Livestock horizons

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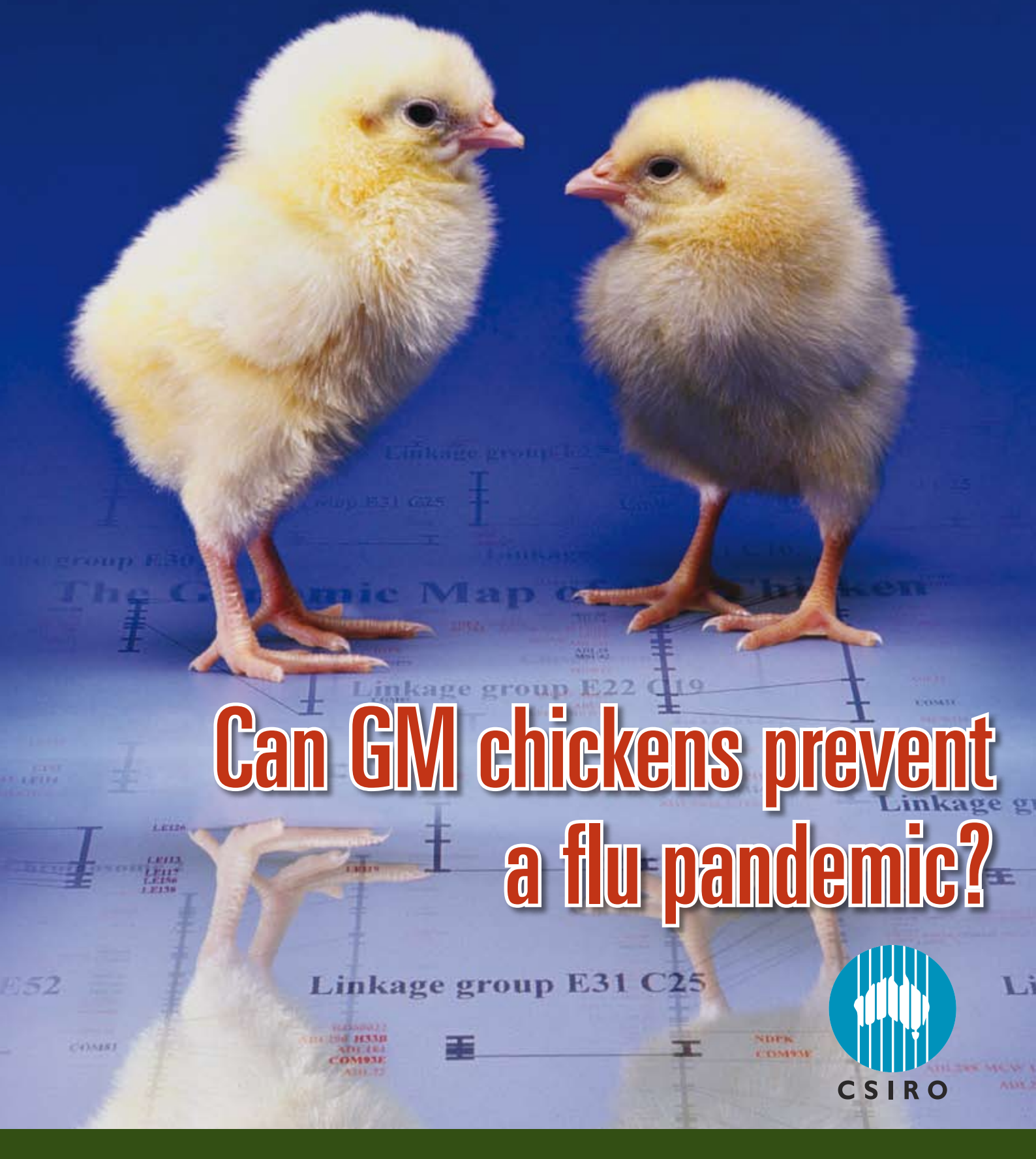

Can GM chickens prevent a flu pandemic?

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Livestock Industries

CSIRO Livestock Industries provides research solutions to enable Australia's livestock and allied industries to be globally competitive

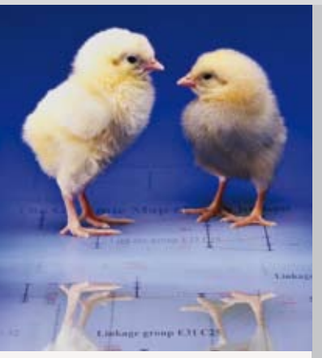
KEY CONTACTS

DR CHRIS PRIDEAUX
BSc (Hons) PhD
Deputy Chief, CSIRO Livestock Industries
Tel +61 7 3214 2517
Chris.Prideaux@csiro.au

DR MARTYN JEGGO
B. Vet Med. MSc PhD
Director, Australian Animal Health Laboratory (AAHL)
Tel +61 3 5227 5160
Martyn.Jeggo@csiro.au

DR JACK MALECKI
BMedSc (Hons) PhD
Director, Business Development & Commercialisation (BD&C)
Tel +61 3 5227 5028
Jack.Malecki@csiro.au

DR PETER WILLADSEN
BEcon BSc (Hon) PhD
Chief Scientist
Tel +61 7 3214 2467
Peter.Willadsen@csiro.au



Livestock Horizons

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Subscribe by email to enquiries@csiro.au

The Editor, Livestock Horizons
CSIRO Livestock Industries
Queensland Bioscience Precinct
306 Carmody Road
St Lucia QLD 4067
Tel +61 7 3214 2200
Fax +61 7 3214 2900

Cover: *Artwork by Frank Filippi based on a chicken genome photograph by Peggy Greb, courtesy of the Agricultural Research Service, United States Department of Agriculture. The chicken is the first bird to have its genome sequenced. Recent of outbreaks of bird flu have accelerated scientists' interest in the chicken genome to gain a better understanding of how genetic variation may play a role in developing different strains of the disease. Information from the chicken genome will help scientists better understand basic developmental biology, as well as improve vaccine production models. A team led by Richard Wilson, from the Washington University School of Medicine in St. Louis successfully assembled the genome of the Red Jungle Fowl, Gallus gallus, which is the ancestor of domestic chickens. Like humans, the bird has between 20,000 and 23,000 genes. But it has only 1 billion DNA base pairs compared to our 2.9 billion pairs. This indicates that humans share about 60 percent of their genes with the chicken, while humans and rats have 88 percent of their genes in common. The reduced number of base pairs in the fowl genome results in part from chickens possessing less so-called "junk DNA" than humans do.*

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Banish no-risk GM messages

Public concern about the use of GMOs (genetically modified organisms) is not confined to food safety but includes worries about the uncontrollable spread of pests and diseases, possible effects on wild fauna and flora, and loss of biodiversity.

The basis for this concern is essentially uncertainty, the feeling that we cannot know the long-term consequences of such novel technologies.

Technologies are neither safe nor unsafe. It is the product and how it is used that should be the focus of attention.

Unfortunately, over the past decade, scientists have found themselves in breach of public trust over several issues.

For 11 years, leading scientists stated that BSE (mad cow disease) was specific to cattle and did not pose a threat to humans. However, this was a conclusion reached beyond the available data and knowledge. Rather than attempt to create an impression of absolute certainty, scientists should have said "we don't know".

Within the post-BSE climate, the safety assurances of scientists over GM food have fallen onto very sceptical ears.

We must banish messages implying that there is no risk.

We need to say there are no absolute guarantees of safety with GM, then put into place stringent monitoring and regulatory practices to ensure that if a problem does arise, it can be quickly identified and managed like all other risks in society.

Professor Louise Fresco of the Food and Agriculture Organisation makes a similar point on page 9 of this magazine. She comments that with countries such as China, India and Brazil investing heavily in GM products, there is no going back to a pre-GM era.

Agriculture is a global enterprise and GM is here to stay.

Rather than stay out of the debate, the international science community needs to work together to ensure this new technology is appropriately monitored and regulated.

Unless this is done in a collaborative and open fashion, the risk is that potential safety issues relating to GM products will not be reported and, thus, the appropriate action might not be taken.

While the currently identified risks posed by GM foods may be small, it is the unidentified risk that causes fear amongst the public.

We cannot promise zero-risk but with a sound risk management process, we do not need to fear the technology.

Mr Shaun Coffey
FTSE FAIM FAICD
Chief, CSIRO Livestock Industries
Tel: +61 7 3214 2390
Shaun.Coffey@csiro.au

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Dr Laurence Tiley

Feature

Bird flu: can GM prevent the next pandemic?

Avian flu threatens the Thai poultry industry. Photo: Paula Bronstein, Getty Images

As the world awaits the next influenza pandemic, Cambridge University virologist Laurence Tiley believes it would take only four years to completely replace today's farmed chickens with genetically modified breeds fully resistant to bird flu.

"The tools to make poultry resistant to flu infection already exist," Dr Tiley told CSIRO's Horizons in Livestock Sciences conference in October.

"We have three of what I think are really promising transgenic strategies to suppress virus replication in cell culture systems," he says.

"We have shown that we can inhibit the activity of the virus using these strategies."

Following laboratory tests, the technology is now being introduced into chickens.

