Red Meat and Livestock Industry

Biotechnology Policy

June 2006

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INTRODUCTION

SAFEMEAT, in consultation with partner organisations, recently updated its gene technology policy (May 2005). In doing this, there was a recognition that the industry needed to develop a policy on the broader aspect of biotechnology, which would not only encompass gene technology, but would look more closely at other emerging, and potentially more controversial technologies, such as cloning. An information and discussion day, on various aspects of the topic was held in December 2005 to act as a starting point for the development of such a policy.

SAFEMEAT is a partnership between the Australian Government and the red meat industry (see Attachment 1 for structure and membership). It was established to ensure that red meat products achieve the highest standards of safety and hygiene from farm to consumer and to provide strategic direction and policy advice to the red meat industry.

In relation to biotechnology, most public attention is given to commercially available genetically modified (GM) crops, their use as animal feed, and research into GM animals and cloning, however much of the research effort in Australia and globally is directed into less well-known biotechnology applications such as genomics and molecular markers. These applications are already part of the animal breeders' toolbox complimenting traditional breeding programs. They do not result in GM or cloned animals, and are unlikely to challenge consumers and key export market expectations.

The red meat industry's considerable investment in biotechnology applications for the industry through Meat & Livestock Australia (MLA), means that it is a key player in addressing such issues and providing a leadership role in ensuring an informed and educated industry and marketplace.

Annually, the gross value of Australian cattle and calf production (including live cattle exports) is approximately $7.7 billion; the gross value of sheep, lamb and live sheep is estimated at $1.86 billion; and, goat meat and live goat exports are valued at $75.2 million. Australia is the second largest beef exporter globally behind Brazil, the second largest lamb and mutton exporter behind New Zealand and the leading goat meat exporter.

To maintain this competitive position in the market, the red meat industry is investing in technologies of the future, which includes biotechnology. Awareness of such applications and the significant research and investment in biotechnology in the livestock arena is vital for the red meat industry in Australia to take a proactive role in establishing dialogue and best-practice approaches to deliver technologies to the market.

This approach by the red meat industry is reflected in the biotechnology recommendations made by the Agriculture and Food Policy Reference Group commissioned by the Federal Minister for Agriculture, Fisheries and Forestry. These recommendations can be summarised as increased communication efforts about the benefits of biotechnology applications and the robustness of the regulatory regime; industry and government working together to facilitate faster uptake of biotechnology applications; and, State governments lifting their moratoriums.

This policy document is also timely as Australia has recently been appointed 'lead' country for discussions regarding the safety of food from GM animals at a Codex Taskforce on Foods Derived from Biotechnology meeting. A decision from the USA regarding the regulation and safety of food derived from cloned animals is also expected.

POLICY SUMMARY

MLA/SAFEMEAT SUPPORTS THE FOLLOWING POLICY PRINCIPLES:

THE SCIENCE AND ITS TERMINOLOGY

1. **Biotechnology is broad-ranging.** The Australian red meat industry (the industry) agrees to act to raise awareness of, and gather support for, the broad aspects of biotechnology, including outcomes already in the marketplace and those more likely to enter the marketplace in the future.

2. **Recognise potential benefits.** The industry recognises significant potential benefits from the use of some forms of biotechnology along the entire supply chain, and the need for its development and application in an integrated systems approach. This will require investment in R&D, commercialisation of intellectual property, and the development of strategic research and commercial relationships.

3. **Recognise potential risks.** The industry recognises that applications of biotechnology in livestock and red meat production may also pose some risks that need to be thoroughly researched and understood from the perspective of consumers, the environment and participants in the industry supply chain.

4. **Use consistent language.** As part of a greater industry and consumer education and communication initiative, the red meat industry agrees to use consistent language and definitions relating to the science involved in biotechnology in discussions with stakeholders and the general public.

REGULATION

5. **Safety and environmental obligations -** The industry recognises its obligations with biotechnology to provide products that meet appropriate animal safety, food safety and quality requirements, and have community acceptance in terms of sound and environmentally appropriate production and processing practices.

6. **Transparent, science-based regulation.** The industry agrees that a clear and transparent regulatory system is required for the confidence of all stakeholders, and supports *the Gene Technology Act 2000* and the Office of Gene Technology Regulator and other regulatory instruments governing the use of facets of biotechnology. Further, as a matter of urgency, the industry agrees to work with Government to address the issue of regulatory requirements for cloning, to ensure the industry is positioned to capture the benefits and address the risks before the technology becomes a major tool for the red meat sector.

7. **Access to approved products.** The industry supports investment in biotechnology research and access to regulatory approved products without unnecessary impediments, including unreasonable compliance costs.

8. **International standards.** The industry will collaborate with other countries and international standard setting bodies regarding biotechnology to ensure robust safeguards and transparency of decision-making which does not create artificial barriers or disincentives to innovation or trade.

MARKETS

9. **Ethical and social considerations**. The industry recognises the need to be aware of the ethical and social issues surrounding the use of biotechnology, and the animal welfare and health considerations, particularly in the development of GM and cloned animals.

10. **Supply chain choice.** The industry recognises that producers, processors and retailers have choice in the application, or otherwise, of biotechnology and encourages the

investigation of options to support this choice. However, the industry also recognises that if biotechnology adoption continues this choice may be reduced, particularly in relation to animal health and animal feed options.

11. **Market intelligence**. The industry recognises the potential diversity in technology and market positions that may arise, and the need for the industry to reasonably cater for such diversity and associated outcomes where feasible. The industry supports the proactive monitoring and regular gathering of market intelligence and public perception data – both nationally and internationally – which impact the elements of this policy.

12. **Changing commercial environment.** The industry recognises that community and market expectations are undergoing change and that a high level of uncertainty currently exists in relation to commercial returns on investment in research and development in this area, and that such investments should be subject to rigorous technical and commercial evaluation prior to approval. Further, the industry agrees to maintain sound knowledge about the research effort underway globally in order to maintain a competitive approach in the development of these key technologies.

AN INFORMED INDUSTRY

13. **Proactive communication/education.** The industry recognises the need to proactively inform and educate stakeholders about biotechnology and to develop an industry communication strategy, to ensure a rational and informed debate.

THE SCIENCE AND ITS TERMINOLOGY

Within the red meat industry, there is a lack of understanding of biotechnology. This information gap needs to be addressed by the industry so that sensible investment decisions can continue to be made and research and development (R&D) opportunities recognised and implemented to deliver new and innovative technologies to Australian producers. Ensuring a clear path-to-market is a key part of the process and is vital if Australia is to remain a globally competitive force in the red meat arena.

CSIRO defines biotechnology as “the use of biological systems — living things — to make or change products”. Biotechnology has been used for centuries in traditional activities like baking bread, making cheese and brewing beer. Traditional animal and plant breeding techniques involving ‘crossing’ individual animals or plants and selecting those from the new generation with the desired characteristics from both parents for breeding are also early techniques of biotechnology. These processes saw wild plants and animals become domesticated and shaped into the species that exist in agriculture today. Modern biotechnology applications as outlined below take these earlier selection processes further and although they are applied to both animal and plant research programs globally, the animal applications are the main focus here.

The US-based National Research Council defines animal biotechnology as “the application of scientific and engineering principles to the processing or production of materials by animals or aquatic species to provide goods and services.”

Animal biotechnology research and development globally largely focuses on:

- Genomics and marker-assisted selection
- Livestock disease diagnosis
- GM veterinary pharmaceuticals
- GM pastures and feedstuffs
- GM animals
- Cloned animals

Biotechnology tools being used in livestock research programs in Australia can be broken into three components:

1. General applications not resulting in a GM end-product
2. Gene technology – resulting in the development of a GM product
3. Cloning

GENERAL APPLICATIONS

- Genomics

All the genes in an individual or species are known as the genome. The study of large numbers of genes simultaneously is called genomics. Genomics is the key to a greater understanding of gene function that can lead to further large-scale improvements in the performance of animals. While animals have been improved using conventional means, a large number of characteristics cannot be improved via conventional means either because the methods are too expensive or slow, or selection occurs in the wrong sex, or the animal has to be killed to obtain the measurement. The main focus of genomics in livestock is to study genes in order to understand and/or predict their relationship to the resulting physical body of the animal, with a focus on traits which cannot be improved as effectively by conventional methods.

Genes act in regulated networks, and their regulation can be affected by events elsewhere in the body and outside the body, including diet and stress. Animals have between 20,000-25,000 genes, which is why genomic approaches are needed to:

- find the function of relevant genes;
- better understand the complex interactions between genes and the environment;

- relate gene activity to animal performance; and,
- identify new features of an animal because the number of interactions between so many genes is exceedingly complex.

One of the primary tools in the genomic analysis of a species is the production of the genome sequence of the animal. A genome sequence is the DNA sequence of the entire genetic material of the animal, but due to current limitations in technology, not even the human genome sequence is fully complete. However, even a genome sequence that is in the draft phase will allow the identification and the ability to study all genes using the methods of genomics. A genome sequence is an important tool for studying the genome.

In livestock, the key focus is identifying genes involved in resistance to parasites or diseases and those responsible for features such as growth rate, muscle size or fat composition. Animals with these desired features can then be used in breeding programs.

A genome sequence is being undertaken globally on numerous species, including people, and the status of some of this research has been included below.

- Completed (within technology limits) - human, mouse, red jungle fowl.
- High-level draft - cow, dog, chimpanzee.
- Significant draft - pig, cat.
- Others underway - wallaby, rabbit, bee, frog, fruit fly, zebrafish.
- Significant mapping information and sequence is available for the sheep.

The National Institutes of Health (NIH) has applied a threshold of 6X Draft Genome Sequence for animals for which it will provide funds for genomic studies, which includes the mammals – humans, mice, rats, dogs and cows. A 6X Draft Genome Sequence means that the location of every base, or DNA letter, in a particular genome is determined an average of six times, ensuring a relatively high degree of accuracy.

With the gene sequences for several organisms now known, it is possible to prepare whole arrays of genes, groups of genes or pieces of genes by a variety of technologies. Such collections of genes are being used as a way of finding out which genes are doing what at each particular moment of time.

