulation proponents. Although mad cow disease is not associated with genetic manipulation, it has raised several concerns with methods of agricultural production in the minds of the public, politicians and even the scientists. The most significant question raised is "Should we do to animals what nature did not intend?".

A leading British scientist is quoted as saying:

> *In five to eight years time, virtually every food that you can think of will be out there in genetically engineered form. And unless we get the regulations right now, the consequences we could face could be disastrous. Potentially we could be faced with disasters that would make the BSE crisis seem minuscule in comparison.*[196]

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[194] CSIRO animal geneticist, quoted in Phelps, 'Genetic engineering: Time for a long, hard look', p 10.

[195] Nossal & Coppel, pp 149-150.

[196] Dr Michael Antoniou, quoted in 'Scientists warn against new cattle feed', *FSNet*, 10 November 1996.

7. CONCLUSION

Much of what is written and spoken about gene technology is about its promise. This is partly because the biotechnology revolution is occurring before our eyes, and the number of commercially successful products is still quite small. However, the number of genetically manipulated organisms about to reach our plate is certain to increase.

The whole issue of genetic modification technology and its use in food production is a sensitive and controversial area. Public debate should be encouraged to enable the successful adoption of the resulting food products. Confidence in the industry by the public is paramount. Regardless of any current decisions made to regulate the products of genetic manipulation technology, it should be noted that the nature of the technology does not permit any decisions made to be final. Biotechnology is a very dynamic science, and hence will require legislative or policy controls to be equally dynamic and flexible.

APPENDIX A: GLOSSARY

antigen A special protein molecule made by the immune system of vertebrate animals, specifically tailored to fit other molecules, for example bacterial toxins, much as a key fits a particular lock.

attenuated virus A virus which has been damaged and so is unable to multiply in its host. Attenuated viruses are used as vaccines.

autoimmune disease A disease in which the body manufactures antibodies against some component of itself; thus a form of civil warfare in the body, one cell attacking another.

bacteria Unicellular microorganism containing a single DNA molecule per cell.

biodegradable Broken down by living organisms.

biological containment Use of genetically altered organisms unable to perform essential functions such as growth, DNA replication or transfer of DNA to other cells, except under very specific laboratory conditions.

biopesticide A genetically engineered organism producing a naturally occurring toxin which is able to control a pest.

cell the fundamental organisational unit of all living matter. The simplest forms of life consist of one cell, for example, bacteria. Higher forms of life are multicellular.

chromosome A very long double stranded DNA molecule consisting of proteins which form sausage shaped forms when visualised under a microscope as a cell divides. The number of chromosomes per cell is characteristic of the species. Humans have forty six chromosomes per cell.

chymosin An enzyme used to clot milk in cheese making. The traditional source of the enzyme is rennet obtained from the stomachs of calves.

clone Cloned organisms are genetically identical. This can only be done with asexual reproduction.

compound A substance consisting of two or more types of atoms which are chemically joined.

Creutzfeldt-Jakob disease A genetic disease of middle life with mental disorientation, dementia and neurological disturbances such as tremor and other involuntary movements. Death usually occurs within a year of the onset of symptoms.

cytoplasm The portion of a cell which is not the nucleus; the site where proteins are made and where chemical energy is generated; the "factory" of the cell.

differentiation The process whereby cells gain more specialised function.

DNA Deoxyribonucleic acid. A double helical molecule consisting of a sugar phosphate backbone and a sequence of coding units forming the genetic code of an organism. Particular stretches of DNA constitute a gene.

donor organism The organism from which genetic material was obtained.

enzyme A protein that facilitates specific processes necessary for a cell's functioning. The enzyme is itself unchanged at the end of the process.

gene A segment of a chromosome which determines a characteristic of an organism. Genes consist of DNA.

genetic code The code whereby the structural information for protein is encoded in the DNA.

genetic manipulation The technology bey which genes are isolated, transferred to other cells, replicated and activated to produce new substances or perform new functions. The next generation of progeny may or may not inherit the altered characteristic.

genome The total complement of genes in a cell or individual.

hormone A class of chemical messenger molecules, travelling in the blood stream, synthesised by cells of a gland. They are normally capable of growth and metabolism at distant cells which possess receptors for that hormone.

host organism The organism into which genetic material is placed.

human genome project An ambitious plan by scientists to identify the sequence of proteins of all the DNA in humans, which will take several decades at current estimates.

hybrid Organisms resulting from genetically distinct parents.

insulin A hormone made by cells in the pancreas necessary for the proper utilisation of glucose within the body.

