Delivering science and technology to benefit New Zealand’s pastoral sector

Statement of Corporate Intent 2015-2020
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Presented to the House of Representatives pursuant to Section 44 of the Public Finance Act 1989.
As a Crown Research Institute, AgResearch provides a link between our Government shareholder and the sectors we serve so we engage closely with both to support government and industry strategies. Growing exports will require that we grow production volumes in our biological economy while improving the quality of our natural resources. This is both challenging and vital to New Zealand’s success. Science is essential in helping achieve the increase in productivity that we need.

The landscape in which we operate is changing and the way science is developed and delivered here, and overseas, is emphasising collaboration and co-location. We are committed to ensuring that New Zealand science can anticipate and plan for these changes. Initiatives include our Future Footprint Programme to catalyse agri-innovation clusters and playing a significant role in National Science Challenges, including hosting the Our Land and Water Challenge. We support New Zealand’s economic growth through these innovation system initiatives and by working to grow business investment in research and development. We will continue to play a lead role in many of these initiatives and will respond to others as they are advanced by Government. We continue to contribute to New Zealand’s priorities by driving impacts and delivering outcomes for the pastoral, agri-food and agri-technology sectors through quality science, building research collaborations, strategically investing our Core Funding and capital, strengthening relationships with stakeholders and end-users, and transferring technology and knowledge.

The sectors we serve have diverse needs and complex interconnections. To achieve our Core Purpose, we engage with many organisations within those sectors to understand their needs, gain their confidence to invest in research and development, secure that investment and, (jointly with those stakeholder organisations), deliver the innovation they need to grow their productivity, market access and export value. We will continue re-weighting our research towards sectors and firms that see research as a priority, have the ability to pay for it, and where the routes to create impact are apparent. We will continue to work with the sector to describe the changes that are underway at AgResearch and how they will provide long term benefits.

We – our partners, stakeholders, management and staff – will work together to make the difference for all New Zealand, to grow the pastoral and related sectors in a sustainable way to underpin our economic prosperity. This SCI shows how we plan to do so over the next five years.

Sam Robinson
Chairman, AgResearch

Dr Tom Richardson
Chief Executive, AgResearch
PARTNER WITH THE PASTORAL, AGRI-FOOD AND AGRI-TECHNOLOGY SECTORS TO IDENTIFY THE INNOVATION THAT IS NEEDED AND DELIVER OUR COLLECTIVE EXPERTISE TO CREATE VALUE FOR NEW ZEALAND.

AgResearch’s core value proposition is our ability to:

“Partner with the pastoral, agri-food and agri-technology sectors to identify the innovation that is needed and deliver our collective expertise to create value for New Zealand.”

AgResearch’s purpose is to enhance the value, productivity and profitability of New Zealand’s pastoral, agri-food and agri-technology sector value chains to contribute to economic growth and beneficial environmental and social outcomes for New Zealand.

AgResearch will fulfil its purpose through the provision of research and transfer of technology and knowledge in partnership with key stakeholders, including industry, government and Māori, to achieve the following outcomes:

A. Increase the value of these industry sectors to the New Zealand economy through the development of high-value pastoral-based products and production systems that meet current and future global market needs

B. Position New Zealand as a global leader in the development of environmentally sustainable, safe and ethical pastoral production systems and products

C. Ensure that New Zealand’s pastoral sector is able to protect, maintain and grow its global market access

D. Increase the capacity of rural communities and enterprises to adapt to changing farming conditions in ways that balance economic, environment, social and cultural imperatives.

The sector-aligned impacts shown in this Statement of Corporate Intent are mapped against our Statement of Core Purpose outcomes in Table 1. To achieve these outcomes, AgResearch is the lead CRI in the following areas:

• Pasture-based animal production systems
• New pasture plant varieties
• Agriculture-derived greenhouse gas mitigation and pastoral climate change adaptation
• Agri-food and bio-based products and agri-technologies
• Integrated social and biophysical research to support pastoral, agri-food and agri-technology sector development.

AgResearch will work with other research providers and end-users to particularly contribute to the development of the following areas:

• Biosecurity, land, soil and freshwater management
• Climate change adaptation and mitigation
• Food and beverage sector (including foods for human nutrition and health, food technologies and food safety).

AgResearch’s core value proposition is our ability to:

“Partner with the pastoral, agri-food and agri-technology sectors to identify the innovation that is needed and deliver our collective expertise to create value for New Zealand.”
### TABLE ONE  
AgResearch’s Statement of Core Purpose outcomes (A to D left) mapped against the six outcomes described in this SCI

<table>
<thead>
<tr>
<th>IMPROVED DAIRY ON-FARM PERFORMANCE</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Improved production from home-grown feed</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Improved rate of genetic gain in the national herd</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Improved animal health and milk quality</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Adoption of new farm management practices which improve productivity</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>5 Control targets met for nationally monitored diseases</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>6 Improved animal welfare</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<table>
<thead>
<tr>
<th>IMPROVED MEAT AND FIBRE ON-FARM PERFORMANCE</th>
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</thead>
<tbody>
<tr>
<td>7 Improved productivity of forage</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Improved productivity in meat- and fibre-producing animals</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Improved animal health status of meat- and fibre-producing animals</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>10 Continuous improvement in farm management practices</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<thead>
<tr>
<th>IMPROVED RETURNS FROM DAIRY PRODUCTS</th>
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</thead>
<tbody>
<tr>
<td>11 New high-value dairy and food solution products and processes</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<th>IMPROVED RETURNS FROM MEAT AND FIBRE PRODUCTS</th>
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</thead>
<tbody>
<tr>
<td>12 Meat products and processes which consistently meet the needs of existing and new markets</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Improved processing efficiency</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Higher value wool products</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>IMPROVED PAN-SECTOR AND MĀORI AGROBUSINESS PERFORMANCE</th>
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</thead>
<tbody>
<tr>
<td>15 Reduced environmental footprint of pastoral farming operations</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 Practical policy solutions developed and adopted</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>17 Improve on-farm productivity in Māori agrobusiness enterprises</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>18 New products from Māori agrobusiness enterprises</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
We exist to create beneficial outcomes for New Zealand agriculture. We deliver our Core Purpose in the context of New Zealand’s economy, trends in agriculture, agri-foods, agri-technologies and the science system.

**ECONOMIC DRIVERS**

Agriculture is at the heart of New Zealand’s export success. The value of agricultural exports in 2014, as shown in Figure 1, represented about half of New Zealand’s merchandise exports.

The long-term prospects for New Zealand’s agricultural products are favourable, thanks to broadening primary sector growth and freer trade. But in the short and medium term, price volatility creates challenges for farmers and processors. According to the Ministry for Primary Industries (MPI) in December 2014:

“... continued diversification of products is important to safeguard our export earnings from sector-based commodity cycles. Moreover, it strengthens our opportunities for growth across markets and consumer channels.”

AgResearch is supporting the sector to diversify its products, create value in market niches, de-commoditise and improve its efficiency to reduce export price volatility and increase the sector’s resilience to low prices. These approaches are important themes in the Primary Growth Partnerships and MBIE Partnership Programmes to which we contribute.

**TRENDS IN AGRICULTURE**

Despite price volatility, New Zealand’s agriculture, agri-food and agri-technology sectors have continued to build value and increase export returns over many years. While a growing share of added-value products will enable export returns to increase more rapidly than export volumes, doubling primary industry exports in real terms from $32 billion in June 2012 to over $64 billion by 2025 will require both higher production volumes and a greater share of higher value products.

Growing production and productivity in our biological economy, while improving the quality of our natural resource base in line with these goals, is both challenging and vital to New Zealand’s success. Good progress has been made on reducing our greenhouse gas intensity since 1990 but more work is required. Similarly, clean water is an essential resource for New Zealand. The National Objectives Framework supports setting sustainable quality and quantity limits. Partnerships between the sector, policy agencies and scientists will be essential to find ways to grow within those limits.

Science has a particular ability to integrate measures, perspectives and knowledge to find innovative solutions that achieve both growth and environmental goals.

As host of the Our Land & Water National Science Challenge, AgResearch has an important role in that process, along with the sector, government, industry and other non-government organisations and communities. Scientific evidence can give confidence to farmers that their actions are appropriate, confidence to sectors that a collective solution is possible and confidence to policy makers and communities that policy goals and the communities’ aspirations will be achieved.

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**AGRICULTURE SECTOR STATISTICS – 2014 or latest available figures**

**6.7 MILLION DAIRY CATTLE**
- 4.92 million dairy cows
- 11,997 dairy herds
- 1.72 million ha farmed for dairying

**29.6 MILLION SHEEP**

**3.73 MILLION BEEF CATTLE**
- 12,290 sheep and beef farms
- 7.5 million ha

**0.95 MILLION DEER**

**20.7 BILLION LITRES OF MILK**
- 1.69 million tonnes of milk solids

**114,842 TONNES WOOL (CLEAN)**

**1.17 MILLION TONNES RED MEAT**

**EXPORTS**

- **$15.6 BILLION OF DAIRY PRODUCTS AND INGREDIENTS**
  - 95% of milk is exported

- **$8.8 BILLION OF MEAT, TEXTILES AND BY-PRODUCTS**
  - 90% of wool (clean) production is exported
  - 93% of sheep meat is exported
  - 80% of beef and veal is exported
Agri-technology exports grew from highly competitive and because they enable our agriculture sector to be important to New Zealand, both because overseas customers have a high level of confidence in the safety and provenance of our products and because high-value exports and, as part of the proposed New Zealand Food Safety Science and Research Centre and other projects, we are working to ensure overseas customers have a high level of confidence in the safety and provenance of New Zealand’s food products.

TRENDS IN AGRI-FOOD
Our success as an exporting nation depends on how well-positioned New Zealand businesses are to succeed in a global environment. From 2008 to 2014, the share of processed primary products in New Zealand goods exported increased from 33% to 42%

There is scope for this trend to continue as unprocessed primary products still made up 31% of goods exported in the year to March 2014. AgResearch is contributing to improve opportunities to process agricultural products into high-value exports and, as part of the proposed New Zealand Food Safety Science and Research Centre and other projects, we are working to ensure overseas customers have a high level of confidence in the safety and provenance of New Zealand’s food products.

TRENDS IN AGRI-TECHNOLOGIES
Agri-technologies are increasingly important to New Zealand, both because they enable our agriculture sector to be highly competitive and because they are a significant export industry themselves. Agri-technology exports grew from about $1.3 billion in 2009 to about $1.9 billion in 2013 and their effective use contributed to a multifactor productivity improvement of 1.2% per annum from 1996 to 2012 for the New Zealand agriculture sector, compared to 0.7% per annum for the measured sectors of New Zealand’s economy.

Agri-technologies are important outputs of AgResearch science. Past research programmes have targeted the development of new and improved forage cultivars, endophytes (such as AR37), biological pest control agents (such as for Argentine Stem Weevil and Clover Root Weevil), measurement technologies and decision-support tools (such as Farmax). Current research supports these technologies, with a focus on decision support tools; growing the value of products disseminated through our subsidiary Grasslanz Technology; and commercialising intellectual property emerging from our science.

TRENDS IN THE SCIENCE SYSTEM
The government has encouraged the business sector to double their R&D to more than 1% of gross domestic product. To leverage greater business sector research and development activity, the government has also dedicated a higher proportion of its science and innovation investment to business-led R&D through Callaghan Innovation, Primary Growth Partnerships and other channels. AgResearch is at the nexus of agricultural production and environment and our research has yielded, and will yield, billions of dollars in benefits but the challenges New Zealand and our sectors face are too big for any one institution to solve.

We believe driving economic growth requires creating denser clusters of talent, with less duplication, fewer silos, more co-operation and a value-added approach. We are leading the way to meet these requirements by creating clusters and shared infrastructure. Our Future Footprint Project and Science Roadmaps (see p.38 and p.48) along with New Zealand-wide initiatives, such as Innovation Hubs and National Science Challenges, aim to achieve those goals. The changes we make will increase value for taxpayer and levy-payer investments, combine education, research and end-users to be more efficient; maximise use of infrastructure and increase collaboration.

HELPING KIWIS CONNECT WITH SCIENCE
AgResearch's key stakeholders and end-users include 25,000 small and medium-sized enterprises that make up our dairy, sheep & beef and deer farming sector, the owners of those enterprises and their families. New Zealand farmers and farming families have led the world in taking a scientific approach to farming, either innovating themselves, innovating in partnership with research and technology suppliers or adapting and adopting technologies to improve their farm businesses.

AgResearch has worked with rural community stakeholders for many years to explore how science and technology can improve their lives and businesses, help rural communities engage with science and technology, promote the relevance of science and technology to rural life and support debate about science and technology issues. We work with industry initiatives to promote careers in science to primary and secondary school students and their teachers, as well as to tertiary students. These include the NZ Young Farmers’ Get Ahead and Teachers’ Day Out programmes and the DairyNZ Year 13 Science Careers Day. We are also a regular participant in the Royal Society’s Science Teaching Leadership Programme, hosting secondary school teachers two terms at a time to develop their leadership skills and lead the improvement of science teaching at their schools.

These activities align with the national strategic plan for science in society A Nation of Curious Minds - He Whenua Hihiri I Te Mahara and AgResearch will continue working to support this strategy.
Senior Waikato high school students with a passion for science got a taste of a career in agricultural science at the second annual DairyNZ Year 13 Science Career Day hosted by DairyNZ, AgResearch, LIC and the University of Waikato in March 2015. This workshop showed senior science students the many career opportunities within New Zealand agriculture.

“Ensuring that agriculture, such an important driver of the New Zealand economy, has the science talent it needs for continued innovation is vital. It has been very pleasing to have had such a fantastic response to this year’s event from students and teachers alike. When a student writes on their feedback form they’d like to do it all again to learn more, you can’t ask for a better response than that,” says event organiser, DairyNZ Industry Education Facilitator, Susan Stokes.

Forty students from 16 Waikato schools took part in agricultural science activities led by scientists from the four organisations. They spanned soil assessment, pasture growth, nutrient leaching, animal productivity and health and meat science.

AgResearch food technologist Dr Mustafa Farouk took part in last year’s event and returned this year to introduce this year’s attendees to meat science.

“It was wonderful to talk to such enthusiastic young people about our work,” he says. “For many of them finding out about the variety of science expertise required by the industry, as well as the different career pathways you could take, was a real eye opener.”

This workshop contributes to building talent required by AgResearch, the research and pastoral sectors and aligns with SCP Outcome D (see p.2).
National Science Challenges

AgResearch hosts the Our Land & Water National Science Challenge (NSC) and contributes to the High Value Nutrition, New Zealand’s Biological Heritage, Science for Technological Innovation and other NSCs. The Challenges have the mandate of leading and influencing the research direction of their respective fields to help the New Zealand public get even better value from its annual $1.3 billion investment in science and innovation.

WE WORK WITH OTHER RESEARCH ORGANISATIONS TO ALIGN AND FOCUS RESEARCH ON THESE CHALLENGES AND HELP THE NEW ZEALAND PUBLIC GET EVEN BETTER VALUE FROM ITS ANNUAL INVESTMENT OF $1.3 BILLION IN SCIENCE AND INNOVATION.

Our Land & Water – Toitū Te Whenua, Toiora Te Wai

The Our Land and Water NSC will “enhance primary sector production and productivity while maintaining and improving our land and water quality for future generations”[15]. The Challenge strategy, co-developed by stakeholders and the science teams, has three themes that are key to delivering transformational change to the sector:

Collaborative capacity: Collaboration stimulates development of new land and water use and management options that open pathways to increased market value and build the social capital necessary to support transition to a limits-based management regime.

Innovative, resilient land and water management: Land users and regulators will have a menu of tested smart technologies, innovative land use options and land and water use practices. These will improve efficiency, productivity and natural capital while linking to real time monitoring that enhances decisions at the individual and community scale, thus achieving primary production growth targets within community and regulatory limits.

