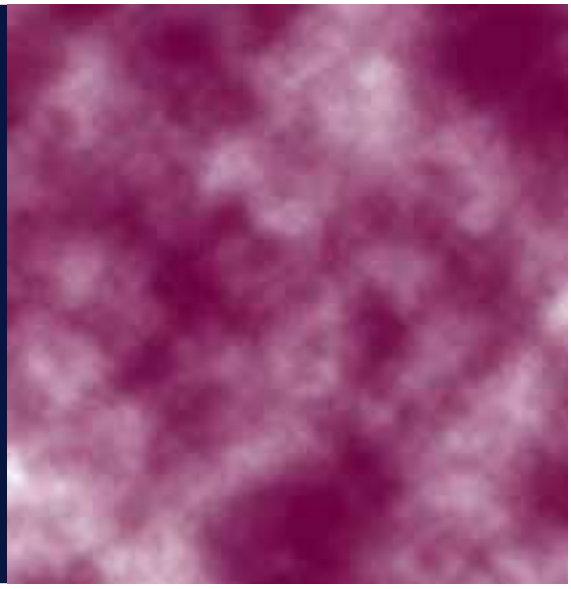
Gene technology & food



Are Australian food producers ready to take advantage of the new biotechnologies?

Will consumers buy genetically modified foods?

Can our regulators avoid disasters of the British mad cow variety?

In 1983 a hybrid bacterial/plant gene was introduced in working order into a tobacco plant growing in the laboratory. Since then the frontiers of plant science have been applied to agriculture; genetically altered crops are growing now.

Are Australians ready to accept a new era of genetically modified foods? How will consumers react?

At present there is a great lack of understanding of what gene technologies are and how they will affect foods. The public is concerned that the foods may not be safe. Some are worried about long-term environmental risks.

At the same time our food and agriculture industries are under pressure to compete with new techniques and products from overseas.

The Australian Academy of Science brought together some of Australia's leading gene technology experts, food industry and consumer representatives and government officials to discuss the topic, *Gene technology and food*, at the National Maritime Museum in Sydney on 31 March 1999. It was the 59th meeting of the Academy's National Science and Industry Forum.

The subject matter brought forth lively discussion from those who held differing views on how the technology should be used and regulated. The forum was widely covered in newspapers and on television.

Dr Jim Peacock and Dr TJ Higgins, both from CSIRO Plant Industry, initiated the idea for the forum, and Dr Keith Boardman put the program together.

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The food industry as honest broker

Mr Mitchell H. Hooke is Executive Director of the Australian Food and Grocery Council, the peak body representing packaged food, beverage and grocery producers. Before that he represented the Grains Council of Australia and the Queensland Grain Growers' Association. The early part of his career was as an extension agronomist for the Queensland Department of Primary Industry.

Biotechnology's potential to meet society's challenges is, prima facie, impressive. It can help:

- manage the environment – environmentalists should be shouting from the rooftops about this technology
- support sustainable food production – more efficiently using water, land, fertilisers and fossil fuels
- increase food supply – world population is growing while the area of arable land is declining
- meet consumer demands for tailored foods with greater health benefits.

So what's all the fuss about? Why is there so much passion, even aggression? So much promoted fear with such outlandish denigration of the technology?

If the science of the technology is sound and has passed peer review, then surely the case is unchallengeable, the conclusions indisputable and the path forward clear.

Just as the food industry is the honest broker in the application of this technology to food and drink products, scientists must be the honest brokers in its development. That includes addressing the legitimate concerns of the community.

If the scientific community fails to heed the warnings of the bovine spongiform encephalopathy debacle in the UK, ignores the social and moral dimensions of new gene technologies, fails to appreciate individuals' differing perspectives of risk, does not recognise the mercenary nature in all of us, does not understand that perception is reality and hopes that somebody else will defend the honour and integrity of science, then it will put this new technology's applications at risk in the short term.

I say in the short term, because there is an inevitability to gene technology. Already the total area planted of the world's five major genetically improved crops has grown from 2 million hectares to 28 million hectares in the three years to 1998.

The issue is not whether there will be this technology, rather when and how well placed we will be to capitalise on it, to position ourselves competitively in the global market. There is a real risk of Australia becoming a client state, purchasing improvements from others who have harnessed the technology's power and captured its intellectual property.

With any new technology there is uncertainty. We are all looking for reassurance that the direction our scientists are taking us is sound, with no unmanageable risks.

We are quite inconsistent in our attitudes to risk. We are prepared to accept risk if we think we have a degree of control over it. But we are not prepared to accept risk when decisions about it are out of our hands.

There is also an undercurrent of phobia about monopolistic supply chains, aided by intellectual property rights or technologies that provide the capacity to derive a monopoly rent from the market.

The opponents of new biotechnologies are well organised, well funded and fervent in their arguments. They rarely let facts get in the way of a good emotional argument and mostly argue from the luxury of their own comfortable western existence.

Just as the Australian Food and Grocery Council has sought to promote a regulatory regime that will provide consumers with confidence in

Mr Mitchell H. Hooke

the safeguards of public health and safety and the environment, those opposing this technology have sought to undermine the integrity of that regulatory regime. I have seldom witnessed such a mischievous, unsubstantiated attack on a regulatory authority as we are currently witnessing on the Australia New Zealand Food Authority, which is being charged with being sycophantic to industry, anti-consumer and incompetent.

One could explain some of that aggression in terms of a wish to return to the early days of that authority, when there was a strong predisposition to use food regulation for social engineering.

Unless those who have the capability stand up and join in this debate, communicating in lay terms about the technology and its profound implications, we will continue to witness the irrational reactions of politicians and regulators to the irrational reactions of a community confused and concerned, if not cynical.

Food companies won't, indeed cannot afford to, fly in the face of consumers' wants, irrespective of what we perceive to be their needs. My industry is feeling somewhat targeted and isolated in the application of this technology to the agricultural food production system.

How industry adopts new technology

Professor Christopher Hudson is Research and Development Director of Goodman Fielder Ltd, Australia's largest food company. He is also Adjunct Professor in food science and technology at the University of Queensland and a Director of the Australia New Zealand Food Authority.

This is a timely topic because:

- consumers are aware of gene technology and its application to the food chain
- international companies are making very significant investments in research and development
- significant intellectual property positions are being prepared
- seed companies are being concentrated into three or four global players
- commercial success will be linked to consumer acceptance and regulatory environments.

In the recent history of the food industry, a number of new technologies have been adopted. Paradigm shifts have occurred roughly once a decade:

1940s heat preservation, canning, pasteurisation

1950s food additives, specialty ingredients

1960s packaging, aseptic processing, UHT

1970s microwave cooking, nutritional positioning

1980s irradiation, biotechnology

1990s functional foods.