- Molecular markers (marker assisted selection)

Marked assisted selection allows genes with significant effects to be targeted specifically for selection in breeding programs. Some characteristics are controlled by a single gene, but most of those of economic importance are quantitative traits that are likely controlled by a larger number of genes. These genes, usually called quantitative trait loci (QTL) are not uniform in their size of effects, some are too small to be individually of commercial importance, while others are so large they can cause the phenotype to be classified into two or more classes. These latter sort are also referred to as major genes, and examples are double muscling in cattle and callipyge in sheep – an abnormal increase in muscular tissue caused entirely by enlargement of existing cells.

Genetic markers allow faster genetic progress in livestock breeding programs. Prior to the use of markers, the performance of animals and their relatives was the only way of measuring the genetic potential of their genes. Characteristics such as those listed below may benefit from marker-assisted selection:

- Simply inherited characteristics (coat colour, genetic defects)
- Carcass quality and palatability attributes
- Fertility and reproductive efficiency
- Carcass quantity and yield
- Milk production and maternal ability
- Growth performance

- Functional genomics
Functional genomics is the study of gene function and is often considered to be synonymous with studies of gene expression. Gene expression refers to the process by which the coded information of a gene is transcripted into RNA, and many genes are translated from RNA into protein.

- Proteomics
Genes work by expression into the myriad of proteins that make up the structure and function of an organism. Proteomics is the study of genes through studying the activities, interactions and quantities of many proteins simultaneously in the tissues of a plant or animal.

One approach to proteomics is to analyse all the proteins being produced at various times and see how they vary. That way, it is possible to find out which proteins are basic 'house-keeping' ones, and which are produced as part of a developmental stage or in response to a particular situation, such as infection. Protein analysis can be compared to genetic activity in related cells to determine which proteins might be produced by particular genetic sequences.

This science depends on separation, isolation and characterisation of large numbers of proteins. The main factor limiting growth of this area is the lack of generic methods to study proteins in large numbers at the same time.

- Metabolomics
Metabolomics is the study of all the small molecules produced in the animal body. While the proteome can be studied by looking at the proteins that are active in a cell, the action of those proteins in total can only be studied indirectly by looking at proteins. To be able to study protein action directly, the fluctuations of all of the small molecules that are produced by proteins (metabolites), must be able to be tracked. Genetic differences between genes that influence proteins either directly by protein sequence or indirectly through regulation of the amount of protein can be tracked in this way.

Quantification of these outcomes and their relationship to the proteins made and the genes expressed is the challenge for bioinformatics.

- Bioinformatics
Bioinformatics is the use of computers and information technology to analyse biological information. Given the complexity of genetic systems bioinformatics is an increasingly important tool in biotechnology. It is important in the study of DNA sequences of the genome, including the assembly of the DNA sequence, the identification of unknown genes directly from sequence information, the prediction of gene function for unknown genes, and the prediction of gene networks.

- Phenomics
The phenotype is the sum of the observable characteristics of an individual. The expression of these characteristics results from the interaction of genetic and environmental factors. Phenomics is the study of the range of variation in measurable traits, or phenotypes, within a species.

- Nanotechnology
Because atoms and small molecules are nano-sized in diameter, nanotechnology is often defined as the building of materials and machines from atoms. This technology is most developed in cosmetic and coating industries.

GENE TECHNOLOGY

The use of gene technology to produce genetically modified organisms (GMOs) is currently one of the most controversial applications of biotechnology. Gene technology is also referred to as genetic engineering and genetic modification.

Using gene technology, scientists aim to introduce, enhance or delete particular genes of a living thing, thereby permanently changing its characteristics.

Genes are made of DNA. They contain coded instructions for proteins, which give living things their particular characteristics like hair and eye colour. Most living organisms use DNA as the genetic code. Gene technology or genetic modification allows researchers to insert a copy of a gene from organism into the DNA of another organism, including from one species to another. The resulting organism is genetically modified or transgenic.

Gene technology is defined by the Australian *Gene Technology Act 2000* as "any technique for the modification of genes or other genetic material, but does not include sexual reproduction, homologous recombination or any other techniques specified in the Regulations."

In relation to agricultural biotechnology, GM crops have been commercialised which are used in feed rations; and GM vaccines have been developed, however, GM livestock remains in the development phase. Like other applications of biotechnology, the reasons for investigating gene technology in livestock include increasing growth rates, lean muscle mass and disease resistance and lessening their environmental impact. Human pharmaceutical research involving livestock species is also occurring.

Gene silencing refers to the processes that allow researchers to switch off the activity of a targeted gene, so that it is possible to determine the impact of the loss of the particular gene on the phenotype.

Proteins derived from ribonucleic acid (RNA) make up the structures and perform the functions of living things. Most messenger RNA (mRNA) acts as an intermediate stage between the gene and its proteins. Gene silencing works to degrade the RNA instructions of a specific gene and it is composed of several technologies.

Gene silencing is a tool that:

- Might allow the function of many genes to be investigated
- Could silence some genes throughout an organism or in specific tissues
- Like genetic manipulation it offers the versatility of partially silencing or completely turning off particular genes
- May selectively silence genes at particular stages of an organism's life cycle.

Gene silencing may help researchers find out what specific genes do, produce new pharmaceuticals and develop disease resistant plants and animals. CSIRO holds some important intellectual property in this area and is leading the development of the use of gene silencing in livestock.

CLONING

Cloning is the production of genetically exact duplicates (clones) of an organism by means other than sexual reproduction.

Cloning naturally occurs in plants, however in animals and people it is rarer and only occurs at the embryo stage. Identical twins are natural clones. While clones can be readily produced in some organisms, especially in some plants where even a small cutting will give an identical plant, cloning in mammals is more difficult. A less controversial cloning technique called embryo splitting in mammalian species resembles the natural process that results in twins (twinning), which occurs when a fertilised egg splits during development and forms two embryos instead of one. This feature of the egg has been used by researchers to split embryos artificially and implant the resulting clones into recipient females.

To clone an adult mammal is far more difficult, and requires that the nuclear DNA from a donor cell be reset to the embryonic state, that a recipient egg be found and its nuclear DNA removed and be replaced by that from the recipient cell. This was achieved only in 1996 with the production of "Dolly" the lamb in Scotland, who was cloned from a cell of an adult sheep. The cloning technique used to create Dolly is called somatic cell cloning. The donor DNA can be deliberately modified during the process of cloning and the resulting offspring can be genetically modified as well as cloned.

Individuals of all the major livestock species have been cloned, but animal cloning technology is still considered to be in the early stages of development.

There are four main drivers of cloning technology development.

1. Improving productivity – farmer and economy
2. Improving the product – consumer
3. Improving human health
4. Research into basic cell biology – what makes cells tick?

Of most relevance to the red meat industry initially is the potential for productivity improvements. Cloning is seen as one of the potential next steps in addressing biological limitations in animal reproduction moving from artificial insemination (AI) technologies which have been around since the 1940s, embryo transfer used since the 1970s and in vitro fertilisation used since the 1990s. The genetic gains achieved by cloning in cattle could see a 30 per cent genetic gain in 10 years compared to a 30 per cent genetic gain in 30 years with artificial insemination. This is more likely to be taken up in dairy cattle due to the relative simplicity of the production environment and outputs. The red meat industry, however, does not have a single market endpoint, but rather a fluctuating set of different market endpoints which require many different kinds of animals to fulfil these adequately. It is therefore difficult to envisage large-scale use of cloned animals in this sort of environment.

There are issues associated with livestock cloning related to its potential impact on animal population genetic diversity. The United Nation's Food and Agriculture Organisation (FAO) is currently undertaking projects in this area.

Potential uses of livestock cloning include:

- Multiplying animals which are outstanding performers in a particular environment – dairy cows, beef and dairy bulls.
- Allowing breeders to take a small number of animals with superior genetics and rapidly produce more - it can take up to 13 years to get the improved bloodlines for a particular wool type from the parent stud down to the flock level.
- Duplicating valuable animals nearing the end of their lives so that their genetic value can still be accessed.
- Using cloned bulls to disseminate genetics in remote and vast locations where other reproductive technologies such as artificial insemination are impractical.

Since the arrival of Dolly in 1996, hundreds of apparently healthy and fertile clones have been born as a result of somatic cell nuclear cloning. However the overall efficiency rate of the technology remains low, with less than one per cent developing into live, healthy offspring. Problems hampering the technology include:

- Decreased implantation rates
- Higher rates of miscarriage following implantation
- Placental abnormalities
- Large offspring syndrome
- Increased peri-natal morbidity and mortality

Research involving genetically modified animal clones (usually pigs) is underway for xenotransplantation purposes. Xenotransplantation is defined by the National Health and Medical

Research Council (NHMRC) as transplantation from one species to another; for example, from a pig to a human. The term covers transplantation of organs, tissues or clusters of specialised cells. Xenotransplantation requires genetic modification to incorporate human genes into donor animals that will cause transplanted tissue to be recognised as human thus eliminating the usual adverse tissue reactions.

Because of the biological and technical problems associated with cloning, interest and investment in cloning has waned in Australia.

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COMMERCIAL OUTCOMES

A variety of agricultural biotechnology-derived products have been commercialised globally, with plant-focused outcomes much more advanced. Those targeting the animal industries largely relate to animal health and improving the genetic potential of animals, and whilst GM livestock is not available commercially, gene technology applied to plants has resulted in commercial GM varieties of four major feed crops being grown globally. This is important to consider as they are widely used as feed. The market for commercially-available clones is largely dominated by the USA, where the technology is most advanced. Commercial clones are limited to elite breeding stock, and a voluntary moratorium exists on the use of clones, their progeny or products (such as milk and meat) in the food chain.

Specific biotechnology products developed and commercialised in Australia include:

- A multi-gene DNA test for beef marbling has already been delivered to the beef industry. The test allows breeders to identify animals with a high genetic potential for the marbling trait which is in high demand by Australia’s Japanese customers.

- A DNA test used to ensure complete traceability of meat through the production chain is available. It consists of simple, low-cost sample collection using a patented process, a secure archiving and storage system, and 'state of the art' DNA analysis.

