SCION

Next generation biomaterials

SCION'S VISION

Scion is a Crown Research Institute dedicated to building a stronger bio-based economy for New Zealand.

Our vision is to use renewable resources to create new materials, energy sources and environmentally-friendly products and processes.

We believe that using renewable resources to meet New Zealand's material and energy needs is key to economic development that can be sustained for future generations.

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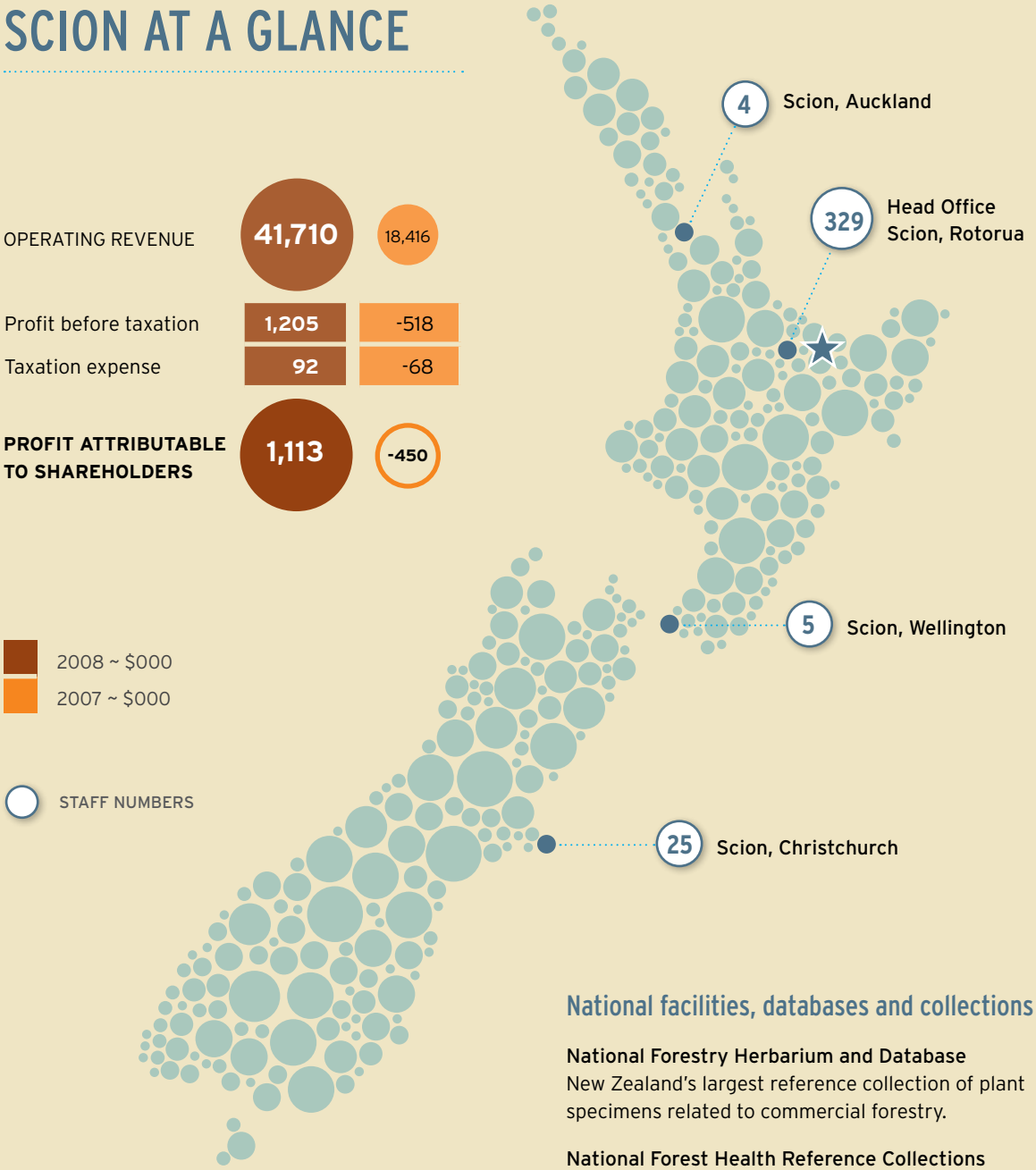
HIGHLIGHTS OF THE FINANCIAL YEAR 2007/2008

SCION AT A GLANCE

	2008 ~ $000	2007 ~ $000
OPERATING REVENUE	41,710	18,416
Profit before taxation	1,205	-518
Taxation expense	92	-68
PROFIT ATTRIBUTABLE TO SHAREHOLDERS	1,113	-450



2008 ~ $000
2007 ~ $000

STAFF NUMBERS

Commercial units

ATLAS Technology
Scion's software development group, ATLAS Technology provides the forest industry with integrated systems for supply chain management and logistics.

COHFE
Scion's Centre for Human Factors and Ergonomics specialises in the assessment, reduction and prevention of work-place risk, and the optimisation of people-oriented work systems.

Veritec
As Scion's commercial testing service, Veritec provides a variety of tests for clients who require analysis of soil, foliage, wastewater and wood.

National facilities, databases and collections ★

National Forestry Herbarium and Database
New Zealand's largest reference collection of plant specimens related to commercial forestry.