Greater value from global markets and value chains: The primary sector will sustain higher economic growth by participating in global value chains, generating new products, services and market segments that are aligned with, are validated against, and improve environmental, social and cultural values.

Operating at the Nexus: The size and complexity of the Challenge means the research spans ecological and social science. The Nexus provides the opportunity to interconnect the three tier themes and catalyse delivery of the Challenge research, as well as the aligned $100m per annum of national research investment.

The transdisciplinary research teams include stakeholders to co-design, co-develop and co-innovate the Challenge activities, maximising adoption and practice change, as described on p.10.

The first two official Challenge appointments are Ken Taylor as permanent Challenge director and Professor Richard McDowell as Chief Scientist.

Ken Taylor was the Director of the Science Group at Environment Canterbury, and chairs a reference group of the Land and Water Forum.
Professor McDowell was the Interim Chief Scientist of the Challenge, and is a Principal Scientist at AgResearch and Professor of Soil and Water Quality at Lincoln University.

Other research partners in the Challenge include ESR, GNS Science, Landcare Research, Lincoln Agritech, Lincoln University, Massey University, NIWA, Plant & Food Research, Scion and the University of Auckland.

**HIGH VALUE NUTRITION – KO NGĀ KAI WHAI PAINGA**

The overarching objective of the High Value Nutrition Challenge is to develop high-value foods with validated health benefits. The Challenge will drive economic growth through excellence in the following themes:

- Clinical application (which food to do what)
- Biomarkers (measuring impact, clarifying risk)
- Meeting consumer preferences and health values
- Science of food.

The Challenge aims to increase the value of New Zealand food exports by improving their value propositions to consumers through health claims, leading to increased premiums and/or increased sales volumes. Research in all the themes will be relevant to the health targets, regulatory needs, consumer preferences/values, and the food types that offer the greatest economic opportunity.

In the High Value Nutrition National Science Challenge priority research round announced in October 2015, $3.6 million was allocated for an AgResearch-led project into gut health where we are working with the University of Otago, the Malaghan Institute of Medical Research and Plant & Food Research. The research is aimed at fast-tracking opportunities helping New Zealand’s food and beverage industry to develop and market foods with validated health benefits, such as improved gut function and comfort.

AgResearch staff will also be working in four other teams that have received grants from High-Value Nutrition priority round. They are Immune Health, led by the Malaghan Institute of Medical Research; Metabolic Health, led by the University of Auckland; and preliminary projects led by Massey University on the food science of health foods, and by Plant & Food Research on consumer insights in relation to food-for-health in our key markets with a focus on Asia. AgResearch also had three successful projects in the High Value Nutrition contestable funding round.

All three projects are funded for three years with $1,000,000 each from the Challenge and as well as co-investment from industry partners.

“Complex beef lipids for metabolic health” is led by Dr Emma Bermingham. She says meat from grass-fed animals may contain bioactive complex lipids that have the potential to improve metabolic health.

“We want to provide robust scientific evidence that consuming complex lipids extracted from New Zealand grass-fed red meat will lead to reduced cholesterol levels.”

“We are working with Hawkes Bay company Firstlight Foods, which produces premium grass-fed Wagyu beef.”

Reducing the risks of developing allergies in children is the aim of the project “Natural protection of milk” led by Dr Alison Hodgkinson. She is partnering with Miraka, the Māori-owned dairy processing and exporting company which is looking to expand its business by diversifying into higher-value dairy products.

The third project “a2 Milk™ for gut comfort” is aimed at demonstrating the health benefits of a2 Milk for people who believe they are intolerant to cows’ milk and is led by Dr Matthew Barnett.

“The third project “a2 Milk™ for gut comfort” is aimed at demonstrating the health benefits of a2 Milk for people who believe they are intolerant to cows' milk and is led by Dr Matthew Barnett.

“With partner the a2 Milk™ Company we will be running human clinical studies to confirm the benefits of dairy products that are exclusively of the A2 protein type on increased gut comfort through preventing intestinal inflammation in some consumers,” he says.

**NEW ZEALAND’S BIOLOGICAL HERITAGE – NGA KOIORA TUKU IHO**

The New Zealand’s Biological Heritage Challenge addresses the services sustaining the healthy ecosystems on which our global reputation is founded. The Challenge will increase the relevance, value and impact of biosecurity and biodiversity research through:

- A new integrated ‘one ecosystem’ research agenda
- Deeper collaboration across research boundaries and disciplines
- Larger-scale research programmes focusing on ‘mission-critical’ research
- Stimulating and rewarding research excellence; and
- More effective public engagement.

The Challenge aims to reverse the decline of New Zealand’s biological heritage through a step-change in research innovation, globally-leading technologies and sector action.

The Challenge involves researchers from all seven Crown Research Institutes, eight universities and Te Papa Tongarewa.

AgResearch’s Dr Maureen O’Callaghan is the Programme 2 Leader.

**SCIENCE FOR TECHNOLOGICAL INNOVATION – KIA KOTahi MAI – TE AO PŪTAIAO ME TE AO HANGARAU**

The Science for Technological Innovation Challenge will provide New Zealand with the advanced scientific, engineering, mathematical and ICT expertise required to support knowledge-based manufacturing and service industries that will drive improvement in the country’s economic wellbeing. Research targets include:

- New medical device technologies to improve health outcomes for New Zealanders, reduce healthcare costs, and generate export earnings
- Improved yields in our primary industries (meat, dairy, forestry, fisheries, horticulture) using innovative technologies
- New materials made from sustainable sources and new monitoring technologies supporting sustainably productive agricultural environments
- Innovative software embedded in manufactured products and underpinning applications and services that support New Zealand’s knowledge-based economy.

The Challenge involves researchers from AgResearch, AUT, Callaghan Innovation, GNS Science, Lincoln Agritech, Lincoln University, Massey University, Scion, University of Auckland, University of Canterbury, University of Otago, Victoria University of Wellington and University of Waikato.
The proposed New Zealand Food Safety Science and Research Centre

This proposed Centre is a joint investment by Government and New Zealand’s food industry, recommended by the Report on the WPC Contamination Incident. The Centre is hosted by Massey University with support from AgResearch, Cawthron Institute, ESR, Plant and Food Research, University of Auckland and University of Otago and it provides:

- Rapid access to science-based information
- Rapid deployment of best teams, optimising skills for maximum cost-efficiency
- Better, more cost-efficient use of existing resources and investment in new resources to fill gaps and create opportunities
- Ways to prevent and avert catastrophic events
- Better control of messages, particularly in crises.

The Centre emphasises a co-creation / co-invention model (see p.10) in which industry workshops identify needs and industry, government and research providers combine to develop strategies to meet those needs. AgResearch’s Dr Gale Brightwell has been appointed interim deputy director of the Centre. In addition to the Centre investment and our existing Core Funding investment in food safety, AgResearch has committed a further $1 million p.a. of Core Funding to a food provenance and assurance initiative (see p.40).
AN ADOPTION AND PRACTICE CHANGE ROADMAP

AgResearch has always aimed to maximise the impact of its research and the value it creates for the sectors we serve. Our Adoption and Practice Change Roadmap, completed in May 2013 (see p.48), recommended new approaches that we are now implementing across our research programmes.

Based on case studies showing what successful adoption and practice change looks like, we developed:

- Planning tools to maximise potential for adoption and practice change from the beginning of a project
- Monitoring and evaluation techniques to measure the difference our science makes
- Principles of success to guide what leads to successful adoption and practice change
- An understanding of the skills and brokering capability required to support our researchers to work alongside stakeholders.

PROJECT PLANNING TOOLS

We have developed project planning tools, starting with an Impact Planning Tool to clarify stakeholder roles throughout the project. The template helps the project team identify the role the stakeholders, including AgResearch, play throughout the life of the project through to achieving impact. This includes identifying opportunities or needs, developing solutions, delivering or transferring those solutions to end users, and ensuring impact into the future. The template is designed to prompt discussion among the project team, and can be useful in stakeholder discussions to better understand and clarify expectations, particularly when starting a project. It can be updated throughout the life of the project if and when changes occur.

The Programme Logic helps us develop a clear implementation pathway from research activities to short, medium and long term impact with next- and end-users. Examples of simplified frameworks can be seen on pp.14 to 32. We have developed a simple logic that can be used with project teams allowing everyone to participate in its development.

Supporting tools include an Indicator Tool, which lists potential progress indicators for processes, outputs, impacts and signs of unanticipated outcomes that could be applicable before, during and after a project. There is also an Indicator Sorting Tool to select the most appropriate indicators focusing on relevance, usefulness, clarity and accessibility criteria.

EVALUATION METHODS

We are supporting project teams to evaluate throughout the life of the project. This is to keep the project on track to deliver impact, and to measure the impact it has created.

As well as quantitative and qualitative indicators, evaluation methods include:

- Participant feedback sheets to evaluate workshops with stakeholders or other project participants
- The Objective/Reflective/Interpretive/Decisional (ORID) process to help participants and stakeholders provide qualitative information on the strengths and weaknesses of an event or project
- Narratives and case studies to provide context to quantitative indicators and illustrate change and how change occurred. Collections of narratives or case studies can enable in-depth analysis.

These methods are used to drive impacts in each area where AgResearch aims to deliver outcomes for the sectors we serve and New Zealand as a whole.

Find out more about these planning tools and how AgResearch plans for impact at www.beyondresults.co.nz.
CO-OWNED SECTOR OUTCOMES

How we invest to create the greatest impact for New Zealand agriculture

To understand where AgResearch should focus its efforts to have the greatest impact in the sector, we have invested considerable effort into understanding the goals of our stakeholders and then working to develop an appropriate portfolio of short, medium and long-term programmes to achieve those goals. These programmes are grouped into outcome areas through which we help achieve the targets our sector stakeholders have prioritised in their strategies.

AgResearch research and development portfolio (for 2014/15)

Note that AgResearch carried out some R&D in 2014/15 that was not aligned with our Core Purpose, mostly because it supported the Core Purposes of our collaborators. That R&D (with a value of about $1.8 million) is not included in the $119 million shown in this diagram.
Our work is divided into six outcome areas to benefit the sector.
The dairy industry is a vital contributor to the New Zealand economy and it presents a substantial opportunity for economic growth. The 2013 dairy industry strategy was developed by DairyNZ, Federated Farmers (Dairy), the Dairy Women’s Network and the Dairy Companies Association of New Zealand. It shows how it is vital to have sustainable development (meeting present needs without compromising the ability of future generations to meet their needs) and to remain competitive on the world stage. These considerations led to an enhanced emphasis on social responsibility, higher standards of animal and human welfare, and environmental stewardship.

AgResearch contributes to almost all of the dairy industry’s following 10 strategic objectives, through research and development, modelling and analysis, technology and knowledge transfer, expert advice and by developing people, in partnership with one or more dairy industry organisations:

• Farm Profit – increase on-farm profit and resilience through greater efficiency
• Research and Development – research and develop innovative technologies and solutions to meet the future needs of dairy farms
• Talented People – attract, develop and retain highly skilled and motivated people throughout the industry
• Biosecurity and Product Integrity – enhance the assurance levels of New Zealand’s biosecurity and product integrity
• Industry Information Systems – create and maintain industry-wide systems and structures to serve the needs of dairy farmers
• Environmental Stewardship – proactive environmental stewardship and wise use of natural resources
• Animal Welfare – farm to high standards of animal health, welfare and well-being
• Work Environment – provide a world-class work environment on-farm
• Local Communities – enhance the communities we live in
• National Prosperity – grow dairying’s contribution to the prosperity and well-being of New Zealand.

Some key priorities in the strategy include:

• Attracting people to the industry
• Changing systems and intensity
• Effective environmental impact mitigation options
• Strategic management practices.

The industry is also addressing threats including:

• Availability of water
• Ability to maintain resilient, profitable systems
• Product integrity and reputation
• Increasing standards for product testing.

In particular, the industry has to manage its growth within limits described by local policy.

The dairy industry has an increasing focus on industry and farm-based information systems to help farmers make wise decisions, from the tactical to the strategic level. Some key information systems include:

• Dairy Industry Good Animal Database (DIGAD), which contains animal genetic records, herd test results, animal breeding values and other animal-related fields
• DairyBase, a web-based package that records and reports standardised dairy farm business information, both physical and financial
• National Animal Identification & Tracing (NAIT), powered by OSPRI New Zealand, which links people, property and livestock in New Zealand
• Forage Value Index (FVI), the independent source of Forage Value Indices and seasonal dry matter performance values for short term and perennial ryegrass cultivars in New Zealand.

The growth of dairying in the South Island (now 39.2% of all cows and 41.6% of all milk solids production), especially in Canterbury, Otago and Southland, requires a re-focus on the needs of South Island dairy farmers. AgResearch is working with DairyNZ and Southland dairy farmers to form a Southern Dairy Hub – an innovation centre testing concepts that will benefit southern dairy farmers and future dairying in the south.

We also support the aspirations of the growing dairy goat and dairy sheep industries to discover new components and functional benefits of non-bovine milk, improve the efficiency of farming and farming practices and ensure the environmental sustainability of goat and sheep dairying in New Zealand.
## Programme Logic for Improved Dairy On-Farm Performance and related opportunities to improve Pan-Sector and Maori Agribusiness Performance

**FIGURE 4**

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Example Programmes</th>
<th>Outputs</th>
<th>Pathways to Implementation</th>
<th>Indicators</th>
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</thead>
<tbody>
<tr>
<td>Improved production from home-grown feed</td>
<td>Clover root weevil biocontrol and pest management strategies Black beetle Yersinia trial Next generation biopesticides Improving forage legumes Pastoral Genomics Resilient grasses</td>
<td>Biocontrols for insect and plant pests Improved forage cultivars and endophytes</td>
<td>Industry organisations, regional councils, biopesticide manufacturers Grasslanz Technology Ltd, plant breeding companies</td>
<td>Profit from productivity, dairying’s economic contribution to NZ</td>
</tr>
<tr>
<td>Improved rate of genetic gain in the national herd</td>
<td>Animal factors affecting methane Dairy sheep farm systems</td>
<td>Roles of key genes, new genetic technologies</td>
<td>NZ animal breeding and genetics companies</td>
<td>Animal production efficiency, rate of gain in breeding value</td>
</tr>
<tr>
<td>Improved animal health and milk quality</td>
<td>Facial eczema Parasite resistance in dairy cattle</td>
<td>Vaccines, anthelmintics, animal management strategies, breeding solutions</td>
<td>Animal breeding and genetics companies, DairyNZ, veterinarians</td>
<td>Progress on industry animal health/milk quality initiatives</td>
</tr>
<tr>
<td>Adoption of new farm management practices which improve productivity and profitability</td>
<td>Land use change and intensification Rural futures Technology transfer extension handbook</td>
<td>Decision-support tools, e.g. Overseer, Farmax, etc.</td>
<td>DairyNZ, rural professionals, farm consultants and land managers</td>
<td>Practice change on-farm, including adoption of farm planning</td>
</tr>
<tr>
<td>Control targets met for nationally-monitored diseases</td>
<td>TB vaccine</td>
<td>Vaccines, disease management strategies</td>
<td>TBfree New Zealand, Polybatics, animal health companies</td>
<td>Annual period prevalence for bovine tuberculosis</td>
</tr>
<tr>
<td>Improved animal welfare</td>
<td>Dairy goat supply systems Off-pasture wintering systems</td>
<td>Recommendations on improved practices</td>
<td>DairyNZ, MPI, rural professionals</td>
<td>Compliance with the New Zealand Animal Welfare Code (2010) for dairy cattle</td>
</tr>
</tbody>
</table>

### OUR STRATEGY

**Improved Dairy On-Farm Performance impacts are delivered through the innovation pipelines shown in Figure 4. These pipelines include many research projects on cattle, goat and sheep dairy farming.**
REDUCING THE 30% LOSS OF CONCEPTIONS

Senior scientist Dr Debbie Berg (shown here) and others from AgResearch’s Reproduction team are partners in an MBIE and DairyNZ-funded, research programme to improve dairy cow fertility. The improvement will come through selecting cows that are naturally more fertile, as well as developing new management tools to take advantage of the better genetics.

