

2012
Annual Report
Part A

Scion's purpose is to drive innovation and growth from New Zealand's forestry, wood product and wood-derived materials and other biomaterial sectors, to create economic value and contribute to beneficial environmental and social outcomes for New Zealand.

Scion at a glance

299 full-time equivalent staff

Rotorua: 278

Wellington: 3

Christchurch: 17

Dunedin: 1

Operating revenue: \$44.1m

Last year: \$43.4m

Total comprehensive income: \$1.6m

Last year: \$1.8m

Return on equity: 6.0%

Last year: 7.3%

Key to investors:

DBH	Department of Building and Housing
ESR	Environmental Science and Research
FFR	Future Forests Research Ltd (a government-industry partnership)
FOA	New Zealand Forest Owners Association
FRFANZ	Forest and Rural Fire Association of New Zealand
FRST	Foundation for Research, Science and Technology (now MSI)
MfE	Ministry for the Environment
MPI	Ministry for Primary Industries
MSI	Ministry of Science and Innovation
OECD	Organisation for Economic Co-operation and Development
PGP	Primary Growth Partnership (a government-industry initiative)
RPBC	Radiata Pine Breeding Company Ltd
SLMACC	Sustainable Land Management and Climate Change (an MPI investment programme)
SWI	Solid Wood Innovation (an industry/MSI consortium)



Front cover

The material pictured here is a bioplastic blend developed by Scion in partnership with ZESPRI. The blend is made from kiwifruit residue and a commercial bioplastic PLA (polylactic acid) that can be used in plastics processing equipment while still being compostable. It has been used to make an environmentally friendly biospife - a spoon-knife utensil for cutting and eating kiwifruit, which ZESPRI is currently trialling as a replacement for the petrochemical polystyrene spife. **(See page 15)**

Annual Report 2012

Our Annual Report is in two parts - A and B. Together they fulfil our annual reporting responsibilities under the Crown Research Institutes Act 1992.

Part B contains the employment and environmental reports, directors' report, performance targets and financial statements.

Printed on fully recycled Cocoon Silk, supplied by B&F Papers.

SCION ANNUAL REPORT 2012

PART A

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Our vision

Prosperity from trees *Mai i te ngahere oranga*



Measuring millions of tonnes of carbon stored in New Zealand forests. **Page 8**



Combating 6,000 hectares of wildfires each year with fire research. **Page 17**



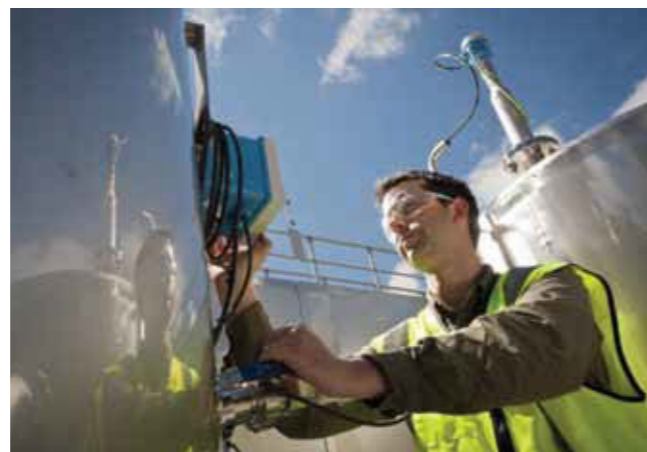
Feeding global plastics markets with wood fibre technology. **Page 13**



Unleashing insects to control insects. **Page 17**



Reducing harvesting time on steep country. **Page 9**



Transforming municipal biosolids into useful chemicals. **Page 19**

FROM THE CHAIRMAN AND CHIEF EXECUTIVE



Tony Nowell



Warren Parker

E ngā mana, e ngā reo, e ngā maunga,
e ngā awa, e ngā pātaka o ngā taonga
tuku iho, tenā koutou.

All authorities, all voices, all mountains,
all rivers, all treasure houses, greetings
to you.

Science outcomes for the forest industry

Scion completed a successful first full year under the Crown Research Institute (CRI) Taskforce reforms. It is pleased to report on the positive differences the reforms have made to long-term planning, technology development and alignment of investment with the New Zealand forest industry.

We are particularly pleased with the new technologies and information released to the industry over the past 12 months. These will help to improve productivity and environmental performance, and establish new markets. They reflect the full spectrum of the targets set in Scion's science and innovation plan for the six Intermediate Outcomes (IOs).

Examples for each IO are outlined in more detail in this report. They include:

- IO1 Commercial forestry - Supporting the implementation of the Emissions Trading Scheme (ETS) through the development of carbon calculators, and forest management through the application of remote sensing technology (LiDAR) and release of decision support tools for kauri and totara.
- IO2 Solid wood processing - Enabling the modification of radiata pine so that it can compete with and substitute tropical hardwoods by proving a new wood treatment technology.
- IO3 Wood fibre, pulp, biopolymer and biochemical industries - Accelerating new wood plastic pellet product developed through our international license partner Sonae Indústria, who has brought substantial market knowledge, product development expertise and other benefits to Scion's renewable composite materials programme.
- IO4 Forest health and preparedness for biosecurity incursions, fire and climate change - Releasing new support tools for rural fire prevention and management; and for the assessment of extreme weather events on plantation forests.
- IO5 Forest industry's license to operate and environmental performance - Working in partnership with the Rotorua District Council to successfully design and commission a pilot scale plant for treating municipal biosolids waste. Wider opportunities to commercialise the protected TERAX™ technology are now being explored in conjunction with the partner.
- IO6 Increase energy security through the utilisation of forest biomass for energy - Further reducing the cost of producing sugar for energy and other high value co-products from radiata pine residues.

Forest industry direction and interaction

Collaboration with other research providers and industry is a strong feature of Scion's achievements, ensuring access to the best capability domestically and internationally. Early stage partnering opportunities with industry are being sought to enable early and fast commercialisation and technology transfer.

Scion's focus on strengthening end-user engagement in the past year has led to a very pleasing result in the Ministry of Business Innovation & Employment commissioned survey of CRI stakeholder experience: 87% of relevant funding partners and other end-users said they have an effective relationship with Scion.

The launch of the Wood Council's New Zealand Forest and Wood Products Industry Strategic Action Plan, and updated forest growers' science and technology priorities, means Scion will be in an even stronger position next year to ensure its programmes are well-aligned to industry and other stakeholder requirements.

Forest growers have expressed strong support for Scion to continue and speed up genetic modification research - despite the setback of vandals destroying trees in an Environmental Protection Authority-approved, contained field trial.

Investment of core funding

In 2011/12, Scion invested its \$17.73m (excluding GST) core funding to support the achievement of targets specified in the Statement of Corporate Intent (SCI). Progress was monitored quarterly and substantially reviewed in April to inform changes in allocation for 2012/13.

Core funding has provided a new dimension to industry partnering. In the first quarter, for example, it resulted in the reprioritisation of some \$0.5m to support research in forest protection. And, at year-end, Scion's forest genetics investment was integrated with that of the Radiata Pine Breeding Company (RPBC) to accelerate the development of disease tolerant genotypes and support future plans to sequence the *Pinus radiata* genome.

Strategic Advisory Panels formed

As part of the CRI Taskforce reforms, Strategic Advisory Panels to the Board and senior executive were established for science, users and Māori. With three members each, the panels provide independent, expert perspectives on Scion's science and technology plan, the effectiveness of industry and iwi engagement, and overall organisational strategy.

The Science and User Panels undertook a detailed assessment of IO2 (solid wood processing competitiveness) and IO3 (wood fibre, pulp, biopolymer, and biochemical industries) in November. Their recommendations have informed Scion's 2012-17 SCI, technology commercialisation and science network development.

The Māori Panel (Ngā Rangitira Rōpu) met with the Board in February to overview Scion's Māori Plan. The panel identified priorities for iwi with respect to the forest industry and suggested ways to improve partnership building and communication with iwi entities.

Communication with all panels is ongoing. In the coming year, the panels will re-assemble to assess the forest growing IO and make input to Scion's strategic update.

Organisational structure aligned to new strategy

Scion changed its structure in the first half of the year to reflect its refreshed strategy and SCI. The executive team was reduced and new science teams formed to strengthen science leadership, improve career pathways and succession management, and facilitate easier engagement for customers.

These changes, implemented with minimal disruption to operations and delivery, are supported by a leadership development programme. Core systems and processes were also enhanced and a communications plan for external stakeholders put in place, funded in part through reinvestment of surpluses.

Financial performance

Revenue in a difficult economic and operating environment grew 1.6% to \$44.1m, although this was 4% below budget (\$45.8m). Net profit after tax (NPAT) at \$1.6m exceeded budget (\$1.3m). This represented a pre- and post-reinvestment return on equity (ROE) of 8% and 6.0%, respectively (budget 8% and 4.9%).