National Forest Health Reference Collections
A national diagnostic resource incorporating the mycological herbarium, insect and culture collections.

National Forestry Library
The largest collection of forestry, forest products, and pulp and paper literature in the Southern Hemisphere.

National Wood Performance Archive
Records of wood durability and performance across four sites in New Zealand, gathered over more than 60 years.

Permanent Sample Plot Database
A database of tree growth and development.

Quarantine Facility
Scion's containment facility is registered under the MAF Biosecurity Standards for Invertebrates and Microorganisms.

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Mitigating climate change

Working with biotechnology leaders

Cleaning up New Zealand lakes

Mapping the pathway to sustainable biofuels

Fostering a passion for science

Creating bioplastics from renewable resources

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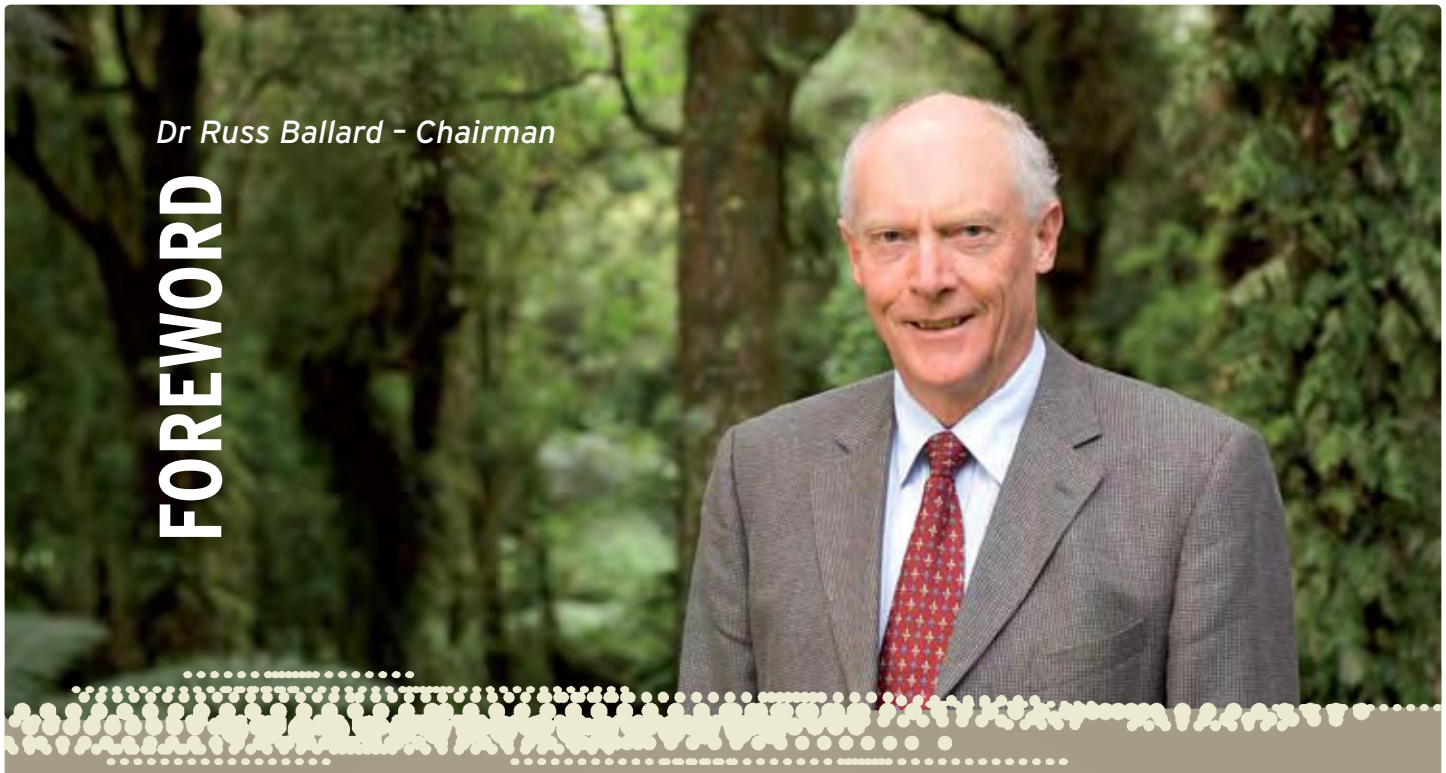


FOREWORD

Dr Russ Ballard – Chairman

It is with great pleasure that I introduce this overview of some of Scion's highlights from the past financial year. This document showcases the many ways in which Scion is providing benefits to New Zealand through the delivery of our science.

As a Crown Research Institute, Scion has a vital role to play in providing new and novel ways of tackling those issues that have national and global importance. During the past year, we have seen an extraordinary rise in the attention being placed on topics such as greenhouse gas reduction, rising oil prices and emissions trading. This document shows how the research strategy adopted by Scion provides new knowledge that can support our understanding of these topics. Our research can also help New Zealand start finding answers to the questions that matter, such as: how can we have a positive impact on climate change; how do we reduce our dependence on non-renewable energy; how can we secure our environment for future generations?

Scion's research approach is based on a vision of the New Zealand economy underpinned by the use of renewable resources and waste streams, to create new materials, energy sources and environmentally friendly products and processes.