These developments came about because of consumer needs: changing demographics, changing lifestyles, and increasing knowledge of and interest in food. Science and technology offered the industry and regulators methods to manage risk, improve food safety and increase appeal to consumers.

A number of changes faced consumer resistance: there was a backlash against pasteurisation, people were suspicious of additives

Dr Chris Hudson

and preservatives ('chemicals') and there was a scare about microwave cooking. Irradiation has not taken off. Novel foods have received much attention from regulators.

Genetic selection for desirable traits has been used for many years in traditional plant and animal breeding, as well as selection from the mutations of microorganisms. New biotechnologies are being used in fermentation, enzymes and cell cultures.

Gene technology could change aspects of the food chain from farm to supermarket. It could:

- enhance agricultural productivity
- lower costs
- contribute to more sustainable agriculture
- allow new products with better qualities
- enhance food nutrition
- increase manufacturing efficiency
- improve quality assurance
- make food companies more competitive.

The technology will be applied to food over three time horizons, with each horizon adding value to products. Horizon 1 covers agriculture, increasing efficiency, protecting plants and improving sustainability. These things are happening now. Horizon 2 will introduce new traits, enhance nutrition and taste, and increase yields of foods. These are not on the market yet. Horizon 3 will see industrial, pharmaceutical and biochemical applications for plants, and functional foods. These are a few years away.

Horizon 1, where the emphasis has been on agriculture, has seen explosive growth. Areas planted to genetically modified soybeans have grown from 400 000 hectares in 1996, to 5.25 million hectares in 1997, to 14 million hectares in 1998. Most of this is in North and South America. Large areas of genetically modified maize, potato, tomato, oilseeds and cotton have been planted.

Consumer acceptance will be vital for successful commercialisation. Some of the issues raised by gene technology are:

- consumer attitudes to gene technology
- consumer views on specific foods
- food regulation developments internationally
- research investment in gene technology with an agrifood (rather than a biomedical) focus
- intellectual property ownership of key technologies.

This last raises the question of how Australia will manage its role. Many value added benefits will come from improved agricultural production.

Regulatory concerns are food safety, allergies, the environmental release of modified organisms and product labelling. The Australia New Zealand Food Authority has proposed regulations on labelling and safety assessment. The US Food and Drug Administration and European regulatory agencies have developed risk assessment procedures.

The key areas in food safety assessment are protein composition and structure (including their potential to cause allergies), the composition of the food and its degree

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Plants

Dr TJ Higgins

***Dr TJ Higgins** is Chief Research Scientist and Program Leader in CSIRO Plant Industry in Canberra. His research focus is the application of gene technology for plant improvement, particularly improvement of the nutritive value of animal feed and human foods.*

Genes can be put into more than 70 plants, including cereals (wheat, rice and barley), fruits, vegetables, nuts and ornamental plants. The area cultivated with genetically engineered plants has grown from 1.7 million hectares in 1996, to 11.0 million hectares in 1997, to 27.8 million hectares in 1998.

Most of this is soybeans, corn, cotton, canola and potatoes. The genetic traits that they contain are herbicide tolerance, insect resistance and quality enhancements such as delayed ripening.

The other 65 plants with added genes are still mostly at the experimental stage.

In the future, plant genes will be modified to:

- improve performance in the field – resisting stress, disease and drought, improving reproduction and shape, and making more efficient use of nutrients
- improve food quality – changing composition of oils, carbohydrates, proteins and vitamins, and improving taste and texture
- meet new uses – in bioremediation and as industrial reagents, vaccines and diagnostic antibodies.

What is gene technology? It is the addition, altering or removal of genetic material, usually a single gene, to alter the organism's characteristics.

What is a gene? It is a length of DNA containing a code for the production of a protein. Additional DNA code shows where to start and end the gene. Other codes control the timing of the production, the location and the quantity of protein produced. Living things contain between 5000 and 50 000 genes arranged in chromosomes.

An example is transferring a weevil resistance gene from french beans to peas. First the protein code is taken from the bean and the control code is taken from the pea and both are spliced together to make a chimeric gene. This is combined with a second gene and put into a soil microbe which normally transfers genes into plants. This process occurs at low frequency but the second gene allows us to select out the cells that have integrated and expressed the two new genes.

It takes six months of tissue culture to grow whole plants from the cell with the new genes. Field trials with the new transgenic plant and a control are then conducted to show whether the gene is protecting the pea seeds from the insect. In this case the weevils found the transgenic peas quite unpalatable and left them alone.

Before undertaking a project such as this, there are a lot of issues to consider:

- the importance of the crop to agriculture
- whether traditional breeding and selection have found the source of resistance
- other agricultural practices, such as insecticides, which may be options for controlling the problem
- the risk of introducing anti-nutritional factors (such as the thing the weevils don't like) into the food
- the risk of introducing allergens.

Extensive field trials are needed to show the safety of the modified plant. Proponents must devise a management plan, present public information and prepare a commercialisation strategy.

Success depends upon having:

- a reliable gene transfer system
- available genes
- the freedom to operate and use other people's technology

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Plant improvement using selection and breeding – historical perspective

Year	*World population (m)*	*Development*
8000BC	5	cereals and pulses domesticated
2000BC	50	rice, potato, oats, soybean, grape, cotton, banana domesticated
1583	500	sexuality in plants described
1742		first company devoted to plant breeding and new varieties
1799		first cereal hybrid described
1900		maize hybrid breeding: Mendel recognised
1927		x-rays used for mutation breeding
1983	5000	first use of gene technology for plants
1999	6000	50m hectares of genetically altered plants

Animals

Dr Oliver Mayo *is Chief of CSIRO Animal Production. His current research interest is the delivery of the results of genetic research to Australian livestock industries.*

Over the long term, food prices have declined. They are now 30 per cent of prices in 1900. Because consumers are driven by cost, prices will continue to decline. Farmers need new technologies to stay in business. That is the real force for biotechnology in animals.

We have been working on sheep. Their physiology, reproduction and genetics are well understood, they have a shorter life and lower cost than cattle, and they are a good subject for experimentation.

Our transgenic sheep (see photo on page 16) has had DNA injected into a fertilised egg. This DNA promotes body growth, increasing body size and producing more meat. This sheep has produced a male lamb.

Australia has most of the best sheep wool and meat genes in the world. This is an area where we can continue to compete on world markets.

