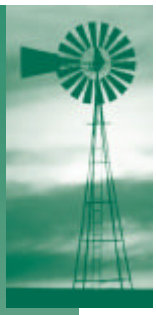

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Biotech Bulletin 13

Gene Technology and the Livestock Industry

Welcome to the Agrifood Awareness Australia Limited's (AFAA) Biotech Bulletin. This edition, entitled "Gene technology and the livestock industry", presents a snapshot of some of the applications of gene technology research underway in the livestock industry around the world.

INTRODUCTION

Towards the end of this year an announcement will be made that an international team of researchers has released the bovine genome sequence. According to CSIRO, "the results of the sequencing promise to benefit human health by contributing to its knowledge, as well as having an impact on the dairy and beef industries by advancing the health and disease management of beef and dairy cattle, and improving the nutritional value of beef and dairy products."

Sequencing of the bovine genome began in December 2003 and is scheduled for completion by September 2005. The sequencing will help medical researchers learn more about the human genome and the possibility of developing better ways of treating and preventing disease.

While the bovine genome is a significant project, considerable biotechnology and gene technology research is underway in animal production globally. The technology is primarily being utilised to:

- map the genetic profile of particular animals;
- diagnose, treat and prevent disease; and
- develop more productive animals.

This Biotech Bulletin presents some of the research currently undertaken globally using gene technology in the livestock industry.

AUSTRALIA

In Australia, a large amount of gene technology research is currently underway, primarily being carried out by organisations such as Australia's Commonwealth Scientific Industry Research Organisation (CSIRO) and universities.

The following is a brief overview of the main areas of livestock production in Australia that are investigating the potential of gene technology and some of the projects.

Cattle

Improving quality - Scientists from CSIRO Livestock Industries and the Cooperative Research Centre (CRC) for Cattle and Beef Quality have identified genetic and non-genetic factors that influence beef quality and have found ways of manipulating those factors to guarantee the eating quality of beef.

Commercial GeneStar tests are now available to identity tenderness and marbling (the amount of fat distributed through the muscle). Both GeneStar tests use laboratory analysis of an animal's DNA, which can be extracted from tail hair roots. This Australian-patented technology will allow beef producers to breed animals for their ability to more consistently deliver enhanced gastronomic experiences.

Further information: www.csiro.au/pubgenesite/index.htm

Protecting against disease - Vaccines are now often produced using gene technology. Two examples of vaccines currently being used to protect livestock against deadly diseases are outlined below.

Bovine herpes virus (BoHV-1) and Bovine viral diarrhoea virus (BVDV) cause a number of losses to cattle in Australia. Infected cattle show symptoms such as pneumonia, diarrhoea and suppression of the immune system. The infection can lead to a secondary viral or bacterial infection causing severe pneumonia or death.

The Queensland Department of Primary Industries and Fisheries (QDPIF) has developed genetically modified (GM) vaccines to protect cattle from infection of BoHV-1 and BVDV. The Office of the Gene Technology Regulator (OGTR) issued a licence in April 2005, allowing trials.

The purpose of the trials is to evaluate the safety and effectiveness of the vaccines. The licence application (DIR 050/2004) allows for up to 19 GM vaccines to be examined, on a limited scale and under controlled conditions.

The QDPIF will conduct the field trials in an animal containment facility in Queensland over five years between July 2005 and June 2010. The trial involves the inoculation of up to 180 cattle in total, aged between four to six months with the GM vaccines administered via a nasal drip.

For further information: www.ogtr.gov.au/ir/dir050.htm

Cattle ticks in Australia's tropics transmit a parasite disease called anaplasmosis, which causes severe anaemia and even death in cattle that lack immunity. According to CSIRO, the cattle tick causes productivity losses of more than $100 million a year in Australia and more than US$1 billion a year in Brazil. Using gene technology, CSIRO researchers, with the CRC for Vaccine Technology, developed a world-first recombinant vaccine, TickGARD, commercialised in Australia in 1994. TickGARD does not eradicate ticks, but cuts down their survival rate and severely damages their ability to reproduce.

The vaccine is increasing in use, particularly in Queensland.

