

# 2020 SCIENCE – OUR FOCUS

New Zealand depends on agriculture as the backbone of its economy. And this dependence looks set to continue, with global demands for the high quality food, fibre and health-related products we are well placed to supply.

But delivering these products comes with its own set of challenges. We face great pressures on our environment and natural resources, while increasing imports bring more biosecurity threats.

If we are to boost agricultural productivity to meet growing demand – while maintaining New Zealand’s revered environment, society and culture – responsive and responsible agricultural science and technology will be key.

This balance is captured in our 2020 Science strategy – our vision for how all those involved in the sector and related industries can work together to keep New Zealand prosperous to 2020 and beyond.

Through our 2020 Science strategy, we have been working closely with industry partners to double the value produced by the dairy, meat and textile industries, while halving costs and environmental impacts, by 2020.

The 2020 Science strategy is made up of Five Big Ideas outlined in the following pages.

## THE FIVE BIG IDEAS

# 1

### FUTURE DAIRY INDUSTRY

Double the value of the dairy industry while halving impacts on the environment.



# 2

### FUTURE MEAT & TEXTILE INDUSTRIES

Double the value of the meat and textiles industries while halving the costs and impacts on the environment.



# 3

### PESTILENCE-FREE NEW ZEALAND

Reducing the risk of pests and diseases gaining a foot-hold in New Zealand and helping to manage those already here.



# 4

### AGRICULTURE AND ITS COMMUNITIES

Working with rural communities and agribusinesses to ensure they both remain sustainable for future generations in a global environment.



# 5

### OPPORTUNITIES BEYOND FOOD AND FIBRE

Working with other researchers in New Zealand and around the world to use our knowledge of agricultural plants and animals for valuable new opportunities.





**“AgResearch now has a comprehensive 2020 Science plan, that will allow scientific and technological advancement to ensure that New Zealand remains at the forefront of the booming international demand for high value pastoral products. 2020 Science shows how we will work with industry to achieve this”.**

**Dr Travis Glare – General Manager Science Strategy Services**

BELOW: Dr Cecile de Klein, Programme Leader of the Sustainable Environmental Management programme.



## BIG IDEA 1 FUTURE DAIRY INDUSTRY

**Double the value of the dairy industry while halving impacts on the environment.**



**Peter Benfell** – Science & Technology General Manager, Agriculture & Environment and Chair of the Big Idea 1 Project team

**The dairy industry is an important contributor to New Zealand and its major export earner. The number of dairy cattle and the productivity of dairy farms have increased markedly over the last decade and, as with all human activities, this industry has impacted on the environment.**

Science and technology – under Big Idea 1 – is contributing to solutions aimed at doubling the value of the industry while halving its impacts on the environment.

This will be achieved through productivity gains, sustainable intensification, reducing emissions to air and water, and developing new, high-value products and enabling technologies and services. Examples of key AgResearch-led programmes contributing to this are the Surface Water Quality and the Sustainable Environmental Management Programmes.

This year, a major achievement of the Surface Water Quality Programme was the development of the Best Management Practice Toolbox. This web-based decision support tool is based on the premise that ‘no one size fits all’ and provides farmers with a list of the most cost-effective mitigation options for their specific situation and their specific concern (i.e. nitrogen leaching, phosphate loss, faecal contamination or GHG emissions). The Toolbox currently includes the best available knowledge on existing mitigation options, and will be updated frequently as our knowledge of these options improves or when new options are developed.

The Sustainable Environmental Management Programme is the research component of a large body of work on sustainable environmental management of dairy farms. In partnership with DairyNZ,

and in collaboration with a number of other research organisations, this work receives funding from industry and the Foundation for Research, Science and Technology. The overall aim of the programme is to provide the industry with farmer-friendly tools and options for benchmarking, measuring and mitigating emissions to water.