Though there are no transgenic animals on farms, a number of gene techniques are used in the sheep industry in Australia:

- pedigree determination – this is not yet commercial
- gene identification
- gene mapping
- finding the genes that affect important traits
- using markers to help select traits
- mitochondrial inheritance – this affects energy use
- genetic engineering.

Genetic engineering of livestock is well behind plants. In 1983 US scientists conducted an experiment placing growth genes into mice, only a year or two after plant genes had been modified in this way. Why has it taken so long to apply these techniques in industry?

One reason is the difficulty of inserting genes into eggs. The

Dr Oliver Mayo

efficiency of this procedure is very low and so the cost is high. Even so, animals with better weight gain, wool growth or milk production are being evaluated in contained field trials.

Animal cloning offers the possibility of transforming a whole cell line, not just one egg. Cloning by nuclear transfer may be a more effective way of making transgenic livestock.

We are not interested in cloning humans. We recognise the ethical concerns. My concern is that hasty regulation in this area might interfere with responsible and far-sighted research.

Genetic modification offers benefits in:

- animal welfare and product safety – less use of insecticide or other chemicals
- farm productivity and product quality – since the wool price is declining over the long term, there is a need to keep farmers competitive
- the production of pharmaceuticals in animal milk or other tissues
- animal models of human disease
- animals whose organs or tissues may be transplanted into humans – pigs could supply the shortfall in human donors.

Biological defleecing is an example of the non-medical, non-food use of transgenics. This technique briefly stops growth so that a sheep's wool falls off. After shedding their wool, the transgenic sheep grow better than shorn sheep.

A number of proteins have been produced in the milk of mice, pigs, sheep, goats and rabbits. These include human proteins: collagen, factor VIII (for treating haemophilia), $\alpha\lambda\pi\eta\alpha_1$-antitrypsin (for treating emphysema), and protein C. The mammal proteins are folded the right way and have the right sugars attached for humans. Proteins from potatoes and lettuce are not so easily extracted or used. Twenty clinical trials are under way.

Animals can also produce human tissue for therapeutic purposes. Transgenic pigs are under development to try to produce neural cells for sufferers of Parkinson's and Huntington's diseases, pancreatic cells for diabetics, liver cells to treat liver failure, and whole livers, hearts and kidneys for those suffering failure of these organs.

Big money is being invested in the biomedical field: about $800 million in 1998. That is more than the budget of CSIRO.

The objections to the use of transgenic animals for transplantation are:

- the possibility that animal retroviruses will be activated in humans – like HIV
- the problem of disposing of the rest of the pig
- the possibility that pigs with human-like immune systems could become reservoirs of human diseases, requiring human treatments.

Plants can make haemoglobin, which is usually seen as an animal product. The deep sea dragonfish can make chlorophyll, which is usually associated with green plants. Nature is pretty good at moving genes around and recycling them. There is nothing that we can do which matches what nature has already done.

Microorganisms

Professor Noel Dunn *is Director of the Cooperative Research Centre for Food Industry Innovation in Sydney, which works with 16 companies. Before that he was a Professor in the Department of Biotechnology at the University of New South Wales. He is studying dairy starter cultures, particularly gene cloning, bacteriophage resistance and the construction of better cultures.*

Bacteria and fungi are the origin of a number of food ingredients which include:

- enzymes
- colours
- flavours
- antioxidants
- antimicrobials
- amino acids
- vitamins
- nucleotides.

In addition living microorganisms used in foods include:

- yeast – for baking and brewing
- lactic acid bacteria – for making cheese and yoghurt
- probiotics – which contribute to health.

Conventional mutation and natural gene transfer is used routinely to develop superior commercial cultures and this is essential for the maintenance of commercially competitive processes. These approaches do not require regulatory approval.

Gene technology is being used to elucidate cellular mechanisms in microorganisms. The acquired knowledge can then be used in conventional strain improvement programs; thus gene technology is of indirect benefit in these situations.

Microorganisms are also proving very important for characterising and modifying plant and animal genes prior to reintroduction of these genes into animal or plant cells. Microorganisms are important because they grow quickly. As a result, gene technology is very advanced in a number of microorganisms.

Professor Noel Dunn

Several purified recombinant enzymes produced by microorganisms are approved for use in food processing in Australia. One is cattle rennin which is now produced by a recombinant yeast. Others are for use in the beverage industry.

No living microorganism that has been modified using gene technology has been approved for use in foods through the Australian regulatory process. However, two constructs have been approved through the UK system. One is an amylase-producing brewers yeast and the other is a maltose-utilising bakers yeast; both constructs contain only yeast DNA. Approval was granted subject to strict conditions of use.

To commercially utilise gene technology in living microorganisms in foods, a preferred approach is termed 'self-cloning' technology. Cloning vectors, the primary tool for gene technology, are constructed using DNA components obtained solely from within a particular group of food-approved microorganisms. For example, *Lactococci* are used as cheese starters and cloning vectors have been developed which contain solely lactococcal DNA. These cloning vectors are being used to construct improved commercial strains.

Constructs will have more consistent properties and contribute to production of quality cheese products. This will lead to a significant increase in market share. Seeking regulatory approval to use these constructs will involve companies being confident of consumer acceptance when products finally go to market.

Genetically modified microorganisms are already approved in Australia for use in processing dairy products, such as yoghurt and cheese, and beverages, such as beer.

The regulatory framework

Dr Paul Wellings *is Head of the Innovation and Science Division of the Commonwealth Department of Industry, Science and Resources, on secondment from his position as Chief of CSIRO Entomology. He has conducted research into insect populations and the biological control of pests.*

The current framework for regulating gene technology revolves around the Genetic Manipulation Advisory Committee, a non-statutory body which oversees research into genetically modified organisms. The committee issues guidelines and works with the biosafety committees of research institutions. It provides technical advice to other government agencies and can impose sanctions for failure to comply with guidelines.

Volume of assessments

	95–96	96–97	97–98
Small scale	417	293	358
Large scale	0	6	2
Deliberate release	19	25	35

Small-scale proposals are predominantly medical and large-scale proposals mainly pharmaceutical. The majority of deliberate release of genetically modified organisms have been agricultural.

There is a need for regulatory reform because gene technology offers significant economic potential for Australia which may not be realised due to:

- public concerns about the human safety and environmental effects of the technology
- industry uncertainty about regulation.

On 30 October 1997, the Cabinet announced that gene technology would be covered by uniform laws and that compliance with them would be compulsory. Commonwealth, state and territory governments are discussing a framework for the new regime. These proposals are subject to consideration by governments in all jurisdictions.

The new regulatory system would create a nationally consistent regulatory environment, build public confidence in the technology, provide specific controls to manage risks and hazards, and make the regulatory path clear to all interested parties. Use would be prohibited until specifically approved.