Re-investment initiatives are contributing significantly to Scion's capacity to deliver science and technology to the industry faster and with greater impact. A multi-year reinvestment programme, subject to financial performance, is mapped out in Scion's SCI.

Internal reinvestment of \$0.9m was made into staff capability development and building an outward-orientated, customer-facing culture; automation and standardisation of core processes and systems; remedying deferred maintenance; placements of scientists within industry; and providing Scion staff with the skills to effectively engage with iwi.

Asset management and capital structure

A 10-year plan for Scion's Te Papa Tipu, Rotorua Campus was developed in 2010. This was updated in 2011/2012 through a comprehensive review of all building maintenance requirements and "suitability for purpose" over the next decade. The review has informed the consolidation of Scion's building footprint, including the removal and demolition of some buildings, and implementation of a new office floor plan to enhance team work and building performance.

A major element in the plan was the complete refurbishment of approximately one third of Scion's ageing laboratories. After extensive design input, work on reconstruction and refitting began in January and was scheduled for completion in mid-July. The \$5.5m project is the largest modernisation undertaken by Scion for many years and has reduced cash reserves to \$2.8m as at 30 June 2012 with less than \$1m remaining to be spent on the project.

A modest cash balance of around \$0.7m to \$1.1m and positive operating cashflows are projected for the SCI planning period. With high uncertainty persisting in the external operating environment, this capital structure is considered prudent. This also provides scope for Scion to invest in initiatives such as technology commercialisation as the economy recovers.

Future outlook

Scion is now well-integrated with the New Zealand forest industry. The Wood Council's Strategic Action Plan to grow forest and wood product exports from the current \$4.6b to \$12b by 2022 provides priorities and targets for Scion's research and development. Forest growers plan to seek support to introduce a levy in November 2012. This would broaden the industry contribution to research and provide a more stable base than present for longer term planning of industry's science and technology needs.

The transition to bio-based and renewable economies is gaining momentum internationally. This is supporting the transformation of forest industries, especially in the northern hemisphere. It is reflected in increased investment in clean technologies, biorefineries and industrial biotechnology, and the judicious use of genetic engineering and land use change.

With its extensive network of research collaborators, Scion is well-placed in all of these areas of science and technology, including advanced manufacturing for high-value wood processing. It will play a leading role in enabling the New Zealand forest industry to maximise opportunities arising from the growing scarcity of non-renewable materials, energy and water.

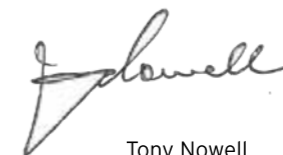
Forestry assets are significant (some \$2b in 2010) to Māori economically and culturally. Iwi interest is strong in the planting of indigenous species as part of their plans for integrated land management and participating further up the value chain. Scion's Māori Plan addresses these opportunities as well as driving productivity improvements in the current plantations of exotic species.

Achievements and acknowledgement

This has been a very busy and rewarding year for the Board and executive team. The ongoing resilience and commitment of Scion's Canterbury-based staff to meet contractual commitments following the devastating February 2011, 6.8 magnitude earthquake, and numerous aftershocks has been extraordinary. It is much appreciated.

The Board also wishes to thank Peter Berg for his considerable and diligent service to Scion as a Board member and Chairman of the Organisation and Remuneration Committee, and to wish him well in all his future endeavours.

Finally, the Board wishes to extend its sincere thanks to Scion's executive and staff for their dedication, professionalism and commitment through a period of significant change organisationally and a challenging external operating environment.



Tony Nowell
Chairman



Warren Parker
Chief Executive

SCION'S STRATEGIC FRAMEWORK 2012 TO 2017

Prosperity from trees

Maximise forest industry impact: ensure financial viability

Meet shareholder's financial expectations

Contribute to National Outcomes that create economic value and better social and environmental outcomes

Create impact by delivering Science and Innovation (Intermediate Outcomes)

Demonstrate high quality science which meets user needs in the short and long term



Deliver innovative customer solutions with service excellence

Develop compelling science proposals with customers to secure funding

Deliver contract tailored solutions in full and on time using the best teams nationally and internationally

Allocate and monitor Scion's investment portfolio efficiently and agilely

Transfer and/or commercialise Scion technologies quickly



Maximise the speed and impact of Scion's science and technology

IO1 Maximise the value and profitability of commercial forestry

IO2 Improve the competitiveness of the solid wood processing industry

IO3 Expand opportunities in the wood fibre, pulp and paper, biopolymer and biochemical industries

IO4 Improve New Zealand's forest health and preparedness for biosecurity incursion, fire and climate change

IO5 Ensure New Zealand forest industries' license to operate domestically and internationally and enhance environmental performance

IO6 Increase New Zealand's energy security through the expanded utilisation of forest biomass for energy



Increase sector engagement, science quality and productivity

through Learning & Growth (L&G) initiatives

Develop our people and culture to be customer focused and high performing (L&G1)

Grow productivity through smart processes and systems in a safe, stimulating workplace (L&G2,3)

Foster national and international science collaborations to access the best talent, ideas and technologies (L&G5)

Accelerate technology translation and commercialisation; foster engagement through secondments (L&G4,6)

Build Scion's tikanga and capacity to engage effectively with Māori and develop the Māori economy (L&G7)

RESEARCH PERFORMANCE

Our vision

Prosperity from trees
Mai i te ngahere oranga



COMMERCIAL FORESTRY

101 Maximise the value and profitability of commercial forestry



Taking carbon into account

> Investment: MfE, MPI

New Zealand is in the fortunate position of being able to use carbon stored by forests to offset a large portion of its national greenhouse gas emissions. This enables the country to avoid significant cost under Kyoto commitments. The trading of carbon domestically and internationally also creates a new revenue stream for forest growers.

Over the past decade, Scion has worked closely with the Ministry for the Environment (MfE), the agency responsible for national reporting, to develop scientifically robust and defensible methods for measuring and modelling forest carbon.

Scion's models are used to estimate carbon stocks for key species at a specific time, and to predict changes over time. They are an integral part of MfE's Land Use and Carbon Analysis System (LUCAS) which provides information on carbon stocks and changes at a national level to satisfy international reporting requirements under the Kyoto Protocol.

To meet the challenge of calculating carbon in planted forests, Scion has created a carbon prediction model known as C_Change, and linked this to Scion's growth models for New Zealand's two key commercial species, radiata pine and Douglas-fir.

"The well-proven, national applicability and accuracy of Scion's models were the key reasons for using them in carbon calculations under the forestry Emissions Trading Scheme," says Dr Craig Trotter, Ministry for Primary Industries.

The 300 Index growth model for radiata pine and 500 Index growth model for Douglas-fir predict total volume in live and dead stems for each age from the time of planting to harvest age. Both of these models are routinely used by the forest industry to forecast growth and yield of wood products.

Scion's leader of carbon research Dr Peter Beets says the advantage of the system is that it accurately allows for the impacts of silviculture when predicting carbon sequestration.

"Pruning, thinning and harvesting operations have a large impact on carbon stocks. So does wood density. The growth models used to forecast carbon take all of the site and management factors into account," he explains.

Scion has combined the three models into one overall model called the Forest Carbon Predictor (FCP). The FCP is used to estimate the amount of carbon stored per hectare in planted forests based on LUCAS plot measurements.

During the past year, Scion has worked closely with the Ministry for Primary Industries (MPI) to provide key components of the carbon calculation and forecasting system for planted forests registered in the Emissions Trading Scheme (ETS).

Forest owners with at least 100 hectares of radiata pine and/or Douglas-fir forest who participate in the scheme will have carbon stocks within their forest calculated by the system.

Dr Craig Trotter, who is leading the ETS design for MPI, says the well-proven, national applicability and accuracy of Scion's models were the key reasons for using them in carbon calculations under the forestry ETS.

"Scion's expertise in forest inventory and carbon assessment is embedded in New Zealand's international and domestic efforts to reduce net greenhouse gas emissions and contribute to controlling climate change."

GM field trials to continue

> Investment: Scion Core

With 20 years' research in genetic modification, Scion is at the forefront internationally in applying GM techniques to radiata pine and other conifers.

Forest growers believe that GM could provide environmental and economic benefits, and they support research to investigate this technology in New Zealand.

"GM has potential to reduce the need to use persistent herbicides in forest establishment and to eliminate the spread of wilding trees from plantations through the development of sterile clones," says NZ Forest Owners Association senior policy analyst Glen Mackie.

Research results from field trials in containment provide the scientific evidence to enable informed debate on the use of GM options. Unfortunately, Scion's current research goal to obtain data on herbicide tolerance in radiata pine, using forestry operational concentrations of herbicide, was set back when all trial trees were damaged by criminal action. This work is being re-established.