If shown to be successful in chickens, it is possible that two well-characterised flu-resistant transgenic chickens could then be expanded to replace a significant proportion of the world's broiler chicken population in as little as four years.

However, Dr Tiley said, overshadowing the technical challenges was the issue of persuading the public of the potential benefit of genetically modified food.

The bird flu threat

Avian influenza, or bird flu, is an accomplished species jumper.

The natural hosts of bird flu are aquatic shorebirds, such as ducks and geese. In its natural host, the virus is very stable.

However, when the virus jumps into a new species it can become highly pathogenic to its host. This characteristic is evident in the case of another virus, SARS, which became highly pathogenic when it jumped species from its natural host (see story on page 17).

Upon entering chickens, the flu virus is not well adapted to its new host. High levels of natural variation in the virus can result in the propagation of variants able to reproduce more successfully and potentially jump into other species.

Pigs are a route of bird flu infection in humans. Pigs can catch both avian and human influenza, enabling the viruses to mix, creating new and potentially dangerous strains.

Chickens also act as "amplifiers" of the virus, massively increasing the level of exposure of humans to these new strains.

H5N1 is a strain of avian influenza responsible for the current outbreaks of highly pathogenic bird flu. According to the World Health Organisation, never before in the history of this disease have so many countries been simultaneously affected, resulting in the loss of so many birds.

Prior to the 1997 H5N1 outbreak in Hong Kong, which claimed the first human lives, resulting in six deaths, it was thought that birds and humans were separated by a strict species barrier, preventing direct infection.

Because pigs could catch both bird and human flu, it was assumed pigs were the 'mixing vessel' between birds and humans, providing the opportunity for genetic reassortment of the virus into potentially new deadly strains which could then be passed back to humans.

"The rather rude awakening we received in 1997 was that chickens could provide a direct bridge to humans," Dr Tiley says.

When humans have caught the H5N1 virus from chickens, the virus has proved highly pathogenic, killing 50 percent of the people it has infected.

Since the first outbreak of H5N1 in 1997, more than 60 people have died.

At present, however, transmission of H5N1 from chickens into humans is very infrequent and there is no evidence of efficient person to person transmission.

"But this is what we are all waiting for and dreading," Dr Tiley says.

"I think it is absolutely guaranteed that we will have another pandemic, probably within the next 10-15 years."

Estimating the impact of the next pandemic is difficult because viruses behave differently.

One of the unusual features of the 1918 pandemic was that the virus tended to kill people of a relatively young age, whereas flu normally concentrates its mortality in older people.

In 1918 the average age of death in the United States dropped sharply to 35 years. In comparison, neither world war last century had any impact on the average age of death in the US.

The mortality rate for the Spanish flu pandemic of 1918 is estimated to be about two percent but the virus still managed to kill 50 million people in a single year. It is estimated the percentage of the population in 1918 infected with Spanish flu was between 25 and 90 percent.

"This was before the era of intercontinental flight," says Dr Tiley.

"Now with H5N1 we have a virus with a mortality rate of 50 percent," Dr Tiley says.

"The figures for a 'worst case scenario' are absolutely staggering."

"Scientists might be accused of 'crying wolf' but we just cannot afford to be complacent."

Dr Tiley said to eliminate the risk to humans, or reduce it to an absolute minimum, getting rid of major routes of infection via chickens and pigs was essential.

A global problem

The latest models estimate that a H5N1 pandemic could cost the global economy $166 billion.

This figure, however, is based on a moderate pandemic with low mortality, such as the 1968 Hong Kong flu pandemic (which still killed approximately one million people) and not a severe pandemic like the Spanish flu.

The successful containment of the 2003 outbreak of another bird flu strain, H7N7, in the Netherlands required the slaughter of 30 million chickens.

"This was quite expensive but at least did control the outbreak," Dr Tiley says.

"Currently we have 150 million chickens being slaughtered in Southeast Asia and we have not got on top of the outbreak at all."

Contact in Asia between free-ranging poultry and water contaminated with virus-laden faeces from shorebirds, the primary hosts for influenza, is the most common route of infection.

Low pathogenic strains of the virus occur naturally in shorebirds but when these low pathogenic strains jump into chickens they can evolve into highly pathogenic strains. These strains have then passed back to shorebirds, causing not only high mortality rates but also the potential for shorebirds to transmit the virus.

With a migratory bird population, there is the potential to transmit the virus considerable distances around the world.

Dr Tiley said the notion that virulent strains of the virus would kill infected migratory waterbirds, limiting the spread of potential pandemic strains, was unduly optimistic.

"Even though you have a mortality rate of around 95 percent with the virus in shorebirds, you still have five percent of birds that survive, or you might have birds with the virus in an incubation phase."

Preventing a pandemic

How, then, do we protect ourselves against the next pandemic?

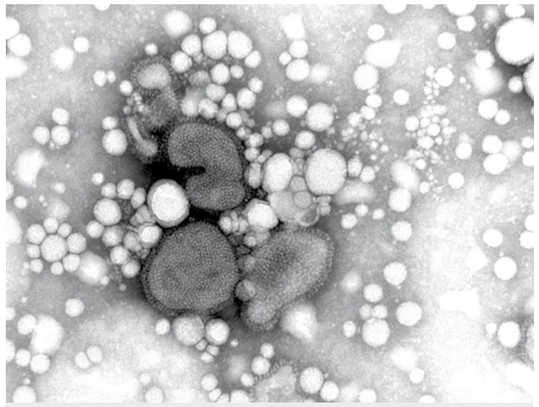
"Certainly improving farming practices would be a good place to start," says Dr Tiley.

"Chickens, ducks and pigs should not be kept in the same farming environment."

Dr Tiley said vaccinating poultry was a "double-edged sword" because it does not provide full immunity. Rather, the virus is pushed down to a sub-clinical level, that is, the virus is still present but does not cause disease.

"This helps producers but it is no way to stop an epidemic, because the virus is still circulating in poultry flocks."

Mexico's poultry industry suffered a major epidemic of avian influenza more than a decade ago and has still not eliminated the virus, despite an intensive vaccination campaign.



Avian influenza viruses replicating in egg allantoic fluid. Photo: AAHL EM group

Another approach is to engineer flu-resistance into chickens by selective breeding or by transgenesis (GM).

Dr Tiley described three promising transgenic strategies for developing flu resistant chickens.

One is based on a natural anti-viral protein, Mx. The Mx protein is naturally expressed by many vertebrates in response to a broad range of viral infections. It strongly inhibits infection by suppressing the virus' transcription and viral replication. However, the Mx protein is inactive in most modern chicken breeds. Engineering chickens with an "always-on" Mx gene might be detrimental to their welfare, so the strategy would be to make expression of the gene in chickens contingent on influenza infection.

Humans also express the Mx gene but still catch flu. This is because the virus has developed techniques to suppress the host's natural response to it through the expression of a protein known as NS1. Therefore, another protective strategy would be to engineer chickens with a RNAi (gene silencing) transgene to knock down the virus' expression of several virus genes, including NS1.

The third approach involves introducing a transgene that would produce 'molecular decoys' to keep the virus' RNA polymerase molecules from transcribing other viral genes. Experiments have shown that a transgene can act as a decoy, disrupting viral replication.

Delivering any of these transgenes into chickens is a challenge but recent advances have solved most of the technical problems involved.

The same technology could also be used to engineer flu resistance in turkeys, ducks and pigs.

"Why stop there," Dr Tiley asked. "You could also use it to engineer resistance to Marek's disease and Newcastle disease."

GMO – a four letter word

Public opposition to GM foods is an obstacle to producing transgenic flu-resistant chickens. If the public refused to eat GM chicken, there is little chance the technology would be adopted.

"The concept of GM animals is almost universally unpopular in just about every country, with the UK probably the most hostile towards transgenics," Dr Tiley says.

"There are a lot of misconceptions out there."

In one recent survey, it was found that 60 percent of Americans did not realise tomatoes contained any genes. Other popular misconceptions included the belief that if a person ate a genetically modified food product, it would modify their own genes, while others thought a tomato modified with a fish gene would 'taste fishy'.

"With this level of misconception about GM, it's not surprising the public are going to be hesitant about accepting it," Dr Tiley says.

He said anti-GM proponents were able to "stir up" concerns in the public about any risk associated with GM, "however infinitesimally small" it may be.

"Public education is vital," he says.

"You need credible sources of information and scientists have clearly a very important role to play in this regard."

However, he said, there was a "distressing" level of public distrust and cynicism of politicians and scientists – for which "the BSE crisis appears to be largely responsible".

Dr Tiley said there were some risks associated with GM technology.

"Where I think there is a potential risk with flu-resistant GM chickens is that if we don't achieve 100 percent protection against flu infection, we may end up with a population of birds where you get a sub-clinical infection," he says.

Dr Tiley said the arguments for using GM to breed flu-resistant chickens from a human health, animal welfare and economic perspective were strong.

He said it could take six years to trial the technology in chickens and repopulate broiler stocks with disease resistant chickens, "if we started now".

However, in a pandemic situation, this may be too late.

"If we do have another pandemic, I'm sure it would focus people's attention on what the real risks are."