“The fertility programme’s biggest challenge is in reducing the apparent 30% loss of conceptions, which occur in the first 35 days after insemination,” says Debbie.

“We are identifying the timing, and possible reasons for pregnancy failure. Collecting this information, which requires a multi-disciplinary approach, will provide the foundation for future objectives in the research program. All we know is that embryos are failing to develop in a significant number of our dairy cows – we don’t know whether this is due to a failure of fertilisation, or due to an event later in embryonic development.”

Dr Sara Edwards, Science Team Leader, Reproduction says one of the team’s challenges was to determine whether single cell embryos have been fertilised or not, something that is very difficult to do at this early stage.

“We did this by extracting DNA from these single cells – bearing in mind this is a single copy of DNA (there is very little there), and then we amplify it,” she says.

“We started with a team of AgResearch and DairyNZ staff, commercial embryo flushing companies and support from Fonterra. At Day eight post-insemination, the team flush (recover) embryos from dairy cows at various farms in the North Island. These embryos are frozen and then transported to Invermay for DNA extraction, amplification and analysis,” says Sara.

Dr Ian Sutherland, Science Group Leader, Animal Productivity says that the research team has faced significant technological and logistical problems.

“Despite this, the level of success achieved so far in determining the fertility status of embryos is a real triumph for the team, and an excellent demonstration of the multi-disciplinary research AgResearch is able to deliver.”

This project aims to help the dairy industry reach its target of a 78% 6-week in-calf rate, which is estimated to deliver $28,000 p.a. in increased profit on a 400-cow farm, compared to the 2011 rate of 65%.

80% REDUCTION IN BLACK BEETLE

Preliminary results from a project carried out by AgResearch’s Innovative Farm Systems Group funded by Ballance Agri-Nutrients, DairyNZ and the Ministry of Primary Industries’ Sustainable Farming Fund have found that mini-plots treated with a prototype product that contained an AgResearch-patented bacterium, Yersinia entomaphaga MH96, averaged more than an 80% reduction in the adult black beetle population during spring 2014. This was significantly greater than in plots treated with a chemical pesticide, which averaged 45% reduction, and much better than untreated plots, which averaged about a 25% reduction.

The trial was carried out in the Waikato, at AgResearch’s Ruakura campus and a nearby farm. A large plot trial carried out at the same time achieved similar reductions in black beetle numbers.

“Spring application offers the distinct advantage that, if timed correctly, black beetles will be killed before they have laid eggs. This will reduce the damaging larval population that can severely reduce pasture growth, particularly under dry conditions,” says AgResearch Senior Scientist Dr Mike Wilson.

Further work is underway to confirm last year’s autumn results and, if successful, this work could lead to a biopesticide that is effective against this important pasture pest. Biological solutions for black beetle and other key pasture pests are under development in the “Next Generation Biopesticides” programme, led by AgResearch.

This project could provide an alternative method of controlling black beetle in dairy pastures in addition to novel ryegrass endophytes, thereby increasing pasture production and profit from productivity.
BOOSTING THE DAIRY SHEEP INDUSTRY

The new MBIE-funded six-year programme, “Boosting exports of the emerging New Zealand dairy sheep industry” is led by AgResearch’s Dr Linda Samuelsson. The research collaborators are from the University of Otago, Callaghan Innovation and Victoria University, and industry partners Waituhi Kuratau Trust, Kingsmeade Artisan Cheese, Antara Ag Farms (formerly Blue River Dairy) and Spring Sheep Dairy. The programme includes four research aims straddling our Improved Dairy On-Farm Performance and Improved Returns from Dairy Products outcome areas.

During 2014/15, AgResearch’s Dr David Stevens and his team conducted three animal trials with Antara Ag Farms. The first studied the behaviour of lambs around automatic milk dispensers using video surveillance of lambs. The results from this trial were used to design an early weaning trial using a protocol of restricting access to milk from one week of age, to help lambs begin to eat hard feed and wean them onto hard feed at four weeks of age.

In another part of the programme, Dr Li Day and Marita Broadhurst are collecting milk at Spring Sheep Dairy, Antara Ag Farms and Kingsmeade to investigate the influence of seasonality, age, lactation stage, farm of origin and other factors on milk composition. Meanwhile, Dr Wayne Young is investigating how sheep milk affects the consumer’s immune and digestive systems.

The programme’s environmental research team is taking monthly samples of the Antara Ag Farms effluent pond and milking parlour to understand nutrient concentrations in dairy sheep effluent. Effluent flows are continuously monitored to measure the effluent (nutrient) volumes moving through the system. Effluent samples will also be collected from Kingsmeade until the end of the milking season.

This research aims to help grow exports from the New Zealand dairy sheep industry, creating greater value from milk by knowing its composition and the functionality of its components, improving the net volume and value of harvested ewe’s milk, and establishing criteria to ensure the environmental sustainability of sheep dairying in New Zealand.

20% LOWER N LOSSES THROUGH INTEGRATION

A project, based on research which began in 2001 supported by a range of funding parties, assessed how integrating a range of nitrogen (N) efficiency and nitrous oxide emission mitigation options could reduce reactive N loss to the environment. Research was undertaken on dairy farms located in five regions, with contrasting soil, climate and farm management attributes.

Funding was made since 2001 by the Ministry of Primary Industries’ Sustainable Farming Fund; the Ministry for Business, Innovation and Employment and the Pastoral 21 (Environment) programme, which is funded by the Ministry for Science & Innovation, DairyNZ, Fonterra and Beef & Lamb New Zealand. The analysis suggests milk production increases of 7-30% between 2001 and 2009 were associated with increased N leaching and nitrous oxide (N₂O) emission losses of 3-30% and 0-25% respectively. On the other hand, the study found that integrating several strategic and tactical management and mitigation options could offset these increased N losses. Researchers say the single most effective measure for reducing N leaching losses from the farms was to limit the duration of pasture grazing during autumn and winter months. Averaged across the catchments, this was estimated to reduce N leaching losses by around 20% relative to the 2009 base farm losses.

Three mitigation practices were found to consistently deliver reductions in per-hectare N₂O emissions relative to the 2009 base farm emissions. These were improving animal performance combined with a reduction in stocking rate, introducing a higher-energy supplement to the cow diet and applying DCD to pasture. The researchers say these modelling assessments suggest that integrating a range of strategic and tactical management and mitigation options can reduce N losses to the environment, while maintaining milk productivity. They say it is apparent from this analysis that there is no ‘one size fits all’ approach to the challenge of reducing N losses from these dairy systems and that the ability to reduce losses will vary between individual farms depending on their existing management practices and level of farm inputs.

This project aligns with the Environmental Stewardship goal of the Strategy for Sustainable Dairying.
NEW DAIRY GOAT R&D FACILITY

Work to increase New Zealand’s goat milk supply took another step forward in March 2015 when AgResearch opened its dedicated dairy goat research facility at Ruakura.

“The dairy goat industry is a great example of where science has made a difference right across the value chain, from on-farm to off-farm and work which has supported Dairy Goat Co-operative (DGC) in establishing and growing their business,” says AgResearch Partnership & Programmes Director Dr Greg Murison.

“DGC has an excellent track record of developing and marketing high-quality exports based on a strong R&D component,” he says.

AgResearch has three dairy goat research programmes underway, two funded by MBIE and the third by the Ministry for Primary Industries through the Sustainable Farming Fund, with significant cash and in-kind co-funding from DGC.

The first trial in the new 48-goat facility aims to determine the best bedding surfaces for dairy goats.

DGC Chairman Campbell Storey (second from the right in the picture, with DGC Chief Scientific Officer Colin Prosser, Chief Executive Tony Giles and Greg Murison) says the AgResearch work is crucial to the industry’s growth.

“There has been an industry shift where now goats are mainly farmed indoors. There is a greater focus on animal welfare, milk quality and in producing milk fit for purpose with the correct profile to produce what we believe is the best dairy goat infant formula in the world.

“To be making such a claim we need to continually invest in research and development, and working with a world-renowned agricultural research organisation, with a dedicated dairy goat research facility, who will be committed to research goat farming-related issues is an exciting opportunity.”

This facility contributes to achieving the research goals of the dairy goat industry, including discovering new components and functional benefits of goat milk, improving the efficiency of goat farming and integrating sustainability principles from barn to bottle25.
IMPROVED MEAT & FIBRE ON-FARM PERFORMANCE

Landscape

Nearly 7.9 million hectares of New Zealand’s pasture lands are used for sheep, beef and deer farming. About 12,290 farm businesses grow the 29.6 million sheep, 3.73 million beef cattle and 0.95 million deer wintered in 2014. About 855,000 surplus dairy bulls and heifers are retained each year to be raised for beef. The sector’s land area has declined in recent years as anticipated returns from dairying and forestry have driven land use change. The growing dairy sector could potentially increase the dairy beef supply over time but, although calves slaughtered for veal increased from 1.6 to 2.1 million between 2010 and 2014, adult cattle slaughter numbers have remained steady at about 2.4 million per year and beef production available for export was almost unchanged at 584,000 tonnes in 2014. Lamb production available for export also remained almost unchanged from 2010 at 372,000 tonnes in 2014.

The impacts on which AgResearch focuses in this outcome area are heavily influenced by the key industry organisations, Beef + Lamb New Zealand and Deer Industry New Zealand (DINZ). In addition, the Red Meat Sector Strategy developed by Beef + Lamb New Zealand and the Meat Industry Association (MIA) described a critical role for innovation to assist in improving the sector’s fortunes. Based on that strategy, the Red Meat Profit Partnership PGP programme aims to enable more consistency in farm performance and profitability by assisting farmers to extend their capability based on best practice information and resources, sharing information, and providing suitable tools and support. The FarmIQ PGP programme has also set goals for on-farm production that are supported by AgResearch’s science-based innovation.

Our Strategy

Senior AgResearch staff work with senior Beef + Lamb New Zealand staff and the Farmer Research Advisory Group (FRAC) members to develop research projects to meet the needs of sheep and beef farmers. The FRAC, includes one member each from the seven farmer councils and acts as a conduit between farmers, Beef + Lamb New Zealand’s board and research team. Researchers also have opportunities to propose project ideas to the FRAC. The result of the process is a research portfolio that is closely aligned with farmer needs while not duplicating existing or past research.

We also work with Beef + Lamb Genetics, continuing from our work with its predecessor Ovita, to help build stronger genetics by focusing on industry-relevant outcomes and adoption, and with Pastoral Genomics to help achieve stepwise and sustainable gains in forage productivity.

We take a similarly consultative approach in working with DINZ to identify and carry out research projects to help achieve the goals of DINZ’s Passion 2 Profit.

Improved Meat and Fibre On-Farm Performance impacts are delivered through several innovation pipelines shown in Figure 5 that include many research projects. Some examples are shown on these pages.
TARGETING 50% IMPROVEMENT IN NITROGEN RESPONSE

The N-Guru decision support software released in July 2014 was the first product from the $32 Million, seven-year Clearview Innovations PGP programme led by Ballance Agri-Nutrients with co-investment from MPI.

AgResearch worked with Ballance to design software to improve nitrogen use efficiency on pastoral farms by recommending variable rather than uniform rates of nitrogen fertiliser application, where soil nitrogen content varies sufficiently across the farm.

When combined with soil nitrogen tests for multiple locations around a farm, N-Guru predicts the response of pasture to added nitrogen and enables Ballance sales staff to advise farmers on the minimum nitrogen fertiliser to use in each part of the farm to obtain the desired growth response. The same nitrogen can therefore produce more pasture drymatter than it would if distributed uniformly. This can either save the farmer fertiliser cost or enable greater production for the same amount of fertiliser.

N-Guru will continue to be refined with farmer feedback and it is expected to drive between 20 and 40% of the nitrogen-use efficiency improvement Ballance aims to achieve through the Clearview Innovations programme. The programme aims to increase nitrogen uptake efficiency from a response of 10 kgDM per kg of N to 15 kgDM per kgN – a 50% improvement.

Clearview Innovations also aims to increase phosphate use efficiency by 20%.

This research is helping improve on-farm management and reduce farming’s environmental footprint while increasing efficiency.
### Programme logic for Outcome 2: Improved Meat & Fibre On-Farm Performance and related opportunities to improve Pan-Sector and Māori Agribusiness Performance

<table>
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<tr>
<th>Impacts</th>
<th>Example Programmes</th>
<th>Outputs</th>
<th>Pathways to Implementation</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved productivity of forage</td>
<td>Next generation biopesticides, Undermining weeds, Global change processes, Improving forage legumes, Pastoral genomics, Endophyte innovation</td>
<td>Biocontrols for insect and plant pests, Improved forage cultivars and endophytes</td>
<td>Industry organisations, regional councils, biopesticide manufacturers, Grasslanz Technology Ltd, plant breeding companies</td>
<td>New forages and forage management leading to step-change in productivity</td>
</tr>
<tr>
<td>Improved productivity in meat- and fibre-producing animals</td>
<td>Sheep Genomics Projects, Sheep Reproductive Performance, Beef Production, Deer Progeny Test</td>
<td>Roles of key genes, new genetic technologies</td>
<td>Beef + Lamb Genetics, Genomnz, NZ animal breeding companies</td>
<td>Increase in production and profit from sheep, beef and deer</td>
</tr>
<tr>
<td>Improved animal health status of meat- and fibre-producing animals</td>
<td>Parasitology ecology &amp; pharmacology, Parasitology - CARLA™, Haemonchus vaccine</td>
<td>Diagnostics, anthelmintics, disease management strategies</td>
<td>Animal breeding and genetics companies, Polybatics</td>
<td>Reducing incidence and cost of pests and diseases in sheep, beef and deer</td>
</tr>
<tr>
<td>Continuous improvement in farm management practices</td>
<td>Pastoral 21 – management to improve hill pasture, Pastoral 21 – integrated farm planning</td>
<td>Decision-support tools, management approaches</td>
<td>PGP’s, industry organisations, rural professionals, farm consultants</td>
<td>Improved farm productivity; improved farm decision-making</td>
</tr>
</tbody>
</table>
33,000 ANIMALS IN TB TEST TRIAL

A new test for bovine tuberculosis (TB) developed by AgResearch in a five-year MBIE-funded contract is attracting international attention.

Emeritus Scientist Professor Bryce Buddle (shown below) says the project team has encouraging preliminary results from a trial which show the potential for a more accurate and cost-effective diagnostic test in the battle against bovine TB.

“The current test used on New Zealand farms often gives false positives, and a blood test is needed to confirm infection. We have developed a new skin test with a similar sensitivity to the existing reagent bovine tuberculin, and fewer false positive reactions in non-infected animals,” he says.

The new test displays specific M. bovis proteins on the surface of polyester “Biobeads”, giving a cost-effective and more reliable skin test reagent for bovine TB. The technique has been developed by New Zealand biotechnology company PolyBatics, which is commercialising the new test.

The proteins show stronger immune responses when displayed on very small particles and they can be used in a very low concentration; the Biobeads can also be produced at low cost using fermentation.

The team has a large field trial underway to obtain estimates of test sensitivity and specificity in comparison with the existing test. More than 30,000 cattle and 3,000 deer have already been tested and results for specificity have been very encouraging, with significantly fewer false positives than for bovine tuberculin and the test is on track to deliver equivalent sensitivity.

Bryce says the new skin test reagent has attracted international attention and material has been supplied to the United States Department of Agriculture, and the United Kingdom Department for Environment, Food and Rural Affairs to test the reagent.

This research contributes to TBfree’s goal to eradicate bovine tuberculosis from New Zealand.