- A GM vaccine against cattle tick was released in Australia during 1994. This was the first vaccine to be used commercially against ticks anywhere in the world. At the time this vaccine was commercialised ticks were causing productivity losses of more than $100 million annually in Australia. The vaccine worked by reducing the survival rate of ticks by damaging their ability to reproduce, however, because the vaccine required regular booster shots, not practical in many remote parts of Australia, it is no longer available.

Globally, there is a growing number of commercially-available biotechnology applications. To put this into perspective, according to the US Department of Agriculture, there are 105 licensed biotechnology products for animals in the USA. These include veterinary vaccines, biologics and diagnostic kits. The animal health industry invests more than US$400 million annually in research and development, and current sales of biotechnology-based products for use in animal health generate US$2.8 billion. Examples of specific products include:

- More than 10 commercial gene markers for pork industries globally have been commercialised by the Pig Improvement Company (PIC). The markers target coat colour, selection against the halothane gene (associated with Porcine Stress Syndrome), and selection against the RN mutation which affects meat quality amongst other things.

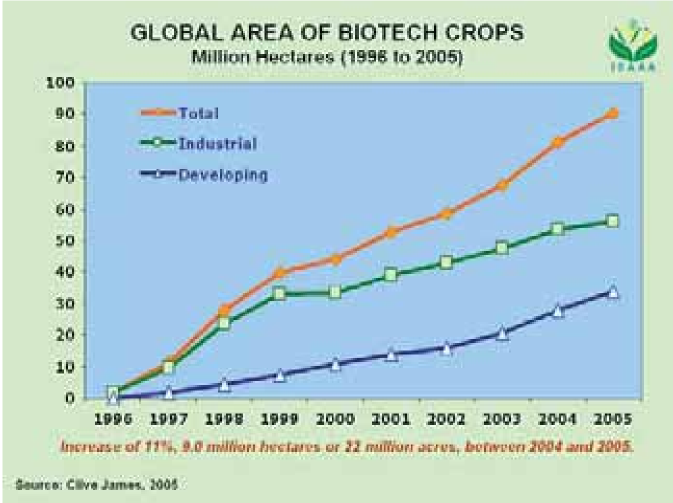
- The world’s first GM vaccine developed to combat shipping fever, a complex form of pneumonia in cattle by Canadian company, the Vaccine and Infectious Diseases Organisation (VIDO).

- Metabolic modifiers, a group of compounds that modify animal metabolism in specific and directed ways, have been developed using gene technology. The first modern biotechnology product to be commercially approved for animal agriculture in the USA was bovine somatotropin (bST) for use in the dairy industry in 1994. bST was developed to achieve increased milk yield, production efficiency and decreased waste, and is now administered to more more than half of the USA dairy herd and in more than 19 countries (excluding Australia).

GENE TECHNOLOGY

- Plants

In 2005, GM crops were grown by 8.5 million farmers across 21 countries on 90 million hectares. This area was largely comprised of varieties of soybean (60 per cent of global area), corn (24 per cent), cotton (11 per cent) and canola (five per cent) – all major animal feed sources. Genetically modified papaya, rice and lucerne were also grown on a small-scale.



Countries dominating GM variety plantings were the USA, Argentina, Brazil, Canada and China. Australia ranked tenth for its use of GM cotton varieties across approximately 200,000 hectares. The use of insect-resistant varieties in Australia has seen pesticide applications reduced by up to 75 per cent since 1996. Of particular interest to the red meat industry because of residue issues, endosulfan use has been reduced by 90 per cent across GM cotton-growing areas. Australia also grows commercial quantities of carnations modified to exhibit various shades of mauve, lilac and purple. Two GM varieties of canola were approved as safe for human health and the environment by the federal regulator in 2003. However, state government bans prevent commercial cultivation of the canolas. The bans are based on market access concerns.

Other countries growing commercial GM crops include Paraguay, India, South Africa, Uruguay, Mexico, Romania, Philippines, Spain, Colombia, Iran, Honduras, Portugal Germany, France and the Czech Republic.

- Animals

The first GM animal to be sold to the public reached the market in 2004. GloFish are GM ornamental fish which contain a gene from a sea anenome, and under black light, they glow a brilliant red colour.

There are no commercially available GM livestock, with the closest product to the market place considered to be a salmon modified to grow faster than conventional salmon. The salmon research is negotiating the regulatory system in the USA. It is proving difficult for GM animals to travel this path because the Food and Drug Administration (FDA) has not issued any formal policy statements, guidelines, or regulations specific to GM animals. Most GM animals are treated as “new animal drugs” for regulatory purposes in the USA.

No GM animals have been approved to enter the human food chain, however, a few individual GM animals have been rendered and allowed to be used as animal feed in the USA.

CLONING

Sheep, cattle, goats, pigs, mice, rabbits, horses, rats, cats, mules and dogs have all been cloned, although only a few are available commercially. Some cloned animals are sold commercially in the USA, however a voluntary ban is in place regarding the use of food products derived from these clones or their offspring in the foodchain until regulatory approval is granted.

According to a workshop held in 2002, commercial beef producers are not buying clones. The principal customers for such animals are seedstock producers who select, breed and develop superior livestock to sell their semen and offspring. Specialty cattle producers working with rare breeds represent 10 per cent of the clone market in the US. It was estimated that commercial beef producers may not buy clones for another 15 years, when the price may have reached a more competitive US$1,200. Cloning is big business in the US, where the cattle industry was valued at US$50 billion in 2002, and the estimated potential value of cloning in the future is US$20 billion annually.

REGULATION IN AUSTRALIA

Much of the biotechnology research in Australia is conducted under existing research guidelines and legislation, however specialist legislation is in place for all gene technology research. Further, all animal research must be conducted in adherence to established animal welfare and ethics guidelines.

Gene technology research is subject to higher levels of scrutiny and is regulated by specific legislation targeting human health and environmental safety risks. The Australian approach in this area is considered to be world-leading, and is being used as a model by other countries, particularly in Asia, as they develop gene technology regulatory systems.

Human cloning is banned in Australia. Animal cloning is not subject to specific animal cloning legislation, however this is currently the subject of government discussion.

GENE TECHNOLOGY

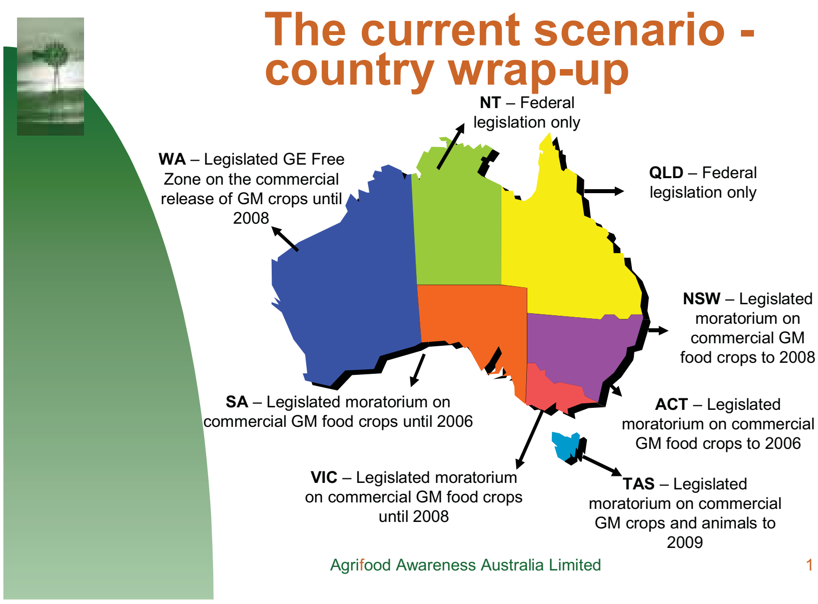
The Office of the Gene Technology Regulator (OGTR) is responsible for regulating gene technology. It was established when the *Gene Technology Act 2000* came into force in 2001. The Act establishes a national scheme for the regulation of genetically modified organisms (GMOs) in Australia, in order to protect the health and safety of Australians and the Australian environment by identifying risks posed by or as a result of gene technology, and to manage those risks by regulating certain dealings with GMOs.

The *Gene Technology Act* covers:

- Risks to human health and the environment
- Live and viable GMOs
- Research, manufacture, production, breeding, import

The *Gene Technology Act* does not cover:

- Cost/benefit considerations
- Comparisons with alternative technologies
- Marketing and marketability
- Intellectual property
- Human beings and cloning



The market or trade impacts of GM products are the responsibility of State and Territory Governments, and all, apart from the Northern Territory and Queensland, have implemented GM legislation specific to market/trade issues which has effectively banned commercial approvals of GM food products. Each State's approach is unique – on timing, product and process, and most of these bans have occurred as a result of the OGTR's commercial approval for GM canola in 2003.

The bans all relate to GM food crops, or specifically GM canola except in Tasmania. Under the Tasmanian moratorium, GM animals and GM animal feed are specifically mentioned, with the Tasmanian Government stating in 2001, “GM animals and livestock reared on GM feed pose risks to the Tasmanian market image…The Tasmanian Government recommends that producers refrain from the use of imported animal feed that contains transgenic material…Accordingly, GM animals and GM livestock feed will not be permitted in Tasmania outside of research and physical containment facilities”.

Food Standards Australia New Zealand (FSANZ), the food regulator, is also involved in the regulatory oversight of GM products – those destined for the food chain. FSANZ is responsible for ensuring the safety of all foods sold in Australia and New Zealand, and in this role the organisation develops standards for food manufacturing and labelling, provides information to consumers, coordinates national food issues such as food recalls, and undertakes scientific assessments on both domestic and imported foods. In the context of GM foods, FSANZ is responsible for carrying out safety assessments of GM foods on behalf of the governments of Australia and New Zealand to ensure they are safe for consumption. All GM foods must undergo assessment before they can be sold in Australia and New Zealand.