For further information: www.csiro.au/index.asp?id=/reports/Outcomes1998/TickVaccine.xml

Dairy

The CRC for Innovative Dairy Products is undertaking research in several areas to address issues that face producers and processors of milk. Dairy CRC scientists are investigating genetic markers in the dairy cow, including a recently discovered marker highly predictive of milk volume. Using marker assisted selection to breed animals which will produce a higher volume of milk has important implications for on-farm productivity. This mechanism for identifying elite animals has the potential to greatly enhance traditional methods of proving sires or using bloodlines.

Clinical mastitis cases on-farm can cause substantial production losses. Scientists at the Dairy CRC are investigating the genes associated with susceptibility to mastitis in dairy cows. If cows with a genetic predisposition to develop the condition are identified, specific measures may be undertaken to protect them. Over the long term, cows with these genes may be bred out of herds.

Research is also being conducted to identify valuable micro-components in milk (proteins, carbohydrates, peptides and lipids) and the genes associated with them. If dairy cows produced more of these components in their milk, it could assist farmers and processors to develop a wide range of health-promoting products.

Other potential applications for the dairy industry from the CRC's research include faster and more directed genetic gain, longer lactations and advanced breeding technologies.

Further information: www.dairycrc.com

Pigs

Disease and stress - CSIRO is helping pig producers develop animals that are disease resistant and better adapted to farming, improving their health and productivity. Stress caused by environmental conditions and mild infections, with no obvious symptoms, is believed to be the fundamental reason

for growth rates to fall in pigs. Stress impairs the immune system making animals more susceptible to infection, therefore reducing production.

CSIRO Livestock Industries, in collaboration with Australian Pork Limited, is identifying genes involved in resistance to disease and stress. Knowing how animals respond to stress and disease should help producers develop better management systems that will improve animal health and welfare while lifting productivity.

Researchers are also investigating how they can reduce the use of antibiotics in livestock production. By selecting animals with genes resistant to infection, scientists will help producers reduce or eliminate their use of antibiotics.

Further information: www.csiro.au

Infection protection - A GM pig vaccine developed by CSIRO is currently being considered by the OGTR for field trial approval. Imugene Ltd has applied to conduct field trials of the GM pig adenoviruses (PAV). Inoculation with the GM virus (PAV) is expected to stimulate the immune response of pigs and make them less susceptible to infections. At present, the OGTR has 'stopped the clock' on the consideration of this application, until the applicant supplies additional data that the OGTR has requested.

Pigs raised in commercial production facilities are exposed to a range of organisms that may cause infections that adversely affect their health and production. If the research is successful, the inoculation of pigs with the modified virus may provide an alternative to the use of antibiotics in commercial pig meat production.

For more information: www.ogtr.gov.au/ir/dir045.htm

Sheep

Better wool - Australian fine, superfine and ultrafine wools are bringing premium prices at international auction. The industry could capitalise on this demand if it could produce more fine wool, but poor understanding of the inheritance of fibre diameter has impeded breeders' efforts to make gains.

CSIRO Livestock Industries scientists have been working on projects to identify genes that influence fibre diameter and fibre quality in sheep fleeces. The scientists are ultimately studying the genes that are active in the wool follicle cells that produce individual wool fibres. When the genes are identified, breeders will be able to use genetic markers to distinguish between stud animals carrying "golden" or "less desirable" variants of particular genes. By determining exactly which genes an animal is carrying, breeders can design breeding programs to produce elite progeny and thus be able to make more rapid gains in reducing average fleece diameter.

Further information: www.csiro.au

Improving productivity - The Australian Sheep Industry CRC currently has two projects focusing on a range of outcomes to improve productivity and profitability in the Australian sheep industry. The projects include:

- improving the efficiency of breeding programs to ensure a clear understanding of the relationship between wool and meat production;
- designing breeding programs to investigate the inheritance of worm resistance. The long term solution is to breed sheep that are resistant to worms;
- investigating the gene responsible for black and badgerface patterns as well as random spotting in the merino sheep. The desired end product is to have a commercially available test to screen white sheep for different pigmentation genes;
- applying marker-assisted breeding to bring fine wool genes into "meat" merinos; and
- developing prime lamb production systems that use individual animal identification technology and validating the use of electronic identification in prime lamb production systems.