Science outcomes highlighted in these pages show how we are actively leading the way in research and development areas that are critical to achieving that vision for New Zealand. Outcomes around the diversification of our traditional forest resource into new activities and land use options that can create value for the industry, include bioenergy technologies and biomaterials development. These outcomes are enabling New Zealand to position itself on the world stage as a country that can provide some solutions to effectively deal with global issues. This is illustrated by our growing number of international collaborators and clients.

In addition, government emphasis on environmental sustainability means that forestry, the emerging industrial biotechnology sector and ultimately, Scion, have key roles to play in supporting the achievement of success.

Our focus now is to build the concept and practices of sustainability into all economic activities so New Zealand can become a leading example of how sustainable environmental practices attracts inbound investment and economic growth. Our improving financial position now means we can look forward to implementing a business plan for the next three years that includes significant reinvestment into key areas of science.

This document has been produced to complement Scion's Annual Report, which contains the company's full financial statements and reporting requirements. The Annual Report is available to view on *www.scionresearch.com*

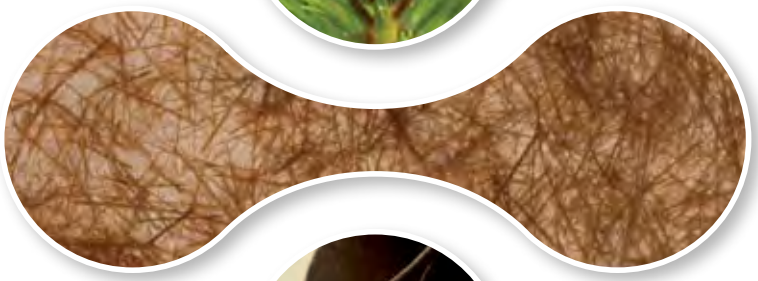
I trust you enjoy reading some of our highlights from the 2007/2008 financial year and can see the role that science is playing in addressing issues that are relevant to us all.

SCION'S STRATEGY

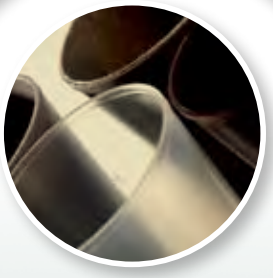
Scion's mission is to contribute to the sustainable economic transformation of New Zealand by demonstrating leadership and innovation in . . .

New forests and forest science
Driving innovation through diversification. Scion's heritage in forestry research is being used to value, capture and enhance the benefits of existing and new forests.

Sustainable design
Building a balanced environmental and economic future. Scion is committed to supporting New Zealand industry in reducing its ecological footprint, in a way that drives economic benefit.



Bioproduct development
Transforming renewable resources into global advantages. Scion is developing multiple new uses for natural, renewable resources for economic, environmental, social and cultural returns.



Ko te manu e kai ana i te miro, nona te ngahere. Engari, ko te manu e kai ana i te matauranga, nona te ao

The bird that consumes the miro berry, owns the forest. However, the bird that consumes knowledge, owns the world

Partnering for innovation

Scion's strategy is strongly aligned to Maori values and aspirations and Scion is continuing to implement enduring partnerships with Maori. The next five years will see Maori research agendas coming to the fore as Maori forest ownership increases.

Scion's sustainability focus aligns well to the quadruple bottom line emphasis that a Maori wellbeing focus provides. Research into soils on Te Arawa land trust farms, biofuel opportunities with tallow and the use of lake weed in vermicomposting, all achieved funding pathways enabling Maori to be early adopter investors in new science and technology developments.

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> As we look back over the 2007/2008 year, with its national emphasis on climate change policy and sustainable economic development, Scion finds itself in the right place at the right time. This is no accident.

Dr Tom Richardson

FROM THE CHIEF EXECUTIVE OFFICER

For the past three years, we have invested in developing methods, our own capability and our partnerships to enhance the delivery of innovative outcomes in the areas of sustainable land use, renewable energy and climate change response. These outcomes have the potential to make a significant change to the development of the New Zealand economy. Our performance this year reflects our growing contributions and leadership in these areas supporting national policy development and implementation, and commercial opportunities.

At the same time, we have continued to work closely with the private sector to develop technologies and tools that improve short-term performance and underpin longer-term growth.

Scion's mission is to contribute to the sustainable economic transformation of New Zealand by demonstrating leadership and innovation in science, research and development. Over the past year we have achieved a number of significant science outcomes that support us in getting to where we want to be.

Scion continues to provide much of the science needed to identify and maximise the wide range of benefits forests can provide while maintaining the current solid wood, pulp and paper outputs of our forest estate. This year we made a number of advances across a range of areas that will eventually enable us to provide a holistic approach to reporting on the sustainability of planted forests (page 11).

In the manufacturing arena, our new technologies continue to provide opportunities for firms to increase their competitiveness. Scion is enhancing capability in harvesting systems to support the industry in this vital area (page 12).

Some technologies generate more debate than others, and part of Scion's role is to provide scientific information to enhance that discussion. Genetic modification is one such technology where Scion continues to undertake the work necessary to inform public debate and maintain New Zealand's options for the future (page 15).

Two key outcomes related to New Zealand's bioenergy options were delivered this year. The first was a situation analysis on New Zealand's biomass resources that identified promising options for bioenergy production. This report was closely followed by a feasibility study that demonstrated the viability of using New Zealand-grown trees to produce transport biofuels for use nationally (page 16 - 17).