Grappling with hauler efficiency

> Investment: PGP supported by companies & MPI, managed by FFR

Grapple time could be cut by up to a quarter with a new device developed by Scion to haul felled trees on difficult terrain. The device is a cost-effective and simple restraint that reduces grapple swing when picking up stems on hillsides, giving hauler operators greater control of the cable logging system.

The technology, which can be readily adapted to existing machinery, was found to significantly reduce grapple time when extracting bunched trees. Field testing with a hauler crew showed a potential reduction in grapple time of 20-25% (an estimated gain of 10-15 cycles/day). This will amount to considerable productivity gains for steep country harvesting operations and improved safety once the device is made widely available.

Indigenous forestry offers good return

> Investment: FFR, Scion Core

Growth modelling by Scion has provided solid evidence that a 50-60 year rotation of planted New Zealand kauri (*Agathis australis*) can yield a rate of return comparable with exotic forestry species. Such results show the potential to create a new high-margin export industry using indigenous trees for commercial use.

The model, which is available as a web-based calculator through Future Forests Research (FFR), shows that kauri compares well with exotic tree species for wood quality, growth rates and return on investment.

Scion and the University of Auckland's School of Business Mira Szász Research Centre are working with Northland iwi forestry groups, collectively named Te Tai Tokerau Innovation Forestry Cluster, to develop a future forestry infrastructure in Northland to improve employment opportunities and economic returns.



Satellite imagery aids forest management

> Investment: FFR

Satellite imagery is proving an effective tool, meeting forestry industry needs for cost effective, up-to-date information on the status of forest resources.

Recent technology advances have made it possible to acquire inexpensive imagery at a spatial resolution likely to be useful to forest managers.

A collaborative project between Scion and industry consulting company Indufor Asia-Pacific Ltd has enabled Rayonier Matariki Forests to use satellite imagery to assist with forest management.

The project demonstrated that RapidEye satellite imagery can be used to identify new harvest areas and delineate stands, and areas within stands with growth that differs from expected values.

Routines have been developed for these purposes and are currently available as an add-on to ArcGIS.



Managing woody debris in streams

> Investment: MSI, Bright Future Scholarship, Scion Core

The ecological impact of woody debris in streams was the focus of a doctorate completed in 2012 by Scion freshwater scientist, Brenda Baillie.

The large catchment-scale study showed how wood debris provides natural habitat, shelter and food for freshwater organisms. However, when too much logging debris is left in stream channels, it harms the ecosystem. On-going work is evaluating the effects of extreme weather events on stream and riparian environments in recently harvested sites.

Forestry companies and regional councils have incorporated the study's recommendations and related work into slash management plans. The study also made a valuable contribution to the proposed National Environmental Standard for Plantation Forestry.

SOLID WOOD PROCESSING

I02 Improve the competitiveness of the solid wood processing industry



A new kind of wood adds value

> Investment: Scion Core

Substituting just 1% of tropical timbers with sustainably grown radiata pine would represent a significant opportunity for New Zealand. A Scion-developed process could lead to such a step change that would grow the value of our wood-based products.

Scion's wood processing scientists are developing a technology platform that can deliver multiple new applications for wood. During the past year, the team has successfully developed "dewatered" wood from radiata pine.

The dewatered wood is not an end product. It is a superior material that relies on downstream modifications to achieve a high-value, wood-based material that meets a range of market needs, which cannot currently be met by radiata pine.

An early application of the technology with a commercial treatment agent, using dewatered radiata pine, has demonstrated that the resulting modified wood product has similar physical and appearance properties to tropical hardwoods such as teak.

The research, being led by Wood and Fibre Science Leader, Douglas Gaunt, is developing a transformative technology using supercritical carbon dioxide. Supercritical fluids behave like both a gas and a liquid and have been used in commercial applications to remove chemicals from a substance without distorting the original structure of the material.

The potential for dewatered wood and its subsequent modification was recognised in the late 1990s by Scion's Dr Robert Franich. With the use of supercritical fluids, the science has only just caught up to his original vision.

Superficially, dewatered wood looks and feels like any other piece of timber, but is slightly heavier as it contains 40% moisture content, compared with about 10% in kiln-dried timber. The real differences are only visible at the microscopic scale of wood cells and

"The technology gives radiata pine another mechanism to compete with high-value hardwoods thus increasing export earnings for New Zealand," says Dr Elspeth MacRae, General Manager Manufacturing and Bioproduct Development.

show themselves in properties of wooden products that have been through subsequent processing steps.

Dr Elspeth MacRae, General Manager Manufacturing and Bioproduct Development, says the technology gives radiata pine another mechanism to compete with high-value hardwoods thus increasing export earnings for New Zealand.

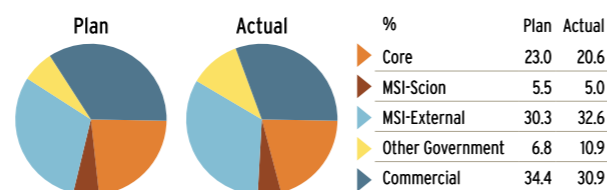
"In this process, water is removed from within the centre of wood cells while leaving moisture in the cell walls. To achieve this, we've had to understand the formation and interaction of water molecules within cell walls."

She emphasises the new technology is not a drying technology; rather it results in wood properties which are fundamentally different. This enables further modification to a range of exacting stability, hardness, colour and durability requirements. Mostly, these subsequent modifications will occur by impregnating transforming agents into freshly dewatered wood.

In addition to new wood products, liquid extracted from the dewatering process has been analysed by Scion's NMR (Nuclear Magnetic Resonance) spectroscopy team and a range of biochemicals identified. There are potential revenue streams from these extractives.

The technology is protected by international patents. To date, research in New Zealand has been limited by availability of a dewatering supercritical fluids facility that can process larger amounts of wood. One of the next steps in this research is designing a Supercritical Pilot Plant at Scion's Rotorua campus to assist in the market and economic evaluation of the process and prototype products.

I01 Distribution of investment



Contributing to building productivity

> Investment: Scion Core, Building and Construction Productivity Partnership

Scion's Built Environment programme will contribute to lifting productivity in the building and construction sector by helping to increase uptake of high-margin, wood-based building and consumer products in New Zealand.

In its first year, the programme examined the New Zealand construction sector and international developments. It also identified routes to increase the use of wood and profitability of wood-processing and the construction industry, says Research Leader Dr Jeff Seadon.

The resulting four-year research and capability plan will allow Scion to better understand the needs of the industry and undertake more targeted, responsive research. The plan complements the newly established Building and Construction Sector Productivity Partnership's goal of a 20% lift in sector productivity by 2020.

Accelerated testing for timber decay

> Investment: Scion Core, Forest and Wood Products Australia, Lonza Ltd and Arch Wood Protection

New methods for evaluating wood preservatives could halve durability testing time for H3 (above-ground and outdoor) timber, and give a more reliable and cost effective result.

Testing new wood preservatives against reference preservatives for H3 timber, currently takes six or more years.

Scion scientists, led by the late Dr Mick Hedley, colleagues at CSIRO (Australia's Commonwealth, Scientific and Industrial Research Organisation) and industry representatives developed a range of accelerated decay testing protocols. These were deployed in Australia and New Zealand in 2008 and evaluated over the past year.

The protocols are now awaiting approval from the Australasian Wood Preservation Committee and, if adopted, would significantly reduce the time to market (and therefore cost) for new wood preservation products.

Saving costs by predicting timber warping

> Investment: SWI

Warped timber adds costs to the wood-processing industry and can undermine the reputation of timber as a reliable building product.

Scion scientist Dr Jonathan Harrington has determined that the longitudinal shrinkage patterns in green timber could be used to predict warping of dried boards. The next phase of the research will be to develop a scanning metric for longitudinal shrinkage that can be used as a predictor of warping.

Dr Keith Mackie, from industry-led Solid Wood Innovation, says segregation of potentially inferior material as early as possible in the processing sequence would save drying costs on inferior timber and would deliver a more consistent quality timber product to the building and construction industry.

Fingerprinting technology speeds plant analysis

> Investment: Scion Core

Chemical "fingerprinting" of parts of plants, using Scion's recently updated Nuclear Magnetic Resonance technology, takes only minutes of analysis, allowing the biochemicals (or metabolites) to be identified and characterised easily.

During the past year, the technology has been used to characterise liquids from the wood dewatering project, as well as the biochemical response of plants that have been chemically treated.

Advanced Characterisation Research Leader Dr Stefan Hill says the technology and growing metabolomics database has the potential to detect novel and potentially commercially valuable compounds for biomaterials and bioenergy production.

