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Information Paper 6

# Biotechnology and animal production

This fact sheet explores the use of gene technology and biotechnology in animal production in agriculture. Globally, there is much research underway in this area, with Australian research contributing significantly to the effort.

Research in this area aims to increase the productivity and efficiency of livestock by:

- Increasing the nutrition levels of animal feed
- Genetically modifying animals to be more productive
- Disease diagnosis, treatment and prevention
- Mapping the genetic profile of particular animals
- Controlling pest animal species

The development of consumer-oriented and environmentally friendly products is also a research focus.

**Increased productivity**

Australia's first GM **calves** were born in 2002. The four calves contained an extra gene for milk protein production. Conventional cows have about three-and-a-half per cent protein in their milk. This protein content could be increased by 10 per cent in a cow with an extra protein gene, resulting in a more nutritious product for consumers.

The four GM calves were also cloned, which means that they were genetically identical. Unfortunately, because cloning technology is still in the early stages of research, only one of the four cloned GM calves has survived. This work has now ceased. It is hoped that further investigation into the genetic map of cows, and refinement of the cloning and genetic modification procedures will improve results in the future.

Genetically modified **sheep** which contain an extra copy of a sheep growth hormone gene were produced by CSIRO researchers. The resulting sheep grew larger and leaner than normal sheep and, in some breeds, produced more wool and more milk. However, some of the sheep suffered side-effects from excess growth hormone such as overgrown knuckles, hooves which needed to be trimmed regularly, and diabetes. The GM sheep also appeared to have a lower tolerance to parasites. This research has now been concluded.

**Salmon** modified to grow faster than conventional salmon has been developed by researchers in North America. The salmon contains an additional salmon growth hormone gene, and an antifreeze gene from an ocean pout fish which allow it to produce growth hormone all year-round, rather than just producing growth hormone in the warm months like conventional salmon. The GM salmon is still awaiting final regulatory approvals from US and Canadian regulatory agencies, before it can be used in commercial fish farms.

**Identifying, treating and preventing diseases**

Researchers from CSIRO, and animal health company, Imugene Limited, have already began working on a vaccine for the deadly strain of the avian influenza affecting poultry throughout Asia.

It is hoped that a trial vaccine will be ready soon to protect Australia's poultry industry, with the vaccine able to be adapted for new strains of the virus should it be required in the future.

The detection and regulation of immune responses in pigs is also being investigated. By learning more about a pig's immune responses, the antibiotics and chemicals currently used to control disease may be reduced or replaced.

Researchers in Australia are studying 40 natural immune-system regulators – molecules called 'cytokines'. Pigs treated with cytokines:

- gained equal or more weight when compared to pigs administered in-feed antibiotics
- showed fewer signs of bacterial infection lost less weight at weaning
- enhanced the efficacy of vaccines and as a result allowed lower doses of vaccines to be used
- had reduced harmful immune responses, such as inflammation, to disease.

**Mapping genes**
An international project to map the genetic profile of **cattle** was launched in 2003, and in 2006 researchers released the most complete sequence of the cow genome ever assembled. The US$53 million project involved researchers from Australia, the United States of America, Canada and New Zealand.

Expected benefits of the project include the ability to:

- identify the genes that control growth efficiency, lactation, muscle development, reproduction and milk composition; and,
- breed disease resistant cattle.

CSIRO researchers also released the DNA map of more than 98 per cent of the sheep genome in 2006. This new sheep genetic data will allow fast-tracking of the genes responsible for sheep health and productivity, as well as for wool and meat quality. Tests which will allow sheep breeders to identify and select animals with superior muscle quality and quantity, parasite resistance and wool quality, will be another aim.

**Consumer focused research**
Consumers may be guaranteed tender, juicy steaks in the future because of tests developed by CSIRO scientists. One DNA test identifies cattle carrying a 'tenderness' gene and can be performed at any stage on the live animal. The other DNA test identifies animals with the desirable trait of fat distributed through the muscle.

Researchers in the USA have bred GM laboratory mice whose tissues contain high levels of the healthy properties of fish oil. The research may one day be applied to beef cattle or dairy cattle to produce meat and/or milk with high levels of Omega-3. Omega-3, which is found in abundance in fish oil, and is known to prevent heart disease and reduce blocked arteries.

**Managing pests**
Introduced pests cause a myriad of problems for the Australian environment, such as erosion, and loss of native vegetation and wildlife. They can also have a major economic impact on agricultural systems. Researchers are investigating control options for some of these pests using gene technology. For example, control of carp using gene technology is being investigated because carp can cause significant damage to waterways and they are becoming increasingly dominant over native fish species.

Researchers in New Zealand are investigating the use of gene technology to control **possums**.

**The environmental focus**
A pig which utilises phosphorous more efficiently has been developed by researchers in Canada. The so-called **"Enviropig"** is able to breakdown and absorb phosphate in its diet, and therefore expel as much as 60 per cent less phosphorous in its manure. Conventional pigs are unable to use an indigestible form of phosphorus called phytate present in their cereal diets, so producers have to add a phosphate supplement, which in turn means the resulting manure contains concentrated phosphorous.

Application rates of manure to land in areas of intensive pork production can result in pollution of local surface water and ground water. High phosphorous levels in water courses can result in plant and algal growth, tainting the water and robbing it of oxygen, leading to the death of fish and other beneficial aquatic organisms.

**Non-agricultural applications**
The production of materials for **pharmaceutical** or medical purposes from animals is another aspect of gene technology science, including the use of animal organs, particularly those from **pigs**, for human transplants. Researchers are genetically modifying pigs to try and overcome issues associated with organ rejection. Up to 700 people die each year in Australia awaiting transplants of organs such as hearts, kidneys and livers.

**Research regulation in Australia**
Australian research involving gene technology and animals is regulated by the Office of the Gene Technology Regulator.

**Further information**
- GM animals
http://www.csiro.au/pubgenesite/biotechLivestock/index.htm
- GM calves
www.genaust.com.au
- Pest animals
www.invasiveanimals.com/
- Possums
http://www.landcareresearch.co.nz/research/category_list.asp?SciCategory_ID=8
- GM salmon
www.aquabounty.com/
- Omega-3 dairy or meat products
www.massgeneral.org/news/releases/020403kang.htm
- 'Enviropig'
www.uoguelph.ca/enviropig/