microorganism A living entity too small to see by the unaided eye. Also called microbes. Examples include bacteria and viruses.

molecule A group of atoms which together make a stable substance.

nucleic acids Two types of polymer molecules, DNA and RNA, which act as the repositories of genetic information.

nucleus the control centre of the cell, where the DNA resides, separated from the cytoplasm by a membrane.

protein Complex, often very large molecules composed of amino acids, which perform most of a cell’s work. Proteins include hormones, enzymes, antibodies plus carriers and receptors for other molecules.

recombinant organism the formation of an organism where the combination of genes are broken and reformed in a new combination. No new genetic material is necessarily added.

toxin a poison.

transgenic organisms Organisms resulting from genetic engineering experiments in which genetic material is moved from one organism to another, so that the latter will exhibit a desired characteristic.

vaccine A substance which confers protection against a pathogen. The vaccine is sufficiently similar to the pathogen that it evokes an immune response. This provides effective immunity against the pathogen, but the vaccine itself does not cause an acute form of the disease.

virus The smallest and simplest form of life. Microorganisms which are parasites, capable only of reproducing within living cells.

APPENDIX B: AN UNDERSTANDING OF GENETICS[197]

All living organisms consist of basic building blocks called cells which are invisible to the naked eye. These cells specialise and perform different functions in more developed organisms such as plants, animals and humans. But all cells are basically similar in their design. A cell consists of a nucleus and cytoplasm. The cytoplasm is where the work of the cell is done. The nucleus is the control centre of the cell where the major decisions are made. It also contains the apparatus for replication.

The replication or reproduction of an organism is important to enable continuity of a species. Genes are the medium through which living things transmit genetic information from one generation to the next. Therefore a gene is "*life's way of remembering how to perpetuate itself*".[198] The memory is chemical and is based upon an intricate structure of molecules found in chromosomes and other gene-bearing bodies in all organisms ranging from viruses and bacteria to human beings. These reproduction molecules are based on nucleic acids called deoxyribonucleic acid or DNA.

DNA is responsible for the master blueprint, and it is permanently kept in the nucleus. DNA exists as paired strands of circular, staircase-like assemblies - the famous double helix. To enable replication or the division of a cell, the genetic machinery or DNA of the cell needs to be copied. To enable this, the double helix unwinds and protein enzymes create a new strand of DNA complementary to the old one.

In more specialised cells, such as those in humans, the genetic material or DNA is broken up into parts called chromosomes. Each chromosome contains a single, long molecule of double-helix DNA. Along the length of each chromosome lie the genes which form the genetic code of the organism. Each cell of an organism contains all of the genes of that organism, and different cells activate different genes depending on their function. For example, stomach cells produce digestive juices, while plasma cells produce antibiotics and brain cells control nerve impulses.

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197 This Appendix provides a highly simplified description of gene technology. For a fuller explanation refer to Phil Larkin, *Genes at Work: Biotechnology*, CSIRO: Melbourne, 1995.

198 David Suzuki & Peter Knudtson, *Genethics: The Ethics of Engineering Life*, Allen & Unwin, Sydney, 1989, p 25.

APPENDIX C: A CHRONOLOGY OF THE DEVELOPMENT OF GENETIC MANIPULATION TECHNIQUES[199]

Year	Milestone
1859	Darwin reports his theory for the evolution of species.
1866	Mendel describes fundamental units of inheritance in peas.
1871	DNA is isolated from a cell.
1908	Gene frequencies in Mendelian populations are modelled mathematically.
1909	Genetic factors are given the name genes.
1925	Position on a chromosome found to affect a gene's activity.
1943	DNA implicated as the genetic molecule.
1940s	A gene is found to code for a single protein.
1953	Double-helix structure of DNA is proposed.
1956	Twenty-three pairs of chromosomes identified in the human body
1966	DNA's complete genetic code deciphered.
1972	First recombinant DNA molecule created in the laboratory.
1973	First recombinant DNA experiments take place where foreign genes are spliced into and function in an organism of another species.
1973	First public concern that genetic manipulation procedures might generate potentially dangerous organisms.
1975	Asilomar Conference considers possible biohazards of recombinant DNA technologies.
1980	The Australian Government establishes a committee chaired by Professor Frank Fenner to review the method of surveillance of biotechnology.
1981	Recombinant DNA Monitoring Committee (RDMC) established in response to Fenner Committee report.
1982	Human insulin produced using recombinant DNA techniques
1987	• Project to sequence the entire human genome proposed commercially. • The Genetic Manipulation Advisory Committee replaces RDMC.
1990	A special Premiers Conference is held which agrees to the development of a national approach to the assessment and control of GMOs (genetically manipulated organisms).
1991	In the United States, the first genetically manipulated foodstuff, a tomato, is released into the food chain.
1992	The House of Representatives Standing Committee on Industry, Science and Technology releases a report entitled *Genetic Manipulation: The Threat or the Glory?*.
1996	• August: Planting of 30 000 hectares of Ingard cotton in NSW and Qld. • December: The first genetically manipulated food product, soybeans, arrives in Australia:

[199] Sources include:

David Suzuki & Peter Knudtson, *Genethics: The Ethics of Engineering Life*, Allen & Unwin, Sydney, 1989, pp 44-45;

Martyn Newman, *Contemporary Australian Issues*, vol 2, DW Thorpe, Port Melbourne, 1994, pp 137-163.

Kaye Healey, *Genetic Engineering: Issues for the Nineties*, vol 23, Spinney Press, Balmain, 1994, p 12.

	• Queensland Government gives in-principle support of a Molecular Bioscience Institute at the University of Queensland.

APPENDIX D: DESCRIPTION OF SOME GENETICALLY MODIFIED PRODUCTS CURRENTLY AVAILABLE

The first gene technology product approved for use in Australia was chymosin, which is a rennet used to coagulate milk during cheese production. The *Food Standards Code* also approves the use of certain enzymes produced by modified microorganisms to be used in brewing, distilling and baking processes.[200] These genetically produced substances have been used since at least 1994.[201]

In relation to food products, Australia researchers are also investigating the use of the Flavr Savr tomato, already widely used in the United Kingdom. An Adelaide-based company, BresaGen, is currently researching transgenic pigs. The pigs contain a modified human gene sequence, allowing the production of leaner pork.

ROUNDUP READY SOYBEANS

Produced by Monsanto, the Roundup Ready soybean includes the genetic material of virus, bacterium and petunia plant. This makes the plant resistant to Monsanto's own weed-killer, Roundup, which contains glyphosate. This character allows these soybeans to be sprayed with Roundup, with only the weeds being affected. Up to one third less pesticide is needed to produce a commercial crop when using the genetically manipulated seed.[202]

In July this year, Monsanto lodged a submission with GMAC requesting advice on the procedures required to allow importation of the genetically modified soybean. GMAC advised Monsanto in October that they did not consider the importation a significant biosafety risk, provided the beans remained physically contained during transport and handling.[203] The Australian Food Council, which represents many of the manufacturers and processors who will receive the soybean, holds the view that

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200 'Gene technology and food - the challenge ahead', *The Food Standard*, ANZFA, Issue 22, December 1996, pp 4-5.

201 'Gene cuisine', p 7.

202 Robinson, *Landline*, 27 October 1996.

203 Communication with ANZFA, September 1996.

the bean is the same as the conventional bean.[204] This view is supported by GMAC.[205]

Coinciding with the release of the altered soybeans were changes to the present residue limit of the herbicide Roundup allowable in soybeans for human and animal consumption. According to press reports, the new limits approved by Australian regulatory authorities allowed the maximum residue limit to rise from 0.1 milligrams per kilogram to 20 milligrams.[206] According to the same article, the changes were condemned by Bob Phelps the coordinator of the Australian GeneEthics Network. He noted that the changes were at odds with Monsanto Australia's claim that gene technology would reduce chemical use and residues. Monsanto said the move was not linked to the importation of altered soybeans, but was part of wider attempts to achieve international harmonisation of chemical residue standards.[207] Australia's new limit is now consistent with the World Health Organisation's Codex Alimentarius food standards and with residue limits in the United States.

Australia uses up to 175,000 tonnes of soybeans annually, of which only 75,000 tonnes is produced locally.[208] The Roundup Ready soybeans were grown commercially for the first time in the United States this year and are expected to form 2 percent of the total American harvest of about 50 million tonnes.[209]

The United States Food and Drug Administration has approved the sale of these beans. The Roundup Ready bean has met with strong protest in Europe. Specific manufacturers are refusing to knowingly use the bean in their products because of public dissatisfaction. Specifically, Unilever, Nestle and Kraft Jacobs have said they will not use the bean.[210] In Australia, ANZFA has requested that Monsanto implement a communication strategy to provide information about food derived

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204 Carole Renouf, *Spilling the Gene Beans*, Australian Consumers Association, Media Statement, 12 December 1996.