Work over the past year has resulted in some notable achievements, including:

- A Science/Extension Forum for the dairy industry. Organised in conjunction with DairyNZ, the aim was to improve communication and interaction between the research, development and extension activities of the Sustainable Environmental Management Programme. The forum gave the wider industry a better understanding of the programme and its progress to date. Importantly, researchers were also able to grapple with industry issues such as uptake and application of research.
- Creation of a database of the environmental practices and behaviours of dairy farmers. Due to the lag time between cause and effect, this database helps demonstrate how well the industry is progressing in terms of on farm practices even though this might not be directly measureable in terms of improved water quality.
- Development of a deliberation matrix that provides industry and policy makers with a ‘balanced view’ of the industry by understanding not only the environmental issues but also the economic and social contributions that the dairy industry makes to the community.
- A survey of nutrient models has produced two papers designed to help clarify the confusion around different models and to improve confidence in, and understanding of, the models.
- Studies into microbial losses, using experimental sites to measure the transport of E. coli, are underway. Separating the effectiveness of best management practices into high and low-flow scenarios has already led to a breakthrough in determining the effectiveness of mitigation options on farm.

Nitrification inhibitors are another major focus. In work to date:

- The long term effectiveness and regional viability of inhibitor use, together with the effectiveness of inhibitor use in winter forage systems, are the focus of research into tools and options for reducing nitrogen, phosphorus and microbial losses to water. This research will also aid in the development of regional best management practices for optimisation of inhibitor use to reduce nitrate-leaching losses.
- Researchers are now working with DairyNZ, Meat & Wool New Zealand and the fertiliser industry to develop and communicate an agreed and consistent message on nitrification inhibitors, and to provide regional guidelines for pastoral farmers.
- Farming system studies were established as a result of work on the integration of mitigation strategies into existing and future farm systems. Ongoing measurements from these studies are providing valuable information on the effectiveness of integrating key methods (herd-homes and nitrification inhibitors) available to farmers. Data are also being gathered on the achievability of the research target of 50% decreased nitrate leaching. As an added bonus, the study site has been giving leaching data from a range of treatments since 2001. This has enabled AgResearch to review results in the context of other management approaches.

Maximising farmers’ awareness of their environmental options and enabling them to adopt the most appropriate environmental tool are also essential. To this end, the lessons learnt from two case studies identifying the key drivers of adoption were discussed at the AgResearch/DairyNZ Sustainable Environmental Management Forum. The results confirmed the need for:

- Clear and consistent messages.
- Farmers and/or extension officers to have confidence in the technology.
- An understanding of the cost/benefits and other trade offs.
- Mitigation technology to be seen as part of the farm system.

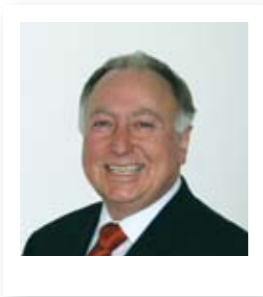
These findings will now all contribute to the development of generic principles of on-farm adoption.

## BIG IDEA 2 FUTURE MEAT & TEXTILE INDUSTRIES

**Double the value of the meat and fibre industries while halving the costs and impacts on the environment.**



**Dr Jimmy Suttie**  
Science & Technology  
General Manager, Applied  
Biotechnologies and Chair of  
the Big Idea 2a Project team



**Dr Robert Finch**  
Science & Technology  
General Manager,  
Food & Textiles and Chair of  
the Big Idea 2b Project team

While meat and wool are New Zealand's second highest export earners, slim margins and limited resources are posing significant threats to the industry. Big Ideas 2a and b aim to double the value of the meat and textile industries respectively, while halving costs and environmental impacts by 2020. A co-ordinated and integrated approach to the challenges facing our meat and wool industries is essential if New Zealand is to remain competitive on the world stage.

But before we can take on the world, we need to ensure an integrated and cohesive approach at home.

2008 was the year that those efforts gained traction from the ground up at AgResearch, with a series of flagship internal summits designed to increase research depth, capacity and funding and ensure our scientific weight is headed in the right direction, as we help the industry face the challenges of Big Idea 2.