TARGET PRODUCTIVITY

AgResearch staff Ray Moss, Trevor Knight and Shirley Nicholls spoke at a field day in late 2014, held on Andrew and Nicky Newton’s Hyton Farm, near Cheviot in North Canterbury. The research on the farm is one sheep and beef component of the Pastoral 21 programme ‘Lifting farm profit and production while reducing environmental impact’, running from 2011 to 2016 with investment by sheep and beef farmers through Beef + Lamb New Zealand.

The scientists are studying how to establish new plant genetics on land so steep it is usually sown by aircraft.

Ray Moss has trials on four sites, with two aspects (north vs south) on each site, monitoring production, quality and persistence for 16 different treatments, including existing pasture (control), grass-legume-herb mix, legume mix, spring vs autumn sown and finally, with vs without summer fallow. Seven legumes, four grasses and two herb species are being used.

Meanwhile, Trevor Knight is working on novel legumes to increase early spring feed supplies. Results to spring 2014 showed the standard perennials generally had the best production and hybrids with potential scored close to white clover. Many other legumes in the 2012 planting died out during the first year. The annual legumes in both plantings produced very well in the first spring but, although they flowered and set seed, there was little re-establishment.

Shirley Nicholls and the Germplasm Development team are developing more phosphate-efficient clovers using interspecific hybridisation.

“We want to produce plant material with all the current beneficial traits and valuable new traits introduced from these other species. We had some plants on hand at the field day to show what you can produce when you cross two quite different species,” says Shirley.

This research supports Beef + Lamb NZ’s goal to increase productivity on sheep and beef farms by 3% p.a, with lower inputs and more sustainable farm systems33.
Aiming for +$34m P.A. Net Earnings

Deer Industry New Zealand’s Passion 2 Profit (P2P) has been established as a $16 million Primary Growth Partnership programme over seven years with $7.4 million co-investment from MPI. P2P aims to deliver $56 million in extra revenues a year and increase net industry earnings by $34 million per year.

The P2P programme includes two inter-linked projects:

- Marketing premium venison
- Market-led production.

AgResearch is contributing to the second project by helping farmers integrate the best scientific knowledge on deer feeding, animal health, and genetics into their farm systems.

We can also help package technologies into solutions that are convenient for farmers to apply, especially in feeding, genetics and animal health. Specific goals of the P2P programme on-farm are to:

- Increase survival to sale rates to 76%, from the industry average of 72%
- Increase growth rates so carcass size at slaughter will increase by 4 kg by year seven, resulting in a 6% feed saving per kg venison produced.
- Reduce the average age at slaughter by 8%, making more deer available during the chilled season.
- Increase processing efficiency by 7% per kg of venison, due to heavier average carcass weights
- Increase the average value of a deer carcass by 1%, due to increased loin and leg muscle yield.

Improving 28 Traits

An enormous international effort to map the sheep genome, published in June 2014, has already had very valuable spin-offs for New Zealand agriculture. The paper, in the prestigious journal Science, represents eight years’ work by researchers in eight countries, 26 institutions with 73 authors.

AgResearch Principal Scientist John McEwan and Bioinformatics Team Leader Rudi Brauning are two of the authors.

John says New Zealand scientists have been using the information from the project for the last six to seven years as it has been generated.

“The international effort produced a very high quality assembly of the sheep genome. Associated work has identified more than 30 million DNA variants, and the assembly means the order of all those variants is also known,” he says.

A 606K SNP chip based on this information developed by FarmIQ and a series of other lower density chips are being used to improve genomic selection for 28 traits in most of New Zealand’s dual purpose sheep, within the Beef + Lamb Genetics project. These traits include facial eczema, parasite resistance, number of lambs born, meat yield and adult ewe liveweight. Commercial implementation uses lower density chips developed from these results.

Using the low and medium density (5K and 50K) SNP chips has been estimated to generate $200 million for the New Zealand industry over the next 15 years.

Beef + Lamb New Zealand Chief Executive Dr Scott Champion says the work was underpinned by the huge commitment New Zealand sheep farmers have made to genomic research through their earlier investments in Ovita.

“The outcomes being celebrated here are a taste of what’s to come through the new entity Beef + Lamb New Zealand Genetics.”

FarmIQ CEO Collier Isaacs says the new genome information has been absolutely critical for the high density SNP chip completed in 2013.

“It’s primarily being used by FarmIQ to track eating quality traits in New Zealand sheep. In the last year it has been used to report breeding values for ram lambs to terminal sire breeders on a research basis. The amount of information which the high density SNP chip can provide is really impressive. If you use the analogy of the previous 50K SNP chip giving genetic information down to the city you came from in New Zealand, this will provide the house. It’s about 12 times more dense.”

This research supports Beef + Lamb New Zealand’s Genetics’ goal to make the most of new and existing genetic technologies for sheep and beef cattle breeding, to breed the animals New Zealand needs for the future.
Landscape

The food and beverage industry contributed 56% of New Zealand merchandise export value in the year to December 2014. Milk and milk products are New Zealand’s largest food export ($15.6 billion in the same year) and New Zealand is the world’s second largest milk and milk product exporter. Products range from commodities through to specialist ingredients/extracts and branded consumer products. The Fonterra co-operative is the largest New Zealand dairy company, collecting most of New Zealand’s milk supply. There are two other long-established co-operative dairy companies, Tatua and Westland, and newer processors such as Synlait, Open Country and Miraka. On a smaller scale, the Dairy Goat Co-operative manufactures and exports goat milk nutritional products and there is an emerging New Zealand sheep milk industry.

AgResearch’s priorities are focused on developing new high-value dairy and food solution products and processes. This aligns with Priority 9 of the Building Innovation area within the Government’s Business Growth Agenda, with the High Value Nutrition National Science Challenge and the strategies of New Zealand’s dairy companies.

Some of the underpinning science required to deliver this outcome is also common to the Improved Returns from Meat & Fibre Products outcome area, such as food structures and functionality, and both sectors also share interests in areas such as food safety.

Our Strategy

Improved Returns from Dairy Products impacts are delivered as shown in Figure 6. These pipelines include many projects and some examples are shown in this section.

AgResearch delivers improved returns from dairy products through New Zealand dairy processing companies, including Fonterra. By 2017, AgResearch will have made a significant contribution to at least one dairy product that is in testing or in the market.
Jobs in the primary sector are projected to increase from 350,000 in 2012 to 403,000 by 2025, as a result of successfully implementing primary industry strategies, according to a 2014 MPI report.37

AgResearch Portfolio Leader for Dairy Pasture to Plate, Kevin Argyle, was asked to join the Dairy Capability Working Group to determine the dairy processing sector’s short, medium and long-term capability needs and develop a ‘roadmap’ to deliver development activities. The Working Group is chaired by Ruawai dairy farmer and former Fonterra Board director Greg Gent and other members of the working group include dairy industry representatives, education providers, and government departments.

In December 2015 Food Safety Minister Jo Goodhew welcomed the final report of the Dairy Capability Working Group.

“The Working Group found the food safety capability of New Zealand’s dairy sector is in good shape,” says Mrs Goodhew.

“Looking forward, to maintain our reputation as a world class provider of safe and suitable food we now need to anticipate the changing face of food safety.

“For the report’s recommendations to make a real impact we need strong commitment from the dairy sector. However, it is helpful that the report isn’t just about dairy. As a food producing nation all food sectors will find the report useful.

“The report supports a holistic and future-focused approach to food safety, where the end consumer is firmly at the centre. This approach will be critical to achieving the government’s target to double agricultural sector exports by 2025.”

The Whai Hua Primary Growth Partnership programme aims to develop new, added-value dairy ingredients, based on immune-enhancing dairy milk products. Commercial partners Wairarapa Moana Incorporation, Miraka Ltd and Kanematsu New Zealand Ltd work closely with industry partners in the Asian and New Zealand markets, with a focus on health-conscious consumers, and AgResearch is Whai Hua’s research partner.

The programme began in June 2013 and is planned to finish in June 2016, with 50:50 government and industry funding totalling $3.9 million. By early 2015, an independent mid-term review reported that the programme offers significant potential benefits from the projects and possible spin-offs.

The Whai Hua programme was estimated to create $8.6 million per year in economic benefits to New Zealand by 2021.

AgResearch is helping achieve the programme’s objectives to develop dairy herds which produce milk with high immune-enhancing properties, carry out product development and functionality testing.
Programme logic for Outcome 3: Improved Returns from Dairy Products and related opportunities to improve Pan-Sector and Māori Agribusiness Performance

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Example Programmes</th>
<th>Outputs</th>
<th>Pathways to Implementation</th>
<th>Indicators</th>
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</thead>
<tbody>
<tr>
<td>New high-value dairy and food solution products and processes</td>
<td>Gut barrier function</td>
<td>Understanding human health targets for functional foods</td>
<td>New Zealand dairy processing companies</td>
<td></td>
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<td></td>
<td>Gastrointestinal tract physiology</td>
<td>Characteristics of niche products and ingredients</td>
<td>New products, processes and services with high dairy content</td>
<td></td>
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<tr>
<td></td>
<td>Brain health</td>
<td>Understanding food assurance issues; strategies to improve food assurance</td>
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<td></td>
<td>Goat milk</td>
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<td></td>
<td>Sheep milk functional characteristics</td>
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<td></td>
<td>Food assurance microbiology</td>
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</table>
Landscape

Meat is New Zealand’s second largest food export behind dairy products and New Zealand is the world’s largest sheep meat exporter. Total exports from sheep and beef operations, including textiles and by-products, were around $8.8 billion per annum for the year to December 2014. The export value from venison, velvet and co-products is about $241 million per annum. Most meat industry export revenue depends on traditional whole meat foods. A voluntary trade association, the Meat Industry Association, represents these processors, marketers and exporters, and co-operates with Beef + Lamb New Zealand to develop and implement a “whole of sector” strategy encompassing on-farm and off-farm activities. AgResearch works with the MIA and other investors in meat industry R&D to co-ordinate investments so they deliver the greatest value and to deliver that value to end-users.

Maintaining market access and growing new markets for traditional meat exports will be essential but New Zealand is becoming more resource constrained so the sector cannot rely on increasing export revenue by simply increasing red meat production. Changes in land use are creating challenges for supply, with the number of lambs killed diminishing in recent years. The industry is also vulnerable to competition from developing agricultural economies with cheaper value chains and capacity to increase exports beyond their current local focus. These factors all create an impetus for science-led innovation to create more value from red meat and other carcass components.

The wool industry has also faced significant challenges. In 2013/14, 114,842 tonnes of clean wool were exported. About 43% of New Zealand’s wool exports that year were strong crossbred wool, another 33% was fine crossbred, 16% was medium wool and 7% was fine wool. Fine wool is roughly 3-5 times more valuable than strong wool, per kilogram.

AgResearch’s focus on wool aims to:

- Support marketing credentials for wool, especially with respect to its environmental credentials
- Assist wool sector firms with new product development
- Work to support existing product functionality, such as insect and stain resistance
- Find new uses for wool by understanding its attributes.

Much of the underpinning science required to deliver this outcome area is common with the Improved Returns from Dairy Products outcome area.

Our Strategy

Improved Meat & Fibre Off-Farm Performance impacts are delivered through several innovation pipelines, as shown in Figure 7. These pipelines include many research projects with many research partners and some examples are shown on the following pages.
SCIENCE FOR IMPACT

7 YEARS, +$75M EXPORTS

The Meat Industry Research and Innovation Partnership, launched in October 2014, is an $8.7 million investment over seven years by the Meat Industry Association and MBIE to support the Red Meat Sector Strategy. The programme aims to both increase meat export value and address significant industry risks. AgResearch, ESR and Carne Technologies are research providers to the partnership. The research goals include:

- Extending the quality and shelf-life of chilled meat exports in response to “slow-steaming”
- Addressing known and emerging pathogens, including E.coli H7-O157 and related bacteria
- Developing new value-added products out of existing products
- Maximising meat and bone meal value to aquaculture feed market.

The programme balances applied and fundamental research, including supporting graduate students in meat science and engineering and expects to add at least $75 million to exports by 2020.

This programme supports the Red Meat Sector Strategy’s goal of creating a strong brand position in premium markets.

+$880M ON-FARM REVENUE TARGETED

The Red Meat Profit Partnership (RMPP) is a seven-year PGP programme valued at $64 million. Its partners include Beef + Lamb New Zealand, Alliance Group, ANZCO, Silver Fern Farms, Greenlea, Blue Sky Meats and Progressive Meats as well as Rabobank and ANZ Bank. It aims to deliver up to $880 million per annum in additional on-farm revenue by 2025.

AgResearch carried out the Informing Extension Pilot Project Design to enable RMPP to understand, based on proven practice, when and why to use different approaches to extension to achieve uptake by sheep and beef farmers. The partners also wanted to inform the design of extension pilot projects being tested by the partnership, and to be able to confidently measure and evaluate their success or otherwise.

The study was undertaken over four stages, with each stage informing the direction of the next. Nine types of extension approaches were identified based on differences in the design of each approach and the circumstances in which each approach was successfully applied. The key design and contextual factors, along with success measures for extension projects identified from a literature review, were used to develop a monitoring and evaluation programme logic (or log frame) for each approach. The final stage identified extension studies that were typical of each approach and these were used to detail implementation steps and provide successful examples.

This research supports the RMPP goal to help the red meat industry become more profitable, confident and productive.
**Programme logic for Outcome 4:** Improved Meat and Fibre Off-Farm Performance and related opportunities to improve Pan-Sector and Māori Agribusiness Performance.

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Example Programmes</th>
<th>Outputs</th>
<th>Pathways to Implementation</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat products and processes that meet the needs of existing and new markets</td>
<td>Meat protein combi-foods&lt;br&gt;Added value foods – structure, delivery, digestion&lt;br&gt;Deer Select&lt;br&gt;MIA partnership programme&lt;br&gt;Food assurance microbiology&lt;br&gt;Value from Quality – shelf life</td>
<td>Understanding of meat characteristics and component interactions&lt;br&gt;Prototype food products&lt;br&gt;Understanding food assurance issues: strategies to improve food assurance</td>
<td>New Zealand meat processing and exporting companies</td>
<td>New differentiated products for existing and new markets</td>
</tr>
<tr>
<td>Improved processing efficiency</td>
<td>MIA partnership programme&lt;br&gt;Food Product Modeller</td>
<td>Prototype processing technologies</td>
<td>Meat industry equipment companies, Ovine Automation Ltd.</td>
<td>New technologies that contribute to improved processing efficiency</td>
</tr>
<tr>
<td>Higher value wool products</td>
<td>Wool protein cross-linking&lt;br&gt;Wool quality sheep screening&lt;br&gt;New wool products&lt;br&gt;Bleach damage&lt;br&gt;Eco-credentials</td>
<td>Understanding wool characteristics and interactions&lt;br&gt;Prototype wool products</td>
<td>New Zealand strong and fine processors and exporters</td>
<td>Contributions to new differentiated fit-for-market products for new markets</td>
</tr>
</tbody>
</table>
Outcome 5
IMPROVED PAN-SECTOR PERFORMANCE

Landscape
Many goals are common across the agri-food sector, including market access, environmental performance and biosecurity. International consumers of New Zealand’s products seek food safety and prices they can afford, followed closely by sustainability credentials.

New Zealand’s economic growth depends strongly on agriculture sector productivity growth. However, out of 31 countries for which OECD statistics provided the required data for the year 2009, New Zealand ranked 15th in agricultural GDP per worker. This was a substantial decline from 1998, when New Zealand ranked 8th out of 29 countries. If agriculture is to make a major contribution to economic growth in New Zealand, we must accelerate our agricultural productivity growth.