By Margaret Puls, CSIRO

Protecting Australia against bird flu

Paul Selleck, researcher at AAHL

CSIRO Livestock Industries' Australian Animal Health Laboratory (AAHL) performs two vital functions in protecting Australia against the spread of bird flu – in disease diagnosis and research to assist with the prevention of the spread of bird flu into poultry.

AAHL, Australia's national laboratory for the diagnosis and surveillance of animal diseases and emergency disease outbreaks, is one of the most sophisticated laboratories in the world for the safe handling and containment of animal diseases.

AAHL's expertise is recognised internationally through its designation as an OIE (Office Internationale des Epizooties) Reference Laboratory for Avian Influenza and an OIE Collaborating Centre for New and Emerging Diseases – the only such facility designated internationally. The laboratory plays a key role in the Southeast Asian region. Construction of an additional Diagnostic Emergency Response Laboratory (DERL) within the secure section of AAHL has commenced. This will enhance AAHL's capacity to process samples more quickly.

Vaccines

AAHL's bio-containment capability has allowed it to play an important role in testing the efficacy of vaccines and antivirals. AAHL scientists are working on the development of new generation vaccines, and in applications of biotechnology for "flu-proof" birds.

Diagnostics

AAHL has received isolates of the current H5N1 HPAI (highly pathogenic avian influenza) from Southeast Asia and made samples available to the World Health Organisation Collaborating Centre in Melbourne. AAHL has fine-tuned Australia's rapid diagnostics to detect these strains and tested the efficacy of a number of vaccines in chickens and ducks.

Pathology of the disease

AAHL has developed models of bird flu infection in both chickens and ducks. Present work is showing that Australian wild water fowl also suffer fatal disease – information important for surveillance planning. Molecular analysis of bird flu viruses is crucial to assessing pathogenicity, the likely geographic origin of the virus, whether it might be mutating in ways of concern, and whether it might have developed resistance to antiviral drugs.

For more information contact:
Dr Martyn Jeggo,
Director, Australian Animal Health Laboratory
Tel: +61 3 5227 5160,
Martyn.Jeggo@csiro.au

CSIRO drug effective against bird flu

Relenza™, the world's first effective influenza treatment, developed from CSIRO research, has shown to be effective in laboratory tests against the H5N1 bird flu virus.

The tests undertaken by CSIRO Molecular Health and Technologies researcher Dr Jennifer McKimm-Breschkin, showed Relenza™ inhibited the virus enzyme neuraminidase, which is needed by the virus to spread from cell to cell.

CSIRO's Dr Peter Colman and Dr Jose Varghese identified that a small region in the neuraminidase protein was identical in all strains of influenza. Using this data, Relenza™ was developed to bind onto this part of the virus and prevent the virus multiplying.

Clinical trials with human influenza strains showed that for maximum benefit the drug needs to be taken within 1-2 days of the first signs of infection. It is inhaled which targets directly to the site of infection, the respiratory tract.

While available for human use, Relenza™ is unlikely to have any application in the poultry industry.

Relenza™ is based on fundamental research conducted at the Australian National University, CSIRO and Monash University from the late 1970s.

For more information contact:
Dr Jennifer McKimm-Breschkin,
Tel + 61 3 9662 7257,
Jennifer.McKimm-Breschkin@csiro.au

Cornell virologist to study at AAHL

Cornell University virologist Ton Schat will commence a six-month study project investigating a disturbing genetic mutation in the bird flu virus at CSIRO's Australian Animal Health Laboratory (AAHL) in April 2006.

CSIRO's Australian Animal Health Laboratory

Dr Schat is a professor of avian virology and immunology at the College of Veterinary Medicine. In collaboration with the US Centres for Disease Control's influenza branch, Dr Schat will study an observed change in a gene in the highly virulent avian influenza H5N1 virus and how that change influences the virus's virulence in chickens and ducks.

For more information contact:
Dr John Lowenthal,
Tel + 61 3 5227 5759,
John.Lowenthal@csiro.au

GM and risk management

An expert panel debates issues in livestock sciences

L-R: Louise Fresco, Chris Delgado, Thomas DeGregori, Paul Thompson, Margaret Gill, Margaret Alston

MAGGIE GILL

Chief Executive & Director of Research, Macaulay Institute, Scotland

Scientists need to be asking the questions to make sure our own governments are asking the right questions and not leaving it to the public to ask the questions.

PAUL THOMPSON

WK Kellogg Chair in Agricultural, Food and Community Ethics, Michigan State University, USA

In risk analysis one of the critical types of research needed is human factors research.

With GM, for example, we had an incident where some transgenes were found in Mexican maize. Fortunately, it appears that this is not something that has become permanently established. In Mexico, it is legal to sell transgenic corn for animal feed; it's just illegal to grow it. It became clear that Mexican farmers were growing some corn they had purchased. We had many risk analyses on pollen flow and all kinds of biological mechanisms but no one asked the question: 'if you are selling animal feed, what is the likelihood that a farmer is going to buy some and try to grow it?'

This is the human factor, looking at human behaviour as it relates to the spread of risks. Although clearly the biological work is critical, unless that research is also augmented by studies of how human beings are going to handle sensitive material, a lot of the risk research comes to naught.

THOMAS DEGREGORI

Professor of Economics, University of Houston, USA

A lot of our risk analysis is about analysing things that aren't risky and I think the transgene in Mexico is an example of this. We are dealing with a larger climate of fear and this leads us to ask wrong questions when undertaking risk analyses.

In the US we have literally spent billions of dollars pursuing non-existent risks. We've got a whole series of public debates going on about things that aren't risky. Some of them deal with livestock, some of them deal with GM. Continuing to ask the wrong questions is not only going to get us the wrong answers but waste a huge amount of resources pursuing answers to meaningless questions.

One of the problems is that many people have an idealised picture of agriculture as it once existed which, in fact, never existed. Most of the students in my class think pesticides weren't used until the era of modern synthetic pesticides. They don't realise that in the past we used arsenic, we used copper sulphate. In fact, we still use copper sulphate in organic agriculture because we think it is "natural". But there have been articles published in microbiology journals which show that bacterium develop resistance to antibiotics because of copper sulphate.

The question is 'how do we move forward with sustainability and minimal toxicity for consumers' and not try to go back to something "purer" and "finer" that never existed.

PAUL THOMPSON

WK Kellogg Chair in Agricultural, Food and Community Ethics, Michigan State University, USA

There's a philosophical and ethical dimension to the most basic elements of risk analysis. One of the great problems that we have in the US is this notion that risk analysis, at least in the early phases of hazard identification and exposure quantification, is a purely scientific process. In order to have a risk analysis, you have to decide that there is something bad going to happen, something that you want to avoid. Some of the difficult issues, and I think GM is a case in point, involve subtle kinds of value judgements. 'Is a beer can in the woods a bad thing?' Most Americans would probably think so, but until the can causes some other impact on wildlife or ecological processes, it is difficult to see why that is a bad thing. Is a transgene in a wrong place a bad thing? Is it a pollution event in and of itself? I think most Americans would probably react to a transgene in the wrong place pretty much as they would a beer can in the woods. They would see it as a bad event in and of itself. I think there has to be a philosophical element built into the early stages of risk analysis and this pretence that risk analysis is purely a scientific process has to be dropped.

LOUISE FRESCO

Assistant Director-General, Agriculture Department, Food and Agriculture Organisation, Italy

I sense that more and more in our OECD developed countries, the question is not so much one of risk analysis but the demand of an increasingly vocal middle-class for zero risk. In many of our societies, we have a group of people who have grown up after the Second World War, have never really seen major issues of death or poverty and who believe that a happy and healthy life is a universal human right. I do not mean this to criticise, but I think it is these groups asking for zero risk and who probably do not always understand that risk is 'probability times impact'. Such a thing as zero risk does not exist.

To me, risk is always an issue of choosing between different options, choosing between the different costs that different technologies may bring about. In the GM case, the question that many developing countries ask is 'why should we refrain from using GMs if we feel that the risk is so small compared to the benefits it would give our countries?' Whether you agree or disagree, the issue is definitely that we cannot impose a universal Western view of risk analysis on the world.

When it comes to avian influenza and other problems, the issues of food and animal diseases are global problems. Hence there is not such a thing as an individual's risk, or an individual country's risk. There is a universal global planetary risk that needs to be dealt with in a global manner. We do not have a world government that decides on issues of risk or what we should do, or how we control flows of people or flows of research funding. I don't think the UN is the best place to decide on research funding but it is the place where we are slowly getting governments together to make collective decisions. However, we are really lacking a world body that takes these decisions in emergency situations. While the risk and food issues have become global, our modes of operation have not.

In countries like China, India, Argentina, Brazil and South Africa, GM is now a feature of their agriculture. We cannot go back. It is the fastest growing area of agricultural research and agricultural application. There may be countries willing to keep out of the debate but internationally GMs are here to stay and this will determine the demand for products. The impact that China alone is making on the GM issue is such that you cannot ignore it anymore.