Each summit brought together a range of scientists who work in related fields, but rarely have a chance to meet because they are spread across two islands, four campuses and a number of research centres.

A Meat Summit in May 2007 kicked off the series, bringing together AgResearch senior scientists across all aspects of the meat industry, from genomics through to functional genomics and meat as a product. The two-day meeting resulted in a collaboration between the meat science team at Ruakura and the genomics team from Invermay, and the formation of a

joint Foundation for Research, Science and Technology funding application.

A Reproduction Summit followed, pooling together the expertise of AgResearch's two main reproduction sections.

Reproductive technologies are an important focus for AgResearch. Two important profitability indicators for animal production are the number of animals born and the growth rate for the animals once they're born.

Reflecting the importance of this work, AgResearch's two reproduction sections have put together a joint application to the Foundation to fund sheep and beef reproduction research and they are developing new products to enhance reproductive technologies.

Those involved in forage research were brought together in November for a Forage Summit, addressing many aspects around plant feeding and plant biotechnology relevant to forages in the future. AgResearch's goals under Big Idea 2 are wide ranging, with the organisation well positioned to continue its much needed role in helping New Zealand meat and textile producers make the shift away from short-term tactical to longer-term, strategic thinking.

There are also exciting new technologies in the pipeline to address some of the fundamental science in sheep production. Completely new areas like stem cell biology and epigenetics are under the spotlight too, as well as genetic testing capabilities designed to address meat quality and

tenderness issues, and advances to tailor the final product to meet the needs of increasingly choosy consumers.

These consumers are also becoming ever more demanding when it comes to function in textiles, and AgResearch's wool textiles goals aim to meet this demand. The textiles team is focused on the development of new technical products and smart textiles that will generate new uses for wool, next-to-skin low-pill apparel with improved softness and drape, light-weight travel wear with easy-care wrinkle resist properties and high performance active sportswear with new functionalities.

Traceability throughout the textile processing chain is becoming more important in today's world and AgResearch has some new technologies that will allow this to happen.

AgResearch has a vision where the meat and textile producing industries can be provided with a range of tools that permit a flexible approach to production systems. It is very important that New Zealand responds quickly to changes in consumer demand. To stay up with the game, producers need smarter technology – and a rapid way to incorporate it into farm practice. Smartly applied technology is the way to continued prosperity.



ABOVE: Dr Allan Nixon examines a New Zealand Wiltshire sheep used in the search for genes controlling wool growth. Natural fleece shedding in these sheep allows comparison of growing and resting wool follicles.



## BIG IDEA 3 PESTILENCE-FREE NEW ZEALAND

Reducing the risk of pests and diseases gaining a foot-hold in New Zealand and helping to manage those already here.



**Dr Travis Glare**  
General Manager, Science Strategy Services  
and Chair of the Big Idea 3 Project team

**Plant and animal diseases, along with pests and weeds, represent substantial costs to the farming sector. The solution lies in reducing the risk of pests and diseases gaining a foot-hold and helping to manage those already here.**

As part of this focus AgResearch has been heavily involved with the Foundation for Research, Science and Technology funded Better Border Biosecurity (B3) programme. It is a large collaborative programme involving five research institutes. AgResearch's plant-based biosecurity capabilities form a large part of the research aimed at preventing new unwanted pests or plants entering and becoming established in New Zealand.

The B3 programme includes a comprehensive study of soil brought into the country on the footwear of travellers which is breaking new ground in the understanding of contamination risks. The research is likely to be extended to other soil vectors such as shipping containers and used vehicles. All this information will eventually be linked to data about geographic source and time of year to enable the development of a more accurate risk profile of soil contaminants based on country of origin, volume of contaminant and season. Once

the study identifies the risks, the next step is to identify opportunities for MAF Biosecurity New Zealand to refine its border screening processes.

AgResearch scientists are also working with B3 to develop better diagnostic tools for use at New Zealand's borders. These include web-accessible electronic taxonomic keys, genetic databases and quick biochemical tests, many of which have global applications. AgResearch is currently working to commercialise a novel biochemical test for evaluating the viability of small immobile organisms, such as insect eggs, that are frequently intercepted at the border with shipments of imported produce.