Both studies highlighted ways for New Zealand to reduce its dependence on fossil fuels, achieve greater energy self-sufficiency and substantially reduce its greenhouse gas emissions through the use of non-food crops.

These are just a few projects that illustrate the role our science is playing here at home; others are highlighted throughout this report. It is a pleasure to note that much of our success has been achieved through better relationships and more strategic partnering with a growing range of organisations, both nationally and internationally - making our science better and our impact greater. These partnerships are also enriching for all us at Scion who are involved.

As you read through our highlights, I am sure you will recognise the calibre of staff we have here at Scion. It is through their passion and dedication that we are able to achieve this success.

I invite you now to share in our research, people and the benefits they can bring to all of New Zealand.


highlights
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CLIMATE CHANGE

Climatic and atmospheric change are having a profound impact on many ecosystems and there is a growing global awareness that forestry is an important part of mitigating that impact. In addition, making the changes that are needed to combat climate change requires a greater understanding of the effect we are having on the environment and how we can manage the key issue of carbon.

Scion has taken a lead role in providing the science and knowledge needed to help manage and mitigate the potential impacts of climate change. From understanding the physiological response of a species across a range of climatic conditions, to quantifying the environmental impacts of processes and products, we are working collaboratively with others to help formulate New Zealand's climate change response.

Measuring footprints on the environment

Scion is using Life Cycle Analysis (LCA) methods to calculate the environmental impact of different building materials in New Zealand. LCA provides a way of assessing how much energy, water or chemical has gone into manufacturing a product and what greenhouse gas or other emissions have been released in the process. A large project undertaken for the Ministry of Agriculture and Forestry (MAF) involves the development of datasets for New Zealand building materials using LCA studies of timber and other types of construction. Results of this project will provide the basis for fair comparisons of different building materials such as timber, steel, concrete and plasterboard. This scientifically-robust data will be valuable in the future, when limits pertaining to carbon dioxide emissions and embodied energy could be included in the New Zealand Building Code.

Learning from international collaborators

Scion entered into a collaboration with Argentina's Instituto Nacional de Tecnología Agropecuaria (INTA) to study the impacts of climate change on southern hemisphere beech (*Nothofagus*) forests. The focus of the joint research is on understanding the physiological response of the species across a wide range of climatic conditions. This project provides an opportunity for Scion scientists to study beech growth responses in climate zones far outside New Zealand norms. The result will be robust climate-based models to predict growth responses under future climate scenarios. The collaboration builds on the long standing relationship between New Zealand and Argentina, established through their common membership of the Montreal Process since 1995.

Understanding the economics of carbon

With the introduction of an official carbon market in New Zealand, an incentive has been created for forest owners to manage their estates as carbon sinks.

Scion completed a major report for MAF this year looking at how forest management regimes could be changed to best enable carbon sequestration and carbon-price risk. This study provides a basis for understanding how current knowledge and management models, developed to aid timber production, can be updated to effectively represent planted forest management incorporating carbon.

Nobel Peace Prize honour shared

A Scion scientist has shared in a Nobel Peace Prize for his contribution to building knowledge of human-induced global warming. For the past five years, Dr Peter Beets has provided expertise on forestry carbon stocks and land use change to the Intergovernmental Panel on Climate Change (IPCC). The IPCC was established by the United Nations in 1988 in response to growing international debate about the risks of anthropogenic climate change.

The 2007 Nobel Prize was awarded to the IPCC jointly with former US Vice-President and climate change activist Al Gore. The IPCC in turn presented Peter with a certificate honouring his role, along with a number of other contributing scientists. The Panel comprises 2,500 scientists and researchers from more than 130 nations, the majority of whom work for the Panel on a voluntary basis.

Dr Peter Beets

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Improving water quality

Scion continues to work closely with Matamata-based company, Blue Pacific Minerals, to develop a product capable of improving water quality. The volcanic mineral zeolite has been modified to enhance its natural ability to absorb phosphorous. When applied to a lake bed, the modified zeolite acts as a sediment cap, absorbing and trapping the harmful nutrient. Monitoring results from a trial in Rotorua's Lake Okaro reveal a 40-60% reduction in phosphorous levels following the application of 112 tonnes of modified zeolite in September 2007.

SUSTAINABLE LAND USE

A key objective for many land owners today is to gain maximum value from the land whilst maintaining its productivity and protecting the environment. Maintaining soil and water quality; controlling erosion; managing pests and weeds; reducing waste; balancing crops and stock levels – all these factors play a role in the sustainability of agricultural and forestry practices.

Scion is measuring and managing the environmental impacts of different types of land use and farming methods, with the aim of finding sustainable solutions that enhance the long term productivity of the land. Through the development of new products and processes, Scion is supporting the economic and social values of land without causing harm to the environment.

Tools for defining sustainable forest management

Scion has identified key indicators of forest productivity for New Zealand based on data from trials established throughout the country. Regular measurement of productivity indicators on any given site will reveal whether forest management practices are maintaining, enhancing or reducing productive capacity. The key soil indicators of productivity for radiata pine are soil carbon to nitrogen ratio, total soil nitrogen, total soil phosphorous, depth of top soil and porosity. The need for these productivity indicators arose from New Zealand's commitment to developing forest management practices that do not deplete the productive capacity of the land. Government involvement in international forestry agreements such as the Montreal Process and forest certification demonstrate New Zealand's commitment to this aim.