Now that GM crops are grown on large areas in these countries we should be concerned about regulatory issues and the monitoring impact. We do not have great protocols on monitoring the environmental impact of GM cotton, for example – the effect it has on the ecology, soil or organic matter, decaying leaves and debris. Does GM cotton have any effect on soil, flora and fauna? We don't know. If we do not have internationally agreed monitoring and reporting systems and a transparent database, it concerns me that there may be things happening out there relevant to risk analysis that we do not have access to.

We need internationally sound, scientifically-based agreements on what we monitor, how we report on it, and how countries will deal with it.

CHRIS DELGADO

Director – ILRI-IFPRI Joint Program on Livestock Market Opportunities, International Food Policy Research Institute, USA.

If you take pollution for example, no one thinks the optimal level of pollution is zero. With avian influenza, do we believe zero risk is achievable? Many people would say yes. Presumably the way to achieve this is to kill off all the chickens, maybe the wild birds and ducks too. Eventually, you could be fairly certain of getting rid of the disease. Where you play out the trade-off is a critical issue, and one that needs to be informed by science and governed by political legitimacy.

I think the question is what forum or organisation allows you to have open discussion of risks versus benefits? The danger is that one group or another will take hold of the debate. For example, on the issue of avian influenza, I am very concerned about the human risks but I'm also concerned that if you eliminate poultry from small holders, probably a lot more people are going to die from this. You need to factor this in when developing a response.

- This is an edited extract of a panel discussion from CSIRO's Horizons in Livestock Sciences conference, 3 October 2005. Any errors are the responsibility of the Editor.

Feature

Super rubber created from genes of insects

In a world first, CSIRO scientists have copied nature to produce a near-perfect rubber from resilin, the remarkable elastic protein that facilitates flight and jumping in insects.

This important research breakthrough was reported in the respected international journal *Nature* (13 October 2005).

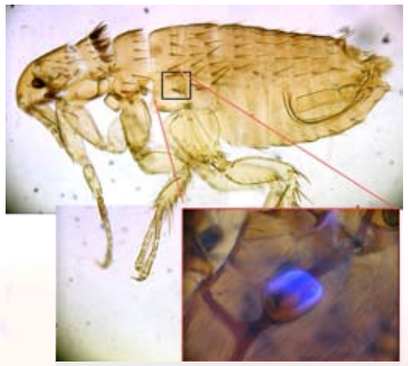
Resilin has a near 100 percent capacity to recover, or "bounce back" after stress is applied and the material's extraordinary durability may have applications in industry and medicine. It could even be used to add some extra spring to the heels of sport shoes.

Resilin is the substance which gives fleas and spittlebugs their extraordinary jumping ability. If humans could jump like fleas, we would be able to leap 100 storey buildings.

The durability and elasticity of resilin aids insects in flight, enabling bees to flap their wings in almost frictionless motion 500 million times in a lifecycle.

"Resilin is the most efficient elastic protein known," says CSIRO Livestock Industries principal scientist, Dr Chris Elvin, who leads the resilin project.

"It has evolved over hundreds of millions of years in insects into a highly efficient material. Everyone knows fleas jump like crazy, but how do they do that?"



Flea image showing location of its resilin pad by Darren Wong and Dr David Merrit.

Elastic proteins occur in a wide range of biological organisms. These proteins exhibit rubber-like elasticity, undergoing high deformation under stress without rupture, and recovering to their original state when the stress is removed.

Apart from flight and locomotion, resilin is used for other functions where efficient energy storage and repetitive movement are required, for example, in the sound-producing organs of cicadas and moths.

Dr Elvin believes that resilin may have application for spinal disc implants, heart and blood valve substitutes or for industrial applications such as high efficiency rubber, microactuators and nanosprings.

"Spinal disc implants need to last for 100 million cycles, which is roughly how many times we move our back in a lifetime," Dr Elvin says.

"We know resilin can last that long."

For Dr Elvin, the resilin project – which has led to three international patents, with a fourth in process – is the result of nearly four years of research.

"I came across resilin some time ago and started reading the literature on this fascinating protein," says Dr Elvin.

"No one had ever reproduced a material which displays a number of mechanical and physical properties of native resilin in the lab."

Dr Elvin's research team has achieved a number of firsts in the process of extracting resilin from insects to produce a new super rubber.

The team was the first to clone a portion of the 'resilin gene' in *Drosophila melanogaster* (fruit fly) and express it in bacteria as a soluble protein.

"In a way, 'pulling out the gene' was the easy bit," says Dr Elvin.

The team had, for the first time in the world, produced a purified resilin protein – but in a soluble form.

"However, we needed it in a solid form to be able to do anything with it," says Dr Elvin.

This process proved more difficult for the researchers, who used a number of methods before finding success with a rapid photochemical method that produced a solid rubber material.

Structural testing of this material showed that it displayed near perfect resilience (97%), far exceeding that of synthetic polybutadiene 'superball' high resilience rubber (80%) and outperforming elastin (90%). (Elastin is an elastic protein in humans which accounts for the elasticity of structures such the skin, blood vessels, heart, lungs, intestines, tendons, and ligaments).

Float like a butterfly, jump like a flea

The research team also demonstrated that resilin is only produced in the pupal stage of insects and, therefore, must last a lifetime of insect motion extension and contractions.

"The pupal stage of insects is when all the adult tissues are laid down," says Dr Elvin.

"The resilin gene is turned off in adults and there is no way of renewing their supplies. Resilin must also survive for the entire lifetime of the organisms."

Now the CSIRO team is exploring alternative methods of producing artificial resilin material.

"Producing resilin out of an insect is not the important thing – the important thing is the concept, the ideas – the molecular detail of how this works," Dr Elvin says.

CSIRO scientists are using the patented techniques to produce other biopolymers like resilin that display potentially useful properties.

"There are a whole range of projects that could be spun off from this work, it's very exciting," says Dr Elvin.

With scientists now in a position to harness the properties of this remarkable natural material, it would seem the buzz about resilin is only beginning.

By Margaret Puls, CSIRO

Dr Chris Elvin with a strip of resilin rubber in CSIRO's Queensland Bioscience Laboratories – photo by Frank Filippi, CSIRO. Top left: Dragonfly and a UV-illuminated rod of resilin. Artwork by Dr David Merritt, David McClenaghan, Dr Nancy Liyou, Ted Hagemeijer

Behind the resilin story

The design of compounds that replicate the exquisite functionality of nature represents an exciting emerging technology.

Four Divisions of CSIRO have contributed to the resilin project which was funded by a CSIRO Emerging Sciences grant in Nanotechnology.

These are Livestock Industries (project leader); Textile and Fibre Technology, which has undertaken the testing of the properties of the material; Manufacturing and Infrastructure Technology, which has undertaken research characterising the molecular structure of the material and Molecular and Health Technologies, which is testing the biocompatibility and molecular structure of resilin peptides.

Other key collaborators include University of Queensland, Australian National University and Monash University.

Float like a butterfly, jump like a flea

- The froghopper – a type of spittlebug – holds the Guinness World Record for highest jump by an insect. When the froghopper jumps, the insect accelerates at 13,000 ft (4,000 m) per second and overcomes a G-force of more than 414 times its own body weight.
- Fleas can easily jump a hundred times their body length at any given moment. This is achieved due to the flea's internal structure, called a pleural arch, which is constructed of resilin. A flea can jump 600 times or more in an hour while it searches out a host.
- Resilin consists of cross-linked protein chains. It has no regular structure but its randomly coiled chains are crosslinked by di- and tri-tyrosine links at just the right spacing to confer the elasticity needed to propel some jumping insects prodigious distances.
- Resilin is capable of absorbing the force applied to it as well as releasing the entire energy back once that force has been released. In insect flight, approximately 85% of the energy used to lift the wing is stored and reused while lowering it. The insect's chest walls and muscles are also built to aid in this process.
- Resilin is a member of a family of elastic proteins that includes elastin, as well as gluten, gliadin, abductin and spider silks.

Of Martians, men and agriculture

Challenges for agriculture and society

Horizons in Livestock Sciences
Redesigning Animal Agriculture
2 - 5 October 2005
Gold Coast International Hotel, Queensland, Australia

By Dr Andrew West
Chief Executive, AgResearch New Zealand

Dr Andrew West

The concept of absolute food security has been assumed by many developed nations or societies as a complete given into the future.

I personally believe that this high degree of comfort has eventuated since the development of nuclear weapons and, in conjunction with these weapons, substantial and enduring political alliances.

Belief in total food security has largely come about as a major ramification from these weapons removing the ability of one developed nation to blockade another.

In the United Kingdom, the presumption that absolute food security is so great that farming the landscape for the principal utility of urban recreation rather than food production, would appear to be steadily gaining momentum.

When people believe that food will always be available, and cheaply available, their views on agriculture and what is right and wrong with agriculture, radically change, with this expectation of change it would seem being at its greatest in their own back yards.

Practices and standards for production, environmental management and animal welfare dramatically rise in a fashion that would probably collapse if food security was genuinely threatened, or if prices of food rose steeply and sharply.

In the farm of the future, the theme of CSIRO's Horizons in Livestock Sciences conference in 2006, should we be at all concerned about food security? It certainly is an issue in the developing world.

Another issue I see in discussion about agriculture is the pervading and pervasive anthropogenic analysis of agriculture.