It is proposed that the new framework will use existing bodies and legislation as far as possible. It will make decisions case-by-case, using rigorous scientific risk assessment. Decisions will be open, clearly explained and timely. Ethical and socioeconomic issues will be considered separately from scientific issues. Applicants will bear the regulatory costs and legal liabilities.

The bodies which regulate various products will use their legislation where it covers genetically modified products. The National Registration Authority will assess genetically modified products for agricultural and veterinary use, the Australia New Zealand Food Authority will assess foods, the Threrapeutic Goods Administration will assess medicines, and the National Industrial Chemicals Notification and Assessment Scheme will oversee industrial products. A new Gene Technology Office will coordinate processes and regulate products not dealt with by the legislation governing other agencies.

After initial screening at a gene technology shopfront, proposals will be streamed to the appropriate agency. The Gene Technology Office will coordinate risk assessment harmonisation for all agencies.

The pathway is complex; a product with a number of uses may have to go to a few agencies. Contained (laboratory) research would follow existing procedures, but the Gene Technology Office and its Gene Technology Advisory Committee would take over from the Genetic Manipulation Advisory Committee. All field trials would have to be approved.

Dr Paul Wellings

Proposals for the release of genetically modified organisms would need management plans approved by the Gene Technology Office. The states and territories would monitor compliance, possibly through contract auditors. The proponents would bear the cost of monitoring. The management plans would cover the life cycle of the products, from approval for sale or environmental release to destruction.

Following consideration and directions from the Cabinet, the next step is the drafting of legislation for all parliaments. Operational details will be worked out, leading to the establishment of a gene technology office. This phase of activity will involve another round of stakeholder consultation, following on from the consultation which took place in 1998.

The implications for nutrition

Professor Richard Head *is Chief of CSIRO Human Nutrition and Affiliate Professor in the Department of Clinical and Experimental Pharmacology at the University of Adelaide. His research interests are the biology of functional foods and their role in protecting human health.*

It is essential to look at the cascade of historical developments in biological science, as described by Chris Hudson. The second wave of gene technology will benefit nutrition.

Over the decades many scientific discoveries have been applied to food and nutrition. In terms of the chemical aspects of diet, key discoveries this century have been enzymes, drug metabolism, lipid messengers, peptide messengers and free radicals.

In relation to society, nutrition has had a very positive influence on health. Nutrients go beyond sustenance, protecting us from chronic diseases. A great social problem is undernutrition: 2000 million people currently lack essential micronutrients, such as iron. Cardiovascular disease and cancer have a relationship with diet, becoming more likely in the absence of protective agents.

By 2020, cardiovascular disease will be the number one contributor to illness and death. Central nervous system depression and stroke will be increasingly significant. In Australia, the circulatory diseases, cancer and diabetes are increasing, and may have dietary links.

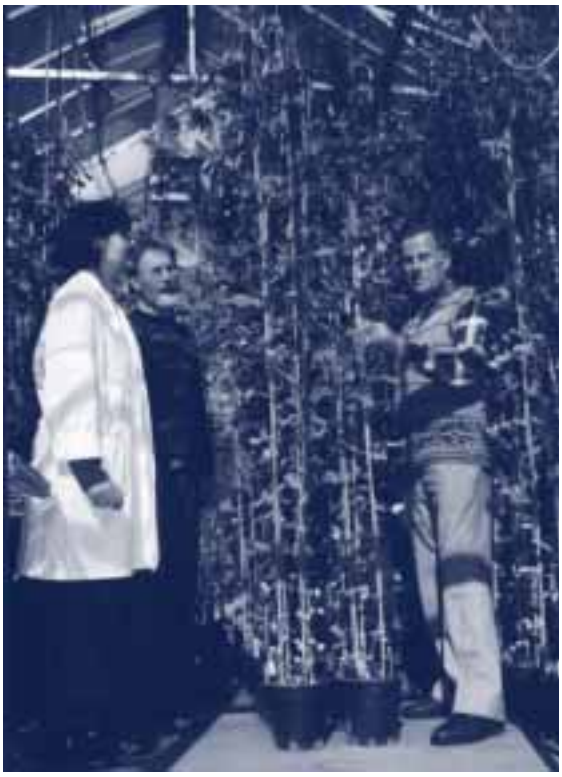
Improving diet will lead to longer lives, an ageing population and diet-linked degenerative diseases. As life expectancy increases, quality of life becomes the issue, and health care costs increase.

Gene technology has the potential to save lives, improve the quality of life and decrease health care costs. The technology can be used for prevention, through diagnosing illness and through diet. The challenge is to find the links between the technology and health problems.

The technology may be able to provide nutrients that will overcome deficiencies and reduce the risk of specific diseases. Varying the structure of key molecules can lead to variations in the content, and health effects, of foods. Key molecules include:

- natural antioxidants, which play a role in atherosclerosis and cancer
- resistant starches, important in gut health and colon cancer
- fatty acids, important in cardiovascular disease.

The gene technology employed should be set against the prevalence of diseases in global, regional and Australian populations.



CSIRO Plant Industry scientists, Stephanie Gollasch, TJ Higgins and Hart Schroeder, with genetically engineered peas in the glasshouse.

How industry adopts technology

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of equivalence to an existing counterpart, and the level of expression of genetic changes implemented. Foods which are substantially equivalent to a conventional counterpart have no mandatory labelling requirements.

Market research has shown that consumer food choices are driven by:

- the desire for healthy, nutritious, safe foods
- convenience – how food fits with lifestyles
- taste and enjoyment
- value for money.

Consumer acceptance of gene technology is affected by information gained through mass media and word of mouth, perceptions of the role of scientists, industry and governments, religious and ethical considerations, the understanding of risks versus benefits, the activities of consumer activists and the marketing strategies of the food companies. Consumers want to see that regulatory authorities have addressed food safety, efficacy and environmental issues.

International studies of consumer attitudes show that personal benefits are the driving force. Consumers support strong, independent oversight, particularly in the USA. Probably as a result of recent problems, Europeans have a lower opinion of their authorities.

The processes of gene technology are unfamiliar and misunderstood, Consumers are demanding adequate information. Technical terms need to be chosen carefully and explained clearly.

Consumers desire technological growth at a modest, careful pace. The mode and efficacy of presentation and marketing of gene technology products is critical.

It is not a question of whether or when gene technology will be applied to food. The horse has already bolted. The stable door is not yet shut but it is well on the way.