Agriculture also has a major influence on the New Zealand environment and the wellbeing of society. It is our most common land use after native vegetation and takes up 39% of New Zealand’s land area. Agricultural practices are increasingly subject to regulation to manage their environmental impacts, so agricultural productivity improvements must go hand-in-hand with reduced environmental impact and improved resource use efficiency, including improved nutrient management.

Despite the vital importance of rural land-based resources to our economy, New Zealand is one of the world’s most urbanised countries: 86% of the population lived in urban areas in 2010. If rural land is to be productive, the people who work the land must want to live in rural areas. It will also be vital for economic growth from land and natural capital to go hand-in-hand with environmental, economic and social sustainability.

Continued health of our productive and natural ecosystems requires those biological systems to be protected from the threat of invading pest animals, insects, plants, bacteria and viruses. Our country’s island ecosystems are uniquely susceptible to catastrophic pest invasions that can cause hundreds of millions of dollars of damage per year. Biosecurity research strengthens our border security against known and previously unknown threats, and develops new detection technology that reduces the cost of protecting against existing threats. Biocontrol research delivers cost-effective techniques to manage existing pests without creating adverse environmental impacts, such as those resulting from chemical control methods. AgResearch is a major partner in the Better Border Biosecurity collaboration, which is the key New Zealand grouping of biosecurity researchers who work to protect New Zealand from pests of plants.

Our Strategy
Improved Pan-Sector Performance impacts are delivered through the innovation pipelines shown in Figure 4 to Figure 7 and specific pan-sector research is shown in Figure 8. These pipelines include many research projects with many research partners, of which some examples are referred to on the following pages.
Research on agricultural greenhouse gas mitigation undertaken through the Deep Sequencing of the Rumen Microbiome project was published in the top-ranking journal Genome Research. This paper showed that methanogens differ in gene expression in high versus low methane-emitting sheep. The work had investment from the Office of Science of the US Department of Energy, the MPI Global Partnerships in Livestock Emission Research, the Pastoral Greenhouse Gas Research Consortium, New Zealand Agricultural Greenhouse Gas Research Centre and AgResearch Core Funding. An allied paper showed why the methane emissions in these sheep were different.

High-methane-output sheep produced about 16 g of methane per kg drymatter (DM) intake (with an extreme up to 17 g) while low-methane-output sheep produced about 25% less, at 12 g/kgDM (with an extreme down to 10 g). The mean methane production rate was about 14 g per kgDM.

*This project could lead to breeding-based approaches to reduce New Zealand’s greenhouse gas emissions and improve animal productivity.*

**LESS METHANE THROUGH GENOMICS**

AgResearch scientists announced at the New Zealand Agricultural Greenhouse Gas Mitigation Conference held in Palmerston North on 28 April 2015 that they had identified five different animal-safe compounds so far that can reduce methane emissions from sheep and cattle in short term trials by at least 30%.

Principal scientist Dr Peter Janssen, who coordinates the methane research programme, said the findings were the result of five years’ work, during which the team screened more than 100,000 compounds through computer-based searches and in laboratory experiments.

The inhibitor work is funded by the Pastoral Greenhouse Gas Research Consortium (PGgRc) and New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC) and led by AgResearch’s Dr Ron Ronimus. It is seeking new types of inhibitors that slow down or kill methanogens, the microbes in an animal’s rumen that generate methane.

Using the genetic information that became available when the first complete genome of a methanogen was published by the AgResearch team in 2010, they focussed on finding compounds that would inhibit methanogen function and leave the rest of the rumen system unaffected.

“The screening process identified five compounds that have now been tested successfully in sheep, showing a reduction in methane production over a two-day period from at least 30%,” says Ron.

PGgRc Chairman and NZAGRC Steering Group member Dr Rick Pridmore says the successful test of methane inhibitors is news that New Zealand farmers can get excited about.

“The results are significant for two reasons. First, because they work on livestock consuming a grass-based diet and, second because the short-term trials showed such dramatic results.

“It must be stressed that these are early days. Further trials are needed to confirm that these compounds can reduce emissions in the long term, have no adverse effects on productivity and leave no residues in meat or milk.

“We are already looking to engage with a commercial partner.”

The research team is now running trials to see if the inhibition effects last long-term and whether it will result in increased animal productivity as well.
“Methane produced by rumen methanogens represents about 9% of the dietary energy in the forage consumed by the animal,” says Peter. “If some of that energy can be redirected to the animal, it may lead to an increase in the animal’s ability to produce meat, milk or wool. This would be a real win-win for farmers.”

*Developing methane inhibitors is one of four aims of the PGgRc and the NZACRC joint methane mitigation research programme.*

**REducing N₂O-N Emissions To 3.3 MT**

In a paper published in 2014 by an international collaboration including AgResearch Principal Scientist Cecile de Klein⁴⁵, the authors assessed five approaches to reducing anthropogenic nitrous oxide (N₂O) emissions worldwide. N₂O makes up about 8% of global greenhouse gas emissions but emissions from food systems account for about 77% of the total anthropogenic N₂O emissions, or 87% when emissions associated with nitrogen fertiliser production and organic wastes are included.

Under a “business as usual” scenario, nitrous oxide emissions were predicted by the authors to increase from 4.4 million tonnes of N₂O-N in 2010 to 7.5 million tonnes in 2050 due to increasing demand for food by the world’s human population. However, the authors assessed five approaches to reduce emissions, including improved crop production, improved animal production, improved manure management, improved food utilisation and lowering the animal-derived protein in the diets of humans in affluent countries. They showed that combining credible improvements in these five areas could reduce N₂O-N emissions to 3.3 million tonnes in 2050.

*This work supports New Zealand’s contributions to international efforts to reduce greenhouse gas emissions.*

**A 30 Farm Knowledge Sharing Network**

AgResearch is working with AgFirst, DairyNZ, Landcare Research, Lincoln University, Massey University, NIWA, Pastoral Greenhouse Gas Research Consortium, Plant & Food Research and Scion to investigate greenhouse gas mitigation options for Māori pastoral farmers.

This is a three-year research project funded by the New Zealand Agricultural Greenhouse Gas Research Centre.

The project will start by developing a profile of the Māori pastoral sector and selecting a representative network of 30 Māori farms from across New Zealand. Each farm will be profiled and modelled in OVERSEER™ to determine and benchmark its emission profile.

The second stage of the project, mitigation modelling and design, will model a range of mitigation options and their impacts on four case study farms. These four farms will receive in-depth analysis using the Farmax, Mitigator and Forecaster decision support models.

The third stage, led by AgResearch’s Dr Margaret Brown, will work with the four case study farms and their farm advisors to establish discussion groups around each farm, using hui/field days and workshops to demonstrate the mitigation model results.

This project aims to help the Māori pastoral sector increase resource efficiency and farm profitability, while lowering greenhouse gas emissions.

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⁴⁵ Statement of Corporate Intent 2015-2020
Programme logic for Outcome 5: Improved Pan-Sector Performance and related opportunities to improve Māori Agribusiness Performance

<table>
<thead>
<tr>
<th>Impacts</th>
<th>Example Programmes</th>
<th>Outputs</th>
<th>Pathways to Implementation</th>
<th>Indicators</th>
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</thead>
<tbody>
<tr>
<td>Reduced environmental footprint of pastoral farming operations</td>
<td>Clean water, productive land Sustainable land use research initiative Animal variation in emissions Compounds to reduce methane emissions Plant effects on nitrous oxide North Otago irrigation</td>
<td>Implications of changing pastoral farming for the environment Implications of the changing environment for pastoral farming Approaches and technologies to build resilient agro-ecosystems</td>
<td>Farming technology supplies</td>
<td>Impact of pastoral farming on the environment</td>
</tr>
<tr>
<td>Practical policy solutions developed and adopted</td>
<td>Achieving green growth in the NZ pastoral sector Life Cycle Analysis methodology Animal deposition modelling Rural futures – water policy</td>
<td>Understanding policy implications through models Approaches to stakeholder engagement and policy development</td>
<td>Regional councils, MPI, rural communities</td>
<td>Policies informed in natural resource management and primary production</td>
</tr>
</tbody>
</table>
Outcome 6
IMPROVED MĀORI AGRIBUSINESS PERFORMANCE AND VISION MĀTAURANGA

Landscape
The Māori economy is a vital element in growing New Zealand’s overall economy. The Māori asset base rose to $42.6 billion in 2015 – up by $6 billion since 2010 – but the productivity of that asset base remains relatively low and only 5.5% of New Zealand’s exports are from Māori businesses. There is a lot of potential to lift the productivity of the Māori asset base, which would deliver benefits through improved profitability and greater exports, leading to greater wealth and more opportunities for Māori. A 2011 Te Puni Kōkiri report states Māori land owners aspire:

- To retain and improve existing long-term businesses associated with the land, especially farming, and for owners to use the land directly rather than through lease, and
- To achieve sustainable financial return for owners, provide employment for the owners where possible and to build a financial base for coming generations.

PriceWaterhouseCoopers (PwC) analysed the scope to improve Māori freehold land usage and productivity in 2014 for the Ministry for Primary Industries. PwC found about 45% of the land was satisfactory in its current use, 39% (mostly in non-dairy grazing) could have its productivity upgraded in its current use, and it would be beneficial to convert about 13% from its current use to a more productive use. The benefit of intervening to improve the productivity of Māori freehold land in these ways was estimated at a present value of more than $1 billion in gross domestic product (GDP) terms.

Māori agribusinesses face many challenges to improve their productivity, including the regulatory framework with which they operate, limited capital to invest, and governance issues, in addition to the challenges faced by other New Zealand agribusinesses. The regulatory framework is being addressed through Government’s review of the Te Ture Whenua Māori Act 1993 but the other challenges remain substantial.

Our Strategy
Our goals to improve Māori Agribusiness Performance aligns with the Business Growth Agenda under “Harnessing Māori resources’ productive potential”, including:

- Work with Māori to identify and promote best practice governance models for collectively held resources
- Partner with Māori, and other primary sector participants, to enable initiatives to advance the productivity of Māori agribusinesses

Our goals are also consistent with those of the Federation of Māori Authorities (FoMA) and Te Puni Kōkiri (TPK).

Previous analysis has divided Māori freehold land into three tiers:

- Tier 1: Well developed for agribusiness (20%)
- Tier 2: Under-performing entities. Developed for productive use but underperforming relative to industry benchmarks (40%)
- Tier 3: Under-utilised lands (40%)

We engage in different ways with each tier, to match what we can provide to their individual needs.

For Tier 3, we mentor agribusinesses and link them through our networks to organisations that can assist them to reach Tier 2 by putting in place existing good practices and technologies.

For Tier 2, we help them benefit from networking and clustering, farm optimisation and decision support tools incorporating the Māori dynamic – particularly the need to create value over time through operating performance rather than capital gain.

For Tier 1, we help them grow through developing new products and new markets, creating better processes and thereby taking more control of the value chain. These organisations have the resources to invest in research and development, both by themselves and with the government through the Primary Growth Partnership, National Science Challenges or AgResearch Core Funding.

To deliver to all three tiers, we link to potential investors and build relationships and networks that make us a valued partner.

In the government sector, these partners include MPI, MBIE, Callaghan Innovation and TPK. To support our delivery, we are building the capacity of our own people and more effective networks throughout the Māori agribusiness sector. Particular examples include a network focusing on forages, greenhouse gas emissions and benchmarking with Parekarangi Trust farm, Ngāi Tahu and work relating to the Hawkes Bay Regional Growth Strategy.
Delivering to Vision Mātauranga

AgResearch’s goal to improve Māori Agribusiness Performance lies within the wider goal of Vision Mātauranga – to unlock the innovation potential of Māori knowledge, resources and people. This strategic aspiration is relevant to the Vision Mātauranga themes of:

- Indigenous Innovation: Contributing to economic growth through distinctive R&D
- Taiao: Achieving environmental sustainability through iwi and hapu relationships with land (including kaitiakitanga)
- Mātauranga: Exploring indigenous knowledge and RS&T.

To assess progress towards unlocking the innovation potential of Māori knowledge, resources and people, AgResearch monitors the indicators shown on p.53.

Tihangaia framework

During 2013, the AgResearch Board adopted the framework shown in Figure 9 as a platform for AgResearch to develop more meaningful partnerships with Māori. The Tihangaia framework is not a new concept within Māoridom but recognises the necessary step change needed within AgResearch to stimulate growth, identify opportunities and capture benefits for a prosperous Māori economy.

AgResearch is positioned at the core of the Tihangaia framework to demonstrate a willingness to play an integral leadership role in delivering quality outputs to Māori and to symbolise a desire to work in partnership with cross-sector partners to achieve this. The three supporting pou (pillars) each represent a work stream:

- Pou Hononga – strengthening long-term partnerships with Mana Whenua organisations at campus and farm level.
- Pou Kōkiri – developing high-level strategic partnerships across multiple-sectors to stimulate development, growth and practice change adaptation relevant across the sector.
- Pou Wānanga – Board and management engage with sector leaders to gain insight into matters that are nationally significant for the Māori agribusiness sector.

Maori cultural competency programme

To deliver on our Vision Mātauranga goals, we must provide our staff with the knowledge, skills and experience to interact and collaborate effectively with Māori. To achieve this, we developed a cultural competency programme customised to the varying needs of AgResearch governance, management and staff. For the Board, AgResearch leaders and key science staff, a series of four workshops is helping them:

- Understand and be aware of the social, environmental, economic and cultural imperatives that drive Māori economic development and the Māori agribusiness sector
- Understand key values and principles important to Māori and how they influence decision-making in Māori agribusiness
- Confidently articulate the relevance of Māori needs in science programmes and research proposals
- Have an understanding of cultural etiquette and be confident in addressing Māori audiences.

Ongoing coaching and mentoring by AgResearch’s senior Māori staff will support these staff in their development through the programme.

AgResearch has also recently engaged the services of an external expert as Vision Mātauranga advisor to assist us to understand and reposition our approach to the Vision Mātauranga for stronger revenue and change.
AgResearch and Te Tumu Paeroa: the new Māori Trustee, signed a Memorandum of Understanding (MOU) in 2015 which signifies a new long-term relationship for the future of Māori agribusiness in New Zealand. Te Tumu Paeroa manages 100,000 ha of Māori land and has wide-ranging research opportunities to optimise Māori farm performance.

Jamie Tuuta, the Māori Trustee and head of Te Tumu Paeroa, signed the MOU with Chris Koroheke, AgResearch’s Portfolio Leader Māori Agribusiness (left and right, in image across).

“AgResearch’s commitment is to contribute to and support the growth of Māori agribusiness,” says Chris.

“Te Tumu Paeroa’s vision is to mobilise Māori land,” says Jamie.

“Much of our work is to enable Māori to achieve higher commercial aspirations for their land and assets and grow their value in a sustainable manner. We are always seeking to partner with organisations that have capabilities that assist us to provide benefits to the owners that we work on behalf of.”

An initial project will enable AgResearch to consider the potential and Te Tumu Paeroa’s vision for the land under its management.

This MOU will help Te Tumu Paeroa achieve its vision to mobilise Māori land and assets to create this generation’s legacy.
INTERNATIONAL ACTIVITIES

As well as working in New Zealand, AgResearch also works overseas where there is benefit to New Zealand.

Overall direction

There are four areas where it is appropriate for AgResearch to carry out international work, under our Statement of Core Purpose:

• National, sector or company initiatives where we can add supporting R&D capability
• Direct science collaboration to ensure international class science, access intellectual property and capability
• Science diplomacy to support New Zealand’s international profile and free trade agreements
• Direct requests from international companies for R&D capability that do not conflict with the interests of New Zealand or our sector partners.

Examples of international work

AgResearch scientists collaborate with scientists in research organisations around the world, leading to about half of AgResearch’s journal publications having international co-authors.

An example is AgResearch’s involvement in the Livestock Research Group of the Global Research Alliance on Agricultural Greenhouse Gases. This group is co-chaired by Dr Harry Clark of the AgResearch-hosted New Zealand Agricultural Greenhouse Gas Research Centre.