There are six GM commodities approved for the food supply in Australia and New Zealand. They are varieties of soybean, corn, cotton, canola, potato, and sugar beet. Only GM cotton is produced in Australia, and the amount of GM potatoes and sugar beet being produced globally is negligible.

To allow consumers to identify foods with GM ingredients, a mandatory labelling regime for GM foods where introduced DNA or protein is present in the final food came into effect in 2001. Food or ingredients labelled “genetically modified” either contain new genetic material or protein as a result of genetic modification or they have altered characteristics – for example changed nutritive values - compared to the conventional food. The labelling on or attached to a package of GM food must include the statement ‘genetically modified’ in conjunction with the name of that food, ingredient or processing aid.

Australia’s labelling regime focuses on the end product, rather than the way in which the product was made. For example, products from animals fed GM feed are not required to be labelled as GM, because the products – meat, eggs or milk – are the same as those from animals fed conventional feed rations. The products do not contain any genetic material from the feed they have consumed.

CLONING

Cloning (somatic cell nuclear transfer) is not included within the definition of ‘gene technology’ as defined in the *GT Act*. This is because somatic cell nuclear transfer does not involve the modification of genes or other genetic material. It involves the replication or duplication of genetic material. If research involves cloning and genetic modification then it is regulated under the gene technology legislation.

Both GM and cloned animals are subject to State and Territory government welfare legislation applicable to animals used for scientific purposes. However, in Australia, animal cloning is not covered by any existing regulatory requirement, nor is food from cloned animals or their progeny captured by the Food Standards Code. This means that current arrangements do not prohibit the use of non-GM cloned animals for food, however, at this stage industry is observing a voluntary moratoria on bringing such products to market.

Foods from cloned animals may be closer to the market than those from GM animals as regulatory agencies in the USA are currently assessing the safety of such foods. Upon completion of this process, the USA is likely to be the first country to approve such foods as safe and able to be traded commercially. A draft risk assessment released in 2003 by the Food and Drug Administration (US FDA), found, “food products derived from animal clones and their offspring are likely to be as safe to eat as food from their non-clone counterparts, based on all the evidence available."

The safety assessment of foods from GM and cloned animals is an issue for which FSANZ is responsible. FSANZ believes that a whole of government position on the issue of food derived from cloned animals and their progeny is warranted and they have referred this matter to other Australian Government agencies to develop policy guidance in this area. Subsequently a committee has been formed to investigate the issue.

According to a scientific review commissioned by FSANZ in 2003, "there is no known scientific reason to expect that the production traits of livestock clones (and any offspring), will differ in any major way from the parent, and allowing for any differences in husbandry, to expect that any food or other products derived from the clone would differ in nutritional value and other food qualities..."

POLICY PRINCIPLES:

5. **Safety and environmental obligations -** The industry recognises its obligations with biotechnology to provide products that meet appropriate animal safety, food safety and quality requirements, and have community acceptance in terms of sound and environmentally appropriate production and processing practices.

6. **Transparent, science-based regulation.** The industry agrees that a clear and transparent regulatory system is required for the confidence of all stakeholders, and supports *the Gene Technology Act 2000* and the Office of Gene Technology Regulator and other regulatory instruments governing the use of facets of biotechnology. Further, as a matter of urgency, the industry agrees to work with Government to address the issue of regulatory requirements for cloning, to ensure the industry is positioned to capture the benefits and address the risks before the technology becomes a major tool for the red meat sector.

7. **Access to approved products.** The industry supports investment in biotechnology research and access to regulatory approved products without unnecessary impediments, including unreasonable compliance costs.

8. **International standards.** The industry will collaborate with other countries regarding biotechnology to ensure robust safeguards and transparency of decision-making which does not create unsupportable barriers or disincentives to innovation or trade.

RESEARCH IN AUSTRALIA

The application of biotechnology within livestock in Australia is heavily focused on identifying genetic markers, with several already commercialised, to discover economically important characteristics in sheep, for example wool production and quality and parasite resistance and the markers associated with tenderness, yield, and marbling of the meat in seven different cattle breeds.

Australia's genetic research in livestock is dominated by CSIRO, state government agencies and universities. Cooperative Research Centres involving beef, sheep, poultry and dairy are also major players in this technology area (see Attachment 2). Most activity centres on QTL identification and gene expression analysis.

CSIRO's investment in biotechnology extends across research portfolios involving plants, aquaculture, livestock, preventative health, food and forestry. Plant biotechnology research is the most advanced with not only the use of genomics, molecular markers, proteomics and the various other tools all utilised within broadacre and horticulture crops, but the commercially development of GM cotton varieties lead by CSIRO, and field trials of GM lupins, field peas, rice, grapevine and potato varieties all undertaken by the agency.

In relation to livestock, the focus is improvements in meat characteristics such as marbling and tenderness, reduced reliance on chemicals in ruminants, disease prevention and emergency diagnostics and improving the welfare or animals (see Attachment 3).

CSIRO holds the key intellectual property and is leading the development of the use of gene silencing (RNAi) in livestock. CSIRO is a major player in the bovine genome mapping project, and CSIRO's Genes for Product Quality research aims to identify and utilise genes gene networks and biochemical pathways that are important to product quality characteristics in livestock.

The main tools used by CSIRO in biotechnology projects involving livestock are:

- Genome sequencing - DNA banks, databases, DNA variation
- Gene expression profiles - clones, microarrays, tissue samples
- Gene regulation, proteomics and protein-protein interaction
- Phenomics - mutant phenotypes, specific cell lines, somatic perturbations, disease states
- Bioinformatics and computational biology

Meat & Livestock Australia funds a significant amount of the biotechnology research underway within a number of organisations (see Attachment 4). The research portfolio includes sheep, beef and plant genomics, vaccine development, and GM pastures. Previous research has resulted in genetic tests to identify carriers of recessive traits in Australian beef cattle such as Pompe's disease and Maple Syrup Urine Disease.

GENE TECHNOLOGY

- Plants

The deployment of gene technology in crops of importance for animal feed purposes is also occurring. Australia grows commercial quantities of GM cotton and carnations, and two herbicide tolerant canola varieties have commercial approval from the Federal regulators, but are banned at the state government level because of perceived market issues. Products in the regulatory pipeline undergoing field trials or having undergone field trials in the past include Indian mustard, cottons, rice, wheat, sugarcane, white clover, lupin, grapevine, carnation, pineapple, papaya and poppy.

Research particularly targeting crops used as animal feed in Australia includes:

- Nematode resistance in pastures
- Virus-resistant pastures
- Phytate as a source of phosphorous for sub clover
- Lupins for increased animal nutrition

- Perennial ryegrass, hybrid ryegrass and tall fescue with enhanced herbage quality and reduced pollen production

- Animals
A small number of GM animals have been developed in research programs in Australia. The example of most relevance to the red meat sector involves GM sheep research. In 2002, CSIRO research involving GM sheep concluded that although the sheep grew bigger and faster, produced double the milk, and grew more wool, they required more care.

The sheep contained an extra copy of a growth hormone gene which affected animal development characteristics such as growth rate and fatness. The extra growth hormone caused the sheep's hooves to overgrow and therefore require extra clipping. They were also leaner, more susceptible to diabetes and exhibited a lower tolerance for parasites than the control sheep.

The research, involving approximately 100 sheep, concluded that there was currently little commercial benefit in GM sheep. The project has since concluded. No other projects involving GM livestock are currently underway in Australia.

CLONING

At the height of its cloning research efforts, Australia ranked in the world's top ten countries for research into cloning technologies for animal industries, with cattle, sheep and pig clones all produced in the laboratory setting. Since this time however research efforts have has waned. In its prime, the number of clones planned for production by six research organisations, for the year 2003 numbered approximately 80 in Australia and New Zealand.

Criteria used to select animals for cloning by the Australian and New Zealand research teams included:

- Production traits – meat, milk, wool
- Scientific purposes
- For use in conjunction with gene technology – meat, milk, medical
- Rare and endangered breed regeneration

In the past few years, the Dairy Cooperative Research Centre (CRC), CSIRO, SARDI and BresaGen have concluded their cloning research. Reasons for this include a lack of demand, technical issues, technology costs and consumer perceptions. The technical expertise is available for research and development purposes should such hurdles be overcome in the future. A small demand for cloning technologies does exist for breeding stock, particularly in the dairy industry, and cells are being collected and stored for future use from elite stock, however there is no intention to progress this further in the near future.

The dairy industry cloning experience

The Australian dairy industry funded research in cloning for over a decade through the Dairy Research and Development Corporation and then the Dairy CRC, in conjunction with Genetics Australia, Monash University and the Victorian Institute of Animal Science.

Highlights of the program included the first cloned cow in 2000, three dairy bulls in 2002, and four calves in 2002 that were both cloned and genetically modified with the inclusion of an extra cow casein gene, in an attempt to increase the protein levels in milk. The survival rate of these animals and others produced into adulthood was not high.

The research ceased in 2004 as it became apparent that the research was not going to deliver returns for the CRC and its stakeholders within the funding period. The CRC instead focuses on investigation of the early stages of embryo development, embryo diagnostics and bovine stem cells.

RESEARCH OVERSEAS

Biotechnology research in livestock globally largely centres round the field of livestock genomics which involves research and funding organisations from a number of countries (see Attachment 5). The research focus is largely map construction, QTL identification and gene expression analysis. Major investment is occurring within the cow, pig, chicken, sheep, goat, horse and aquaculture areas.

Once again, gene technology research is more advanced in plants, but there is some work occurring in animals that should be monitored, as should any international developments to overcome some of the barriers to the widespread use of cloning. There is a significant research effort underway in China, Europe and the USA in relation to cloning and GM animal production.

GENE TECHNOLOGY

- Plants

Biotechnology is being applied to the majority of field crops, vegetables and fruits globally by researchers in 63 countries (see Attachment 6). This includes the field crops lucerne, barley, canola, clover, cotton, maize, rice, sorghum, and wheat.

In the USA, approximately 80 per cent of the GM corn and 70 per cent of the GM soybeans produced are used for animal feed. Feed sourced from GM crops has not been found to pose a risk to the animals that eat it, or the humans that eat the products such as meat, milk and eggs derived from these animals. Further, the genetic material from feed is not found in these end-products. For these reasons, labelling of such products from animals fed feedstuffs with GM content is not required in any country around the world.