The technology may also help assess biochemical responses to genetic modification and characterise plant responses to pathogens such as needle cast diseases. The collection of all metabolites in an organism is called the metabolome.

Alleviating costs in leaky buildings

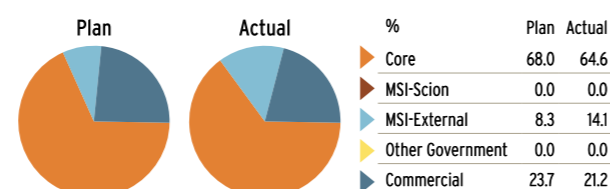
> Investment: DBH

Cost-saving novel research and technical advice from Scion's wood preservation team contributed to the Department of Building and Housing (DBH) publication, "Dealing with timber in leaky buildings".

The team, led by Dr Tripti Singh, evaluated treatments for partially degraded framing to alleviate the necessity of fully replacing wood when repairing leaky buildings. Research showed a double coating of boron-glycol was effective in limiting the spread of early stages of decay, provided the preservative was applied to at least three faces of the timber.

The DBH guide, published in June 2012, provides practical advice on decayed timber, including on-site treatment.

IO2 Distribution of investment



WOOD FIBRE, PULP, BIOPOLYMERS AND BIOCHEMICALS

IO3 Expand opportunities in the wood fibre, pulp, biopolymer and biochemical industries



Members of Scion's wood fibre dice development team are Science Leader Dr Alan Fernyhough, Business Development Manager Jeremy Warnes (pictured at right), Materials Scientists Ross Anderson and Damien Even (pictured at left), and Research Leader Dr Karl Murton.

Wood fibre dice take on global plastics markets

> Investment: Scion Core

A breakthrough technology in fibre processing, combined with an exciting new business partnership, is creating global opportunities for using long wood fibres in plastic products.

In 2011, Scion negotiated a licensing agreement with Sonae Indústria Group for the manufacture and sale of wood fibre "dice" that has the potential to be much more revolutionary than its humble appearance suggests.

A major advantage of the wood fibre dice over agricultural fibres is that they do what dice do best. They roll, behaving just like plastic pellets, when fed into processing machinery.

This ease and accuracy of handling means the dice can be fed directly into conventional extruders, then the compound can go into injection moulders for processing as fibre-reinforced plastics.

Wood fibres typically have lower costs and more consistent supply than other fibres, and wood-fibre-reinforced plastics are stronger, lighter and have a lower environmental footprint than conventional plastics.

Sonae Indústria's Global Manager Woodforce Christophe Chambonnet sees the commercial decision by the multi-national giant as an exciting prospect.

"I have no doubt that we are creating a new perspective on the use of renewable wood fibre," he says. "Scion is clearly a leader in research involving sustainably derived bioproducts. Together with our expertise, we make a unique and powerful team."

Sonae Indústria is a leading global player in the wood industry, with 27 production sites in seven countries processing seven million tonnes of wood a year. The agreement with Scion gives them an exclusive licence to commercialise the technology in Europe and create whole new markets for sustainably produced wood fibres.

Wood fibre dice add strength to traditional polymers via a highly consistent and cost-effective route. So much so, that Sonae Indústria launched the technology as "Woodforce" in December 2011. Commercial-scale manufacture of Woodforce is already at 5,000 tonnes per year.

The new product has attracted attention from several European and North American compounding companies which are trialling Woodforce. Subsequent injection moulding trials have resulted in good quality parts, sparking interest from further down the supply chain.

Scion materials scientist Damien Even has successfully trialled the use of Woodforce in industrial-scale plants in Europe. Knowledge gained from overseas commercial trials is extremely valuable as Scion seeks to use this technology more widely in New Zealand.

"Wood fibre is a superior option with clear advantages over agricultural or glass fibres, so we will be working hard to promote the benefits of this product," Mr Chambonnet says.

"We welcome this as a significant opportunity to redefine our business and expand our horizons. We have reached an agreement with Scion to make Woodforce a unique global brand," says Christophe Chambonnet, Global Manager Woodforce for Sonae Indústria.

While the first commercial applications of the technology are likely to appear in Europe, Sonae is planning to expand into North America, followed by Asia. Such moves will trigger new licensing agreements with Scion. The intellectual property is retained in New Zealand with Scion having filed international patent applications for the technology.

Scion Chief Executive Dr Warren Parker says the licence deal is likely to return significant royalties over the next decade.

"With commercial adoption of the technology in Europe, we believe there will be excellent opportunities for New Zealand manufacturers to enter new markets within our region, using established plant and equipment," Dr Parker says.

Promising trials of eco-friendly foam packaging

> Investment: Biopolymer Network Ltd

The Biopolymer Network Ltd, a collaboration between Scion, AgResearch, and Plant and Food Research, has developed eco-friendly packaging as an alternative to expanded polystyrene (EPS) foam boxes currently used by many New Zealand fresh food exporters.

EPS boxes are increasingly disfavoured by export markets and, in some cases, may be banned due to their poor environmental image and impacts. The new patented technology uses carbon dioxide to make foam from a sustainable biopolymer. At the end of its life, it is compostable in industrial facilities.

Initial industry-type trials have shown promise and Biopolymer Network Ltd is now investing in a pilot plant facility, to be co-located on a New Zealand EPS manufacturer's site, to prove the technology's commercial suitability.

Advances may lead to new wood-based products

> Investment: Scion Core

Scion scientists have made important advances in understanding the two key chemical components of wood - lignin and polysaccharides - which are directly related to its structure and properties.

Using high-technology image analysis, Lloyd Donaldson, in collaboration with J Paul Knox, demonstrated the close association of lignin and polysaccharides in normal and compressed radiata pine. Armin Wagner and co-workers successfully generated a new type of lignin in radiata pine by suppressing the activity of an enzyme.

These results, published in top scientific journals, show that lignin production and structure in pine can be manipulated, which could lead to new wood-based products and also improved methods for removing lignin from wood.

The huhu's puku gives insights for new wood products

> Investment: Scion Core

Huhu grubs may hold the secret to new uses for industrial lignins, produced as co-products of wood processing. Scion researchers have developed new capability to analyse wood-consuming microbes that are host to lignin-modifying enzymes which are biotechnologically useful.

They have found over 1,800 different species of bacteria inside the gut of the huhu grub. The discovery

provides new information on the diversity and activity of gut-associated microorganisms essential for the digestion of wood. It is particularly relevant to biorefinery research which is searching for enzymes to modify lignin.

The research has resulted in a high impact publication describing the microbial contents of the guts of the huhu grub (see Science Outreach Section for publication details).

"Biospife" supports market access to Europe

> Investment: ZESPRI

Kiwifruit residue has been given new life with the development of a bioplastic spife (spoon-knife), the result of a collaboration by Scion scientists and ZESPRI.

Development of the biospife was aimed at reducing the company's environmental footprint. But the prototype was such a hit in Europe at a trade fair for sustainable agriculture in The Netherlands, that ZESPRI ordered 150,000 biospifes. These will be used in retail pre-packs of ZESPRI® ORGANIC supplied to several European retailers.

"ZESPRI is committed to providing sustainable products," says ZESPRI's Innovation Leader Alistair Mowat. "Biospifes provide a good example of how we can reduce our carbon footprint and utilise un-exported fruit in a way that benefits consumers."

(See also cover caption.)

New green bioadhesive creates competitive advantage

> Investment: MSI

A new adhesive, made 100% from New Zealand grown or sourced bio-based ingredients, should help manufacturers of wood panel products meet increasing demands for "green" panel products. The breakthrough should also overcome regulatory and customer concerns about formaldehyde emissions.

By using a green chemistry approach, the Scion research team has come up with formulations capable of bonding MDF and other wood panels together. A scaled-up pilot study, using Scion's fibre-processing plant has also provided invaluable results.

"We now have proof of concept at pilot scale and are focused on providing underpinning science that will lead to commercialisation," says project leader Dr Warren Grigsby. "This will give local manufacturers a competitive advantage over wood panel processing plants overseas."

Unique facility to test biodegradation and composting

> Investment: Scion Core

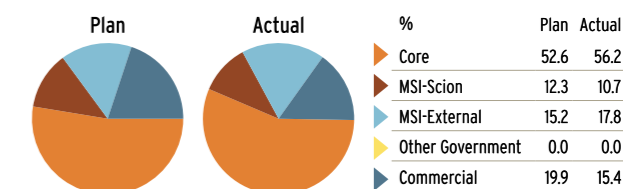
Scion has designed and built a unique-to-New Zealand test facility for measuring the aerobic composting of materials such as bioplastics, paper and wood, and quantifying the time it takes for materials to biodegrade.

The facility was built to the international standard ISO 14855-1 to provide results showing levels of biodegradation within a six-month timeframe.