For further information: www.sheepcrc.org.au

Disease protection - Johne's disease, a bacterial infection, causes heavy losses in sheep and cattle. Johne's disease is a difficult infection to diagnose and fight. Sheep and cattle usually pick up the disease very early in life. CSIRO researchers are developing tests to diagnose the disease early in the development stage of young sheep or cattle, so that infected animals can be culled to limit the spread of the disease. The disease is caused by a bacterium and may not produce obvious signs of infection for several years. If researchers are successful the test kit for Johne's disease could be on the market within a few years.

For further information visit: http://csiro.au/pubgenesite/research/animals/johnes_finalsum_short.htm

GM sheep - Genetically modified sheep which contained an extra copy of a sheep growth hormone gene were produced by CSIRO researchers. The first GM sheep were born in 1987.

The GM sheep grew faster and were leaner and larger than conventionally bred sheep and in some breeds produced more wool and more milk for a prolonged period. However, some of the sheep suffered side-effects from excess growth hormone, such as diabetes, hooves which required regular trimming and overgrown knuckles. The sheep were also more susceptible to internal parasites. This research has now concluded.

Further information:
www.csiro.au/index.asp?type=mediaRelease&id=prgmsheep&style=mediaRelease

Poultry
Protection against disease - A major concern for the poultry industry in many countries is the Infectious bursal disease (IBD). CSIRO has developed a test to distinguish between different strains or forms of the virus, and to provide early warning of the emergence of potentially lethal strains. The virus is transmitted in the birds' droppings, and once present in a poultry farm, it becomes almost impossible to eliminate. CSIRO scientists have now developed a test that can be used on farms to identify the disease. The OGTR issued a 'Dealings Not involving Intentional Release' (DNIR) licence in September 2002 of the IBD test, with the licence due to expire in December 2005. The DNIR licence does not permit field trials but allows dealings with the GMOs in contained facilities, i.e. no release into the environment is permitted.

Further information: www.csiro.au and www.ogtr.gov.au/pdf/public/sept2002qrpt.pdf

Dietary requirements and disease protection - In collaboration with some of Australia's leading poultry companies, the Australian Poultry CRC is working on a number of projects for the poultry industry. These include:

- researching alternative methods for disease control by;
  - identifying novel therapeutics; and
  - improving disease surveillance through the application of genomic technology.

For more information: www1.poultrycrc.com.au/index.aspx

NEW ZEALAND
Dairy cows
According to a report in the UK journal "New Scientist", scientists at AgResearch in New Zealand have genetically modified cows to produce high-protein milk for the cheese industry. The cows possess additional copies of genes for two proteins, resulting in their milk containing up to 20 per cent more beta-casein and twice the amount of kappa-casein in milk compared to conventional cows. The modification should allow cheese-makers to produce more cheese from the same volume of milk. This project is still in the research phase.

Scientists in New Zealand are also field testing dairy cattle that have been genetically modified to:
- produce milk with an inactive (b-lactoglobulin) milk protein so that people with lactose-intolerance can eat dairy products; and
- produce milk with a human myelin basic protein. Myelin basic protein is a layer that forms around nerves and acts as an insulator. It is made up of protein and lipids (non water-soluble fat substances). Without this insulation, information from nerves is inefficient causing weakness, sensory loss or other dysfunctions. This milk offers a possible treatment

for multiple sclerosis. Not all milk would contain this protein; special herds would be used for producing this particular protein.

Further information: www.agresearch.co.nz

CANADA
Cattle
Disease protection - The Vaccine and Infectious Disease Organization (VIDO) based in Saskatchewan, Canada, has been credited with five 'world firsts' in animal vaccine research, including the world's first GM vaccine to combat shipping fever, known as "Pneumo-Star®" vaccine. Shipping fever is a complex form of pneumonia in cattle.

Shipping fever is a particularly harmful disease which involves infection of the lungs and lower respiratory tract by an organism that resides in the tonsils. The vaccination is used for healthy cattle and calves as an aid in prevention of pneumonia. The vaccine stimulates the formation of antibodies which neutralise the bacteria.