Participating countries include Argentina, Australia, Brazil, Canada, Chile, China, Colombia, Costa Rica, Denmark, Finland, France, Germany, Ghana, Indonesia, Italy, Ireland, Japan, Malaysia, Mexico, the Netherlands, New Zealand, Norway, Peru, Philippines, Republic of Korea, Spain, Sweden, Switzerland, Thailand, UK, USA, Uruguay and Vietnam.

AgResearch scientists are also involved in the Global Agenda for Sustainable Livestock and the European Commission’s Horizons 2020 research and innovation framework programme. These multi-stakeholder platforms foster collaborations in which excellent science is contributed to New Zealand as much as New Zealand scientists contribute excellent science to their international collaborators.

AgResearch is a member of a Ministry of Foreign Affairs and Trade (MFAT) panel that is intended to deliver its expertise to developing countries through the New Zealand Aid Programme. AgResearch is also involved in a project in Uruguay under the New Zealand Aid Programme with partners Instituto Nacional de Investigación Agropecuaria (INIA) and Plan Agropecuario (PA) that commenced in December 2013. AgResearch scientists Dr Liz Wedderburn, Dr Trevor Jackson, Oscar Montes and Dr Margaret Brown are working to improve the profitability and viability of family farms in Uruguay without damaging the environment.
30-YEAR COMMITMENT

AgResearch’s Dr Phil Rolston received China’s highest award for foreign scientists at a ceremony in Beijing in January 2015.

The 2014 International Science and Technology Cooperation Award of the People’s Republic of China recognised Phil’s 30-year commitment to advancing agriculture in China.

The award has been made to only 94 foreign scientists and two international organisations since its inception in 1995.

Phil received the award at a ceremony in The Great Hall of the People, attended by more than 2,000 people, including President Xi Jinping, Vice Premier Li Keqiang and Minister of Science of Technology Wan Gang.

He has been involved in 30 R&D projects on grassland and livestock production since the early 1980s and also been instrumental in introducing New Zealand-style grassland farming systems and techniques to western China.

Phil worked with Lanzhou University, the Guizhou Agriculture Commission and other organisations to improve soil fertility through plant selection pasture establishment and management, and in doing so, improved environmental and economic performance in the region. He also assisted Lanzhou University and other institutions to develop forage seed science research and he has trained many Chinese technical staff, enhancing research capacity and accelerating grassland agriculture production in China. Phil supervised establishing the first grazing type dairy farm in Karst region which is still a successful model after more than 20 years. He was delighted to receive the award.

“My involvement in China began in 1983 in the southwest province of Guizhou where some New Zealanders were contracted by the Chinese government to establish a model farm at Dushan. At the time I was with DSIR Grasslands Division and the Director, Dr Ray Brougham, was involved in the project and got me involved.

“Thirty years and 60 visits later, it certainly was a humbling and exciting experience to participate in a ceremony run by the Premier and with so many participants in the Great Hall of the People in Tiananmen Square.”

Outgoing Ambassador to China, Carl Worker, said Phil’s work in China had an important impact.

“Huge areas that used to be almost desert now resemble New Zealand green pasture, with significant improvement in productivity and farmer incomes. This is as a result of Phil’s great work.”

The award was recommended and sponsored by the Embassy of the People’s Republic of China in New Zealand, College of Pastoral Agriculture Science & Technology, Lanzhou University and supported by the Guizhou Agriculture Commission.

This work supports New Zealand’s diplomatic and trade relationships with China.

22 MORE RETAILERS

Through their Just Shorn™ programme to export premium wool carpets to the United States, CP Wool asked AgResearch Science Impact Leader Andy Cooper to participate in the CCA Global Partners Winter Convention held in January 2015 in Washington DC. The conference helped provide Carpet One retailers with the information and tools they need to improve their business operations and sales. Andy gave presentations on the story of wool and its association with the New Zealand brand, attracting many questions from the floor. Andy was also available to talk directly to retailers to help them understand wool’s product benefits.

“They would announce over the intercom that “Dr Wool” from New Zealand would be on the stand,” says Andy.

CCA Global liked the basic wool conference presentation so much they later filmed Andy giving the presentation for their website. Andy says investing the time to attend this conference was worthwhile on many levels.

“Not only did I get to tell the New Zealand wool story direct to carpet retailers, but I got to tell the AgResearch story as well. It was also a chance to reconnect with people in the industry who attended the conference as well as an opportunity to make new connections.”

Confidence in selling wool was high and 22 more retailers signed up to CP Wool’s Just Shorn programme during the convention.

This work supports exports of New Zealand’s added value products through evidence-based science.
INFRASTRUCURURE FIT FOR PURPOSE

Our buildings and facilities need to be of a standard to match the world-class science we are delivering.

Innovation Hubs

Since our Future Footprint Programme (FFP) was announced in 2012, AgResearch has had a key role in developing agricultural, agri-food and agri-technology innovation hubs at Palmerston North and Lincoln. As well as enabling us to work with other agencies to optimise sector and regional development, the Future Footprint Programme will provide us with a much-needed infrastructure update.

Our plans to co-locate staff and integrate science and infrastructure facilities with universities, partner research and sector organisations include:

- A world-class agricultural research and education hub at Lincoln
- An international centre for collaborative food research (FoodHQ) in Palmerston North.

These initiatives will facilitate more collaboration between researchers and the private sector to accelerate innovation and enable organisations to access facilities and equipment more cost-effectively than they would alone.

Our buildings and facilities need to be of a standard to match the world-class science we are delivering.

The masterplans for both campuses are now complete and design planning for new fit-for-purpose facilities at Lincoln, the food science building at Massey University, and redevelopment of glasshouses at our Grasslands site is underway. In Palmerston North we recently signed a Heads of Agreement with Massey University for our new Food Science building on the Massey campus.

We have developed a comprehensive support package for relocating staff and those who have already moved have found that it has met their needs.

We maintain a strong focus on partnership with key industry and regional stakeholders and we continue to share our plans and report on progress to them.

Research Infrastructure

Delivering sophisticated laboratory-based research means an ongoing need for specialised and expensive laboratory equipment. Modern instrumentation has also created huge data volumes and the need for high-performance computing resources. This trend will escalate with technologies such as Next Generation Sequencing being applied to underpin many research areas.

Several nationally-funded collaborative initiatives are available to help AgResearch meet its research equipment needs. These include New Zealand Genomics Limited (to provide advanced high throughput instrumentation and high capacity computing resources) and the National eScience Initiative (to provide supplementary High Performance Computing capability), coupled with REANNZ (Research and Education Advanced Network New Zealand Ltd – formerly the KAREN network) to provide high speed networks.

Improving AgResearch’s internal infrastructure is also important. In
The vision of the Lincoln Hub is to grow wealth through land-based excellence and support the growth of exports from New Zealand’s landbased sectors through growing business, growing talent and accelerating extension. The innovation cluster, based at Lincoln, will bring together industry, research and education to transform the productivity and performance of the primary sector and enhance sustainable economic and environmental outcomes.

The Lincoln Hub - a partnership between Lincoln University, AgResearch, DairyNZ and Plant & Food Research — will have more than 900 scientists forming the most significant concentration of environmental and land-based research in the Southern Hemisphere. The initial phase of development is linked to significant plans for investment in, or growth of, facilities at Lincoln by the New Zealand Government through the partner organisations. This will be complemented by the development of facilities at the Hub by agri-sector industry partners at the same time.

Central to the Hub’s success is collaboration. To facilitate this the founding partners are establishing initiatives that will foster a new way of working in addition to the significant construction programme. These initiatives include joint bids for contestable funds and a seed-fund project.

A concept image from the Lincoln Hub master plan
CORE FUNDING INVESTMENT

Core Funding enables us to invest directly in science, technology transfer and capability building.

Overview

AgResearch’s Core Funding was invested during FY15 as shown in Table 2. The performance of each Core-Funded project that was proposed to continue after June 2015 was assessed from January to March 2015. All but one project were performing well and continued to be aligned with industry stakeholder needs. One project was terminated to rebalance AgResearch’s investment portfolio and meet changing stakeholder needs.

Within the capability expense area we will fund new key positions, award a Science Prize and a Technology prize (see p.44), and also allocate Curiosity Funding to seed new science ideas. AgResearch will fund new positions to meet stakeholder needs as recommended by the Farm Systems and Environment Roadmap and the Food Sciences Roadmap (see p.48).

The Science Prize, when awarded, is for a foremost science publication from AgResearch authors within the last five years and the Technology Prize, when awarded, is based on outputs (technology and/or information) that achieve significant stakeholder/sector impact(s) within the last 36 months (irrespective of when the output was developed). The prizes include Core Funding to the team(s) to pursue new innovative ideas.

From the Science Collections and Infrastructure expense area AgResearch funds the Margot Forde Germplasm Centre. This is New Zealand’s national gene-bank for grassland plants and the Centre also hosts the New Zealand Endangered Species Seed-bank.

For 2015/16, the Board has allocated up to $3 million of Core Funding for three initiatives that started in 2014/15:
TABLE TWO  AgResearch Core Funding Investment by Vote output expense or priority area and category

<table>
<thead>
<tr>
<th>Priority Area</th>
<th>SCP OUTCOME(S)*</th>
<th>VALUE IN 2013/14, $MILLION</th>
<th>VALUE IN 2014/15 (SCI), $MILLION</th>
<th>VALUE IN 2014/15 (ACTUAL), $MILLION</th>
<th>VALUE IN 2015/16 (PROJECTED), $MILLION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BIOLOGICAL INDUSTRIES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary industry productivity and sustainability</td>
<td>A, C, D</td>
<td>25.3</td>
<td>25.5</td>
<td>23.1</td>
<td>21.2</td>
</tr>
<tr>
<td>High value food and biological products and processes</td>
<td>A, C</td>
<td>6.8</td>
<td>7.3</td>
<td>8.0</td>
<td>7.7</td>
</tr>
<tr>
<td><strong>ENVIRONMENTAL RESEARCH</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Climate and atmosphere</td>
<td>B, D</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>Lands and fresh water (including terrestrial ecosystems)</td>
<td>B, D</td>
<td>1.6</td>
<td>1.3</td>
<td>3.5</td>
<td>3.2</td>
</tr>
<tr>
<td><strong>HIGH VALUE MANUFACTURING AND SERVICES</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Novel materials, manufacturing and applications</td>
<td>A, C</td>
<td>1.4</td>
<td>1.4</td>
<td>1.3</td>
<td>1.3</td>
</tr>
<tr>
<td><strong>OTHER</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science collections and infrastructure</td>
<td>A</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Capability</td>
<td></td>
<td>2.6</td>
<td>2.2</td>
<td>1.8</td>
<td>2.0</td>
</tr>
<tr>
<td>To be allocated after 1 July 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.3</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td>38.9</td>
<td>38.9</td>
<td>38.9</td>
<td>38.9</td>
</tr>
<tr>
<td>Within the above totals, Core Funding will be applied during 2015/16 in the following categories:</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Research</td>
<td></td>
<td>28.6</td>
<td></td>
<td></td>
<td>27.9</td>
</tr>
<tr>
<td>National Science Challenges</td>
<td></td>
<td>9.8</td>
<td></td>
<td></td>
<td>10.5</td>
</tr>
<tr>
<td>Science collections and infrastructure</td>
<td></td>
<td>0.5</td>
<td></td>
<td></td>
<td>0.5</td>
</tr>
</tbody>
</table>

* See p.3

**FOOD PROVENANCE AND ASSURANCE.** This project focuses on two specific areas to protect and enhance New Zealand’s food safety reputation and integrity:

» Pre-harvest Food Chain Control, which will focus on developing methods and processes to reduce food contaminants introduced on-farm

» Traceability, Counterfeit and Origin, which will develop non-invasive, real-time testing systems to verify product origin.

**ADDED-VALUE FOODS.** This project focuses on adding value to foods and ingredients over and above their commodity value. Two specific routes best suited to New Zealand foods are being pursued:

» Differentiation: Finding and highlighting key points of differentiation in New Zealand food ingredients/products while leveraging the “New Zealand story” and the well-aligned global “naturality” food trend

» Validated Functionality: Credibly validating health and wellbeing benefits over and above nutrition, which the consumer trusts and for which they will pay a premium.

**FUTURE FARM SYSTEMS.** In partnership with the pastoral agriculture industry, this project will:

» Develop a vision of the critical factors shaping farming systems in the future

» Build the capacity to examine the implications of these factors on farming systems

» Define the farming systems that could result from these factors

» Address the knowledge and capability gaps to ensure these farming systems prosper.

These initiatives have already attracted considerable interest from industry partners who wish to co-invest with AgResearch in these areas, thus helping to grow business investment in R&D as well as delivering valuable science outcomes.

**Investment process**

The overall investment process for AgResearch’s Core Funds is shown in Figure 12. For the 2015/16 year, a process to seek Curiosity Fund project proposals from staff will be run before December 2015 (after this SCI will be finalised) so these funds can be allocated to projects by December 2015.

As signalled in Table 2, $36.6M of core funding for FY16 had been allocated when this SCI was finalised. The remaining FY16 Core Funding investments will be made by the Board using investment priorities guided by the six Outcome Areas described in this SCI (see pp.12-35).
2. Design projects and approve

1. Setting and communicating Investment Areas

Management engages and collates information from staff and shareholders

Management prepares and collates information on stakeholder needs and opportunities for the annual Board strategy session

Board confirms strategic intent for Core Funding at its November strategy session

Management develops a set of Investment Areas aligned to the strategic intent

Science Group Leaders (SGLs) communicate Investment Areas to staff and appoint Project Managers

Project Managers submit short project proposals (new and ongoing)

SGLs review documents and provide recommendations

Approval-in-principle for next year’s allocation

Project Managers submit full proposals for projects that were accepted-in-principle

Management reviews all proposals, taking past performance into account for existing projects, and makes recommendations to the Board

Board allocates Core Funding when it approves the next financial year’s budget

Ongoing throughout the year

October

November

December

January

February

March

April

Mid May

Feedback

FIGURE 12

AgResearch’s Core Funding Allocation Process
AgResearch has many initiatives in place to support our people and infrastructure priorities over the next five years.

Prizes to recognise excellent science and technology

In 2012/13 AgResearch launched a Science and a Technology Prize to recognise and reward outstanding achievements by AgResearch teams in science and technology. The criteria for these prizes are described on p.40.

Science Prize

The paper *Trophectoderm lineage determination in cattle* by members of AgResearch’s Animal Reproduction and Reproductive Technologies Teams received the 2014 AgResearch Science Prize. The lead author on the paper was Debbie Berg, a Senior Scientist in the Animal Reproduction Team. Other authors included Martyn Donnison, David Wells, Ric Broadhurst, David Pearton, Craig Smith and Peter Pfeffer.

This work was an excellent fundamental scientific study into the differences in embryological development between small and large animals. It concluded that findings in small animal models cannot necessarily be extrapolated to larger species, such as cattle, so such studies should be performed in the species of interest. Increasing reproductive success in cattle will be crucial for New Zealand’s long-term profitability and economic growth and the fundamental information about bovine reproduction developed in this study is being used in current research programmes.

The paper received very high international coverage, culminating in a News and Views article in *Nature*. By June 2014 the paper had already been cited 70 times.

AgResearch’s 2014 Science Prize winners, Dr David Wells, Dr Debbie Berg (lead author) and Ric Broadhurst.
TECHNOLOGY PRIZE

The 2014 AgResearch Technology Prize was awarded to the AR37 novel endophyte technology. The scientists, technicians and teams working with and developing this technology included Anouck de Bonth, Stuart Card, Allan Hawkes, David Hume, Sarah Finch, Lester Fletcher, Linda Johnson, Chris Pennell, Wayne Simpson & Lee Sutherland (Plant-Fungal Interactions), Joanne Jensen & Alison Popay (Biocontrol & Biosecurity), Marty Faville, Tom Lyons, Phil Rolston, Doug Ryan & Jana Schmidt (Forage Breeding), Wade Mace (Plant Phenotyping), Syd Easton (Forage Improvement), John Caradus, Bruce Belgrave, Shaun Monk & Dawn Perry (Grasslanz Technology Ltd).