View from the supermarket aisle

Mr Bruce Bevan

***Bruce Bevan** is the Executive Director of the Australian Supermarket Institute. He has also represented retail traders and the road transport industry, after an early career in employee relations.*

Newspaper and television reports about the application of gene technology to food, with notable exceptions, have rubbished the idea. Headlines like 'Frankenstein foods' and 'Mutant foods' said more about journalism than gene technology.

Amongst journalists these days, the attitude seems to be: 'If you don't know, don't bother.' There are not many journalists wanting to gain knowledge.

In the community there is a deep well of ignorance on the subject of gene technology. A survey has found that 51 per cent of respondents were not aware that gene technology could be used in the production of food. About 6 per cent were unsure whether it could or not. Most could not clearly state what the process involved.

The respondents were more comfortable with the genetic manipulation of plants than animals. Medical uses were better supported than other uses.

Gene technology is not a simple concept. The language is not accessible to most people. Given the level of ignorance, it is not clear how labels would enhance food safety, or inform consumers.

Opponents of the technology are playing on ignorance. They say, 'The scientists don't know what will happen.'

Scare campaigns show us the limits of democracy: the opinions of the Australian Consumers Association and Greenpeace cannot change the scientific facts.

We rely on data from people who are trained in their field. Galileo was forced to recant his view that the earth moved around the sun, under threat by the Inquisition.

The recent consensus conference on gene technology was anti-science, anti-knowledge. Galileo would have found the circumstances familiar. The final communique shows that the conference was a waste of time. The participants were at best naive.

Science is imperfect. We cannot foresee all the consequences of our actions. That is not a reason to do nothing. We still have to make decisions.

Labelling is irrelevant to deciding whether food is safe. The proponents of labelling cannot say what use it would be. It will not create informed consent. Labels will be the equivalent of a 30-second soundbite on television.

Gene technology offers the potential for better quality food, a better environment and increased international trade. Genetically modified foods, like conventional foods, should be safe, according to the best available knowledge. Therefore the labelling is irrelevant.

Retailers will comply with government requirements. The industry has an obligation to produce and sell safe food and that can best be achieved in a transparent regulatory framework, based on sound scientific principles. If scientific criteria are not suited to assessing safety, what criteria are suitable?

Plants

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- field evaluation.

In Australia, regulation is carried out by the Genetic Manipulation Advisory Committee (for laboratory and glasshouse studies, and field trials), the Australia New Zealand Food Authority (foods), the Therapeutic Goods Administration (medicines), the National Registration Authority (agricultural and veterinary chemicals), state departments of agriculture, Environment Australia and shire councils.

Over the next 5 to 20 years, some of the benefits of gene technology to consumers will be:

- elevating vitamin E in seeds by adding an enzyme to convert the precursor into the vitamin
- enriching the low iron level of rice grains using the ferritin gene from soybeans
- changing the oil composition of canola for different food uses – more oleic acid for cooking, stearic acid for margarine, others for nutrition
- changing the composition of starches in cereals – adding new starches for dietary fibre or food thickeners.

Benefits for farmers include more crop management options, reducing dependence on herbicides and pesticides, and higher yields of cleaner, high quality products.

Gene technology is providing us with the tools and knowledge that will allow us to improve our health, create a safer and more secure food supply, generate greater prosperity and a more sustainable environment.

View from the consensus conference

Ms Carole Renouf

***Carole Renouf** is a Senior Policy Officer for the Australian Consumers Association, specialising in the area of food policy. She was previously a journalist with the association. She helped organise the consensus conference on gene technology in the food chain.*

I was disappointed by the comments from the Supermarket Institute. I thought we had moved beyond adversarial backstabbing.

The first Australian consensus conference was an interesting exercise in democracy. All the stakeholders endorsed the process and the outcome.

The aim was to get informed consumers' judgment about gene technology and food. There was a lay panel of 14 people who spent nine days hearing all sides of gene technology. So they were well informed.

The consensus conference was a challenging process. The methodology comes from Denmark where it is used as a means for involving citizens in decision-making. A lay panel – people with no prior knowledge of the topic and representing a range of values and attitudes – sets the questions. An expert panel – with different types of knowledge, values and attitudes – gives the answers.

The experts came from science, industry, environment, religion and public health. The lay panel evaluates the evidence and reaches consensus on the advice they give to government, science and industry.

In this conference the lay panel said that decisions should not be made solely on the narrow basis of science. Cultural, moral and religious beliefs must be considered. They rejected the use of the term 'substantial equivalence' to compare a traditional product with that of genetically modified organisms.

The members of the panel said that:

- regulatory and advisory bodies are not serving community interests
- the government does not provide straight answers
- there is a need for a new statutory authority with well balanced representation
- the proponents of genetically modified foods should pay a licence fee and lose it for non-compliance with regulations.

The panel saw a need for increased public awareness and education, with information from varying perspectives. There should be increased consumer representation in decision-making and cooperative consultation between perspectives, facilitated by the government. They also wanted an all-encompassing labelling system.

Is it an apple or an avocado? What should the label say?

The lessons learnt from the lay panel are:

- consumers are mistrustful and cynical
- they feel shut out of decision-making
- ethical and moral considerations are at the top of their minds
- they see technology as serving the interests of a privileged few (multinational companies)
- they recognise the perceived benefits
- there should be less haste and more caution in applying new technology.

Food is perceived as a universal good, part of our heritage, what we feed to our children. It is very important to people. Gene technology does not bring as many benefits to consumers as it does to producers.

Some other reflections arising from the process were:

- information programs must include varying perspectives
- the mug and jug style of education – in which experts fill up the citizens – must be abandoned
- we must take the risk and ask an informed public whether it chooses to embrace change.

Science must acknowledge its limitations. Conflicting evidence creates uncertainty. When science closes its doors and tries to maintain that its knowledge is perfect, we are in trouble.

For more information on the consensus conference, see the ABC website at **www.abc.net.au/science/slab/consconf/splash.htm**.

Consumer attitudes to gene technology

Dr Katrine Baghurst *is a Senior Principal Research Scientist and Manager of the Consumer Science Program at CSIRO Human Nutrition in Adelaide. The Consumer Science Program conducts research into attitudes to food, food choice, nutrition and related health matters.*

In 1998 we conducted a national postal survey of attitudes to genetic engineering and food, selecting people at random from the electoral roll. This followed a 1994 survey in South Australia.

The 1998 survey produced 623 responses, 311 men and 312 women, a 65 per cent response rate. Their mean age was 46, 30 per cent had been to university, and 48 per cent had some religious belief.

Of genetic engineering, 58 per cent had heard little or nothing, although 84 per cent stated that they had heard of biological techniques used in food production and health. Those who could define genetic engineering thought it had something to do with altering genes, mutation or cloning, producing benefits.