Scion is using the facility to tailor the composting of newly developed biomaterials. It is also available to commercial clients, seeking evidence to support environmental marketing claims. The facility is designed to quantify the aerobic biodegradability of plastic materials by measuring the evolved carbon dioxide. It can also be used to examine the degradation of plastic, paper or wood in media, such as soil or aquatic environments, and to investigate whether additives impede or accelerate composting of a biomaterial.



IO3 Distribution of investment



RISK AND ADAPTATION

104 Improve New Zealand's forest health and preparedness for biosecurity incursions, fire and climate change



Climate change impacts on forest productivity and health

> Investment: MPI

Forest growers need to know how climate change can affect the productivity and health of their trees. Accounting for the effects of climate change involves careful consideration of how both direct effects, such as carbon dioxide (CO₂) and temperature, and indirect risk factors, such as fire and disease, influence plantation productivity.

Scion recently completed a three-year research programme, funded by the Ministry for Primary Industries, linking regional climate change information with forest productivity and health.

Research Leader Dr Michael Watt says growers need to understand the combined effects of climate change on trees in their region when making decisions about the choice and siting of species, and their management.

"Increased tree productivity is the major benefit we anticipate nationwide as the climate changes," says Dr Watt.

"Average radiata pine productivity across New Zealand could rise by as much as 37% by the end of this century if trees respond fully to increases in CO₂ and temperature. The greatest percentage gains will occur in the South Island, especially at higher altitudes."

Alternative species to radiata pine are increasingly of interest to growers, and the productivity of two species studied, eucalyptus (*Eucalyptus fastigata*), and redwoods (*Sequoia sempervirens*), will rise markedly with increasing CO₂ and temperature. As temperatures increase, sites that are currently marginal for these two species because of frost risk will also become suitable for planting.

Permanent indigenous cover has a newly valued role in carbon accumulation and so the response of species such as kanuka and manuka to climate change is important. Kanuka/manuka productivity is predicted to rise by 24-37% by the end of the century, with the greatest gains again seen in the cooler south and at higher altitudes.

The threat to South Island radiata pine plantations posed by fungal diseases is likely to increase as the climate warms. By linking climatic determinants of disease with regional climate change data, scientists have mapped the future distribution and severity of key foliage diseases. Over the next 80 years or so, the risk will increase

"Increased tree productivity is the major benefit we anticipate nationwide as the climate changes," says Research Leader Dr Michael Watt.

significantly in parts of the South Island. In the North Island, disease severity is likely to remain relatively static.

Fire risk also is likely to increase as conditions become hotter, drier and windier. Fire seasons will be longer, due to a potential doubling or even trebling of the number of days of very high and extreme fire danger in some parts of the country. The relative increase in fire risk is forecast to be highest in regions that currently have low-fire danger. However, areas on the east coast of both islands, where fire risk is already high, will also see significant increases.

Aerial spray modelling aids forest protection

> Investment: MSI, Lincoln Ventures Ltd, commercial.

Aerial pesticide application is an effective way of targeting pests in tree canopies, but to work best good spray coverage is needed throughout the canopy. Scion and Lincoln Ventures collaborative research has involved close work with the US Forest Service to improve models commonly used to understand spray deposition and drift.

Researchers also worked with ZESPRI to test new aerial spray optimisation methods to assist with its ongoing battle with Psa (*Pseudomonas syringae* pv. *actinidia*) in kiwifruit orchards.

A new web-based application, the Swath Calibration tool, was developed to help spray applicators calibrate their spraying set-up for improved efficacy. It will be available online in 2013.

Fighting wildfires with software and smartphones

> Investment: FRFANZ, MSI, rural fire sector organisations

Scion fire researchers have developed a smartphone application that helps fire managers predict fire behaviour. The software, based on 20 years of research into how fire is likely to behave in New Zealand conditions, allows managers to input wind speed, relative humidity, slope, and other factors into their phone.

The tool is able to calculate how hot and how fast a fire is likely to spread in different vegetation types and can predict extreme fire behaviour triggered by changes in the weather.

Kevin Marsh of City Forests in Dunedin used the fire behaviour software during forest fires at Mount Allan in Otago. He said the fire behaviour software was invaluable

in helping the incident management team to predict fire movement and evacuate people from dangerous areas. "Now this software is available for smartphones, we can potentially have access to it at all times."

Establishing a eucalypt pest control agent

> Investment: FRST, MPI - Sustainable Farming Fund

Scion entomologists believe a tiny, parasitic wasp, *Cotesia urabae*, has the potential to control the voracious gumleaf skeletoniser (*Uraba lugens*), a caterpillar that feeds on eucalypt foliage.

Over the past year, the wasp was released in Auckland, Whangarei and Tauranga in collaboration with Auckland University, and the Northland and Bay of Plenty Regional Councils. Monitoring since release has shown the wasp has established successfully in Auckland, and most crucially overcome the cold temperatures of its first winter.

The Australian wasp is a specialist parasitoid of the gumleaf pest, laying its eggs inside the caterpillar's body. It was selected as the most suitable biological control agent following many years' research by Scion in consultation with a wide range of industry and community groups.

The gumleaf skeletoniser is a serious threat to New Zealand's eucalypt plantations and ornamental eucalypts. Biological control provides a sustainable alternative to applying chemicals.

Keeping forests healthy by controlling needle diseases

> Investment: MSI, FOA (via the Forest Biosecurity Committee), RPBC, Lincoln BioProtection

Scion is exploring options to control needle diseases, which in some areas is the biggest impediment to tree growth rates in commercial radiata pine forests.

During the past year, it has initiated a large research programme drawing on the experience of New Zealand's leading forest pathologists and international collaborators to address this threat.

Every available avenue will be looked at, including chemical spray and biological control programmes, genetic resistance and enhancing ecosystem health.

New Zealand is one of the few countries to have effective systems in place for managing *Dothistroma* needle blight, but there is more work to be done as new diseases emerge and new technologies evolve to overcome them.

With the research programme in place, Scion has progressed its understanding of red needle cast and potential management options.

Faster, cheaper and safer control of wilding conifers

> Investment: MSI, Landcare Research, DOC

Helicopters are being used to deliver spot herbicide treatment to scattered wilding conifers in difficult-to-access terrain.

The self-seeding conifers are a major weed in many areas of New Zealand and are the target of a costly control programme by the Department of Conservation (DOC).

Current control methods rely on flying a chainsaw operator to each tree to cut it down. This method, known as "skid-hopping", is costly, dangerous and time-consuming.

Working collaboratively, Scion and DOC have developed a way to apply the herbicide treatment, at short distance, into the crown of the tree, by helicopter, causing very little damage to surrounding vegetation.

This technique, now fully operational, is significantly quicker and more cost effective than other approaches and eliminates the dangers associated with skid-hopping.



New National Forestry Herbarium database improves public access

> Investment: Scion Core

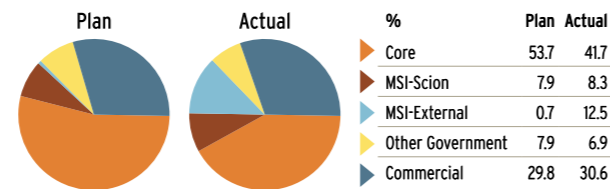
Development of a new database at the National Forestry Herbarium will enable New Zealand's plant diversity to be more accurately quantified.

The herbarium, the centre for identification of cultivated woody plants in New Zealand, holds a nationally significant collection and database comprising 27,521 plant specimens.

In the past year, herbarium staff also substantially upgraded the online key to cultivated pines in New Zealand, responded to 272 queries, hosted 80 visits and recorded some 4000 unique visits to the website.

The herbarium supports New Zealand's national biosecurity system, is a tool used by forestry stakeholders, and supports regional conservation activities for the Department of Conservation, local environmental consultants and botanists.

IO4 Distribution of investment



LICENCE TO OPERATE

IO5 Ensure the New Zealand forest industry's licence to operate domestically and internationally and enhance environmental performance



TERAX™ redefines the economics of organic waste treatment

> Investment: Scion Core, Rotorua District Council, MfE, MSI

Landfilling of organic wastes is an increasingly expensive and environmentally unsustainable option for local bodies and industry. A newly-named TERAX™ hydrothermal deconstruction technology provides the answer and now has exciting results to back it.

With six months of continuous operation during the year, the new TERAX™ pilot plant achieved a major milestone in the six-year-old Waste 2 Gold research programme, successfully breaking down more than 90% of organic waste.

TERAX™ works by breaking down organic waste, such as sewage sludge, into smaller and simpler organic compounds that are useful as industrial chemicals, energy and fertiliser products.