Learning by burning

Managing wildfires in the landscape is vital for protecting life, property and natural resources. Scion fire researchers conducted a series of large experimental burns in Canterbury last summer to improve understanding of fire behaviour on steep slopes. With tremendous support from numerous rural fire agencies, this research involved setting alight privately-owned scrub on Torlesse Station in Canterbury. As part of the same project, Scion also participated in similar burn experiments conducted by Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO) bushfire scientists in South Australia. These experiments form a key part of a six-year research project known as 'Project FuSE' investigating the behaviour of fires in shrub land vegetation. Project FuSE is a collaborative research project between CSIRO and Scion, supported by the Australian Bushfire Cooperative Research Centre.

Joining forces in global biosecurity

Scion and HortResearch were contracted by the United States Department of Agriculture (USDA) to help eradicate light brown apple moth in California, using a method called 'mating disruption'. The project evaluated different formulations of the female moth pheromone, which is used as a low-toxic alternative to pesticides. It works by reducing the likelihood of successful mating. This research collaboration reflects international recognition of Scion's expertise in aerial application, grid system testing, biosecurity and pest control research.

Understanding the fate of waste

Scion scientist, Dr Gerty Gielen, completed her PhD this year with a study focused on the impact of pharmaceutical residues on the environment. After medication is ingested by users, residual drugs enter the sewage system and will eventually enter the environment after varying levels of treatment. To measure the fate and effect of these pharmaceutical residues, Gerty developed a method to quantify their levels in sewage and in soil irrigated with treated sewage. She then measured the toxicity of pharmaceuticals to microbes in general. Her results showed a small but significant level of drug residues in soil and that microbes living in these soils are acclimatising to them.

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FORESTRY

New Zealand has a rich heritage in plantation forestry with timber, log, and pulp and paper exports being significant earners for this country. Well-managed forests are central to New Zealand's ability to maintain production in the forest-products industry, while ensuring land use practices are sustainable. In future, forests will also play a pivotal role in the development of a bio-based economy.

Scion has maintained its commitment to this important primary sector since our beginnings as the Forest Research Institute. We develop new systems and tools that support the industry in improving the productivity and quality of our forests in ways that are cost-effective, efficient and sustainable. Our specialised staff also provide leading expertise in risk management and forest protection, to safeguard this valuable resource for generations to come.

Induced resistance

Induced resistance is a novel mechanism for increasing trees' resistance to diseases using the natural defence mechanisms within the plant. This approach may prove to be a safer and more environmentally friendly way to improve tree health, than by using chemical controls. The initial focus of this research is to investigate the processes and mechanisms of induced resistance that function in *Pinus radiata* and *Eucalyptus globulus*. This programme is both of broad interest to the forest growing industry and is also helping to strengthen our capability in forest protection science.

Wearable monitoring systems

Knowing exactly how people work and the hazards they face is extremely important in demanding occupations like tree felling and fire fighting. Ergonomic specialists at Scion, led by Richard Parker in Rotorua, have developed a wearable system that monitors aspects of workers' behaviour, and their physical and physiological responses, such as how often they look up when felling trees or what happens to their heart rate during certain activities. By linking this information for the first time, researchers can form a detailed picture of how an individual interacts with their equipment, their environment and how the interactions affect them. This unique wearable system has helped identify ways to enhance productivity by comparing new and more experienced workers, and is also being used as a training tool by FITEC and ACC.

Harvesting technology

Harvesting plays a critical role in forestry. In a single operation, years of investment in growing can be realised or destroyed. Scion is enhancing capability in harvesting systems to support the industry in this vital area. ATLAS Technology has been working in co-operation with SATCO Ltd, a New Zealand-based company that manufactures and exports heavy duty logging attachments for excavators and purpose-built forestry machines. Together they are developing bucking optimisation software to work with SATCO's 325 softwood processor head. The new automated system will define how a felled tree is cut into logs for maximum value recovery, while still allowing current productivity rates to be maintained. A prototype is now being tested in the field.

New software developments

A new product was released by ATLAS Technology, Scion's software development group, to help forestry companies plan their harvesting operations. ATLAS Harvest Scheduler enables better management of crew and harvest unit selection, tracking harvest unit area depletion and control of log products from the forest. Initially developed for Hikurangi Forest Farms, a medium-sized forestry company based in Gisborne, the Harvest Scheduler software represents a vast improvement on existing systems. Since using Harvest Scheduler, Hikurangi Forest Farms are now better able to carry out forecasting of company revenues, crew scheduling and log production planning.

Fostering a passion for science

In April 2008, Scion began the new Ministry of Education 'Science for Life' programme with a view to understanding how CRIs can more effectively contribute to science in schools and developing a best practice approach to science education. This research complements Scion's 'Forests of Life' programme that was successfully developed and implemented in local schools to help children learn more about the world around them.

Taking this research to the next level, the Science for Life programme will engage with science teachers and first year University students to gain a greater understanding of what motivates students to pursue a qualification in science, and how that can be enhanced.

Industry and research partnership established

Future Forests Research Ltd (FFR) was established by Scion and the New Zealand forest industry in 2007 to improve cohesion, grow and expand, the impact of research, science and technology in the sector. In the past year a Board of Directors, chaired by Phil Taylor of Blakely Pacific, and Chief Executive, Russell Dale, were appointed. FFR's increasing membership totals 65 across all its research themes.