A panel of stakeholders and AgResearch senior leaders agreed that the novel endophyte technology showed the largest impact of all the nominated technologies, creating substantial economic, environmental and social benefits. It has good pathways to uptake by farmers and is well supported by a strong commercial model and quality science. As well as improving productivity, novel endophytes also benefit animal health. AR37 (shown in Figure 15) is primarily used in the dairy industry but also has benefits for the sheep and beef industry.

Advisory panels to ensure science quality and relevance

SCIENCE ADVISORY PANEL

AgResearch’s Science Advisory Panel (SAP) was established by the AgResearch Board to provide strategic advice on research priorities, scientific programme direction and knowledge and technology transfer that assists AgResearch to deliver its Core Purpose.

SAP members were selected for their expertise, strategic insight and application in scientific disciplines relevant to agriculture. The members are independent and are appointed on their individual merits, not as delegates or representatives of any group or organisation. The Chair and other members were appointed for an initial term of three years.
AGRESEARCH’S SAP MEMBERS AND THEIR AREAS OF EXPERTISE:

Dr Brian Keating (Chair) » Executive Director Agriculture
Food & Health, CSIRO, Dutton Park QLD, Australia
Farm Systems Research

Professor Richard Dixon » Director of the BioDiscovery Institute
University of North Texas, Denton, TX, USA
Plant Sciences

Professor Bruce German » Professor
Department of Food Science & Technology
University of California Davis, CA, USA
Food Sciences

Professor Peter Hunter » Professor of Engineering Science
University of Auckland
Bio-engineering and math modelling

Dr John Oldham » formerly Head of Research
Scottish Agricultural College (2002-2009), Edinburgh, Scotland
Animal Sciences

Dr Frank O’Mara » Director of Research
Teagasc, Carlow, Ireland
Environmental Sciences

STRATEGIC USER ADVISORY PANEL
The CRI Taskforce Report recommended that each CRI have a Strategic User Advisory Panel (SUAP). The AgResearch Board gains independent advice from strategic users by inviting experts to discuss specific issues with the Board and management several times each year. Each meeting leads to a greater appreciation of the issues and actions to develop AgResearch’s science and sector engagement pertaining to the topic.

During 2014/15, the AgResearch Board met with the following end-users to seek their independent advice:

- Traci Houpapa (Chair, Federation of Māori Authorities)
- Board members of Beef + Lamb New Zealand
- Senior executives of Westpac Bank
- Mavis Mullins (Chair of the Poutama Trust, Rangitane, Atihau nui a Paparangi & Te Arawa)
- Andy Ramsden, sheep breeder and winner of the Allflex sheep industry innovation award at the 2014 Beef + Lamb New Zealand Sheep Industry Awards
- Colin Brown, Managing Director, TracMap
- The Board of DairyNZ.

The SAP provides independent high-level strategic advice to the Board but it is not responsible for making decisions on AgResearch’s current or future work programme, or evaluating the balance of activity and resource allocation undertaken by AgResearch; these responsibilities rest with the Board.
Growing talent and supporting change

With AgResearch’s rapid organisational change and resourcing challenges, we have to grow our talent, build staff skills and engage staff more effectively than we ever have before. Beyond our traditional mentoring and peer review approaches to improve individual performance, we identified strengthening our leaders’ skills in coaching as a route to a higher performance level. We therefore instituted a Coaching Culture programme for the 2015/16 and 2016/17 financial years, starting with senior leaders and progressing to junior leaders.

We also put in place a Navigating Change programme designed to help people understand what happens and what they can do to help themselves, colleagues and families, as we implement changes within AgResearch. Between briefings, workshops and leaders’ sessions, 821 person-hours were invested in this in FY14 and the programme continues as required.

To maximise staff retention during our Future Footprint initiative we developed a Relocation Support package after many conversations with staff from across AgResearch. The comprehensive package provides tools, resources and information to support staff members and their families over the coming years, including housing assistance, a two-year salary guarantee, paid leave, and help for spouses. Staff who asked to relocate during 2014/15 have already found this package beneficial.

2 DAYS A WEEK SECONDMENT

AgResearch Research Associate Natalie Mapp (pictured right) is spending two days a week in the Dairy Goat Co-operative (DGC)’s offices acting as a conduit between AgResearch, DGC and the farmers.

The secondment idea came up in 2014 as an opportunity to strengthen R&D integration and opportunity identification, according to Science Impact Leader Warren King. “Both organisations thought it would be easier if one person was responsible for communication.”

By mid-October 2014 Natalie was at her DGC desk two days a week as the Farmer Science Liaison.

Natalie is relishing the opportunity to work so closely with client and farmers.

“BEING PART OF THEIR TEAM TWO DAYS A WEEK HAS BEEN A GREAT EXPERIENCE. THERE IS A MUCH STRONGER WORKING RELATIONSHIP AND MORE TRUST, AT A LEVEL THAT CAN ONLY BE ACHIEVED WHEN YOU WORK TOGETHER FROM THE SAME LOCATION.”
TRANSFORMING OUR CAPABILITY

AgResearch’s science capability is the core of our ability to create impact for our sector.

Roadmaps to strengthen science

OUR ROADMAP CYCLE
AgResearch has established a five-year cycle of “Science Roadmap” projects. Each Roadmap focuses on a key science area and informs planning with respect to positioning, capability, infrastructure, partnerships and other prerequisites to delivering our SGI’s target outcomes. Roadmaps developed to date have been (with the year in which they were reported to the Board):
- 2012: Animal Sciences
- 2013: Adoption & Practice Change; Forage Sciences
- 2015: Farm Systems & Environment; Food Sciences
- 2016: Bio-Products

Our Adoption & Practice Change Roadmap implementation is described on p.10.

FARM SYSTEMS AND ENVIRONMENT ROADMAP
The Farm Systems & Environmental Roadmap, reported to the Board early in 2015, was the last Roadmap in our first cycle to focus on our on-farm science activities and capabilities. It had an important role to integrate the other largely on-farm Roadmaps (Animal Sciences, Forage Sciences and Adoption & Practice Change) through “systems thinking”.

This Roadmap sought to re-position our Farm Systems and Environmental Sciences capabilities to deliver future-focused, integrated, world-leading science. The science aims to contribute to sustainable, profitable farming enterprises in which environmental considerations make a positive contribution, rather than requiring trade-offs between economic and environmental impacts. Overall recommendations included:
1. Continuing to support current industry/policy drivers while shifting towards work on future farm systems that consider environmental sciences, value chains and markets
2. Integrating activity across teams by establishing at least one large farm-system based trial by June 2017
3. Recruiting and/or developing new skills to build a world-standard farm systems and environmental sciences capability
4. Making a long-term resource investment to support our Māori partnerships, to gain trust and confidence o nga kaitiaki o nga taonga tuku iho, and to help the Māori agribusiness sector understand and define its own R&D needs.
FUTURE ROADMAPS
We will complete our Food Sciences Roadmap in 2015, a Bio-Products Roadmap in 2016 and then revisit the cycle commencing in 2017.

FOUR INVESTMENTS TO GROW CAPABILITY
All our Science Roadmaps to date have recommended we invest to grow our scientific capability in specific areas that are needed by our stakeholders. To do this, we have invested Core Funding to initially pay personnel and operating costs so these new recruits can get their science underway while working to understand stakeholder needs and building relationships that lead to stakeholder co-investment. Some of the new staff we recently brought on board through those investments are:

Dr Stephen Miller
The 2012 Animal Sciences Roadmap recommended that we appoint a new Quantitative Genetics Senior Scientist position to provide leadership in quantitative genetics. Having been an international leader in his field and a trusted thinker within the Canadian beef and sheep industry, Steve joined us from the University of Guelph in Canada, in 2013. Steve is focusing on identifying and delivering quantitative genetic research that is strategically relevant to industry, maintaining scientific excellence, identifying and galvanising strategic industry partnerships to produce new research proposals and networking with and presenting seminars to industry stakeholders in the wider pastoral community.

Dr Kirsty Hammond
Kirsty (Te Whānau-ā-Apanui) has been appointed to the Animal Nutrition and Physiology Team. She completed a PhD at Massey University, with co-supervision from AgResearch and DairyNZ researchers. In late 2011, she obtained a post-doctoral position at the University of Reading, UK to work with Dr Chris Reynolds, an internationally recognised science expert in ruminant nutrition and nitrogen metabolism. Kirsty’s research background and science networks are at the nexus of improving animal productivity while minimising environmental impacts from livestock. Kirsty represents a strong investment in talent for the future.

Dr Li Day
Li joined AgResearch as a Principal Scientist and Science Impact Leader – Dairy Processing & Supply in 2014, having previously been a Principal Research Scientist and Group Leader for the Food Structure & Chemistry Group in CSIRO Animal Food & Health Sciences, based in Werribee, Melbourne, Australia. Li’s research interests and expertise relate to the structure, assembly and physical functionality of bio-macromolecules, protein biochemistry, soft-matter rheology and food processing. Li completed her Bachelor of Science in Chemical Engineering in China and a PhD in Food Biosciences at the University of Reading, UK. She is fluent in Chinese and holds a qualification for second language teaching. Soon after arriving in AgResearch, Li was asked to lead our Food Sciences Roadmap.

Dr Kioumars Ghamkhar
A senior research scientist, Kioumars is the new Director of the Margot Forde Forage Germplasm Centre. He joined AgResearch in October 2014 from Australia, where he was with the Victorian Department of Environment and Primary Industries. He was previously at the Centre for Plant Genetics and Breeding at the University of Western Australia, Perth. Kioumars has a M.Sc. (Genetics & Evolution) from the University of Isfahan, Iran, and a Ph.D (Plant Molecular Phylogeny and Evolution) from the University of New England, New South Wales, Australia. In his previous roles, he developed methodologies for core collection development and germplasm rationalisation and provided core collections for forage legume species in Western Australia. He is helping further evolve those methodologies using new molecular techniques at AgResearch.
In executing this SCI, AgResearch will implement its Future Footprint programme to collaborate with like-minded organisations and have World-class science facilities.

Subject to the assumptions noted below, the projected financial performance for AgResearch is shown in Table 3. Because of the significant changes in play over the normal SCI 5 year reporting period that result from Future Footprint, and their impact on AgResearch’s financial performance, the Financial Confidential Section includes 10 year projections to show the ‘normalised’ position post that programme of work being completed.

Assumptions

The assumptions that underpinned our previous three SCIs and the Future Footprint Business Case were developed in 2011. A Future Footprint Business Case update has recently been prepared and the financial projections in this SCI reflect that Business Case.

The material assumptions underpinning the financial projections for FY2016 to FY2020 are described in detail in the Financials Confidential Section. Those assumptions include:

1. Revenue growth of 3% from FY2015 to FY2020
2. Science and non-science personnel costs will increase by approximately the value of the Consumer Price Index (CPI) each year.

If any of the above assumptions do not prove accurate, including delays in new revenue, there may be a material impact on our ability to deliver on these projections. The Board will monitor progress in this area and take appropriate action if we appear unlikely to meet these projections.

Accounting policy

AgResearch’s financial statements are prepared in accordance with the requirements of the Companies Act 1993, the Financial Reporting Act 1993, the Crown Research Institutes Act 1992, the Public Finance Act 1989 and Generally Accepted Accounting Practice in New Zealand (NZ GAAP). The financial statements, including the financial information presented in this SCI, comply with the New Zealand Equivalents to International Financial Reporting Standards (NZ IFRS) and other applicable financial reporting standards as appropriate.

A full Statement of Accounting Policies and a table of risks relating to this SCI are provided on AgResearch’s website at www.agresearch.co.nz. There have been no material changes in accounting policies since the 2015 Annual Report.

Reporting to shareholding ministers

AgResearch makes available to the Shareholders the following documents and information:

QUARTERLY REPORTS
These include:

- financial statements
- comparisons with budgets and comments on financial activities for the quarter
- comment on research achievements and comparisons of such achievements with business plans.

HALF-YEARLY REPORTS
These include:

- unaudited financial statements and notes (including accounting policies) for the half year within two months of the half year
- comparative actual figures for the corresponding period of the previous financial year
- a commentary on the operations and overall performance for the period
- a statement of responsibility
- a statement that the CRI has operated in accordance with the principles set out in Section 5 of the CRI Act and the Companies Act 1993 during the period
- commentary on progress towards achieving annual performance targets (financial and non-financial).

ANNUAL REPORT

An Annual Report of the operations of AgResearch is delivered to the Shareholding Ministers within three months of the end of each financial year. In it, the Board incorporates:

- Audited consolidated financial statements for that financial year, consisting of a report of the operations of AgResearch and its subsidiaries during that financial year, statements of financial position, comprehensive income and cashflows, including budget (as established at the beginning of the year in the SCI) and statements of commitments, contingent liabilities, accounting policies and such other statements as may be necessary to show the financial results of the operations of AgResearch and its subsidiaries during the financial year and their financial position at the end of the year.
- Comparative information for the previous financial period
- The auditors’ report on these financial statements.
- A statement of responsibility
- A report on AgResearch’s performance as a good employer
• A corporate social responsibility report
• A report against financial and non-financial performance indicator targets set in the SCI
• Any direction given by the Shareholding Ministers in writing.


MISCELLANEOUS

Any other information required by the Shareholding Ministers in their capacity as Shareholders.

Dividend policy

The Company’s policy is that it will return surplus cash to shareholders in the form of a dividend when no sound investment opportunities (including reinvestment, commercialisation, capital expenditure and the retention of important capabilities) exist.

It is forecast that no dividends will be paid in the year ending 30 June 2016.

Acquisitions and divestment of assets

As required by section 13(1)(d) of the Crown Research Institutes Act, AgResearch will not acquire shares that give it substantial influence in or over a company; or acquire an interest in any partnership, joint venture, or other association of persons, or an interest in a company other than in its shares except after written notice to the shareholding Ministers.

The Board will obtain prior written consent for any transaction or series of transactions involving a full or partial acquisition, disposal or modification of property (buildings, land and capital equipment) and other assets with a value equivalent to or greater than $10 million.

The Board will obtain prior written consent for any transaction or series of transactions with a value equivalent to or greater than $5 million involving:

• the acquisition or disposal, in full or in part, of shares or interests in a subsidiary, external company or business unit
• transactions that affect a company’s ownership of a subsidiary or a subsidiary’s ownership of another entity (provided that transactions which include “drag-along” clauses that compel AgResearch to sell interests at a future date at the direction of the investors shall be valued at the time of the investment transaction), and
• other transactions that fall outside the scope of the definition of the company’s core business or that may have a material effect on the company’s science capabilities.

The Board will advise shareholding Ministers in writing before entering into any transaction related to property and commercialisation activities below this threshold in accordance with notice requirements agreed between the Ministers and AgResearch from time to time.

Activities for which AgResearch seeks compensation from the Crown

At the date of this SCI, no compensation has been sought from the Government.

Estimate of current commercial value

AgResearch was purchased in December 1992 for $56.9 million. The Board’s estimate of the current commercial value of the Crown’s investment in the Group over the forecast period is approximately $230 million. This value reflects the midpoint of total equity over the forecast period to FY2020 and is based on the Fair Values derived from the Company’s accounting policies. The value of the Crown’s investment, which was $228 million at 30 June 2015, will increase to $235 million at 30 June 2020. AgResearch’s assets are primarily land (including farms) and buildings, valued at market value, and therefore this is an appropriate proxy for AgResearch’s commercial value.
# Key Performance Indicators for 2015/16, at a Glance

We aim to achieve these key scientific and organisational milestones in 2015/16.