More men (47 per cent) than women (24 per cent) thought the new technologies would make life better. This reflects the general finding that men, especially younger men, were more accepting of the results of science and technology than women. More men thought technology could solve problems and raise living standards.

About half the respondents thought decisions were best left to experts, while 70 per cent thought citizens deserved a role in decisions about technology. One-third thought we would be better off if we lived more simply, without technology.

Respondents thought that the technology would have both positive and negative effects on the environment. The perceived risks of the technology were that its effects were unknown, it was out of control, it could be abused in the wrong hands, it interfered with nature and its users were prone to error. Species could be lost and new diseases created. Nearly half thought the benefits outweighed the risks, but 17 per cent thought they did not. Many were not sure.

Dr Katrine Baghurst

Only about 20 per cent felt the risks of genetic engineering had been greatly exaggerated.

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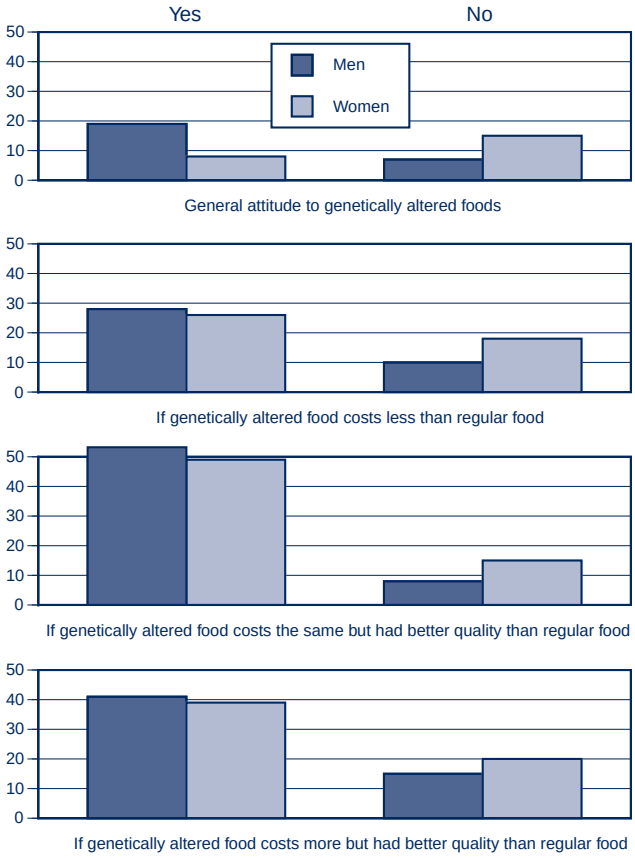
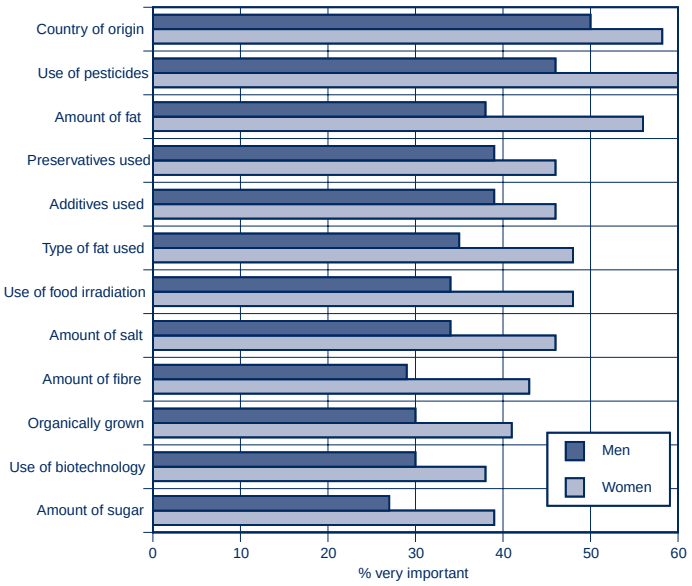
Would you try these foods?



What should be on food labels?



Discussion

This is a summary of discussion at different times during the forum, not the actual words used. Some speakers could not be identified.

Bill Collins, Agriculture Western Australia: Scientists need to take a lead in ethical and moral issues.

Mitch Hooke: Ethical means morals and religion. People need an explanation of what is happening. Some don't understand the make-up of genes and feel man is playing God. Scientists need to broaden their horizons in dealing with information to the community. Information needs to take account of different perspectives. Bill and Betty Battler need to know what's in it for them.

Chris Hudson: The same question arises with other agricultural technologies, for example plant breeding is changing the genetic structure of organisms. Gene technology is the extension of useful techniques that have been in place for centuries. We need to be careful of species.

Roger Edwards, Food and Packaging Cooperative Research Centre: What about the bureaucratic conflict for control of gene technology regulation and safety standards?

Mitch Hooke: Few care about safety regulation until a crisis occurs. Then those affected want to be able to focus on what is in place. There are 700 agencies responsible for the regulation of food in Australia. The states still have responsibility for food standards. We can't ask the states to get their act together, if we can't do it federally.

There is internecine warfare between the food and agricultural agencies in Canberra. Our preference is for a single national regulatory agency. Streamline the process. It is happening in New Zealand, where all is going to agriculture, the UK and NSW.

Chris Hudson: Two factors in regulation are effective administration and resourcing, and public confidence and the credibility of the agency. It is a question of setting the priorities.

Tim Bennett, Australian Native Foods: A number of different bodies – consumers, the Australia New Zealand Food Authority, growers – are having a say on gene technology. Which is the most appropriate body to comment?

Chris Hudson: We've all got a role to play. The key science organisations, like CSIRO, have an important role to play. CSIRO may be seen as having a vested interest in the science but its credibility is still very high. The public may not see them as compromised. The agrifood industry cannot be the spokesperson but we can make sure information and education activities are occurring.

Mitch Hooke: Too much is made of vested interests. It all comes back to the veracity of the message; look at advertising. Nancy Millis is a brilliant presenter, she looks like everybody's grandmother, but it's what she says that really counts. The difference between selling ideas and selling products is that, with products, you must consummate the deal, with ideas, you never really know when the deal is consummated or what drives people to want or need to know.

Bob Hunter, University of Sydney: We scientists have a natural tendency to go with gene technology. What are the consequences of the alternate route, organic farming? That may be profitable.

Chris Hudson: To meet the demand for food in the next century, quantum leaps in production will be required. The new techniques offer the opportunity to meet this demand. Another aspect is that gene technology can identify traits and opportunities that we may not be able to get to quickly using breeding. It may be possible to build the traits back in with recombinant DNA technology. Consumer preferences on varieties are driving the market.