With 90 million hectares of GM crops grown globally in 2005, it is inevitable that GM crops will increasingly be used as livestock feed. While the commercially available GM crops have been modified to improve agronomic characteristics, there is considerable research taking place around the world to develop crops to improve animal production such as crops with improved:

- energy content, for example high oil maize.
- fatty acid profiles such as high-oleic soybeans.
- nutrient availability for example forage with improved fibre digestibility.
- animal health characteristics, such as edible vaccines against diseases.

- Animals

According to a review by Dr Robert Seamark commissioned in 2003 by FSANZ, GM research in red meat livestock globally, including in Australia, is/has focused on:

- **Cattle** - mastitis resistance, modified milk composition and reduced susceptibility of cattle to BSE.
- **Sheep** - GM sheep with increased growth rates, increased feed conversion efficiency, decreased carcass fatness, and increased lactation. In relation to wool, altered properties including lustre and strength, increased linear growth rate of the wool shaft, and potentially improved follicle growth capacity have been some targets. Reduced susceptibility to scapie and the *maedi-Visna* virus, which causes encephalitis, pneumonia and arthritis has also been investigated.
- **Goats** - the cure or prevention of mastitis has been investigated.

Three high profile examples of GM animal research overseas include:

- A **salmon** modified to grow four to six times faster than conventional salmon is in the regulatory pipeline in North America. It contains an additional salmon growth hormone gene, and an anti-freeze gene from an ocean pout fish which will allow it to produce growth hormone all year-round rather than just in the warm months like conventional salmon.
- Researchers at Canada's University of Guelph have developed the so-called **"Enviro-Pig"**, which is modified to produce an enzyme in its saliva which allows it to breakdown phytate,

the macromolecule that plants use to store phosphate. Enviro Pig excretes dramatically less phosphate, a major pollutant associated with high-intensity pig farming.

- A GM **pig** developed in Japan which contains a spinach gene to create a healthier fat profile, changing pig fat into the unsaturated fatty acid, linoleic acid. The amount of linoleic acid in the fat of GM pigs was found to be 20 per cent higher than in normal pigs.

There is also a considerable research effort underway globally involving GM animals (such as pigs, goats and rabbits) in the production of human health applications.

CLONING

As previously mentioned sheep, cattle, goats, pigs, mice, rabbits, horses, rats, cats, mules and dogs have all been cloned globally, although only a few are available commercially.

Some deterrents of the widespread commercialisation of use of clones include:

- The technical problems associated with the technology
- The cost of a cloned animal (estimated at US$19,000 for a dairy clone)
- The fact that clones are not approved anywhere around the world for use in the food chain.

Research in this area continues globally, with the USA considered the world leader in the area because of the amount of research it has underway. The success rates achieved by New Zealand researchers is also noteworthy.

CONSUMER PERCEPTIONS AND ETHICS

Consumer perceptions of biotechnology are shaped by a number of factors, including the availability of information, trust in regulatory processes, consultation, consumer choice about the use or not of a resulting product, and whether a product offers any benefit to the consumer. When it comes to the application of biotechnology to animals, ethical and animal welfare considerations also strongly shape consumer perceptions. Consumer perceptions in turn have the potential to impact positively or negatively on global markets.

It must be noted that a multi-million dollar global campaign is underway focusing directly on consumer information gaps by groups actively campaigning against biotechnology. Such groups are attempting to influence consumers and, therefore markets, by focusing on food safety and the use of GM ingredients in animal feed. The Australian poultry industry, because of its use of imported soymeal containing GM content has been heavily targeted by such campaigners.

Consumer perceptions of biotechnology have been measured to some degree over the past decade. Generally, the US is considered the most accepting of biotechnology applications, and Europe the least accepting, with Australia sitting somewhere in the middle. Findings from these countries are below.

CONSUMER PERCEPTIONS

- United States of America

The results of a nationwide survey of 1,000 people were released in November 2005 by the US-based Pew Initiative on Food and Biotechnology. The results include:

- Fifty per cent of respondents were opposed to GM foods, 56 per cent opposed GM animals and 66 per cent said they were uncomfortable with animal cloning. Across these different types of biotechnology, roughly one quarter of Americans offer consistent support.
- The majority of people polled (65 per cent) claim to have heard about animal cloning and 34 per cent are familiar with GM animals.
- Twenty-three per cent of those surveyed believe food produced from animal clones is safe, while 43 per cent believe it is unsafe.
- Although most Americans oppose genetically modifying or cloning animals, the most widely favoured uses are those that offer direct human benefits, including producing chickens resistant to avian flu (40 per cent "very good reason") or producing cattle resistant to mad cow disease (40 per cent "very good reason").
- Sixty-three per cent of Americans believe government agencies should include moral and ethical considerations when making regulatory decisions about cloning and genetically modifying animals, with 53 per cent feeling that way strongly. Twenty-seven percent believe that such decisions should be based only on scientific evaluation of risks and benefits.
- Among those who are uncomfortable with animal cloning, "religion and ethical concerns" are the most important reason for opposition for over one third (36 per cent), followed by concerns about safety (23 per cent).
- For those respondents who are comfortable with cloning, the top two reasons given were supporting scientific advancement (28 per cent) and lowering the price of food (21 per cent).

Another public opinion poll of 1000 US citizens undertaken in 2005, by the International Food Information Council found:

- Less than 0.5 per cent of respondents identify food biotechnology as a food safety concern.
- Sixty-two per cent of those surveyed expect food biotechnology to provide benefits for them and their families over the next five years.
- Thirty-two per cent of respondents regard animal biotechnology unfavourably, with 30 per cent undecided and 27 per cent seeing it as favourable.
- Once the reasons for applying biotechnology to animals was explained, 60 per cent felt that the application of biotechnology to improving the "quality and safety of food" would positively impact their impression of the technology. Respondents were also impressed with

the environmental benefits of animal biotechnology (52 per cent), but less so with potential farm efficiency benefits (37 per cent).
- Consumers are more favourably disposed to the concept of genomics (53 per cent) than genetic engineering (39 per cent) or cloning (15 per cent) in relation to livestock advancements.
- With regulatory assurances of safety of food produced using animal biotechnology, 53 per cent of those surveyed state they would be likely to purchase a food produced through genetic engineering, and 34 per cent are likely to purchase food produced through cloning.

- Australia
In relation to understanding domestic consumer responses to biotechnology, the fourth biennial Biotechnology Australia consumer perceptions tracking survey of 1067 respondents released in 2005 found:
- Forty-seven per cent of respondents perceive genetic engineering will improve our way of life in the future, while more than a quarter think it will make things worse.
- The majority (64 per cent) believed that it could be useful to use gene technology to modify plants used to produce food.
- Seventy-one per cent of respondents believed that it is risky to use gene technology to modify plants used to produce food.
- Almost half (48 per cent) said it was acceptable to use gene technology to modify plants used to produce food, and almost half (47 per cent) said it wasn't.
- Fifty-one per cent of respondents believed Australian farms and foods need to be free of GMOs to remain internationally competitive.
- People had the least confidence in food from GM animals, followed by meat from animals fed GM stock feed, food containing a GM ingredient, and GM fruit and vegetables.

During the 2005 survey, Biotechnology Australia also focused on the issue of cloning. Key findings include:
- When asked to rank five social issues in order of concern, cloning ranked last behind pollution of the environment, the greenhouse effect, nuclear waste, and GM foods.
- In relation to awareness and knowledge of cloning, 54 per cent of respondents felt they could explain cloning to a friend.
- Fifty-eight per cent of respondents believed that cloning is likely to make things worse, rather than have no impact or improve our way of life.
- When breaking down cloning to animal, human and plant components, cloning plants was considered to be useful by 67 per cent of respondents. Animal cloning was considered useful by 40 per cent of those surveyed, and only 18 per cent of respondents thought human cloning was useful.
- Cloning humans was considered risky by 90 per cent of people, and cloning animals by 67 per cent of respondents. Cloning plants was considered risky by 47 per cent of people.
- Plant cloning was considered acceptable (64 per cent), but human and animal cloning was not.

One the whole, people were more accepting of health and medical applications of biotechnology rather than agricultural and food applications. Agricultural applications were considered by many to be unnecessary. People were particularly uncomfortable about gene transfers across kingdoms.

- Europe
The 2005 Eurobarometer survey of 1,000 European Union citizens asked participants for their views on cloning animals when this is for research into human diseases. Responses were almost equally divided: 31 per cent condemn this practice, 22 per cent could accept it in exceptional circumstances and 35 per cent only if it is highly regulated and controlled. This series of questioning did not explore the use of cloning animals for food production.

In relation to livestock relevant questions regarding GMOs, the survey sought the approval level of respondents in relation to “growing meat from cell cultures so that we do not have to slaughter farm animals". Fifty-four per cent said they would never approve of this application, with 12 per cent approving in exceptional circumstances and 18 per cent responding they would approve if it was highly regulated and controlled.

ETHICS

One of the key drivers of consumer perceptions is ethics – people asking themselves "what one ought to do" in developing their response to something new. The ethical considerations surrounding this technology are an important component of the development process, particularly if consumers are to be reassured that the regulation of these technologies is meeting social and ethical expectations.

No commercially-available GM animals are likely to be available in the near future, which provides some time for ethical issues arising in this area to be aired and discussed. According to research undertaken at the North Carolina State University by Dr Thomas Hoban, ethical issues arise regarding animal biotechnology, because:

- people worry about animal pain and suffering
- people love their pets and care about wildlife
- there is a trend toward vegetarianism and animal rights (especially among young women)
- animals can move around once released into the environment
- once animals are modified, it could be a slippery slope to genetically modify people
- animal biotechnology sounds bad (the 'yuck' factor)

Adding further weight to Dr Hoban's conclusions, according to media reports, the European Commission is supporting the introduction of a labelling system for meat and dairy products whereby humanely treated animals could be stamped with and EU "welfare label". This follows results of a Eurobarometer survey mentioned already which found that 74 per cent believed they can improve animal welfare through their shopping choices, and 57 per cent are willing to pay more for animal welfare-friendly food products but want such food products to be easier to identify.