The new partnership got off to a strong start and has been building steadily with funding commitments from Government and forest growers. This funding will enable more research into increasing the productivity and quality of plantation forestry to generate economic wealth and environmental benefits for New Zealand.

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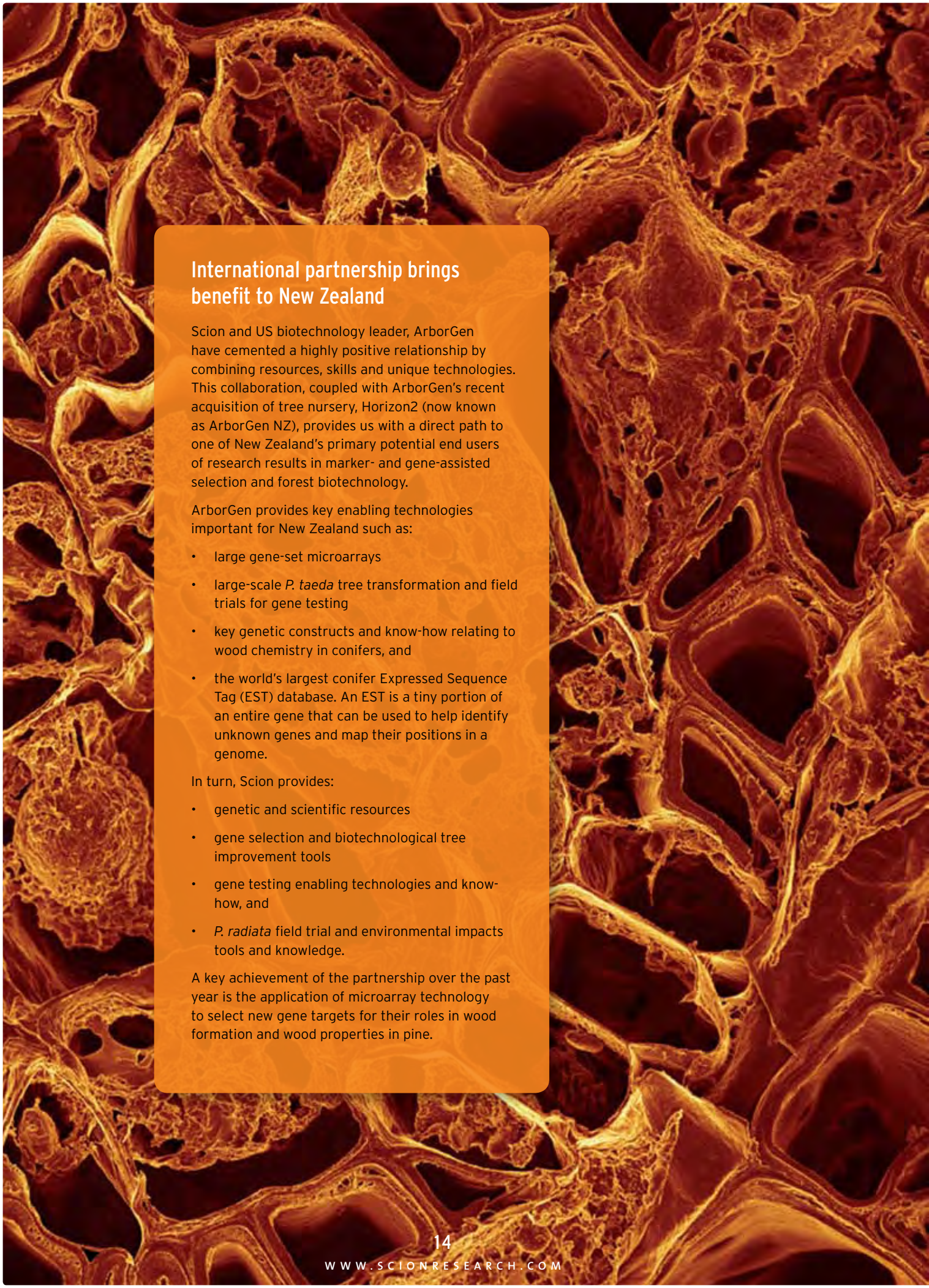

International partnership brings benefit to New Zealand

Scion and US biotechnology leader, ArborGen have cemented a highly positive relationship by combining resources, skills and unique technologies. This collaboration, coupled with ArborGen's recent acquisition of tree nursery, Horizon2 (now known as ArborGen NZ), provides us with a direct path to one of New Zealand's primary potential end users of research results in marker- and gene-assisted selection and forest biotechnology.

ArborGen provides key enabling technologies important for New Zealand such as:

- large gene-set microarrays
- large-scale *P. taeda* tree transformation and field trials for gene testing
- key genetic constructs and know-how relating to wood chemistry in conifers, and
- the world's largest conifer Expressed Sequence Tag (EST) database. An EST is a tiny portion of an entire gene that can be used to help identify unknown genes and map their positions in a genome.

In turn, Scion provides:

- genetic and scientific resources
- gene selection and biotechnological tree improvement tools
- gene testing enabling technologies and know-how, and
- *P. radiata* field trial and environmental impacts tools and knowledge.