Another key element of Big Idea 3 is an AgResearch-developed DNA test identifying different strains of bacteria causing Johne's disease, to help control the spread of this potentially fatal infection – particularly among deer.

The rapid one-step test, developed with Foundation for Research, Science and Technology funding, identifies strains of the Johne's organism generally carried by sheep and cattle. Johne's disease has been in New Zealand for almost a century and has emerged as a significant disease for our livestock industries, with instances gradually

increasing and spreading throughout the country. The contagious infection primarily affects the small intestine of ruminants, causing reduced food intake, weight loss, and even death.

Available to them through their local veterinary service, the test is an important breakthrough as it enables farmers to quickly identify the strain they are dealing with.

Concerns from agricultural and related industries led to the formation of the Johne's Disease Research Consortium late last year. This industry and government initiative will unite and further accelerate research into Johne's disease.

Working with the newly opened National Centre for Biosecurity and Infectious Disease (NCBID) at Wallaceville also strengthens AgResearch's capabilities for Big Idea 3. Notable recent research in association with the Centre includes work in possum control and ways to reduce the bovine tuberculosis threat to New Zealand.

LEFT: Scotch Thistle.

## BIG IDEA 4 AGRICULTURE AND ITS COMMUNITIES

**Working with rural communities and agribusinesses to ensure they both remain sustainable for future generations in a global environment.**

**Sustainable development of New Zealand agriculture via vibrant agribusiness and strong rural communities is the aim of Big Idea 4. It's all about helping decision makers learn about, choose and implement systems that are responsive to society's drivers. This is in recognition that farming today does not sit in isolation, and that the interconnectedness of the sector from local to global scale is fundamental to its success.**

Big Idea 4 work has just begun its development phase. It will involve going beyond economic factors, taking into account social, environmental and cultural influences, to form a framework for the decisions on the agricultural future of our country.

This integrated, multi-faceted approach to sustainability is something of a balancing act, factoring in the natural capital of water, air and soil alongside the social capital of labour, skill, capacity and capability; the economic capital generated by products and land values, and the value of cultural issues – including both indigenous considerations and those found within rural and urban communities.

There is also the recognition that farm, catchment, regional, national and international scales are all interconnected

by consumer markets and evolving global, national and regional measures to improve environmental performance like the Kyoto protocol and Resource Management Act.

As it develops, Big Idea 4 will focus on identifying, defining, analysing and interpreting the drivers and influencers that shape agriculture, including international agreements, consumer market requirements, national policy, finite resources such as land, water and labour and governance systems like ownership structures. This information will be used to give context to the other Big Ideas and to identify paths and transitions towards the development of sustainable agriculture. Importantly, it will also inform a range of decision makers, including national and regional policymakers, agribusiness, banks, utility companies, rural communities and individual farmers. Thanks to Big Idea 4, these people will have much-needed tools and processes to evaluate the consequences of system choices to economic, social, natural and cultural capital, and to identify practices and technologies that can enable a balanced outcome.

All of AgResearch's Big Ideas fit together to make up the organisation's 2020 Science vision, and the technologies, practices and

systems that are developed through them flow into Big Idea 4, to help inform critical decisions on a sustainable future for agriculture in New Zealand. AgResearch's strategy relies heavily on the creation of approaches that will enhance collective learning.

Some of the key questions Big Idea 4 will address include: So what will new sustainable farm systems look like? What will the farm of the future deliver? How will rural communities and agribusiness have to change to keep up? What skills will we need and where will we need them?

This Big Idea is our window into the future. The challenge to all of us is to jointly envision the many possible futures for agriculture – choose between these possibilities and help New Zealand create a vibrant, sustainable agricultural base for the years ahead.