I suppose this is inevitable, speaking as one naked ape to another, but reflect on this. HG Wells in his novel *The War of the Worlds* was one of the few science fiction authors ever to paint the behaviour of aliens – Martians actually - in the exact fashion of humans. Humans came under a relentless, technologically-sophisticated reign of extermination and exploitation by Martian-controlled tripods.

As a lapsed ecologist I would argue that there is little difference between a Martian tripod and a human D9 bulldozer. Both exterminate or create the means to exploit most other terrestrial species in a ruthless and relentless manner.

So, I feel compelled to ask just how much of the world's resources do humans want to consume? How much of the solar energy? How much of the nutrients? How much of that most valuable of all resources to us landlubbers, freshwater? How much of the land and how much of the coastline? And how fast do we wish to continue to exterminate fellow pilgrims – all the other species - on planet earth?

When people believe food will always be available, their views on agriculture change.

How do we reconcile nine billion humans within 50 years (that's 50% more than now) with biodiversity, that is, with the so-called rights of other species to exist and consume – not that they actually have any absolute rights.

In that regard, will humans want to continue to farm livestock? Can and will biotechnology provide us the opportunity to live by plants alone? Or, if we want the real thing – animal protein – will it be produced synthetically in robotic factories?

Is this the animal protein farm of the future?

The curse on science (on science, not of science) is the absolute faith humans have that science and technology will always get our species out of the complete mess it regularly gets itself into.

Well, in my view, that is blind faith. Whilst the well-fed, wealthy and healthy fret over some aspects of the environmental impacts of farming (principally those aspects that impact on human health or human recreation) are we not fiddling whilst Rome burns?

The big picture in the paleontological record is that of the five climate change-induced mass extinctions of the Ordovician, Devonian, Permian, Triassic and Cretaceous.

We've now begun a major extinction event primarily caused by intelligence commanding the use of vast acreages of land (amongst a raft of other causes), yet perhaps we risk triggering a sixth mass extinction event caused by climate change, aided and abetted by continued deforestation for agriculture.

Once started this change may be impossible to reverse. For example, within 50 years it now seems highly likely that the ice cap on the North Pole will have entirely disappeared. It is likely that actions taken (few though they are) are unlikely to stop this signal event, with its incipient feedback loops forcing further climate change.

As scientists associated with the feeding of humans, and in that process consuming far, far more of the landscape than any other human activity, I believe we have a growing obligation to paint the absolute and relative limits of science to resolve all human desires.

I would argue there is little difference between a Martian tripod and a human D9 bulldozer

I also believe we have a growing responsibility to articulate the particular realities of food production about which some middle-class demands may not be possible to achieve or reconcile.

To conclude, the consumer is <u>not</u> always right. Whilst we can and should within livestock farming raise the standards of animal welfare and reduce environmental impacts (including non-anthropogenic impacts) I think it is essential that we create a debate in the following contexts:

- The global impact of livestock farming relative to other human activities, such as consuming high density energy – it is surely not "reasonable" to demand massive reductions in climate change gases from agriculture whilst so many of us refuse to use public transport
- That we can't just export the problems of food production out of sight and out of mind by importing large amounts of food if we wish to assume true responsibility for the planet and its biodiversity
- That humans are, in fact, biological entities and thus need to eat, and that livestock farming is in fact the exploitation of other mammals that helps us to do so in a fashion that we enjoy
- That, to meet the material aspirations of nine billion humans whilst maintaining a moderate element of biodiversity, we are in fact going to have to rely on extensive use of biotechnologies because these technologies will allow us to produce more from a given area of land and thus have the propensity to contain the demand for yet further deforestation with its incipient reduction in biodiversity

The list could go on, but there are some truths or at least implications that our societies need to acknowledge and I think we have a role as scientists and scientific organisations – notwithstanding the possible jeopardisation of contract research funding by so doing – to point this out.

The above comments from a closing address to CSIRO's 2005 Horizons in Livestock Sciences conference are the personal views of Dr West.

Would you like your steak medium, rare or stem cell?

Dr Greg Harper

Will future generations be appalled to learn that as late as the 21st century humans killed animals for meat? Will tomorrow's consumers grow their own meat in an appliance on the kitchen bench? Is there such a thing as victimless meat?

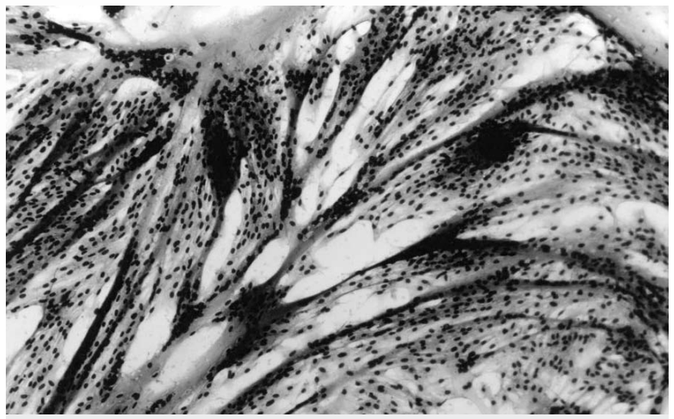
Use whatever cliché you like – stem cell steak, test tube t-bone, slaughter free meat, *in vitro* or cultured meat – the fact is the technology exists to grow meat in a laboratory.

While the idea has been around for 70 years, it was medicine that ultimately drove tissue engineering technology, with space travel behind its most recent application in food. Theoretically the world's annual meat supply can be grown from a single cell.

In 2002, NASA-funded US scientists were the first to successfully grow meat in a laboratory. The Dutch Government recently announced an AUS$7 million project, co-sponsored by the meat-processing industry, to produce edible meat in an industrial setting. Dutch scientists hold a patent for a technique to produce processing meat in the laboratory.

This technique uses special cells that live at the edges of muscle fibres and help repair damaged muscles. However, these cells won't survive unless they are attached to something.

For large scale production, scientists envisage the use of a collagen meshwork carrier for the cells. This is then placed in a bioreactor, soaked in a culture medium and subjected to a number of environmental cues. The cells proliferate and fuse into a tissue that could be harvested and turned into sausages or hamburger patties.



Microscopic image of turkey muscle cells grown in culture. Photo: Douglas McFarland, South Dakota State University

While this technique appears technically feasible, significant challenges remain before it can be produced economically.

Skeletal muscle consists of several cell types and to replicate the taste and texture of unprocessed meat, such as a piece of steak, these different cells types would need to be organised in a three-dimensional structure, subjected to growth hormones at the appropriate time and stretched in some way to replicate animal movement. Suffice to say that stem cell steak will not be on the menu any time soon.

While CSIRO is active in stem cell research, it believes the real future for this science lies in understanding the technology in animals, rather than attempting to replicate what animals do.

According to Dr Greg Harper, Breed Engineering Leader with CSIRO's Food Futures Flagship, there is currently a lot of research activity around defining markers for stem cells.

"While past research has been done on embryonic stem cells, in the last year, scientists have realised you can actually obtain stem cells with almost the same activity as embryonic stem cells from adults – from any tissue source, particularly blood, bone marrow and even fat," he says.

"But at the moment, if you have a cell sitting under a microscope, the only way you can tell whether it is a stem cell is to do a functional assay. That means you divide the cell a couple of times and see what it becomes. Then you can tell whether or not you *had* a stem cell, which is not as good as saying you *have* a stem cell.

"The research focus now is to develop stem cell markers, which can be genes, proteins or even structural characteristics. These are early markers of what cells you have and from there you can start to research applications.

"A lot of this early work has been done in mouse and man. CSIRO aims to take the stem cell marker technology developed in these species and apply it to cattle and sheep."

Stem cell technology used in animals has great potential to assist Australian livestock producers to remain globally competitive. According to Dr Harper, there are good opportunities in our Japanese beef market, which pays a premium for marbled beef.

Stem cell technology will assist Australian livestock producers maintain competitiveness.

"In young cattle destined for Japan, we don't know which ones are going to marble. Marbling is a result of stem cell activity. The gene markers already developed by CSIRO and collaborators, and available commercially do tell some of the story as to how animals become marbled. The rest is stem cell based," says Dr Harper.

"Perhaps if we could count the number of stem cells in muscle tissue, we would be able to understand more about marbling. For example, if an animal has a lot of stem cells, we might be able to predict it will marble more than others, providing it also has the right genetics. Perhaps we could time nutritional supplementation with a view to influencing the number of stem cells that develop later in life."

Dr Harper says within five years scientists will have developed a method of counting stem cells in tissues. Throughout this process, methods of influencing the number of stem cells will have been identified. However, he says the community will then need to decide whether it is appropriate to apply this technology to food production.

"Part of the market wants its food 'good but cheap'," Dr Harper says.

"These people are not particularly concerned by how you get there, as long as it is done safely and animal welfare issues are addressed. But other consumers are concerned about the ethical dimensions and don't support any form of food manipulation."

"CSIRO's stem cell work will always be driven by the needs of industry and ultimately the Australian community. The demand for cultured meat will be trivial in the foreseeable future compared to the global demand for carcass meat. There might be a future niche market, for example in space exploration, but it is hard to imagine the market for cultured meat ever reaching the dimensions of carcass meat markets."