A key achievement of the partnership over the past year is the application of microarray technology to select new gene targets for their roles in wood formation and wood properties in pine.

GREEN BIOTECHNOLOGY

At Scion, we envisage a world where materials and processes derived from plants, are used to reduce our dependence on those derived from oil. Technologies associated with the production of bioenergy, bioplastics and other biomaterials provide opportunities to replace fossil fuels with renewable materials and green technologies.

Plants are a renewable source of not only wood and fibre, but also cellulose, lignin and tannin, which arise from cell walls.

Scion provides the science and research needed to maximise the use of these substances and diversify the ultimate end-use of the forest resource. By building our understanding of the science and genetics of trees, we are changing the way we view them – seeing them as chemical warehouses, rather than just wood and fibre.

Breakthrough in understanding wood density

Scion has made an important breakthrough in gene-assisted selection for wood density in pine species. The finding by Dr Sheree Cato is a rare example of balancing selection, in which two slightly different copies of the same gene are required for the effect, in this case, improved wood density. Such evidence for balancing selection has seldom been demonstrated in outcrossing plants such as pine. This finding also has commercial significance because it provides a marker for selecting genotypes with 1-5% greater wood density. Scion has filed two provisional patents on this gene, a dehydrin involved in drought responses.

Encouraging dialogue

Scion and Te Aroturuki (a national Maori advisory group) have joined with the Environmental Risk Management Authority (ERMA) to promote improved dialogue between hapu/iwi and scientists around controversial technologies. Scion recently presented an overview of the Te Aroturuki process to Maori National Network members who attended the 'Tikanga and Technology' hui in Wellington. The process incorporates a step-by-step guide (toolkit) that encourages scientists to consider Maori values and incorporate outcomes for Maori from their research.

Exploring genetic modification

Scion's field trial of genetically modified trees reached a milestone this year, when the current stand of experimental pine was cut down following final data collection. The experiment has entered a new phase with trees now being left to compost on site. Further data will be collected from the decomposing material as part of the ongoing assessment of potential environmental impacts.

This research trial was installed in Rotorua in 2003 with the express purpose of assessing the impacts, if any, of transgenic trees on the environment. The trees were modified with genes known as 'reporter and selection genes', and genes related to reproductive development. These genes have distinct qualities that allowed their behaviour to be traced by scientists as the trees grew.

Results to date from the live material show no evidence of environmental impact from the trial and no evidence of gene transfer to other organisms. The results of this trial will make a valuable contribution to the ongoing discussion on genetic modification in New Zealand.

BIOENERGY

Soaring oil prices and diminishing stores of fossil fuels have triggered greater global efforts to seek out renewable energy systems. Trees and plants are increasingly being viewed as the oil wells of the future, offering a carbon-neutral way of producing energy that does not contribute to global warming.

Over the past year, Scion has taken a leading role in demonstrating how energy can be created from plants and waste streams. In collaboration with others, Scion has enhanced its technologies for using renewable biomass as an bioenergy feedstock, and assessed land availability, economics and infrastructure. The outcome is a clear pathway to meeting the future energy needs of all New Zealanders.

Transport fuels from woody biomass

A feasibility study completed by Scion and its partners in the New Zealand Lignocellulosic Bioethanol Initiative (AgResearch, Carter Holt Harvey and US-based Verenium) reviewed the infrastructure, technology and economics of a transportation biofuel industry in New Zealand. This study showed no major technical or input barriers to producing large volumes of ethanol from New Zealand-grown softwood feedstocks.

While ethanol made from corn or sugar cane is already used as a transport fuel in many parts of the world, there is a growing need to utilise non-food resources, such as trees and woody grasses. Rapid progress is now being made globally to bring cellulosic biofuels (or second-generation biofuels) towards commercial reality. Scion envisages a biofuel sector that uses biorefineries to break down woody biomass into sugars, which are then fermented and distilled into ethanol or other fuels, such as biobutanol. Other conversion options include gasification and pyrolysis. These technologies will enable the conversion of forest biomass to biofuels in ways analogous to other cellulosic feedstocks, while avoiding competition with food crops.

Purpose-grown energy crops

Scion completed a project funded by the Sustainable Farming Fund to demonstrate how woody biomass could be produced by growing short-rotation crops on marginal land in New Zealand. The study focused on willow, which is already used overseas as a dedicated energy crop, mostly to fuel municipal heating plants producing heat and power. An advantage of this species is its coppicing ability, meaning that it will abundantly resprout from cut stems, utilising the existing root system. The collaborative study between Scion, HortResearch and Pure Power suggests that the development of a willow biomass industry has the potential to play an important role in regional energy supply.

Creating energy from waste

The escalating cost of waste disposal is one of the pressing issues facing New Zealand sawmills. In addition, sawmills are faced with increasing energy costs from timber drying and running machinery. In light of these two issues, Scion completed a study to assess a number of different options for a sawmill to generate electricity and heat on-site, utilising their excess process residue. The analysis was based on detailed modelling of electricity and heat demand, matched with residue availability at the sawmill. The study identified a number of viable pathways for on-site electricity and heat generation by the industry.