205 Renouf, *Spilling the Gene Beans*.

206 Cathy Bolt, 'Jump in herbicide limit', *Australian Financial Review*, 22 November 1996, p 16.

207 Bolt, 'Jump in herbicide limit', p 16.

208 Bolt, 'Jump in herbicide limit', p 16.

209 Cathy Bolt, 'Transgenic bean about to land in supermarkets', *Australian Financial Review*, 12 November 1996, p 2.

210 Renouf, *Spilling the Gene Beans*.

from gene technology prior to their release.[211] At the time of publication, Monsanto had not decided on whether to follow this advice.

FLAVR SAVR TOMATOES

Calgene, a US biotechnology company, claims it has produced a superior tomato. Called the Flavr Savr tomato, Calgene says the tomato is a lush red colour with improved flavour, better able to survive transportation. Calgene's tomato has been genetically manipulated to neutralise the gene which makes the tomato go soft. The tomato can ripen longer on the vine, improving the flavour, and be shipped longer distances before degrading. Calgene has voluntarily labelled its products.

Cleared for sale in 1991, the Flavr Savr tomato was the first genetically engineered food to be sold in the USA.[212] Significantly, its sale "*will open a door that can never be closed again*".[213] Flavr Savr is also now available in the United Kingdom, but is not currently present in Australia. Locally, Unifoods and the CSIRO are currently researching a genetically engineered tomato with improved flavour. Research trials were made in 1993 and 1994. Larger scale trials are being made in the United States.

BT COTTON - INGARD

One of the major economic pests of cotton in Australia is the Heliothis caterpillar. Ingard contains a gene derived from a soil bacterium *Bacillus thuringienis* , which produces a protein toxic to Heliothis, but non-toxic to humans, animals and most other insects. The use of the Bt gene, as it is known, will allow a reduction of pesticide spraying to once or twice a season.[214] Some farmers currently spray their cotton crops up to 12 times a season, a practice that contaminates the soil and water. It also costs the industry $100 million a year for a crop valued at $750 million annually.[215]

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211 Communication with ANZFA, September 1996.

212 'Gene cuisine', p 9.

213 Robert Young, 'Improved tomato products: utilising modern biotechnology', *Food Australia*, 47(5), 1995, pp 203-204; p 204.

214 Robinson, *Landline*, 27 October 1996.

215 Diana Bagnall, 'Gene Limbo', *The Bulletin*, 20 August 1996, pp 40-42; p 41.

In some parts of America, particularly Texas, there have been reports of the Bt cotton being damaged by insects and required spraying. So early American experience suggests there are contingencies unable to be quantified associated with the use of this technology.[216]

RENNET

Some types of cheeses require the use of rennet in their manufacture. Rennet contains an enzyme, chymosin, which curdles milk. Cheese is formed from this curdled milk. Rennet can come from animals, plants or bacteria. Rennet from animals is extracted from the stomach of calves which contain the chymosin. Microbial rennet is similar, but does not produce the same flavour in cheese, while vegetable rennet uses enzymes from figs or pineapples. Traditionally, animal and microbial rennet is used in cheese manufacture.

Rennet is also produced from genetic manipulation. A gene from the calf is inserted into a microorganism, which can then produce large quantities of the enzyme. Genetically manipulated rennet is approved for use in cheese manufacture in Australia by some companies.[217]

TRANSGENIC PIGS

In Australia, Adelaide-based biotechnology company BresaGen is producing transgenic pigs. These pigs contain an extra copy of their own growth hormone gene and a modified human gene sequence which regulates the activities of the pig's genes. As a result, they grow faster and more efficiently, producing leaner pork.

The transgenic pigs owned by the Adelaide-based biotechnology company BresaGen almost made it to market this time last year.[218] The meatworks though were reluctant to handle the meat for which no regulatory authority would claim responsibility.[219] The pigs have a synthetic hormone incorporated into their DNA. They are considered chemically no different to other pigs. Nevertheless, the then

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216 Bagnall, 1996, p. 41; *Action Alert: Urge EPA to hold scientific advisory panel meeting on Bt cotton failure*, e-mail via Agnet sponsored by the Ontario Ministry of Agriculture, Food and Rural Affairs, 14 December 1996. (dpowell@uoguelph.ca)

217 See 'Gene cuisine', p 11, for a table which lists the source of rennet for various brands of cheese.

218 Carol Booth, 'Protest at extra gene pork', *Courier Mail*, 15 December 1996, p 15.

219 Bagnall, p 41.

National Food Authority decided that BresaGen could market them so long as they were accompanied by a label. BresaGen decided to withdraw the pigs from sale rather than risk being at the centre of a public debate.

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