"There is talk about people having mini-bioreactors in their kitchen to grow their own meat. But this is nothing like growing your own vegies in the back yard or making your own beer. Growing your own cow or chicken or pig muscle tissue on your kitchen bench will, I think, be ethically challenging to most people.

"There are also reports that cultured meat may be better for the environment, but I have yet to see any studies where this has been proved."

However, Dr Harper says that as CSIRO develops its knowledge about animal stem cells, it will be able to move into the application of the technology to meet the needs of consumers and the Australian agrifood industry.

By Lisa Palu, CSIRO

For more information contact:
Dr Greg Harper,
Tel +61 7 3214 2281,
Gregory.Harper@csiro.au

Livestock for a sustainable environment

Australia's rural landscape faces challenges on a scale not previously seen.

These include salinity, soil acidity, erosion, herbicide resistance and climate change, with associated effects on social structure and the natural environment. Many of these problems are related to the replacement of native perennial vegetation with annual crops and pastures.

CSIRO's 'Livestock for a Sustainable Environment' group targets these issues through a range of integrated research activities. The group recognises that unless new farming systems are profitable, adoption will not occur at levels needed for landscape change.

Research includes:

Enriching low and medium rainfall areas

Enrich is an exciting new project that specifically aims to use livestock to drive land use change in the low and medium rainfall regions of southern Australia.

One of the programs within the *Enrich* initiative, led nationally by CSIRO Livestock Industries' Dr Dean Revell, aims to explore the use of shrubs as a feedbase for innovative and profitable grazing enterprises that are based on sound resource management principles. The new systems will stabilise the soil, use more nitrogen to reduce acidification and use more water to slow the spread of salinity.

The research is not just focusing on feed production but also on timing, complementarity with other feeds, options for self medication for improvement of animal health and the significance of plant secondary compounds in grazing.

Project activities include:

- Identification of the benefits and limitations of incorporating shrubs, especially native species, in a mixed forage system for grazing enterprises in mixed farming systems.
- Clarification, through modeling and case studies, of where and how shrubs might be profitably incorporated into mixed farming systems.
- Gaining a broader understanding of the merits of shrubs in a grazing system, including the provision of nutrients, and bioactive compounds to improve animal performance and reduce the reliance on chemical use in animal production.
- Descriptions of animal grazing behaviour under a diverse mixed forage system that includes shrubs, and an understanding of how inherent grazing behaviour can be best managed to exploit a new forage base whilst enhancing environmental outcomes.

Supported by CRC for Plant-Based Management of Dryland Salinity, Joint Venture Agroforestry Program, Meat & Livestock Australia and is in collaboration with University of Western Australia, Department of Water, Land and Biodiversity Conservation in SA and the Department of Agriculture WA.

Sustainable Grazing on Saline Lands (SGSL)

Currently over two million hectares of agricultural land in Australia are affected by salt, largely in the mixed grain, sheep and cattle producing zones.

Considerable expansion of affected areas is predicted with groundwater levels continuing to rise.

SGSL operates across 12 sites in WA, SA, Vic and NSW.

CSIRO's Dr Hayley Norman leads one of the SGSL projects in WA, which includes researchers from four CSIRO Divisions and the WA Department of Agriculture.

Using shrub-based systems the group is investigating options for the production of out-of-season feed on saline areas that will potentially prevent a rise in the water table and improve the landscape function of the site. Specific aims include increased profitability of grazing salt-tolerant shrub-based systems; increased water use and reduced recharge on salt susceptible valley floors; improved biodiversity using alternative plants in saline areas; complementarity between shrubs and conventional pasture plants and improved visual amenity of saline areas

SGSL is funded by Land, Water and Wool, an initiative of Australian Wool Innovation Ltd (AWI) and Land and Water Australia and CRC Salinity

Functional implications of high salt intakes

This project addresses the fundamental aspects of the effects of high salt intakes on feed intake, diet selection, programming during fetal development, product quality and species differences. The project group collaborates with three universities and has already published international reviews and book chapters on this topic.

The knowledge gained will be used in the design and management of new grazing systems for saline areas. Australian Wool Innovation recently provided funding for a post-doctoral fellowship to enable further development of this research capacity.

Supported by CRC Salinity and is in collaboration with University of Western Australia and Charles Sturt University

Increasing efficiency of water use in dairy systems

There is at present an acute mismatch between land capability, water supply and cropping patterns within the South West Irrigation District of Western Australia.

Due to this mismatch the full economic potential of the land and water resource has not been realised.

This project will carry out land capability and water resources assessments of the South West and develop tools and strategies for determining best land and water resources use options within dairy systems for the South West irrigation district to ensure maximum economic, environmental and social benefits.

For more information contact:
Dr David Masters,
Tel +61 8 9333 6691,
David.Masters@csiro.au

Bats found to be the natural host of SARS

Photo: Frank Filippi, CSIRO

Bats are the natural host of viruses closely related to those responsible for the SARS outbreak, an international research team, which included CSIRO Livestock Industries' scientists, has found.

"Bats were a prime target for study because they are reservoir hosts of an increasing number of viruses that can infect other animals and people," says Dr Linfa Wang, SARS research leader at CSIRO Livestock Industries' Australian Animal Health Laboratory (AAHL).

SARS (Severe Acute Respiratory Syndrome) emerged three years ago in southern China. In 2002 and 2003, SARS infected thousands of people, killing 774. It was caused by a previously unrecorded coronavirus (crown-like virus).

Initially researchers thought the civet, a small cat-sized animal found throughout Asia, was the source of the virus.

However, further studies proved there was no widespread infection in either farmed or wild civets. This would have been expected if the virus originated in these animals.

But the new research, as reported in the 30 September edition of *Science*, determined that bats are highly likely to be the natural host of SARS, not civets.

The study sampled more than 400 bats in their native habitat from four locations in China. Blood, faecal and respiratory swabs were collected and independently analysed in laboratories in Chian (Wuhan Institute of Virology) and AAHL in Geelong.

Tests revealed high levels of antibodies to the SARS coronavirus. These results are compatible with those expected in a reservoir population naturally infected with an endemic virus and provided the first evidence that bats were the natural hosts of SARS.

This important discovery was made by an international research team including scientists from the Institute of Zoology and Institute of Virology, the Chinese Academy of Science; CSIRO and the Animal Research Institute, Queensland Department of Primary Industries and Fisheries in Australia; and the Consortium for Conservation Medicine in New York. The work at CSIRO was funded by the Australian Biosecurity Cooperative Research Centre for Emerging Infectious Diseases (ABCRC).

SARS is the latest of a long line of deadly viruses isolated from bats which cause disease in animals and humans. These include rabies, yellow fever, St Louis and Japanese encephalitis, West Nile, Hendra and Nipah viruses.

Bats may persistently be infected with many viruses but rarely display clinical symptoms. This suggests that they have evolved a distinctive method for curtailing infection by viruses, even those that are highly pathogenic in other species.

To prevent future outbreaks, it is essential researchers learn more about how bats control virus replication and remain asymptomatic, understand genetic diversity in bat-borne viruses, where different species of bats live and migrate and the ecological factors involved in disease emergence.

For more information contact:
Dr Linfa Wang,
Tel +61 3 5227 5121,
Linfa.Wang@csiro.au

Bat facts

- Bats are the most abundant mammal in the world, and the only non-terrestrial mammal. One mammalian species in five is a bat.
- The bat's lifespan may be over 20 years.
- Their diet consists primarily of insects and fruit, and also fish, amphibians, reptiles, nectar, pollen and blood.
- Viruses isolated from bats include rabies, yellow fever, St Louis encephalitis, Japanese encephalitis, West Nile, Hendra, Nipah and SARS.
- Bats primarily live in tropical climates – species in temperate climates hibernate or migrate.

The spread of SARS

Seven people stood waiting for an elevator in a hotel lobby. One of them coughed.

Together for a chance moment, the group quickly scattered to sightseeing buses, business lunches and airport terminals. Within hours some had flown halfway around the world.

Within days, three of the seven were dead, including the man who coughed.

That, according to epidemiologists, is how SARS spread from Hong Kong to the world.

- Seattle Post, 8 June 2003

The first human victim

Huang Xingchu, 36, from Bopu in Guandong, China, is believed to be the man who started the spread of the SARS virus.

Mr Huang, a chef who specialised in unusual animal dishes, fell ill in November 2002.

He was treated by Professor Liu, 64 – the man who spread the virus to Hong Kong. It was Prof Liu who coughed in the elevator, described above. Prof Liu died but Mr Huang recovered in January 2003.

CSIRO staff achievements

Innovative CSIRO research

A team from CSIRO Livestock Industries (CLI) has been honoured for its work on developing a rapid test to detect very virulent strains of Infectious Bursal Disease Virus (vv IBDV) in chickens.

The *Rewards from Innovation: World's Best Food and Fibre Dinner* at Parliament House, Canberra, on 6 September, recognised the CLI research achievement and 15 other outstanding innovations achieved through the Rural R&D Corporations (RDC) Model.

For much of the past decade, local egg and chicken meat producers have worked to keep Australia free from vv IBDV, a disease that can kill up to seventy per cent of a flock it infects.