Mitch Hooke: Organic and genetically modified need not be mutually exclusive. Our role is to ensure that the regulatory system gives consumers confidence without being so Draconian that it makes it impossible for us to supply products and stops people voting with their commercial feet about the application of the technology. It may be a choice between the natural resistance of toxic products and gene technology which reduces the need for chemicals. At last, changes in agriculture are being driven by the market rather than the producers and their marketing boards.

Neil Willetts, Australian Biotechnology Association: Estimates of the extent of planting of genetically modified organisms exclude China. The Chinese are planting huge areas while we in the West worry about regulation.

TJ Higgins: China has a large but unknown area under cultivation. It is currently used for domestic consumption but they will be exporting genetically modified crops in future. India is also starting; but they are putting regulations in place.

Owen Crees??, Queensland Sugar Corporation: When vegetable oil is produced from canola, does that contain any DNA?

TJ Higgins: DNA cannot usually be detected in oil.

Chris Hudson: It could be classed as the product of a genetically modified organism. But the oil will be substantially equivalent to an existing product. The regulations applying to such products are being negotiated at the moment.

Neil Willetts: In terms of the approval of microoorganisms, where are we up to with the regulatory protocols.

Noel Dunn: Protocols do exist, and they are quite reasonable processes. There is a range of different food-approved organisms.

Keith Boardman, Australian Academy of Science: What about flavours and colours in manipulated organisms?

Noel Dunn: Genetic engineering can be applied to improve the strain. If it is a purified product, approval is much less of an issue, because it may be an equivalent product.

Chris Hudson: As food additives, they have already gone through international risk assessment. Therefore, they would be exempt from the new test.

Adrian Gibbs, Australian National University: Saying that genes turn up in strange places implies that all the possible combinations have been tried in nature. Does that mean we don't have to worry about genetic manipulation?

Oliver Mayo: My point is our profound degree of ignorance. Evolution has made far more extensive changes than we have attempted. I don't have any personal ethical qualms about taking a gene from one taxonomic category and putting it into another category. That is not to say that there are no risks.

Adrian Gibbs: Except for some viruses and microorganisms, genes have stayed very much within definite phylogenetic boundaries.

Oliver Mayo: Turning on the haemoglobin gene in the storage system of a plant, and then making that characteristic available for nutritional benefit, seems entirely reasonable.

Nic Tydens, Monsanto Australia: The UK has bans on hormone-treated beef. What reaction is expected there?

Oliver Mayo: I'm not an expert on public reaction. CSIRO got into gene technology for the sheep industry because of perceived potential for the future; we have publicly discussed it for 15 years. Publicity mostly accrued to companies working on products for medical purposes; they got a more extreme reaction.

George Petersen, University of Otago and Royal Society of New Zealand: There was a public reaction to the idea of antibiotic resistance being transferred through selection markers. What happened?

TJ Higgins: The risk of antibiotic-resistance genes being transferred to humans is very, very low. Other selection markers use components of the plant itself.

Chris Hudson: We will have to look at a way of eliminating marker genes.

Mitch Hooke: There is a very low likelihood of transferring antibiotic resistance. It is equivalent to the likelihood of earth being hit by radiation from a supernova.

Keith Boardman: A selectable marker could be used for experiments and then taken out before producing the commercial product. It's a greater problem with herbicide resistance; you may not want to use that as it is a desirable characteristic.

David Wansbrough, Department of the Prime Minister and Cabinet: How will we deal with the problem if the unlikely happens? What are the chances of nothing unpredictable happening? Is there a contingency system?

TJ Higgins: The Genetic Manipulation Advisory Committee sets guidelines to evaluate those risks for the future. A lot of evaluations have been made, but you cannot say absolutely that something will not show up in 50 or 100 years.

Keith Boardman: It is a question for the genetic manipulation organisations. There is always a management plan.

Oliver Mayo: There will be unpredictable hazards. The Australian Conservation Foundation said that organisms should not be released until all possible risks had been evaluated. It is impossible to meet that condition. CSIRO is looking at a number of classes of risks.

Adrian Gibbs: There is a problem with regulatory authorities gaining public confidence: genetic engineers are running genetic engineering, monitoring seems to be self-monitoring. There is a likelihood of conflict of interest. Is the government going to have a scheme of independent monitoring?

Paul Wellings: That is a Commonwealth and state matter. The proposed process allows for third party auditing.

Bob Vickery: Regarding the legal framework, what is the extent of illegal trade in genetically modified organisms?

Paul Wellings: I am not aware of any. I have not seen any correspondence on it.

Branwen Morgan, Garvan Institute of Medical Research: What if scientists want labelling? Without labelling we cannot do longitudinal studies?

Bruce Bevan: Labels are not helping information get to consumers.

Chris Hudson: Microbiology moved up the list of issues from 1994 to 1998. Was the CSIRO survey influenced by the salami scare?

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Discussion

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Katrine Baghurst: It was done about a year later. The scare might have bumped up the concern about microbiology.

David Fraser, Bankers Trust: The agriculture and fibre industries are major exporters. Consumer demands for labelling and approval processes may delay the adoption of the technology in Australia. Who pays the price? Producers here and consumers in the developing world.

Carole Renouf: There is great export potential in non-genetically modified crops. This is supported by our contacts with consumers in Japan.

Paul Wellings: The Gene Technology Office will be similar to other Western countries' regulatory frameworks. Australia's policy stance matches many other countries, allowing our industries to compete.

Joanne Kydd, Decisions Research: What do farmers think?

Richard Head: The food sector is now a continuum. There is a tight link between the producer and the consumer.

Oliver Mayo: Producers are always in favour of any new technology that will improve their productivity and competitiveness.

Stan Kilroy, Favourite Foods: I am concerned about the criticism of the press. The sense of science must be seen as sense that common people understand. There is a gap between research and people. It is an emotive issue. Science can recruit the news media to inform people.

Carole Renouf: Good media coverage was a critical success factor for the consensus conference. We got terrific coverage, balanced and fair. The journalists learnt a lot about gene technology.

Bruce Bevan: I'm critical of the media. The lesser read parts of the press are much more balanced and often give better treatment to the subject. But the six o'clock television news has the most influence. By importing headlines and other tactics from Europe, they have led the public down the wrong track.

Bob Hansen, Peanut Company of Australia: Most farmers are concerned if labelling shuts out opportunities to use the technology. They will not be able to be internationally competitive. Herbicide resistant soybeans will have a big impact. Regarding the comment that the technology will benefit a privileged few, the cost of food has declined in the last 100 years and life expectancy has increased. Farmers have got little benefit from this; most of the benefits have gone to consumers.