Further information see: www.vido.org

Resarchers globally are investigating and developing various animal vaccines and incorporating them into feed, replacing the use of injection vaccines, such as the Ontario Veterinary College at the University of Guelph in Canada. Researchers have developed a vaccine within alfalfa, a common feed supplement in the animal's diet, to combat shipping fever. The aim is to vaccinate cattle against shipping fever by exposing the tonsils to certain proteins called antigens. The scientists have genetically modified alfalfa to produce antigens resulting in an edible GM vaccine. At present researchers are conducting field trials of the GM alfalfa to unvaccinated calves to see if they will develop immunity to the disease in their tonsils.

For further information: www.ovc.uoguelph.ca/news/news_03_02_13.shtm

Pigs
A pig which utilises phosphorous more efficiently has been developed by researchers in Canada. The "Enviropig" is better able to digest phosphorous contained in cereal grains by utilising an enzyme called phytase. Transferring a gene from bacteria, the Enviropigs produce phytase in their saliva, and are able to breakdown and absorb phosphate in their diet, and therefore expel between 57-64 per cent less phosphorous in their manure. The "Enviropig" can digest 90-100 per cent of the phosphorous in its diet compared to 50 per cent in conventional pigs. Research into the "Enviropig" is continuing as further funding has been obtained.

Further information: www.uoguelph.ca/enviropig/

UNITED STATES OF AMERICA (USA)
Cattle
Leaner beef - Scientists at the Agricultural Research Service (ARS) are researching cattle genes that may contribute to leaner cuts of beef. The scientists are particularly interested in a protein gene that limits muscle growth known as "myostatin". When the gene is altered or suppressed, the result is enhanced muscle growth and reduced fat deposition.

The key benefit of inactivated myostatin in cattle, is the creation of beef that is tender and lower in saturated fat. According to the ARS Meat Animal Research Centre all cuts of beef from cattle possessing the inactivated myostatin have improved tenderness. Researchers are looking to other cattle breeds, like Limousin and Charolais, to determine what triggers their lean physique.

For further information: www.animalbiotechnology.org

Improved quality - At the Institute of International Agriculture at Michigan State University, researchers are studying the molecular genetics of pigs and beef cattle with an emphasis on genetic improvement of performance traits and meat quality.

Pigs

Pork quality - Meeting consumer expectations for meat quality while keeping pork production profitable, is one of the biggest challenges facing Michigan pork producers in the USA. Researchers are looking at DNA markers and gene expression patterns to determine the genetic components that control lean growth and meat quality traits. The Duroc pig (known for good meat quality) was crossed with the Pietrain (known for lean growth but low quality meat), to develop genetic methods to improve growth and meat quality traits. Over the next three years, researchers will analyse the data, then take the information to pork producers to help them make stock selection decisions on-farm.

Further information: www.animalag.msu.edu and Center for Animal Functional Genomics

Rapid response - Scientists at the Agriculture Research Service are trying to determine if GM foot-and-mouth disease (FMD) virus strains can be used as seed stocks for the preparation of vaccines.

Foot-and-mouth disease is the number one foreign animal disease threat to the USA and the most significant disease impacting free-trade in animals and animal products internationally. In South Africa the control of FMD is complicated by the presence of free-living African buffalo that act as hosts for the virus and pose a constant threat to susceptible livestock. Currently FMD vaccines can be effective as part of disease control programs, however due to the high variability of the virus, new vaccine strains need to be developed frequently. Cell culture adaptation is regularly unsuccessful and the virus can often change during this timeframe. To solve this, scientists are researching the use genetically modified FMD viruses to produce better vaccine strains.

Further information: www.ars.usda.gov

INDIA

Cattle, Sheep and Goats

Scientists at the Indian Institute of Science in Bangalore, India have developed an oral vaccine from a GM pigeonpea plant which may work to fight a deadly virus affecting thousands of sheep and goats in India. Researchers identified the antigen from the pigeonpea plant that was found to be effective against the rinderpest virus and at present are testing its effectiveness on sheep and goats.

For further information: www.iisc.ernet.in

We look forward to your feedback on this newsletter.

For further information, please contact the AFAA office on (02) 6273 9535 or via email – info@afaa.com.au

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