While hydrothermal deconstruction technologies, such as wet oxidation, have been available worldwide

for over 20 years, TERAX™ has a particular hybrid configuration that targets the efficient production of valuable compounds, changing the economics of waste disposal by focusing on resource recovery.

New Zealand sends around 2.5 million tonnes of organic waste to landfills each year, a major cost for territorial authorities as well as for industries like pulp and paper, dairy, horticulture, and meat processing.

The Rotorua District Council alone spends about \$1 million per year disposing of biosolids, which is non-sustainable in the long term. For this reason, Scion and the council teamed up to develop the TERAX™ process.

Scion and the council constructed and commissioned a 400 litre capacity pilot plant at Rotorua's Wastewater Treatment Plant to test the process as a potential solution to the district's organic waste disposal problems.

The pilot plant was funded, in part, by a \$1 million grant provided by the Ministry for the Environment through its Waste Minimisation Fund. The purpose of the pilot plant was to optimise the TERAX™ technology at an operational scale, compare against laboratory-scale research results, and provide criteria for a full-scale design.

“A large-scale plant in Rotorua could initially remove thousands of tonnes of biosolid waste per year. Applied to all Rotorua’s organic wastes, it could ultimately achieve net benefits of around \$4 million a year,” says Peter Guerin, Chief Executive Rotorua District Council.

The pilot plant has two separate modules, an anaerobic fermentation plant and the hydrothermal oxidation plant.

Scion’s General Manager Sustainable Design Dr Trevor Stuthridge says, “the anaerobic fermentation plant uses bacterial cultures to pre-treat the organic waste and decrease the volume of solid material that enters hydrothermal deconstruction.

“The second step uses high pressure and temperature with oxygen to break down the waste material and derive useful compounds from it. In combination, the proprietary hybrid system maximises value recovery while lowering overall processing costs.”

Results from the pilot plant have generated a lot of interest from territorial authorities says the council’s Chief Executive Peter Guerin.

“We can now demonstrate that it actually works. The engineering challenges have been substantial as a lot of separate components need to work together, but we can see that it will do what was expected,” he explains.

The next step is construction of a demonstration-scale facility capable of handling all biosolids from Rotorua’s Wastewater Treatment Plant (11,750 tonnes of waste per year for the next 20 years). From there, the partnership seeks to apply the same technology to other organic wastes at the council’s landfill site and onward to other waste generators nationally and internationally. That’s where it’s hoped the investment in research and development will fully pay off.

“If successful, a large-scale plant in Rotorua could initially remove thousands of tonnes of biosolid waste per year”, says Peter Guerin. “Applied to all Rotorua’s organic wastes, it could ultimately achieve net benefits of around \$4 million a year for the council and community.”

Managing biodiversity in planted forests

> Investment: FFR, FRST, OECD

Natural forests are declining at about 13 million hectares a year globally, taking many different species with them. Scion research supports the New Zealand forest industry to manage biodiversity as part of its commitment to environmental certification.

A paper highlighting the opportunity for conserving biodiversity within plantation forests was accepted

by *Biological Conservation*, a high-impact international science journal: Pawson, S M et al. (2012), “Maximising biodiversity in plantation forests: insights from long-term changes in clearfell-sensitive beetles in a *Pinus radiata* plantation”.

A further paper shows how increased biodiversity can be important for the provision of ecosystem services. “Forest biodiversity and the delivery of ecosystem goods and services: translating science into policy”, co-authored by Scion Principal Scientist, Dr Eckehard Brockerhoff, appeared recently in *BioScience*.

Scion also contributed significantly to an international review to inform the Convention on Biological Diversity, a global initiative on ecosystem-management options.

Biowaste solutions for communities

> Investment: MSI

Scion is a key partner in a multi-disciplinary team that brings together leading-edge biophysical, economic, cultural and social science approaches to reduce and reuse nutrient-rich biowastes and minimise landfilling.

A series of hui, involving the community, Māori and regulators, is increasing understanding of environmental issues and enabling communities to be part of sustainable decision-making and outcomes on biowaste management.

Mark Solomon, Kaiwhakahaere, Te Runanga o Ngāi Tahu, has praised the approach, saying it is “a model that should be used everywhere.”

Other team members include Environmental Science and Research, the Cawthron Institute, Plant and Food Research, Landcare Research, Lincoln University, Te Runanga o Kaikōura and Whenua.biz. Ultimately, the research will inform national policy to enable guidelines for sustainable biowastes management with community input.

Contributing to Standards development

> Investment: Scion Core

Scion’s expert knowledge, technical data and independent testing services contribute significantly to New Zealand industry confidence in wooden products and preservatives.

In 2011/2012, wood and fibre Science Leader Douglas Gaunt completed an 18-month study on the development of new, grade-stress standards for plywood. The research was carried out for Forest and Wood Products Australia, and is awaiting adoption by Standards New Zealand and Standards Australia. He also participated in the review of Australian-New Zealand plywood standards.

Wood durability specialist Dr Tripti Singh was appointed to the expert technical committee reviewing amendments

for the chemical preservation of round and sawn timber in the timber treatment standard NZS 3640. She and her team also undertook chemical preservative testing for the industry and these results have fed into applications to have new preservatives adopted by Standards New Zealand.

New web tool supports land-use decisions

> Investment: MPI, MSI EnviroLink Scheme, Hawke’s Bay Regional Council

A new web tool called, “MyLand”, aims to assist land owners to make good, long-term, land-use and management decisions by having ready access to the latest research results.

MyLand integrates results from a broad range of research into land-use potential, environmental impacts, agricultural systems and, for the first time, forestry options.

“Part of the sustainable land challenge now is about giving increasingly savvy land users access to robust tools that bridge the decision-making gap from theory to their farm gate,” says Campbell Leckie of the Hawke’s Bay Regional Council.

Originally developed by Scion and AgResearch as a prototype, MyLand will be available as a Beta version in September 2012 for councils to evaluate and conduct user testing.

Symbiotic relationships feed integrated value chain

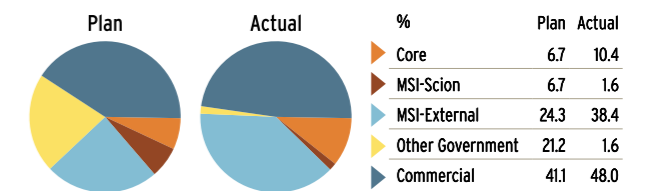
> Investment: Scion Core

Scion scientists provided technical advice and strategic direction for the Kawerau Industrial Symbiosis project in 2011/2012. With several national and local partners, Kawerau Industrial Symbiosis aims to develop a large-scale, closed-loop industrial site that efficiently uses forest biomass and clean energy resources.

Dr Trevor Stuthridge, General Manager Sustainable Design, notes that this integrated approach appears also in the “Bay of Connections Forestry Action Plan” and the “New Zealand Wood Products and Industry Strategic Action Plan”, launched by the New Zealand Wood Council (Woodco).

Says Dr Stuthridge, “This is the first year we have seen such compelling strategies being adopted from business through to a national level and, as such, multiple stakeholders are firmly focused on New Zealand’s long-term bioeconomy future” .

IO5 Distribution of investment



BIOENERGY AND ENERGY SECURITY

106 Increase New Zealand's energy security through the expanded utilisation of forest biomass for energy



Biofuels from forest biomass moves toward commercial production

> Investment: MSI, Scion Core

New Zealand production of biofuels has moved a step closer with the successful development by Scion of a viable way to cost-effectively produce sugars from softwoods such as radiata pine.

The development represents a major milestone towards eventually creating a home-grown transport fuel and energy industry biofuels from planted forests - the only national-scale feedstock source for biofuel production in New Zealand.

It also marks the conclusion of the three-year "Lignocellulosic Biofuel Initiative" project, funded by the Ministry of Science and Innovation, as part of its public good science fund, along with investment from Scion.

"For a number of years, New Zealand researchers have been looking for a viable way to create biofuels from radiata pine," says Project Leader Dr Ian Suckling.

"While we've known that the potential fuel yield from radiata pine is high, softwoods have proven to be extremely tricky to biochemically convert. The difficult step has been the conversion of wood to monomeric (or simple) sugars like glucose. That's the problem this project set out to tackle.

"Our findings were scrutinised by a multi-party team of experts, including scientists from the National Renewable Energy Laboratory in Colorado, USA. On the basis of the high-quality of findings to date, they recommended that Scion should begin to package and market this technology to prospective partners and collaborators."

A commercial overseas partner could be the first to trial the technology. Successful negotiation of the technical and cost challenges offshore would reduce the risk of any future commercial scale implementation in New Zealand.

Wood manufacturers and energy companies, among others, would be logical partners to commercialise the process and he imagines there would be interest from biofuels companies which have already invested in this area.