It must be noted that scientific research involving animals has been undertaken for many years, with significant outcomes for human health. All research involving animals in Australia is subject to approvals and guidelines imposed by Animal Ethics Committees and the National Health and Medical Research Council. The regulations in place have been refined and improved dramatically, particularly in relation to ethics and welfare, since such research began. Gene technology research involving animals must be considered in this context.

Australia's national gene technology regulatory system recognises the importance of the ethical dimension in dealing with genetic technologies, and it has a committee established to specifically provide advice on ethical issues.

Ethics and consumer concerns – the Australian approach

The approach in Australia by both governments and industry to address the complexity of consumer perceptions and ethics of biotechnology has been multi-faceted and has included:

- Coordinating a community consensus forum to open up the debate and allow decision-makers to understand the aspirations, ideas and fears of the general public around the issue of gene technology in the food chain.
- Establishing a scientifically rigorous, transparent and consultative regulatory framework in the areas of human health and environmental safety.
- Implementing a labelling system for food products sourced from GM crops or containing GM ingredients to allow consumer choice.
- Developing a coexistence framework to allow farmer choice in the production systems.
- Communicating as broadly as possible about the regulatory processes surrounding gene technology.
- Potential products in the pipeline, and developments and approaches used internationally.

- Ongoing monitoring of public perceptions to gauge consumer concerns, acceptance of, and misconceptions about, gene technology.

POLICY PRINCIPLES:

9. **Ethical and social considerations**. The industry recognises the need to be aware of the ethical and social issues surrounding the use of biotechnology, and the animal welfare and health considerations, particularly in the development of GM and cloned animals.

KEY AUSTRALIAN MARKETS

Given that cloning is not used in food production, and no GM animals have been commercialised, Australia's red meat industry needs to keep a watching brief on developments in these areas, particularly regulatory decisions coming out of the USA. More pressing however, is the industry's understanding of where Australia's red meat export markets and competitors stand in relation to the current commercial applications of biotechnology, particularly their current status in relation to the growth of GM crops, research into GM crops, and whether or not they use GM crops as a source of animal feed.

The use of animal feed within Australia is also important to understand as activist campaigns against gene technology in particular are pressuring animal industries to substitute any feedstuffs containing GM content. This is despite the fact that these GM crops have been approved as safe for human and animal consumption, and that the products derived from animals fed GM feed are identical to those from animals consuming conventional feed.

DOMESTIC RED MEAT CONSUMPTION – A SNAPSHOT

Domestic expenditure on beef is estimated at $6 billion, with the average Australian consuming 36.2 kilograms of beef per year. In relation to volume, beef is the second most popular fresh meat consumed after chicken.

The annual Australian intake of lamb (10.3 kilograms) and mutton (2.3 kilograms) is amongst the highest intake in the world. Domestic consumer expenditure on lamb is estimated to be approximately $1.7 billion and mutton $311 million.

THE DOMESTIC FEED INDUSTRY – A SNAPSHOT

The domestic market in Australia currently consumes more than half of Australia's east coast grain harvest, and by 2010 it will consume almost all of it according to Grain Growers Australia. This demand is being largely driven by the feed grain market which has risen from 5.5 to seven million tonnes in the past decade.

Industry	Usage	Crops
Dairy	2.5 million tonnes of feed (in addition to pasture)	Sorghum, barley, wheat, triticale, oats
Pig	1.7 million tonnes of grain and 120,000 tonnes of oilseed meals.	Sorghum, barley, wheat, oilseed meals.
Poultry	n/a	Sorghum, barley, wheat, triticale
Beef	More than 780,000 cattle in feedlots were on feedlot rations in June 2005.	Sorghum, barley, wheat, triticale

Imports of maize and soymeal from the USA have occurred during recent drought years. The USA does not segregate GM from non-GM crops, so this imported feed had GM content. Its use by the poultry industry has been a particular focus by those campaigning against the technology, and such a focus on other industries in the future is not unexpected.

BEEF INDUSTRY EXPORT MARKETS - A SNAPSHOT

Australia's key beef export markets 04-05	**%**	**Australia's key live cattle export markets 04-05**	**%**	**Top world beef exporters**
Japan	44.2	Indonesia	57.5	**Brazil**
USA	38.6	China	10	**Australia**
Korea	9.6	Israel	7.1	**Argentina**
Taiwan	2.7	Malaysia	6.1	**New Zealand**

SE Asia	1.5	Philippines	5.8	**Canada**
Canada	0.7	Brunei	2.3	**India**
Other	2.6	Other	11.3	

Of Australia's five nearest beef export competitors, four of them produce commercial GM crops – Brazil, Argentina, Canada and India. New Zealand has not approved any crops for commercial use, but research is progressing through the pipeline.

Brazil is the leading exporter of beef globally. According to ABARE, Brazil is the world's ninth largest food exporting country, and a major exporter of not only beef, but veal, soybeans and maize. There has also been a rapid expansion in agricultural production in the country over the past 20 years, particularly in soybean where it has become the world's second largest producer and exporter of soybean behind the USA. Importantly, Brazil is fast becoming a major producer of GM soybean.

The latest global GM crop production statistics released by the International Service for the Acquisition of Agri-biotech Applications (ISAAA) list Brazil as the third biggest producer of GM crops in 2005, recording the largest growth in area of any country from the previous year, with 9.4 million hectares of GM soybean grown across the country in 2005.

Similarly, there has been significant growth in the GM area of Argentina in the past two years. Argentina now ranks second behind the USA for global GM crop growth. In 2005, GM varieties of soybean, maize and cotton were grown across 17.1 million hectares.

This growth in global GM soybean production is significant from an animal feed perspective. It was estimated in 2005 that 60 per cent of globally traded soybean was comprised of GM varieties. Taking into consideration that segregation of GM and non-GM is minimal and exports therefore comprise a mixture of GM and non-GM; and, only 10 per cent of global soybean trade is required to be certified non-GM, it is estimated that the GM share of global soybean trade is 90 per cent, and 72 per cent of soymeal traded is GM.

Japan is Australia's biggest beef export market and although it is considered as a market sensitive to GM products, according to ABARE it has approved 44 GM crop varieties for food use and 184 field trial applications, and it is a ready market for Canada's GM canola, and for GM maize produced initially in the USA, and then in South Africa and Argentina. Japan has also undertaken a significant amount of animal cloning research.

SHEEPMEAT EXPORT MARKETS – A SNAPSHOT

Australia's key lamb export markets 04-05	**%**	**Australia's key mutton export markets 04-05**	**%**	**Australia's key live sheep export markets 04-05**	**%**	**Top world lamb and mutton exporters**
USA	29.3	Middle East	23.6	Jordan	32.5	New Zealand
North Asia	18.4	North Asia	16	Kuwait	31.2	Australia
Pacific	10.1	US	9.5	Bahrain	14.7	India
Middle East	9.7	South Africa	9.1	Oman	8.9	China
EU	8.5	SE Asia	8.2	United Arab Emirates	5.7	Uruguay
Mexico	4.0	Mexico	7.7	Qatar	4.8	Chile
SE Asia	3.6	EU	5.5	Other	2.2	Argentina
South Africa	3.0	Pacific	3.4			Namibia
Other	13.5	Other	16.9			US

New Zealand and Australia dominate lamb and mutton exports globally, with New Zealand a clear leader. Both countries use 'clean and green' imagery as part of their international appeal, but both are investing heavily in biotechnology, particularly in relation to sheep genetics.

Whilst Australian scientists face uncertainty about the path forward in relation to GM crop research, particularly in terms of commercialisation, New Zealand has already moved through a two-year moratorium phase, and is now looking to the future, where gene technology may play a role in improving agricultural production and developing new pharmaceuticals.

In 2000, the New Zealand government undertook a Royal Commission on Genetic Modification. The findings, released in 2001, aimed to keep New Zealand's options open relating to the use of both the new technology and protecting existing systems such as conventional and organic farming. Ethical and cultural considerations in relation to New Zealand's Maori populations were also incorporated into the Recommendations.

The most advanced animal biotechnology research projects involve sheep (genetic markers) and cattle (genetic markers, nutritional and therapeutic properties in milk, gene function, and human pharmaceuticals). Genetically modified onions, trees, carrots and potatoes have also been subject to trials.

The Ministry for the Environment and the Treasury released a report titled *Economic Risks and Opportunities from the Release of GMOs in New Zealand* which included market research that explored the potential impact GM products might have on New Zealand's reputation. Tourists from Australia, the United Kingdom and the USA were polled and two relevant findings include:

- If New Zealand used GM products in pest control or livestock feed, 55 per cent of respondents said that their image of New Zealand would improve or not change. Approximately one-third said that their image of the New Zealand environment would get worse.
- Between 20-30 per cent of consumers stated they would cease purchasing New Zealand commodities if GM products were released.

Of the other seven export competitors listed, five grow commercial GM crops, whilst Namibia and Chile do not.

As a key lamb export market it is worth noting the situation in relation to GM crop approvals in the EU. The EU is recognised as having a conservative approach in relation to its uptake of GM crops. However it is once again approving GM products after new legislation came into force in 2004. Prior to 1998 when a *de facto* moratoria was imposed on GM product approvals, 11 GM crops had been approved for some form of release, including varieties of corn, canola and soybean. Throughout the six-year moratoria period GM soybean and GM maize continued to be imported into the EU as a key animal feed ration component from countries such as the USA and Argentina.

GOAT MEAT EXPORT MARKETS – A SNAPSHOT

Australia's key goat meat export markets 04-05	%	Australia's key live goat export markets 04-05	%	Top world goat meat exporters
USA	51.7	Malaysia	56.2	Australia
Taiwan	31.7	Singapore	26.5	China
Caribbean	8.0	Brunei	4.3	France
Canada	5.0	Indonesia	2.8	Pakistan
Korea	0.7	Other	10.3	Ethiopia
Other	2.9			New Zealand

Although Australia is a relatively small producer of goat meat, it is by far the market leader in goat meat exports, producing triple the amount of China, the nearest competitor. The two nearest competitors also produce GM crops – cotton in China and maize in France.