Katrine Baghurst: The benefit of gene technology to the consumer may be in quality, not cost. Diabetics or coeliacs might get a more diverse food supply. It is hard to predict which producers will benefit.

Bill Collins: Where is labelling and regulation going?

Paul Wellings: The Commonwealth and states are having discussions on the need to expedite the process of creating the Gene Technology Office. Passing legislation in all jurisdictions will be slow and laborious. The earliest possible date to finalise this process is about 1 July 2000. That would be very quick.

Keith Boardman: There is high acceptance of a specific product with specific benefits. At what stage should consumer involvement occur? The Genetic Manipulation Advisory Committee is good for laboratory and glasshouse trials.

Carole Renouf: We are mainly talking about commercial release. It may also be good to have consumers involved much earlier, perhaps when research and development is being planned. People say, 'We didn't ask for this. Who decided what the problem was?' Labelling demands are partly a result of not being consulted earlier.

Bruce Bevan: Commercial release is usually associated with competitive advantage.

Paul Wellings: The Gene Technology Office would provide risk assessment on environmental and health issues. These matters will be considered before commercial releases.

Branwen Morgan: On labels in the supermarket, additives and preservatives are listed in codes. More specific information on genetic modifications would give consumers the chance to decide whether they wanted to buy or eat that kind of product. Genetically modified foods could have codes.

Bruce Bevan: Labelling is an important part of the food chain. With the huge lack of information out there, where do you find what labelling codes mean?

Katrine Baghurst: Nutrient labels have taken years of consultation. And that's relatively straightforward. For genetically modified foods we would need information from consumers, we would need to know the industry constraints. That will take as long as setting up a regulatory framework.

Hugh Tyndale-Biscoe, Australian National University: Grain companies may put suicide genes into their grains so that they cannot be used for the next crop. What about patent rights?

Paul Wellings: Intergovernmental consultation may be needed on specific technologies.

Consumer attitudes

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People are concerned about humans tampering with nature: about a quarter stated that we have no business meddling with nature. Almost everyone (87 per cent) felt the balance of nature is delicate. About a quarter thought that humans were created to rule over the rest of nature. Most (70 per cent) felt that animals have rights, while 42 per cent thought that plants have rights. Few felt that economic growth is more important than environmental protection (78 per cent disagreed with this statement).

On the acceptability of genetic engineering, plants were seen as more acceptable subjects than animals, microorganisms or humans. Half felt it was morally wrong to engineer humans.

Applications of genetic engineering to medicine, pollution control and waste management had high acceptance. The production of new foods was less acceptable. In food and agriculture, the most acceptable uses of genetic engineering were the production of disease-resistant crops and improvement in the taste and health-value of foods. Of human applications, improving the physical characteristics and intelligence of humans were acceptable to about 20 per cent.

Respondents felt genes should be kept in the family, or the species. Moving genes from one plant to another, or one animal to another, was more acceptable than putting genes from microorganisms or humans into plants or animals.

The level of acceptance was related to associated risks. With no risks, acceptance of many applications was high; with unknown risks, acceptance dropped dramatically to very low levels.

Would you try these foods? Over 20 per cent were willing to try genetically engineered foods. About 60 per cent were likely to try them if they had better quality than regular foods. Cost was another factor, but less important.

Most respondents wanted to know more about gene technology: its risks, benefits and side effects. They were also interested in its application to human health, and in government regulatory mechanisms. Further communication with the public is required.

When asked who they would trust for information, the most popular were CSIRO scientists. After them came, in order, health professionals including doctors, university scientists, environmental groups, farm groups, government scientists, books, family and friends, government agencies, food manufacturers, and companies using new technologies. Last of all came the news media, even though they were probably the medium of information from many of the other sources.

Although most respondents supported inclusion of information about the use of biotechnology on food labels, it was ranked in importance behind issues such as country of origin, use of pesticides/ additives and nutrition information.

People's greatest concern about food was microbiological contamination. This was followed by pesticide contamination, environmental impact and the use of additives. Genetic engineering ranked below all of these.

In general, there are mixed feelings about biotechnology. Acceptance in Australia is higher than in the UK and on a par with the USA. Compared to the 1994 survey, there appears to have been little change in consumer attitudes in Australia.

The greatest area of concern appears to be the genetic engineering of microorganisms; 68 per cent felt this presented a threat to the environment.

The National Science and Industry Forum

The National Science and Industry Forum of the Australian Academy of Science held its 59th meeting at the Australian National Maritime Museum in Sydney on 31 March 1999. This report is a summary of the presentations and discussion at the forum. It does not use the actual words of the speakers.

For copies of this report or more information about the National Science and Industry Forum, telephone Faye Nicholas at the Academy of Science on (02) 6247 5777 or e-mail **ac@science.org.au**.

For more information on the Academy, visit the Academy's World Wide Web site at **http://www.science.org.au**.

Dr Keith Boardman, Chair of the Academy's National Science and Industry Forum

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Organisations from industry, research and government financially support the National Science and Industry Forum. If you are interested in joining, contact the Chair, Dr Keith Boardman, or the Secretary on (02) 6247 5777.

***Professor Brian Anderson** is the President of the Australian Academy of Science and Director of the Research School of Information Sciences and Engineering at the Australian National University. He welcomed participants to the 59th meeting of the Academy's National Science and Industry Forum.*

Gene technologies are some of the most powerful ever devised by humans. We are just beginning to see their potential.

The technology was first applied to plants; now millions of hectares have been planted with genetically altered crops. During the last 12 months, scientists have made dramatic discoveries which will accelerate the breeding of animals to enhance food production levels.

Gene technology raises a number of questions and challenges:

- How will the technology affect Australia's trade imbalance?
- Will the international industry structure be dominated by monopolies and oligopolies?
- How will entrepreneurial Australian companies compete?
- How should public sector research couple with the private sector?
- Do our regulatory authorities have the skills to handle crises without being overcautious?

Professor Brian Anderson

- As a nation, do we have the maturity to handle the hard questions?

The answer to the last question is largely a matter of honestly acknowledging the existence of risks and assessing their importance. The public must have confidence in the risk assessment process.

Even before genetic engineering, human intervention created consequences for the natural environment and agriculture. These have led to a loss of diversity. What will be the consequences of the new technology?

The aim of the National Science and Industry Forum is to contribute to public discussion and government regulation.

A quick-growing transgenic ram produced by CSIRO Animal Production. See page 5.