The development of a cost-effective way of producing monomeric sugars from softwoods, compared to refining petroleum from oil, was a key result of the work. To achieve this, the researchers developed and refined processes using a techno-economic computer model. The model described the process, accounting for the materials, energy balance, capital and operating costs.

Scion research shows that monomeric sugars derived from softwoods can be converted to a variety of transport fuels, such as ethanol and diesel, as well as chemical feedstocks for biotechnology products like bioplastics.

"Research using the techno-economic model and the laboratory worked hand-in-hand," says Dr Suckling. "We'd simulate changes to the production process, testing the more promising in the laboratory and at

"Our findings were scrutinised by a multi-party team of experts ... they recommended that Scion should begin to package and market this technology to prospective partners and collaborators," says Project Leader Dr Ian Suckling.

Scion's biorefinery pilot plant. We fed the most promising results back into the model and repeated the process."

The biggest improvements, resulting in a 26% cost reduction, were in pre-treatment of wood pulp, and the use of new enzymes that created high yields of the monomeric sugars.

While biofuels have yet to be created at scale from radiata pine, the project has developed the key technology steps to convert radiata pine wood to those fuels. Importantly, once further developed the process could be used to produce biofuels from a significant biomass resource - sustainably grown planted forests - here in New Zealand.

Thermodynamic analysis provides focus for energy production

> Investment: Scion Core

Scion is pioneering a new way to analyse the efficiency of bioenergy technologies using fundamental thermodynamic concepts.

The methodology, which has been used in the past to optimise electricity production in power stations, has been adapted by Scion to the analysis of processes for producing energy and fuels from biomass.

To economically compete with fossil fuels, the most efficient conversion technologies must be developed, and run at the lowest cost. This new methodology can help identify where inefficiencies and energy losses occur in different conversion technologies. Results can be compared across technologies and used to guide the selection of technology and research focus. The methodology can also be used to assess the benefits of combining renewable energy from different resources such as using geothermal heat in the processing of biomass to fuels.

Research using the new capability was published in the journal, *Bioresource Technology*.

Building bioenergy knowledge via international connections

> Investment: Scion Core

Scion plays an important role in ensuring New Zealand can meet its energy demands by staying upfront

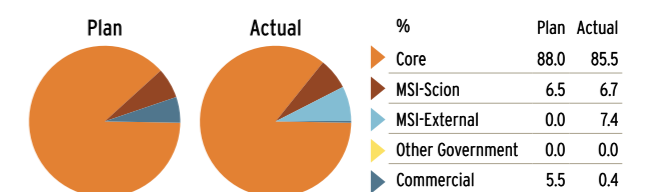
with international thinking and developments. A key connection is the International Energy Agency (IEA) Bioenergy, which is an international research network ensuring that bioenergy makes a substantial contribution to future global energy production. Scion leads New Zealand involvement in the IEA Bioenergy in two ways - by serving on the executive committee and by leading a number of tasks.

Strengthening collaborative relationships and developing capability in New Zealand is also essential. Scion collaborates with a number of international groups in the bioenergy sector. One of the premier organisations - the National Renewable Energy Laboratory in the United States - hosted a Scion energy specialist for three weeks in the past year.

Bringing relevant overseas knowledge directly to New Zealand provides tangible insights into future options for energy supply through forest biomass. A key representative of Canada's Bio-Pathways project, which sought to prioritise traditional and emergent wood processing options, including bioenergy, addressed the Advanced Biofuels Research Network symposium, hosted by Scion in late 2011. Scion is now gearing up to work closely with others to apply the Bio-Pathways methodology to the New Zealand industry.



106 Distribution of investment



OUR COMMUNITIES



Growing the Māori economy through forestry

Māori currently have about \$2 billion of assets in forestry and their influence over land and forests is increasing as Waitangi Treaty settlements conclude. The Māori Economic Development Panel (Te Puni Kokiri 2012) notes the "enormous potential for the Māori economy to lead aspects of growth in the New Zealand economy". Clearly decisions Māori will make over the use of their land will shape the future of the forestry and wood products industry in New Zealand.

Scion recognises the importance of building high-quality, long-term partnerships with Māori to achieve mutual aspirations. In early 2012 the Scion Board appointed a Māori strategic advisory panel, Nga Rangatira Rōpu, to provide advice on Scion's Te Papa Tipu Māori Plan. Members of the rōpu are Roku Mihiniui (Te Arawa), James Wheeler (Te Ātiawa, Te Arawa) and Dr Apirana Mahuika (Ngāti Porou).

The rōpu has reinforced Scion's need to work with Māori to grow cultural and social wealth alongside economic wealth. The utilisation of land and the role of forests as part of the land development cycle is a key focus for Scion. For example, Scion is now working closely with an iwi and Māori trust cluster in Northland, the Te Tai Tokerau Forestry Innovation Cluster, to enhance

the intrinsic value of their land and build employment through development of their kauri and totara resources. Achieving this will build new high-value export focussed manufacturing industries in Northland and secure the future of these species, which have substantial cultural and spiritual meaning to Te Tai Tokerau.

The above work, alongside that with Ngāti Awa, Te Arawa, Ngāti Manawa, Tuwharetoa ki Kawerau, Tuawhenua Trust, CNI Holdings and Ngāti Porou, is evolving a new vision for forestry and land use for New Zealand. Specifically we are working on ways to re-establish the role of New Zealand's indigenous resources, build multi-use forests that strengthen kaitiakitanga, cultural values and create jobs, and how to build new high-value export industries.

Developing Māori scientists

In partnership with Nga Pae o te Maramatanga, Scion offers a 12-week internship to Māori students in their final undergraduate year, or in the preliminary stages of post-graduate study. Reina Tamapo (Ngāti Porou and Whānau-ā-Apanui), who recently completed a Bachelor of Science at the University of Waikato, was this year's recipient.

A previous recipient - Jamaine Fraser (Pae Tahī, Tainui) - completed his indigenous product design project for his Master of Design at the Unitec Institute of Technology.

In a separate programme, Massey University Masters student Christina Marshall (Ngai Apatu) neared the end of a two-year project with Scion to successfully find DNA markers that differentiate the four species of Podocarpus. The project involves significant Māori consultation.

Another student, Wairangi Whata (Ngāti Pikiao) worked with Scion over the summer months to investigate water levels and quality at a wetland site on the edge of Lake Rotoiti. Wairangi was completing her Bachelor of Māori Development at the Waiariki Institute of Technology.

Building international collaboration and networks

Scion is adept at building national and international collaborations, enabling it to assemble large, multi-disciplinary teams with the skills and resources to capitalise on opportunities and tackle challenges facing the New Zealand forest industry. By leveraging international networks, Scion accesses the latest technologies and secures intellectual property of benefit to New Zealand. This is critical if Scion is to remain innovative and competitive in global markets.

Highlights in 2011/2012 included:

- The Vietnamese pulp and paper company, Tan Mai Corporation, signed a Memorandum of Understanding with Scion to provide forestry management, advice, tools, and assistance with seed material and training. The corporation, which is the largest newsprint manufacturer and second largest paper supplier in Vietnam, aims to expand its market share by investing in planted forests to increase wood supply. New Zealand Trade and Enterprise helped to facilitate this initiative.
- Scientific collaboration will enhance opportunities for linking Korean technology platforms in biomass processing with Scion programmes in biofuels and biomaterials. An agreement between Scion and the Korean Institute of Energy Research builds on relationships developed as part of the Ministry of Science and Innovation's Focal Point Programme on Renewable Energy. Scion is also collaborating with the US National Renewable Energy Laboratory in this area.
- Research exchanges between New Zealand, Australian and European scientists are increasing understanding of the essential role forests and forestry play in adaptation to and mitigation of climate changes. Six Scion staff completed exchange trips to France, Scotland and Portugal with support from the European Commission's International Research Staff Exchange Scheme under the TRANZFOR programme. TRANZFOR is a four-year joint programme of scientific co-operation involving five leading research organisations.
- Senior microscopy scientist Dr Adya Singh was invited as a Distinguished Visiting Scientist to the Bioenergy Research Centre of Chonnam National University

in South Korea and the Beijing Forestry University in China. These visits, which focused on wood and fibre research, provide excellent opportunities for collaboration and reinforce the importance of publishing scientific papers to develop international ties.