<table>
<thead>
<tr>
<th>Strategic Goal</th>
<th>Objective</th>
<th>Key Performance Indicators for FY16</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stakeholders</strong></td>
<td>Comprehensive understanding of the sector, including key and emerging players and their relationships.</td>
<td>Grow our understanding of the sector and the sector’s recognition of that understanding.</td>
</tr>
<tr>
<td></td>
<td>Co-owned strategy with key stakeholders.</td>
<td>Grow commercial revenue through closer alignment of stakeholder and AgResearch strategic goals.</td>
</tr>
<tr>
<td><strong>Financial</strong></td>
<td>Sustainable financial performance to enable achievement of strategic goals.</td>
<td>Achieve financial targets.</td>
</tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td><strong>People</strong></td>
<td>Innovative and high performing workforce.</td>
<td>Staff engagement increased.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>We will all have a safe workplace.</td>
</tr>
<tr>
<td><strong>Research</strong></td>
<td>R&amp;D solutions which meet sector needs and contribute to Impacts and Outcomes identified in our strategy (SCI).</td>
<td>Ensure AgResearch has the research portfolio, and capabilities that will meet current and future stakeholder needs and deliver our strategy.</td>
</tr>
<tr>
<td></td>
<td>Quality, relevant science.</td>
<td>Deliver relevant, high quality, reliable R&amp;D outputs that meet stakeholder needs and deliver to our strategy.</td>
</tr>
<tr>
<td><strong>Enabling systems</strong></td>
<td>Robust business processes and systems that enable delivery on strategy.</td>
<td>Improve the effectiveness and efficiency of business processes.</td>
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<tr>
<td></td>
<td>Infrastructure aligned to strategy.</td>
<td>AgResearch infrastructure is fit for purpose.</td>
</tr>
</tbody>
</table>
PERFORMANCE INDICATORS

AgResearch measures its performance using quantitative non-financial or semi-financial indicators that tell us when and in what areas our performance may be satisfactory or unsatisfactory. These indicators do not directly show that we are delivering value to our sector but they are necessary, if not sufficient, leading measures of that value. Some indicators included in our 2014 SCI were evaluated as less relevant or less useful and so are not included in this SCI.

Target values are shown for each indicator, with the values from our 2015 Annual Report also shown.

### GENERIC CRI PERFORMANCE INDICATORS

<table>
<thead>
<tr>
<th>ID</th>
<th>INDICATOR</th>
<th>DEFINITION</th>
<th>FY16 TARGET</th>
<th>FY15 RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>G.1</td>
<td>End user collaboration</td>
<td>Revenue per FTE from commercial sources</td>
<td>$98k</td>
<td>$102k</td>
</tr>
<tr>
<td>G.2</td>
<td>Research collaboration</td>
<td>Publications with collaborators. (Percentage of publications with a) only AgResearch authors, b) with other NZ authors, c) with international authors or d) with a combination of NZ and international authors)</td>
<td>a) 19%</td>
<td>a) 20%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b) 33%</td>
<td>b) 29%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c) 23%</td>
<td>c) 29%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d) 25%</td>
<td>d) 21%</td>
</tr>
<tr>
<td>G.3</td>
<td>Technology &amp; knowledge transfer</td>
<td>Commercial reports per scientist FTE.</td>
<td>2.1</td>
<td>1.0</td>
</tr>
<tr>
<td>G.4</td>
<td>Science quality</td>
<td>Impact of scientific publications. (The average value of 2-year citations per document for scientific journals assessed by SCImago in which AgResearch staff published during the year, weighted by the number of AgResearch publications in each journal. The reference figure is for the 2014 calendar year.)</td>
<td>2.7</td>
<td>2.62</td>
</tr>
<tr>
<td>G.5</td>
<td>Financial indicator</td>
<td>Revenue per FTE, based on average FTEs over the year.</td>
<td>$222k</td>
<td>$213k</td>
</tr>
</tbody>
</table>

### AGRESEARCH-SPECIFIC INDICATORS OF END-USER ENGAGEMENT AND SCIENCE RELEVANCE

<table>
<thead>
<tr>
<th>ID</th>
<th>INDICATOR</th>
<th>DEFINITION</th>
<th>FY16 TARGET</th>
<th>FY15 RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Confidence of stakeholders</td>
<td>(a) Percentage of relevant funding partners and other end-users that have a high level of confidence in the CRI’s ability to set research priorities, and (b) the percentage of stakeholders who were satisfied with their collaboration or partnership with AgResearch</td>
<td>(a) 75%</td>
<td>70%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(b) 85%</td>
<td>80%</td>
</tr>
<tr>
<td>1.2</td>
<td>Revenue from stakeholders</td>
<td>Revenue coming directly from stakeholders. Excludes revenue from central Government, includes co-investment from stakeholders with central Government.</td>
<td>$42M</td>
<td>$48.7M</td>
</tr>
</tbody>
</table>
### AgResearch-Specific Operating Indicators of Knowledge and Technology Transfer

<table>
<thead>
<tr>
<th>ID</th>
<th>Indicator</th>
<th>Definition</th>
<th>FY16 Target</th>
<th>FY15 Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Collection requests</td>
<td>Number of requests and enquiries for access to AgResearch’s publicly available collections.</td>
<td>3000</td>
<td>3079</td>
</tr>
<tr>
<td>2.2</td>
<td>Stakeholder reports</td>
<td>Number of client reports submitted by AgResearch staff.</td>
<td>250</td>
<td>264</td>
</tr>
<tr>
<td>2.3</td>
<td>Trade publications</td>
<td>Number of published articles in stakeholder relevant outlets, including trade magazines, applied industry journals, popular media and stakeholder blogs</td>
<td>130</td>
<td>NA</td>
</tr>
<tr>
<td>2.4</td>
<td>Licensing deals</td>
<td>(a) Total revenue, (b) number and (c) percentage of licensing or other deals of AgResearch-derived IP (including technologies, products and services) with New Zealand and international partners per annum</td>
<td>(a) $10M</td>
<td>$10.5M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) 9</td>
<td></td>
<td>11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) 55%</td>
<td></td>
<td>36%</td>
</tr>
<tr>
<td>2.5</td>
<td>Adoption</td>
<td>Percentage of relevant end-users who have adopted knowledge and/or technology from AgResearch</td>
<td>92%</td>
<td>90%</td>
</tr>
</tbody>
</table>

### AgResearch-Specific Operating Indicators of Delivery to Vision Mātauranga

<table>
<thead>
<tr>
<th>ID</th>
<th>Indicator</th>
<th>Definition</th>
<th>FY16 Target</th>
<th>FY15 Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Effective relationships with Māori</td>
<td>Percentage of Māori agribusiness partners and end-users who rate AgResearch as “good” or better for effective collaboration and partnering in the annual customer relationship survey</td>
<td>100%</td>
<td>67%</td>
</tr>
<tr>
<td>3.2</td>
<td>Revenue from Māori stakeholders</td>
<td>Revenue (direct and leveraged) from Māori agribusiness stakeholders</td>
<td>$1.6M</td>
<td>$1.04M</td>
</tr>
</tbody>
</table>

### AgResearch-Specific Operating Indicators of Research Collaborations and Linkages

<table>
<thead>
<tr>
<th>ID</th>
<th>Indicator</th>
<th>Definition</th>
<th>FY16 Target</th>
<th>FY15 Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>International linkages</td>
<td>(a) Number and (b) percentage of peer-reviewed scientific papers co-authored with an international author</td>
<td>(a) 150</td>
<td>171</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) 46%</td>
<td></td>
<td>51%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Number of technologies licensed in from offshore</td>
<td>(c) 1</td>
<td>0</td>
</tr>
<tr>
<td>4.2</td>
<td>Research collaboration</td>
<td>(a) Number and (b) percentage of joint scientific peer-reviewed publications and (c) number and (d) percentage of IP outputs with other New Zealand or international research institutions per annum</td>
<td>(a) 250</td>
<td>270</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) 84%</td>
<td></td>
<td>84%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) 2</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) 20%</td>
<td></td>
<td>0%</td>
</tr>
</tbody>
</table>
### AGRESEARCH-SPECIFIC OPERATING INDICATORS OF SCIENCE QUALITY

<table>
<thead>
<tr>
<th>ID</th>
<th>INDICATOR</th>
<th>DEFINITION</th>
<th>FY16 TARGET</th>
<th>FY15 RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Publications in peer-reviewed scientific journals</td>
<td>Number of Scopus-indexed scientific papers per scientist FTE.</td>
<td>1.2</td>
<td>1.26</td>
</tr>
</tbody>
</table>

### AGRESEARCH-SPECIFIC NON-FINANCIAL INDICATORS OF ORGANISATIONAL VITALITY

<table>
<thead>
<tr>
<th>ID</th>
<th>INDICATOR</th>
<th>DEFINITION</th>
<th>FY16 TARGET</th>
<th>FY15 RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Staff engagement</td>
<td>Staff survey result for overall level of staff engagement</td>
<td>61.2%</td>
<td>58.2%</td>
</tr>
</tbody>
</table>

### WORKFORCE COMPOSITION AND DEMOGRAPHICS

<table>
<thead>
<tr>
<th>ID</th>
<th>INDICATOR</th>
<th>DEFINITION</th>
<th>FY16 TARGET</th>
<th>FY15 RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Total FTEs and % of total FTEs</td>
<td>Excluding casuals and fixed term employees of less than 6 months duration, by: a) Research Teams b) Research Support c) Other d) Total</td>
<td>a) 388.67  b) 177.54  c) 93.37  d) 659.58</td>
<td>a) 448.95  b) 177.03  c) 76.14  d) 702.12</td>
</tr>
<tr>
<td>7.2</td>
<td>Total FTE and Headcount in Research Teams</td>
<td>Divided into: a) Scientists FTE b) Scientists Headcount c) Technicians/Technologists FTE d) Technicians/Technologists Headcount</td>
<td>a) 241.90  b) 266  c) 165.47  d) 189</td>
<td>a) 267.56  b) 286  c) 212.99  d) 248</td>
</tr>
</tbody>
</table>
### Financial Performance Indicators

<table>
<thead>
<tr>
<th></th>
<th>2014 ACTUAL $000</th>
<th>2015 ACTUAL $000</th>
<th>2016 BUDGETED $000</th>
<th>2017 PROJECTED $000</th>
<th>2018 PROJECTED $000</th>
<th>2019 PROJECTED $000</th>
<th>2020 PROJECTED $000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Margin %</td>
<td>7.1%</td>
<td>6.5%</td>
<td>4.8%</td>
<td>7.9%</td>
<td>7.4%</td>
<td>9.7%</td>
<td>13.1%</td>
</tr>
<tr>
<td>EBITDAF per FTE $000's</td>
<td>14</td>
<td>11</td>
<td>18</td>
<td>17</td>
<td>23</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>Quick Ratio</td>
<td>3.5</td>
<td>3.9</td>
<td>3.5</td>
<td>2.4</td>
<td>0.3</td>
<td>(0.1)</td>
<td>0.3</td>
</tr>
<tr>
<td>Interest Coverage</td>
<td>1,888</td>
<td>2,883</td>
<td>999</td>
<td>999</td>
<td>13</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Adjusted Return on</td>
<td>1.9%</td>
<td>(0.1)%</td>
<td>(1.8)%</td>
<td>0.4%</td>
<td>(0.9)%</td>
<td>(0.3)%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Equity %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revenue Growth %</td>
<td>0.9%</td>
<td>(3.3)%</td>
<td>(4.8)%</td>
<td>1.3%</td>
<td>1.1%</td>
<td>4.8%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Capital renewal</td>
<td>(2.8)</td>
<td>(0.7)</td>
<td>2.0</td>
<td>3.8</td>
<td>7.1</td>
<td>2.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Equity Ratio %</td>
<td>82.4%</td>
<td>83.2%</td>
<td>84.4%</td>
<td>85.1%</td>
<td>85.0%</td>
<td>84.6%</td>
<td>84.3%</td>
</tr>
</tbody>
</table>

(Please refer to the financial assumptions shown on p.50)
GLOSSARY OF ABBREVIATIONS

ACC  Accident Compensation Corporation
AgDocs  AgResearch’s internal document and records management system, based on Microsoft SharePoint
BCC  BCC turns innovative ideas into thriving new businesses (http://www.thebcc.co.nz/)
BCG  Bacillus Calmette–Guérin, a vaccine against tuberculosis
BERL  Business and Economic Research Ltd
BNZ  Bank of New Zealand
CRI  Crown Research Institute
CRW  Clover Root Weevil
CSIRO  Commonwealth Scientific and Industrial Research Organisation (of Australia)
DCANZ  Dairy Companies Association of New Zealand
DIGAD  Dairy Industry Good Animal Database
DINZ  Deer Industry New Zealand
DHA  Docosahexaenoic acid
DM  Dry Matter (e.g. with respect to forage)
EBIT  Earnings Before Interest and Tax
EBITDAF  Earnings before interest taxes depreciation amortisation and foreign
EBV  Estimated Breeding Value
ESR  Environmental Science and Research, a CRI
ETS  Emissions Trading Scheme
FAO  Food and Agriculture Organisation
FFP  Future Footprint – AgResearch’s initiative to organise our science capability to create science innovation hubs.
FTE  Full-time equivalent (staff)
FVI  Forage Value Index
GDP  Gross Domestic Product
GenomNZ  AgResearch’s genetic testing laboratory
GHG  Greenhouse Gas
GTL  Grasslanz Technology Ltd, an AgResearch subsidiary
H1, H2, H3  Three horizons in an R&D pipeline: Product & knowledge development and transfer, applied research, and strategic research respectively
HR  Human Resources
HVN  High Value Nutrition (National Science Challenge)
INIA  Instituto Nacional de Investigación Agropecuaria
IP  Intellectual Property
MBIE  Ministry of Business, Innovation and Employment
ME  Metabolisable Energy (e.g. of forage)
MEDAP  Māori Economic Development Action Plan
MFE  Ministry for the Environment
MS  Milk solids
MPI  Ministry for Primary Industries
NAIT  National Animal Identification & Tracing
NIWA  National Institute of Water and Atmospheric Research, a CRI
NZM  New Zealand Merino
NZPBRA  New Zealand Plant Breeding and Research Association
OECD  Organisation for Economic Cooperation and Development
OSPRI  TBfree New Zealand Ltd and NAIT Ltd are wholly-owned subsidiaries of OSPRI New Zealand Ltd.
PGgRc  Pastoral Greenhouse Gas Research Consortium
PGP  Primary Growth Partnership
PIP  Deer Industry Productivity Improvement Programme
R&D  Research and Development
REANNZ  Research and Education Advanced Network New Zealand
SAP  Science Advisory Panel
SCI  Statement of Corporate Intent
SCP  Statement of Core Purpose
SNP  Single Nucleotide Polymorphism (a difference in a single nucleotide (A, T, C or G) in the genome)
STEC  The shigatoxigenic group of Escherichia coli bacteria
SUAP  Strategic User Advisory Panel
TAPS  Te Arawa Primary Sector
TB  Tuberculosis
TPK  Te Puni Kōkiri
US  United States (of America)
USDA  United States Department of Agriculture
UK  United Kingdom
WRONZ  Wool Research Organisation of New Zealand
YBG  Yellow Bristle Grass
1. AgResearch’s full Statement of Core Purpose can be found at http://www.agresearch. co.nz/about-us/company/mission/core-purpose-statement.


9. ibid, p. 13.


13. ibid, p. 46.


29. ibid, p. 33.

30. ibid, p. 33.


37. 39% more sheep meat by weight was exported by New Zealand than by the next-largest exporter (Australia) according http://faostat3.fao.org/

38. 39% more sheep meat by weight was exported by New Zealand in 2010 than by the next-largest exporter (Australia) according http://faostat3.fao.org/