AUSTRALIA'S RED MEAT EXPORT COMPETITORS AND PLANT BIOTECHNOLOGY RESEARCH

According to a report written by Professor C Ford Runge from the University of Minnesota, 63 countries have been involved in some phase of GM plant research and development, from laboratory/greenhouse experiments, to field trials, to regulatory approval and commercial production.

As has been noted, plant biotechnology research is more advanced than biotechnology research involving animals. Using plant gene technology developments as an indicator of a country's investment and interest in biotechnology overall, the table below looks at the GM plant research status of some of Australia's red meat export markets and competitors. This is also a useful indicator of GM animal feed use.

Export competitors	**GM Crop Status**	**GM Feed Approvals**
North America - Canada - USA	North America is the epicenter of research and development for plant biotechnology, with thousands of field trials conducted in the two countries. Canada has produced, approved, or field tested more GM crops than any other country. In the United States, trial approvals have been granted for canola, chicory, cotton, flax and linseed, maize, melon, papaya, potatoes, rice, soybeans, squash, sugar beets, tobacco, and tomato.	 - Yes - Yes
Latin America - Argentina - Brazil - Chile - Uruguay	Latin American and the Caribbean nations are home to some of the most aggressive adopters of GM plants and appear poised to move to adopt more GM varieties in the near future. Argentina leads the adoption process, with Brazil already emerging as a leader as well. Chile has not adopted commercial GM crops, but is seen as an important potential base of activity. Uruguay cultivates commercial GM soybean and corn crops.	 - Yes - Yes - ? - Yes
Africa - Ethiopia - Namibia	In Africa, the leading country is South Africa, with a total commercial market value for its GM maize, soybeans and cotton of US$146.9 million. Kenya, Egypt, Morocco and Tunisia also report some activity. Ethiopia and Namibia are not listed as countries involved in GM plant research.	 - ? - ?
Europe - France	In Western Europe regulatory import, as well as environmental release, approvals have been granted for some GM crops. These include canola, chicory, maize, soybeans and tobacco. In all, 1,849 field trials were conducted from 1991 to August 2004. France has conducted the largest number of field trials in Europe (520), followed by Italy (270), Spain (263), and the United Kingdom (199) amongst others.	 - Yes
Asia-Pacific - China - India - Japan - Pakistan - New Zealand	China is aggressively engaged in GM crop adoption and research. India has at least 20 academic and research institutions engaged in research across 16 crops. Japan has granted regulatory approval for six GM crops – canola, cotton, corn, potatoes, soybeans and sugarbeet. Field trial and laboratory research has included melon, cucumber, beans, tomatoes, broccoli and rice. Pakistan has only two GM crop experiments identified - insect resistant cotton and fungi resistant rice. It has lagged in developing regulatory and approval guidelines for commercialisation. At the laboratory level, Pakistan has developed GM lines of cotton, sugar cane, soybeans, and tomatoes, according to government scientists. There is also considerable interest in biotech mango production. New Zealand has approved GM canola and onion field trials in the past.	 - Yes - Yes - Yes - ? - Yes

Source: Runge, 2004

The area dedicated to GM crops has increased 50-fold since 1996. Should this rate of uptake continue, and more countries adopt GM varieties, choices in relation to sourcing non-GM animal feed may be reduced, particularly if countries do not implement widespread coexistence systems as is the case in the USA, Canada, Argentina and Brazil to-date.

POLICY PRINCIPLES:

10. **Supply chain choice.** The industry recognises that producers, processors and retailers have choice in the application, or otherwise, of biotechnology and encourages the investigation of options to support this choice. However, the industry also recognises that if biotechnology adoption continues this choice may be reduced, particularly in relation to animal health and animal feed options.

11. **Market intelligence**. The industry recognises the potential diversity in technology and market positions that may arise, and the need for the Industry to reasonably cater for such diversity and associated outcomes where feasible. The industry supports the proactive monitoring and regular gathering of market intelligence and public perception data – both nationally and internationally – which impact the elements of this policy.

12. **Changing commercial environment.** The industry recognises that community and market expectations are undergoing change and that a high level of uncertainty currently exists in relation to commercial returns on investment in research and development in this area, and that such investments should be subject to rigorous technical and commercial evaluation prior to approval. Further, the industry agrees to maintain sound knowledge about the research effort underway globally in order to maintain a competitive approach in the development of these key technologies.

CONCLUSION

Communication of animal biotechnology has been minimal to-date in Australia, and one reason for this is that GM or cloned animals remain some way from the marketplace. Lessons learned from the GM canola debate however highlight that industries funding biotechnology research need to be discussing potential outcomes with key stakeholders, including government; establishing decision-making processes which ensure any resulting products are in the best interests of the Australian red meat industry as a whole; and clarifying a path to market for the biotechnology-derived products of the future.

In relation to regulation, while the process for any GM animals developed is clear, the process for cloned animals needs to be clarified before any potential product is ready to move through such processes. Australia may only be a small player in these areas globally, but should these products move into the markets overseas, Australia will need to be in a position to ramp up the research it has developed at the genetic level and progress it into full-scale outcomes at the whole animal level.

In the interim, communication efforts to educate the broader industry, taking a whole-of-supply chain approach, about all of the uses and outcomes of biotechnology in agriculture, both plants and animals should be a priority.

In taking leadership on this issue, the red meat industry should consider the points below:

Short term

- Monitor international developments – assess the level of GM and non-GM supply chains and the systems that develop and benefits and costs associated, including those relevant to stockfeed.
- Industry and consumer information/education is critical – particularly managing short term activist attention with longer term industry goals.
- Encourage whole of Australian agriculture approach, for example, through SAFEMEAT.

Medium term

- Examine consequences of substituting GM inputs – end of moratoria in Australia and further release of GM products.
- Monitor international developments and commercial response in relation to products derived from cloned animals (for example meat and milk) and participate in consumer education initiatives about the technology.

Long term

- Need to consider the benefits to be derived from GM and conventional crops with enhanced feed characteristics.
- Potential for GM material to enter the supply chain through vaccines or micro-ingredients in the future.

POLICY PRINCIPLE:

13. **Proactive communication/education.** The industry recognises the need to proactively inform and educate stakeholders about biotechnology and to develop an industry communication strategy, to ensure a rational and informed debate.

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ATTACHMENT 1 –
SAFEMEAT STRUCTURE AND EXECUTIVE 2003-2004

SAFEMEAT Structure
Australian Meat Industry Council
Cattle Council of Australia
Australian Lot Feeders' Association
Sheepmeat Council of Australia
Australian Livestock Exporters' Council
Australian Government Department of Agriculture, Fisheries and Forestry
Australian Chief Veterinary Officer
State/Territory Government Agriculture Department representative
State/Territory Meat Industry Authorities representative

SAFEMEAT Executive
Australian Meat Industry Council (Chair)
Cattle Council of Australia
Australian Lot Feeders' Association
Sheepmeat Council of Australia
Deputy Australian Chief Veterinary Officer
Australian Government Department of Agriculture, Fisheries and Forestry
State/Territory Government Agriculture Department representative
State/Territory Meat Industry Authorities representative
Meat & Livestock Australia
National Residue Survey
Australian Quarantine and Inspection Service
Animal Health Australia
Australian Livestock & Property Agents Association Limited

ATTACHMENT 2 – KEY BIOTECHNOLOGY LIVESTOCK RESEARCH ORGANISATIONS IN AUSTRALIA

Research area	Research organisations involved
Genomics	Cooperative Research Centre for Innovative Dairy Products SheepGenomics – Funding: Meat & Livestock Australia and Australian Wool Innovation
Molecular	Cooperative Research Centre for Innovative Dairy Products CSIRO Victorian Government Department of Primary Industries Sydney University Adelaide University Queensland Department of Primary Industries and Fisheries South Australian Research and Development Institute
Bioinformatics	Cooperative Research Centre for Innovative Dairy Products CSIRO Murdoch University Sydney University Victorian Government Department of Primary Industries University of Queensland University of New England
Phenomics	No one - rely on Australian Phenomics Facility cell culture – CSIRO, Melbourne University, University of Western Australia, Queensland Department of Primary Industries and Fisheries
Gene silencing (RNAi)	CSIRO Queensland Department of Primary Industries and Fisheries
Reproduction	Cooperative Research Centre for Innovative Dairy Products CSIRO University of Queensland Queensland Department of Primary Industries and Fisheries

Research organisations involved in biotechnology research above for the livestock industry are also members of Cooperative Research Centres as listed below.

CRC for Beef Genetic Technologies
Core partners: CSIRO, New South Wales Department of Primary Industries, University of New England, Queensland Department of Primary Industries and Fisheries

Research aims:

- To develop and commercialise multiple DNA tests that account for genetic differences in carcass yield, marbling and beef tenderness.
- To develop and commercialise multiple DNA tests and non-genetic treatments that will reduce feed costs for the national beef herd without impacting on cattle weight gain whilst simultaneously improving breeding herd efficiency.
- To develop and commercialise multiple DNA tests and non-genetic treatments to reduce parasite control costs and improve productivity and profitability of beef businesses by use of optimally adapted cattle and improvements in animal welfare.

CRC for Sheep
Core partners: Australian Meat Processor Corporation, CSIRO, Western Australia Department of Agriculture, Queensland Department of Primary Industries and Fisheries, New South Wales Department of Primary Industries, University of New England

Research aims:

- Genetic analysis of sheep production traits to achieve faster rates of genetic gain that will be realised from improved accuracy in selection and the ability to include more traits in the breeding programs.

- Investigate the genetics of worm resistance by analysing the data from existing experimental resource flocks and industry flocks to see what genetic and phenotypic relationships exist between faecal egg count and production traits.

CRC for Innovative Dairy Products
Core partners: Australian Dairy Farmers Ltd, CSIRO, Dairy Australia, Genetics Australia Cooperative Ltd, Monash University, University of Sydney.