In 2003, the Australian Egg Corporation Limited and the Rural Industries Research & Development Corporation funded a CLI research project that provided two key weapons to protect Australia from vv IBDV. The CSIRO research team employed molecular genetic techniques to prove that the disease had never entered Australia, and developed an advanced diagnostic test, reducing the time it takes to identify vv IBDV from three days to just one.

CLI researcher, Dr Sandra Sapats, said she was delighted the research had been well received by industry.

CSIRO researchers judged Geelong's best

A CLI team based at the Australian Animal Health Laboratory (AAHL) has been awarded the inaugural City of Greater Geelong/ BioGeelong Researcher of the Year Award for its work in controlling two dangerous viruses.

Dr Katherine Bossart and her team won the $10,000 overall prize and another $5000 as the Bendigo Bank Biomedical Award winner. The CSIRO team was a key part of an international collaboration that identified a human cell receptor for both Hendra virus and Nipah virus.

Hendra virus killed two people in Queensland in 1994/95 and more than 80 people in Bangladesh in 2004.

Also among the winners was CLI PhD student Melissa Kowalski, who was awarded the $5000 CLI-sponsored Animal Health Award for her work in developing better diagnostics for the plant associated disease, annual ryegrass toxicity.

Dr Sandra Sapats (standing) with Gaylene Gould

Space project stars at Dowerin

CSIRO's Pastures from Space project, a collaborative project involving the WA Departments of Land Information and Agriculture proved a star at the 2005 Dowerin GWN Field Days recently. Dowerin is WA's largest field day event. The Pastures from Space project was awarded the 'Best Sustainable Farm Practices Display Award' presented by the WA Pastoralist and Graziers Association.

Controlling FMD in Vietnam

Australian research is helping Vietnam to manage the highly contagious livestock disease, foot and mouth disease (FMD).

The three-year AusAID project, funded under the Vietnam-Australia Collaboration for Agriculture and Rural Development (CARD) Program, aims to provide Vietnamese veterinary laboratories with the testing capability to diagnose FMD infection and apply this capability in field studies.

The project will provide earlier detection and identification of the disease by establishing a diagnostic capability for FMD virus throughout Vietnam's laboratory network.

CSIRO Livestock Industries will provide biological reagents, technical support and training to Vietnamese farmers, veterinarians and laboratory staff.

For more information contact:
Mr Chris Morrissy,
Tel + 61 3 5227 5425,
Chris.Morrissy@csiro.au

Fat cows shed light on obesity

New information from the genes of cows can help in the fight against human obesity, says Dr Steve Kappes, Deputy Administrator of Animal Production and Protection at the US Department of Agriculture.

Speaking at CSIRO's Horizons in Livestock Sciences conference on the Gold Coast in October, Dr Kappes discussed the impact of the bovine genome project on livestock production and human health.

The bovine genome project involved researchers from around the world, including CSIRO, who have analysed the complete set of DNA sequences for a cow – its genome.

The full genome sequence for the cow was published on an international public database in June. This information provides a powerful new tool for researchers exploring the biology of cows and other mammals.

"One of the areas where we see the bovine genome can have an impact on obesity and human health is in the area of feed efficiency," Dr Kappes says.

"The bovine genome data is helping us to identify the genes responsible for high-nutrient uptake in cows. We think some of these genes may also influence high-nutrient uptake in humans."

Recent reports claim up to two-thirds of Americans are overweight and a third are obese.

"Once we have a better understanding of the biochemical intricacies of obesity, we can develop diets for people more susceptible to processed sugars and for other health conditions," Dr Kappes says.

Photo: Frank Filippi, CSIRO

Genomic research in cattle and sheep will shed light on this process.

"By looking at the phenotypes of these animals – the animal's genetic makeup coupled with environmental influences – we can identify different aspects of the biochemical process involved in nutrient uptake."

This information is likely to be similar for humans, due to the genetic similarity of many mammals.

Dr Kappes says the US National Institutes of Health's decision to fund half the cost of sequencing the bovine genome clearly indicates the importance human health authorities place on the project.

For more information contact:
Dr Ross Tellam,
Tel +61 7 3214 2476,
Ross.Tellam@csiro.au

Animal welfare researcher is Oxford-bound

Kelly Drake

A lifelong ambition will be realised by CSIRO Livestock Industries' Kelly Drake when she commences post-doctoral studies with the Animal Behaviour Research Group at Oxford University in the United Kingdom next year.

Kelly's ambition to work in animal welfare will have been realised at the highest level when she begins work with one of the world's leading figures in animal welfare research, Oxford's Professor Marion Stamp Dawkins.

"I have read a lot of Professor Dawkins' work," says Kelly. "She is very famous in the area of animal sentience and consciousness which is a really big issue now."

It was at a conference named after Professor Dawkins, that Kelly met her mentor.

"I went to a conference in London called 'From Darwin to Dawkins: the Science and Implications of Animal Sentience'," Kelly says.

"The conference featured 600 delegates from 50 countries and it is quite a credit to Professor Dawkins that she is referred to in the same title as Charles Darwin."

Kelly's UK post-doctoral project will be 'The influence of rearing environment on the propensity for injurious feather pecking in laying hens'.

By 2012 the European Union will ban caged hens and this will require the development of alternative systems such as aviaries and garden style production systems.

However, when hens are in close proximity to each other, the incidence of feather pecking can increase. Combined with a proposed ban on beak trimming, this could have a negative impact on egg production due to pain and distress in the hens.

"We will be working on alleviating, the problem of pecking," says Kelly.

Kelly joined CSIRO in Armidale three years ago, undertaking a PhD on the neurophysiological regulation of temperament in ruminants.

"My PhD involved trying to identify what the primary mechanisms are for temperament, in order to understand if you could somehow change these or manipulate them to have animals with a better temperament," she explains.

Her research focus will now move from sheep and cows to chickens.

"I have never worked with chickens before but the whole reason that I got into this area of science was that I believed in animal welfare, regardless of what species it is, and I would like to make a difference."

Ms Drake at work in Armidale

For more information contact:
Ms Kelly Drake,
Tel + 61 2 6776 1341,
Kelly.Drake@csiro.au

CSIRO's poster winners

Muren Herrid and **Jeanette Olejnik** from CSIRO's Food Futures Flagship Bovine Germ Cell Transfer project based in Armidale have both won awards for their poster presentations at the Endocrine Society of Australia and Society for Reproductive Biology Annual Scientific Meeting (4-7 September) in Perth.

Muren was selected as one of the seven New Investigator Award finalists and won the Meat and Livestock Australia prize of $1500 travel for 'best presentation by an early career scientist in livestock related research'. The title of Muren's paper was *Successful germ cell transfer between bulls of different breeds.*

First year PhD student, Jeanette Olejnik, won a student travel award to present her paper *The successful use of Busulfan to deplete endogenous spermatogonia in the ram testis.*

George Riding won the Early-Career PhD poster prize at the CRC for Innovative Dairy Products Third Annual Conference, Managing the Product Pipeline, 7– 9 July, at Seaworld Nara Resort on the Gold Coast.

George's poster was titled *Proteomic approaches to the study of conceptus fluids from first trimester bovine pregnancies.*

George's PhD is being undertaken in association with Monash University and he is funded by CSIRO and the Dairy Cooperative Research Centre.

Muren, Jeanette and George are all students of CLI's Dr Jon Hill, who is based in Armidale.

Di's salinity research wins accolades

Dianne Mayberry, a salinity researcher with CSIRO Livestock Industries and the University of Western Australia in Perth, has won the 2005 Western Australian Science and Innovation Award for Young People, awarded by the Department of Agriculture, Fisheries and Forestry.

It was the second prize in as many months for Di – in October she won the best poster prize at CSIRO's Horizons in Livestock Sciences conference on the Gold Coast.

Salinity is a major problem facing Australian agriculture. In Western Australia, many farmers are sowing saltbush pastures which are highly salt tolerant and also provide feed for livestock.

However, a major setback for agriculture is that sheep grazing on saltbush tend to lose weight and condition.

Ms Mayberry thinks that this could be due to the effects of saltbush on rumen microbial populations. She is looking at how the saltbush eaten by sheep influences microbial population diversity and activity in the rumen. During her honours research she found that rumen microbes from sheep fed saltbush produced more than four times as much methane as those from sheep fed a standard diet.

Di now aims to establish the amount of methane produced by sheep grazing in saltbush pastures. This will enable her to calculate if the amount of methane produced is a major factor in poor animal production from saline land.

Breeding out mulesing

A five-year research project to determine if selective breeding programs can produce blowfly-strike resistant sheep has begun.

Australian Wool Innovation Ltd, CSIRO and the Department of Agriculture Western Australia, are funding the $2 million project in support of the sheep industry's recent commitment to phasing out the practice of mulesing by 2010.

According to CSIRO Livestock Industries' research scientist, Dr Andrew Swan, while surgical mulesing is a highly effective means of preventing fly strike in the breech or rump area of sheep, the project aims to prove that the same effect can be achieved through breeding programs.

To evaluate the consequences of not mulesing sheep in two different Australian environments, the project will involve intensive, long-term monitoring of two flocks of six hundred breeding ewes – one in summer-rainfall Armidale, NSW, and the other in winter-rainfall Mt Barker, WA.