Bioenergy options for New Zealand

Scion completed a situation analysis of the various biomass resources and technologies available to New Zealand. This is the first stage of the Bioenergy Options for New Zealand project. The Bioenergy Options for New Zealand: Situation Analysis identified a viable plan of action that would enable the country to meet targets for heat, power and transport fuels largely through bioenergy derived from forests. The study showed that purpose-grown forest crops on marginal lands offer the most practical means of producing sufficient biomass to meet New Zealand's transport fuel and heat energy needs on a national scale, without compromising food production.

This project forms part of the wider EnergyScape programme aimed at finding ways for New Zealand to meet its target of sustainable, carbon-neutral energy by 2050. The EnergyScape programme is a collaboration between Scion, the National Institute of Water and Atmospheric Research (NIWA), CRL Energy Ltd, Industrial Research Limited (IRL) and the Institute of Geological and Nuclear Sciences (GNS Science).

Renewable energy for schools

Scion contributes technical expertise to a project aimed at converting heating systems in schools from coal burning to wood pellets. The pellet-fired systems allow automated boiler operation with low ash outputs and produce cleaner emissions than fossil fuels. By taking this approach, schools are demonstrating to their students the viability of making environmentally-friendly energy choices.

The nationwide initiative, driven by the Energy Efficiency and Conservation Authority (EECA), has seen the successful conversion of several Rotorua schools to the carbon-neutral boiler systems. Over the past year, Scion led the conversion of a further four schools in the Bay of Plenty area, which has given this programme tremendous impetus. These boiler conversions involve modifying the combustion characteristics, fuel handling and fuel storage facilities of the existing boilers in schools.

Developing environmentally-friendly products

A team at Scion and Mulford Engineering Plastics have produced one of New Zealand's first eco-friendly bioplastic products for use on a large scale. The Biopeg® is a robust fastening product for outdoor use that holds erosion matting in place. This unique product design is being marketed worldwide through Maccaferri Ltd, a recognised world leader in soil stabilisation systems.

The peg and washer are made from different mixes of natural, renewable and degradable materials that decompose into water, carbon dioxide and humus. Decomposition occurs at different rates for each part. At least 30% of the product weight consists of natural or bio-based additives sourced in New Zealand. The eco-friendly plastic material was developed by Scion in combination with Clariant NZ, who are the licensee of this bioplastic formulation.

Understanding consumer perceptions

A three-year research project was completed this year as part of an investment by the Foundation for Research, Science and Technology (FRST) into understanding the social impacts of new and emerging technologies. Natural materials often need modification in order to meet consumer expectations of performance so the project focussed on understanding consumer perceptions of chemically modified biomaterials using decking and shopping bags as examples. This work supports Scion's emphasis on social and community engagement as an essential part of the development and introduction of new technologies.

BIOPRODUCTS

The world has an insatiable desire for consumer products. In order to satisfy these continuing demands into the future, it is necessary to use material from renewable sources, rather than those derived from oil. Such materials must be produced, used and then recycled or disposed of in ways that do not harm the natural environment.

Scion specialises in creating new bio-based materials and products as a basis for sustaining the consumer market. We recognise that plants provide a source of chemical 'building blocks' for almost all renewable materials. Our scientists explore ways of tapping this vast chemical resource to create entirely new materials for future markets. Materials of this kind will ultimately replace the non-renewable items in common use today.

Matauranga and science

Scion's plant-based biomaterials programme combines aspects of traditional Maori knowledge with western science, to research fibres sourced from three native plant species. The goal is to identify if any of these fibres can be used in new biomaterial applications.

Over the past year scientists have identified sites of various sources of kie kie, ti kouka (cabbage tree) and pingao, and made progress on extracting and characterising the fibres from leaves. This follows the success of the harakeke project, and will create new knowledge in New Zealand fibres, their characteristics and the ways traditional and modern processing can impact on those characteristics. Underpinning this work is the development of key Maori partnerships. There is significant potential for this work to evolve into commercial opportunities for the benefit of all New Zealanders.

Biopolymer Network continues to grow

The collaboration between Scion, Canesis Network Ltd (now AgResearch) and Crop & Food Research, known as the Biopolymer Network (BPN) now has some $3.5 million worth of research projects under way including the development of bio-based foams, bio-derived resins and specialty and industrial chemicals. BPN's harakeke surfboard, making waves again this year in Wellington's Lyall Bay and in the Science New Zealand display at Wellington airport, demonstrates how the collaboration supports the development of natural materials to replace synthetic fibres such as fibreglass.

Lignin biodesigns

Lignin, in its various forms, is a key part of condensed chemicals arising from pulping operations, and a component part of many projects in Scion including fibre development programmes and bioplastic initiatives.

Scientists have successfully modified lignins and the products are now being characterised. For the first time *Pinus radiata* cells have been grown successfully in a lab-scale bioreactor. Naturally-occurring enzymes with the potential to modify lignin have been extracted. Potential options to induce useful chemical changes to the lignin starting material have been identified.

New bioproducts from pulp and paper biorefineries

Scion is developing new bioproduct opportunities to extend product options for the pulp and paper industry, thereby extracting greater value from unused parts of wood. The project targets the production of chemical intermediates from the conversion of lignin, hemicelluloses and carbohydrate degradation products.

Outcomes from the first year of this programme include extraction of potentially useful chemicals prior to conventional pulp processing. The second stream of the project is to develop thermo-chemical conversion technologies to transform kraft lignins into chemical intermediates suitable for adhesives or resins. This research enables progress towards the development of biorefineries.

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