The Dairy Cooperative Research Centre (CRC) is the primary centre for undertaking research in animal biotechnology for the dairy industry. It is a seven-year $80 million research project set up by the Commonwealth Government and the Australian dairy industry. Over 90 scientists at six research institutes undertake research in dairy genomics, advanced breeding technologies and the bioactives in milk.

Research aims:
- Identifying critical genes for the regulation of lactation, milk components and milk production, mammary response to pathogen challenge, fertility and bioactives in milk.
- Delivering improved genetics to the dairy industry through a range of advanced reproductive technologies, in particular on in vitro reprogramming, embryonic gene expression and a study of the early period of development.

Australian Poultry CRC
Core partners: University of New England, Bioproperties (Australia) Pty Ltd, Rural Industries Research and Development Corporation, Australian Egg Corporation Ltd, University of Melbourne

Research aims:
- Sustainable poultry health through the discovery, development and application of emerging biotechnology.
- Use genomics to identify novel poultry health and diagnostic products with the potential to improve disease control and surveillance.

ATTACHMENT 3 –
EXAMPLES OF CSIRO'S LIVESTOCK BIOTECHNOLOGY RESEARCH

Research area	Example
Genome project	The first draft of the bovine genetic sequence (hereford) is now publicly available worldwide. The project aims to assist the discovery of new characteristics for improved meat and milk production.
Single Nucleotide Polymorphisms (SNPs)	This research aims to understand the diversity in animals - six breeds initially selected – Holstein, Jersey, Norwegian Red, Brahman, Limousin, Angus, and the preliminary sequencing scan is complete. Project outcomes include parentage verification, diversity assessment, enhanced QTL mapping and characterisation of the structure of the genome.
Genomic and gene mapping	QTL mapping in cattle, sheep and prawns is underway for traits such as meat quality, parasite resistance, net feed intake, retail beef yield and wool quality. Genetic diversity studies investigating breed diversity and breed evolution are also occurring.
Functional genomics	Experiments to investigate the impact of major manipulations of animal management areas such as nutrition, and skeletal muscle development, disease responses, parasite resistance and fetal development.
Phenomics	Investigating the genetics behind major mutations such as callipyge, carwell, poll, myostatin and agouti. Outcomes are genetic tests and a fundamental understanding of how genetic variation leads to a phenotype change.
Functional foods	The use of gene technology to develop functional foods such as reduced lactose content in milk (cattle), increased unsaturated fats in pork, and leaner meat in sheep.
Feed efficiency	Research indicates that selecting for livestock that are more feed efficient is possible. This has implications for land usage, nutrient excretion and odour problems.
Metagenomics on rumen microbes	By identifying the gut microbes that are more efficient in digesting feedstuffs there is potential to reduce methane gas emissions and develop bio-based fuels.

ATTACHMENT 4 –
MLA'S BIOTECHNOLOGY INVESTMENT

Investment area	Research aims
CRC for Beef Genetic Technologies $1m per annum	- DNA markers (marbling and tenderness) - Quality traits – eg marbling - Parentage and pedigree - Product integrity eg SureTRAK
SheepGenomics $3m from MLA and AWI	- Develop sheep genome resources - Target productivity in muscle, wool, parasite resistance and reproductive success
Plant genomics $350,000 annually	- Develop gene markers for production traits - Digestibility and drought tolerance initial focus
Soil biology $300,000 annually ($2.65 million over four years by MLA, AWI and GRDC)	- Identify key soil microorganisms - Develop molecular assays for key beneficial and disease-producing soil microorganisms - Increase rate of soil biology research underway - Develop new tools to underpin a 10 per cent improvement in pasture productivity
Vaccine development	- New generation OJ vaccine to replace current vaccine - Tick fever vaccine improvement - Plants as vectors to produce vaccines cheaply - Bovine respiratory disease – a GM vaccine is currently in pen trials. The vaccine, developed by scientists at Queensland's Department of Primary Industries and Fisheries (QDPIF) are designed to induce protection to Bovine herpesvirus 1 (BoHV-1) and Bovine viral diarrhoea virus (BVDV). These viruses have been targeted by researchers because they have been identified by the feedlot industry as the key agents causing bovine respiratory disease (BRD) in feedlot cattle in Australia. Infected cattle may exhibit a number of symptoms that include pneumonia, diarrhoea and immunosuppression. BRD can lead to secondary bacterial infections that in turn lead to severe pneumonia and death. According to OGTR documentation, other GM BoHV-1 vaccines have been developed and registered for use in Europe.
GM rumen bacteria	- A project developing a GM rumen bacteria to protect cattle from flouroacetate poisoning was technically successful but the MLA Board deciding against proceeding with commercialisation because of potential negative consumer and market reactions. Flouroacetate is a toxic poison found in gidyea and heart-leaf, plants commonly found in country stretching from Mt Isa in Queensland to Alice Springs in the Northern Territory. Flouroacetate poisoning occurs when livestock ingest these plants at certain times of the year.
GM pastures	Past research – bloat safe clover
GM animals	Currently no GM animal research funded by MLA. Instead the focus is trait biology.
Cloning animals	Limited to use as a research and development tool. In the future it may be used to distribute elite genetics, but broader use by industry will be a commercial decision.

ATTACHMENT 5 –
EXAMPLES OF ANIMAL BIOTECHNOLOGY EFFORTS OVERSEAS

Funding organisations	Further information
USDA and other US Funders	Through the Cooperative State Research, Education, and Extension Service (CSREES), the USDA has supported animal biotechnology projects such as the National Animal Genome Research Program which coordinates US cattle, sheep, swine, horse, fish, and poultry animal genome mapping efforts.
Wellcome Trust, UK	The Wellcome Trust is an independent charity funding research to improve human and animal health. Its mission is to foster and promote research with the aim of improving human and animal health. The Trust has been involved in funding human and bovine genome sequencing projects.
Genome Canada	Genome Canada is the primary funding and information resource relating to genomics and proteomics in Canada. Research involves the bovine genome project and deciphering the Atlantic salmon genome to garner information that will be key to understanding fish reproduction and growth and to improving practices in aquaculture and fisheries.
EU Framework Funds	
International Livestock Research Institute	The International Livestock Research Institute (ILRI) combines science and capacity-building to bear on poverty reduction and sustainable development for poor livestock keepers and their communities. Research includes sequencing the genome of a tick-transmitted protozoan parasite which kills cattle in 11 African countries by causing a disease called East Coast fever and then developing a vaccine that protects cattle against the disease.
Ministry of Agriculture, Forestry and Fisheries, Japan	
Meat & Wool New Zealand (Meat NZ)	Meat NZ partners Wool Equities Limited and AgResearch, in a joint venture company, Ovita, the major task of which is to map the sheep genome. In relation to beef genomics, Meat NZ is involved in the bovine genome project and the Australian CRC for Beef Genetic Technologies. The company is also investing in clover and ryegrass genomics through a Pastoral Genomics consortium involving Fonterra, AgResearch, Deer Industry NZ, FRST and Dairy InSight.
AgResearch New Zealand	AgResearch (a New Zealand Crown Research Institute) has established an Applied Biotechnologies Centre which focuses on animal genomics, reproductive technologies including work on cloning, GM animals and other reproductive technologies; forage improvement to develop improved forage plant varieties; and, growth and development research involving functional genomic work in animal tissues and fibre and develops products for human health and wellbeing.
Pig Improvement Company (PIC) International, UK	PIC is the global market leader for improved pig breeding stock. Biotechnology research underway includes the use of genomics to identify some of the key genes explaining differences between animals; the creation of new genetic markers using DNA banks and databases; disease resistance research to improve pig heath and reduce the need for antibiotic treatments, lessen stress and improve pig welfare, and provide a safe and wholesome product for consumers; marker assisted selection in order to improve the accuracy and intensity of selection, and improve important traits which have not been amenable to traditional selection, such as meat quality and disease resistance.
Livestock Improvement Corporation, New Zealand	LIC's mission is "Leading the world with genetics and knowledge to create wealth for pastoral dairy farmers." Biotechnology research includes improving methods to determine how many, and which animals and traits to select in their breeding scheme using molecular markers; maintaining a strategic research alliance on bovine QTL with the University of Liege (Belgium), and the bovine genomics research alliance.

Holland Genetics, Netherlands	Holland Genetics is one of the largest AI organisations in the world, and it is also involved in the bovine genome project.
Genetic Solutions, Australia	Genetic Solutions products, which include SureTRAK®, GeneSTAR® and SireTRACE™ are used by livestock production and processing companies to improve product quality and production efficiency. It is also involved in the bovine genome project.
Cargill/MetaMorphix Genetics, USA	This US alliance has announced that they have completed the first whole cattle genome association study and have developed tools that could identify cattle that meet consumer demands for quality meat products. Using its GENIUS-Whole Genome System™, MMI identified and characterised a dense map of novel genetic markers based on single nucleotide polymorphisms (SNPs) in beef cattle. The company then conducted a whole genome association study in a feedlot and discovered specific regions in the cattle genome that associate with desirable beef traits. Over fourteen million genotyping assays were generated during the extensive research program. The tools are currently being validated in further feedlot studies to examine their use in commercial cattle production.

ATTACHMENT 6 –
FOOD COMMODITIES UNDERGOING BIOTECHNOLOGY RESEARCH GLOBALLY

Field Crops	**Vegetables**	**Fruits**	**Miscellaneous**
Barley	Broccoli	Apple	Chicory
Canola	Cabbage	Banana	Cocoa
Cassava	Carrot	Cherry	Coffee
Clover	Cauliflower	Citrus	Garlic
Cotton	Cucumber	Coconut	Lupins
Flax	Eggplant	Grape	Mustard
Lucerne	Lettuce	Kiwi	Oil palm
Maize	Onion	Mango	Oilseed poppy
Rice	Pea/Bean	Melon	Olive
Safflower	Pepper	Papaya	Peanut
Sorghum	Potato	Pineapple	Tobacco
Soybean	Spinach	Plum	Sugar cane
Sugar beet	Squash	Raspberry	Sunflower
Wheat	Tomato	Rockmelon	
		Strawberry	
		Watermelon	