"It is unclear what problems may arise when running large numbers of un-mulesed sheep so the trials will take place on research stations in NSW and WA where we can closely monitor the animals," Dr Swan says.

"The project's five-year span should also enable us to record any seasonal variations in the incidence of breech strike."

He says the project team is confident that breech strike resistance in sheep is possible through selection on the basis of indicator traits like breech wrinkles and bare breech area.

The project will also evaluate whether breeding for fly strike resistance affects commercially desirable traits such as growth rate and wool production.

To facilitate the research, CSIRO Livestock Industries contacted breeders interested in providing young lambs which had positive attributes for breech strike indicator traits. These animals will be purchased by CSIRO.

"Over the last couple of months, we have sourced six hundred ewe lambs from ten industry flocks based on a scoring system of indicator traits like wrinkling and bare areas on the rump where no wool grows. So far we have seen significant variation between flocks for these traits," Dr Swan says.

"One of the next important tasks of the project will be to identify the rams we will use in the first mating program. Over the coming months we will be seeking industry rams which display the previously identified traits."

For more information contact:
Dr Andrew Swan,
Tel +61 2 6776 1377,
Andrew.Swan@csiro.au

Major refit for Rockhampton laboratories

A major refurbishment project is set to begin at CSIRO Livestock Industries' JM Rendel Laboratory in Rockhampton.

The refit will provide two new laboratories for the safe handling of microorganisms and to facilitate gene research.

There will be new dedicated areas for genetic research, equipment rooms, a dark room, open-plan shared offices and a workshop for the Livestock Environment group, allowing work with Global Positioning animal collars.

Improvements will also be made in the seminar room, library, meeting rooms, visiting scientist offices and canteen.

The refit will allow researchers to use modern scientific techniques to benefit the beef industry.

Strict legislation governs working with DNA and genes, so certain molecular work can only be done in a PC2 level laboratory, as stipulated by the Office of the Gene Technology Regulator.

Construction work, estimated to cost $3 million, is scheduled for completion in 2006.

Rockhampton staff anticipate the laboratories will be commissioned in time for the JM Rendel Laboratory celebrations on 25th birthday on 6 April 2006.

Horizons in Livestock Sciences

Redesigning Animal Agriculture

2 - 5 October 2005
Gold Coast International Hotel, Queensland, Australia

Some 220 delegates attended CSIRO's 2005 Horizons in Livestock Sciences conference on the Gold Coast, 2-5 October. Top international speakers joined Australian experts to discuss future challenges for livestock production systems.

2006 Horizons Conference

THE CONFERENCE

CSIRO is pleased to announce the fourth "Horizons in Livestock Sciences" Conference. This Conference will provide a forum for eminent international speakers, leading Australian researchers and participants to explore the farm of the future.

The theme is "Research for the Farm of the Future". The 2006 Conference will explore the topic of what the farm of the future (beyond 2015) will look like. What drivers will farm enterprises face; how will these shape production and business systems; and what skills and disciplines will researchers need to provide the knowledge and technology needed to serve those enterprises?

Horizons in Livestock Sciences
Research for the Farm of the Future

CSIRO

8 - 11 October 2006
Gold Coast International Hotel
Queensland Australia

www.livestockhorizons.com

Research themes

CSIRO Livestock Industries' research is based on four research themes, each with strategic projects directed towards making Australia's livestock and allied industries a stronger global competitor.

Key Account Executives

CSIRO Flagship research

Dr Rob Kelly
Tel +61 8 9333 6685
Rob.Kelly@csiro.au

Research Development Corporations

Dr Bob Hunter
Tel +61 7 4923 8142
Bob.Hunter@csiro.au

International research/ Animal Health

Dr Marion Andrew
Tel +61 3 5227 5745
Marion.Andrew@csiro.au

Cooperative Research Centres

Dr Ian Purvis
Tel +61 2 6776 1373
Ian.Purvis@csiro.au

Commercial Manager

Dr Greg Davies
Tel +61 7 3214 2929
Greg.Davies@csiro.au

1: Enabling technology: transforming the business enterprise

The focus of this research theme is on adapting, integrating and developing technologies and information into farm and business systems to ensure best management practices for livestock enterprises with full integration into the information economy.

Dr Sandra Eady
Tel + 61 2 6776 1394
Sandra.Eady@csiro.au

Integrated on-farm systems

Research results are integrated into a package that can be readily adopted on-farm through improved management of the production animal. Application of genetic technologies is emphasised.

Dr Dave Henry
Tel + 61 8 9333 6689
Dave.Henry@csiro.au

Integrated livestock business systems

A livestock systems approach, including social and economic factors is used in this research to integrate results from other research areas.

2: Ensuring product integrity and market access

Improving Australia's disease management systems and reducing the risks to trade and production posed by animal disease is central to this research theme and includes the developmental areas of molecular diagnosis, epidemiology and vaccines.

Dr Deborah Middleton
Tel + 61 3 5227 5016
Deborah.Middleton@csiro.au

New & emerging zoonotic diseases

Research in this area aims to achieve better management of current and emerging zoonoses so that risk to human health and trade is minimised.

Dr Gene Wijffels
Tel +61 7 3214 2510
Gene.Wijffels@csiro.au

Reduced reliance on chemicals for control of ruminant disease

Alternative technologies and the development of integrated management practices are the focus in this research to reduce the reliance on chemical control of disease.

Dr Peter Walker
Tel + 61 3 5227 5165
Peter.Walker@csiro.au

Improved control of aquatic animal disease

This research aims to improve the management of risks posed by disease to Australia's aquatic animal industries through improved diagnosis and prevention.

Dr John Lowenthal
Tel + 61 3 5227 5759
John.Lowenthal@csiro.au

Intensive livestock production

Research is being directed towards enhanced productivity through better management of health and production of non-ruminant animals.

Dr Hans Heine (acting)
Tel+61 3 5227 5511
Hans.Heine@csiro.au

Improved diagnosis of infectious animal diseases

Using innovative technologies, this research aims to improve current diagnostic methodologies.

Dr Kritaya Kongsuwan
Tel + 61 7 3214 2512
Kritaya.Kongsuwan@csiro.au

Genetic approaches for increased disease resistance

This research area identifies and utilises genes, gene networks and biochemical pathways that are important to the health of livestock.

3: Understanding and transforming the animal and its products

The focus of this research theme is to increase the value of livestock by improving the animals' inherent capacity to deliver current and new products by using new and emerging capabilities in molecular biology, computational mathematics and bioinformatics.

Dr John Henshall
Tel + 61 2 6776 1302
John.Henshall@csiro.au

Application of quantitative genetics to economically important traits

Quantitative genetics are being used by this research group to enhance critical productivity traits and improve profitability

Dr Bill Barendse
Tel + 61 7 3214 2444
Bill.Barendse@csiro.au

Application of molecular genetics to economically important traits of livestock

This group's research is focused on the development and application of molecular genetics using genetic markers for improved livestock performance.

Dr Brian Dalrymple
Tel + 61 7 3214 2503
Brian.Dalrymple@csiro.au

Genes for product quality

Identify and utilise genes, gene networks and biochemical pathways important to product quality characteristics of livestock.

Dr Jon Hill
Tel +61 2 6776 1331
Jon.Hill@csiro.au

Advanced reproductive technologies

Research is directed towards increasing reproductive performance through a better understanding and application of fundamental reproductive biology.

Dr Andre-Denis Wright
Tel +61 8 9333 6417
Andre-Denis.Wright@csiro.au

Enhanced on-farm productivity

Improving the efficiency and sustainability of on-farm production is a central focus on this research group.

Dr Wojtek Michalski
Tel + 61 3 5227 5772
Wojtek.Michalski@csiro.au

Novel products

This research aims to develop new commercial products through utilisation of biological pathways or products.

4: Achieving industry sustainability and social acceptance

Approaches are being developed in this research theme to increase the beneficial environmental impacts of livestock production and anticipate and address community concerns about livestock and livestock products.

Dr David Masters
Tel + 61 8 9333 6691
David.Masters@csiro.au

Ecoheath

Research in ecohealth aims to integrate livestock production into the improved management of the environment.

Dr David Strom
Tel + 61 3 5227 5740
David.Strom@csiro.au

Livestock welfare

Measurements and strategies are being developed by this research group to improve livestock welfare and ensure market access.

Dr Chris McSweeney
Tel + 61 7 3214 2665
Chris.McSweeney@csiro.au

On-farm food safety

This research aims to develop and apply strategies to improve food safety by managing risks on farm.

Diagnosis, Surveillance and Response Group

This research group provides diagnostic services, enhanced surveillance and the capability to respond to risks and needs posed by emerging and exotic diseases.

Dr Peter Daniels
Tel +61 3 5227 5272
Peter.Daniels@csiro.au

Your CSIRO

Australia is founding its future on science and innovation. Its national science agency, CSIRO, is a powerhouse of ideas, technologies and skills for building prosperity, growth, health and sustainability. It serves governments, industries, business and communities across the nation.

Contact Us

Phone	1300 363 400
	+61 3 9545 2176
Email	enquiries@csiro.au
Web	www.csiro.au