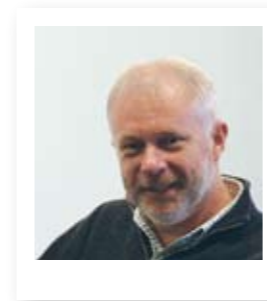


ABOVE: AgResearch Senior Scientist and programme leader for Rural Futures, Dr Liz Wedderburn, Chair of the Big Idea 4 Project team.



## BIG IDEA 5 OPPORTUNITIES BEYOND FOOD AND FIBRE

**Working with other researchers in New Zealand and around the world to use our knowledge of agricultural plants and animals for valuable new opportunities.**



**Dr Jimmy Suttie**  
Science & Technology  
General Manager, Applied  
Biotechnologies and Chair of  
the Big Idea 5 Project team

**Agricultural research often leads to the development of products and services valuable to other sectors. Capturing these opportunities, which represent significant economic benefits for New Zealand, is crucial.**

Recognising, understanding, resourcing and packaging up the ideas that are indirect products of AgResearch's scientific work, or tools and technologies that can be applied more broadly, is the stuff of Big Idea 5.

This Idea makes the most of anything that comes out of the organisation that is still useful, but doesn't directly relate to the animal or plant areas. It sees AgResearch scientists working with their colleagues in New Zealand and around the world to use the organisation's knowledge of agriculture for valuable new opportunities. AgResearch's role ends when these technologies can be partnered or licensed out.

Notable examples under the Big Idea 5 banner include work on wound healing, protein production, biofuels and toxicity testing.

A Foundation for Research, Science and Technology funded partnership between AgResearch, Deer Industry New Zealand and Velvet Antler Research New Zealand (VARNZ), has created a product from deer velvet extract that promotes accelerated wound healing. RepairRx has recently completed pre-clinical trials overseas.

A Protein Summit this year brought together AgResearch scientists involved in protein work to look at the organisation's

capabilities to scale up protein production to take the research work to market. AgResearch's connections with Auckland and Waikato universities and equipment to uncover protein structures further broaden opportunities for protein research.

AgResearch's achievements in fibrous protein research – particularly wool – have also led to work in the areas of human hair and skin for international personal care companies. This research looks at ways to control damage to skin and hair, and to enhance existing personal care treatments.

Rocketing oil prices, sustainability issues and greenhouse gas emissions have firmly pushed biofuels to the fore. A study into the feasibility of creating ethanol from pine tree waste has been undertaken by AgResearch in collaboration with Scion, Carter Holt Harvey and American enzyme company Verennium.

The feasibility study established that it is technically possible to extract ethanol from pine trees but at the time it was uneconomic. The research showed three major costs, which collectively made ligno-cellulosic ethanol uneconomic – feed stock (the trees), the capital cost of a biochemical processing plant and the enzymes to break down the wood.

AgResearch's forage biotechnology team is now working on technology based around oil bodies in plants – and the team has prepared a bid to the Foundation for Research, Science and Technology examining the manufacture of enzymes in oil seed crops to produce relatively low cost enzymes on a large scale.

Another development falling under Big Idea 5 is a new toxicity test that could replace animal testing. In a world first, AgResearch scientists have developed a way of detecting the toxins caused by algal blooms that does not use animals. The current mandatory international test for seafood toxicity uses mice. The World Health Organisation is looking to the scientific community to find a replacement for the mouse test that measures the safety of seafood consumption for humans. In shellfish poisoning, the toxins affect the function of membrane proteins, so the AgResearch team has developed membranes and proteins that mimic human ones. The test measures the change in electrical current from the reaction of the protein ion channel to toxins and no animal testing is required. The AgResearch test – dubbed 'mini mouse' – is more accurate, faster and has the potential for use by analytical laboratories worldwide.

Like much AgResearch work, this project spans a range of sectors – and a number of countries. AgResearch scientists are also now looking at possibilities for this test in screening for new pharmaceuticals. They have been asked to collaborate with the Technical University of Denmark and Sophion, a manufacturer of equipment for pharmaceutical discovery, to develop a screen for the early detection of side effects from potential new drugs.