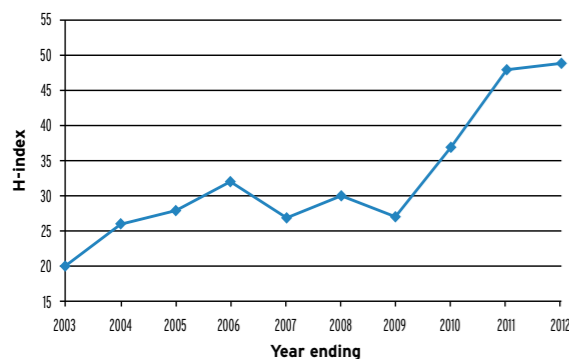
- Microscopy specialist Dr Lloyd Donaldson hosted a sabbatical visitor Dr Ksenija Radotic from the University of Belgrade. Dr Radotic is working on spectral analysis of compression wood in Serbian spruce and radiata pine.
- Dr Oliver Chikumbo completed an exchange with Professor Erik Goodman, Principal Investigator and Director of the BEACON project (Bio-computational Evolution in Action Consortium) at Michigan State University. Dr Chikumbo also worked at Michigan with Professor Kalyanmoy Deb, a world-leading expert in multi-objective optimisation.
- Dr Elspeth MacRae participated in a number of internationally focused activities including:
 - the Knowledge-Based Bio-Economy (KBBE) twinning project between the European Union, Canada, Australia and New Zealand (as the New Zealand representative);
 - co-organisation of the European Cooperation in Science and Technology (COST) - European Science Foundation - International Union of Forest Research Organisations (IUFRO) - Austrian Government supported conference on the "Future Role of Bio-energy from Tree Biomass in Europe" (as an IUFRO representative);
 - reviewed the Star-COLIBRI project outlining an European Union (EU) 2030 Biorefinery Vision and an EU Biorefinery Research and Development Roadmap;
 - advising on a bid for European funding by the New Zealand Ministry of Science and Innovation, the Royal Society, Health Research Council and EuroResearch Support Ltd for a bilateral programme to target developing ties with VTT Technical Research Centre of Finland and other Finnish organisations;
 - participating in a bid under the EU's 7th Framework Programme (FP7) to develop standards for bioproducts under the European Committee for Standardisation (CEN) framework.

SCIENCE OUTREACH

Direct engagement with key stakeholders enables Scion to provide leadership in developing new opportunities and accelerates the uptake of new knowledge and technologies.

High impact publications

Scion provides high quality science to solve forest industry problems and strategically position the industry for the future. Publication of papers in the top scientific journals confirms Scion's international standing and visibility as a research institute. The annual weighted average H-index for Scion publications during the year was 49.67 and continues the upward trend shown in the figure below.



During 2011/2012, Scion scientists produced 126 papers in peer-reviewed publications. Below are details of the five top papers published based on the journal's H-index, which is an international measure of the impact of scholarly publications:

"Biodiversity of active and inactive bacteria in the gut of wood-feeding huhu beetle larvae, *Prionoplus reticularis*" by Nicola Reid, Sarah Addison, Lucy Macdonald and Gareth Lloyd-Jones. *Applied and Environmental Microbiology*, 77 (2011) 7000-7006.

"Proteomic phenotyping of *Novosphingobium nitrogenifigens* reveals a robust capacity for simultaneous nitrogen fixation, polyhydroxyalkanoate production and resistance to reactive oxygen species" by Anne-Marie Smit, Timothy J Strabala, Lifeng Peng, Pisana Rawson, Gareth Lloyd-Jones, and T William Jordan. *Applied and Environmental Microbiology*, 78 (2012) 4802-4815.

"Localization of cell wall polysaccharides in normal and compression wood of radiata pine: Relationships with lignification and microfibril orientation 1" by Lloyd Donaldson and J Paul Knox. *Plant Physiology*, 158 (2012) 642-653.

"Experimental designs for robust detection of effects

in genome-wide case-control studies" by Rod Ball. *Genetics*, 189 (2011) 1497-1514.

"Draft genome sequence of *Novosphingobium nitrogenifigens* Y88T" by Timothy J Strabala, Lucy Macdonald, Vincent Liu and Anne-Marie Smit. *Journal of Bacteriology*, 194 (2012) 201.

Communications enhance engagement and technology transfer

A new quarterly newsletter - "Scion Connections" - was launched in September 2011, with four issues published in the year. It is available free as hard copy and as an e-newsletter.

A "YouTube" channel was set up to host short, informative videos of scientists presenting their own work.

Radio New Zealand's science programme, "Our Changing World" interviewed nine Scion scientists on diverse topics, including biocontrol, biofuels, bioplastics, transforming biosolids and more.



NZ Journal of Forestry Science celebrates 40 years

The *New Zealand Journal of Forestry Science*, published by Scion, celebrated 40 years of publication in 2011 with a special anniversary edition of Volume 41. Scion also produced a separate supplement of papers from the fifth International Union of Forest Research Organisations (IUFRO) meeting on Phytophthora diseases, held in New Zealand in 2010.

Over 1400 papers have been published since the journal began in 1971, providing a permanent record of valuable forestry research. The papers are freely available on-line at www.scionresearch.com/nzjfs

Events to raise awareness and transfer knowledge

Scion engaged with over 300 scientific, industry and community groups, hosting or attending a wide range of events. Highlights included:

Biofuels Symposium ignites ideas

The New Zealand Advanced Biofuels Research Network (ABRN) hosted the second Science Symposium on "Next Generation Liquid Biofuels and Co-Products". The ABRN was formed from the first symposium held at Scion in 2010 and aims to promote better co-ordination and collaboration across biofuels research in New Zealand.

This year's event was co-hosted by the Energy Federation of New Zealand, supported by the Bioenergy Association of New Zealand, and jointly sponsored by CRL Energy Limited and Scion. New Zealand Trade and Enterprise provided travel funds for international speakers.

A key feature of the symposium was a workshop session to introduce the ABRN and develop strategy maps for New Zealand biofuels' research and development that will help shape the future activities of the network.

Scion Bioplastics Workshop updates industry

The second annual bioplastics workshop, held at Scion in October 2011, covered the basics of bioplastics through to the latest advances and technologies in the field. Guest speakers from bioplastics and related companies, and research institutes, also spoke on current materials and views of the industry. The workshop attracted more than 60 registered delegates who were invited to tour Scion's new biodegradation facility, and the extrusion and composites laboratories.

As the global plastics market looks for sustainable, eco-friendly production options, bioplastics are rapidly growing as a preferred means of supply. Some reports forecast bioplastics will account for up to 30% of all plastics by the year 2020. The bioplastics boom translates

into significant opportunities for New Zealand industry, in research and manufacturing and for companies using plastic products or packaging. Scion researchers have earned national and international acclaim for their science capabilities in the bioplastics field.

Forest Ecosystem Services Workshop

Members of Scion's forest environment and economics team held a workshop on Forest Ecosystem Services (FES) at Te Papa Museum, Wellington. The aim was to seek input from stakeholders into the future direction of FES research which looks at issues such as recreation, erosion, aesthetics and biodiversity.

Delegates included the Ministry of Agriculture and Forestry, Department of Conservation, Greater Wellington Regional Council, Auckland City Council, Forest Owners' Association, Landcare Research, Lincoln University, Wingspan Birds of Prey Trust and consulting firms.

Community education

Scion awarded a 2011 Suffrage Scholarship to Rachelle Gordon, Rotorua Girls' High School, towards study for a BSc majoring in biochemistry at Otago University in 2012.

Kieran Gainsford, head boy at Rotorua Lakes High School, worked for 10 weeks on an environmental chemistry project at Scion as part of the work experience programme. He was one of only five to be awarded the Bayer Boost Environmental Scholarship from the Royal Society of New Zealand.

The International Year of Forests was celebrated with a community "Films of Forests" festival. Five free films were screened to more than 500 people, with the final night in the Rotorua Redwoods Whakarewarewa Forest.



Sponsorships promote science and technology

Sponsorship for conferences and events promotes Scion's science and technology as well as supporting community and staff activities. Scion sponsored 27 events during the year ranging from industry expos to science fairs.

Conferences provide a valuable forum for building networks and exchanging knowledge within and between the science and end-user communities. In addition to speakers, Scion scientists staffed trade displays at most conferences listed below, generating good visibility and reach to stakeholders.

In the past year, Scion sponsored the following conferences:

- Forest Industry Engineering Association Carbon Forestry Conference 2011
- Pine Manufacturers' Association and Wood Processors' Association Joint Conference 2011
- New Zealand Ecological Society Conference and Plantation Forests Symposium 2011
- Bioenergy Association NZ (BANZ) and Energy Efficiency Conservation Authority (EECA) Joint Conference 2011
- New Zealand Entomological Society Conference 2011
- Queenstown Molecular Biology Meeting 2011
- PF Olsen Forest Industries Expo 2011
- Packaging Council of New Zealand Environmental Packaging Awards 2011 - Scion award for conceptual design
- Taupo Clean Energy Centre Expo 2011
- Waste Management Institute of New Zealand Annual Conference 2011
- Federation of Māori Authorities Conference 2011
- Forest Industry Engineering Association ForestTech Conference 2011
- New Zealand Notable Trees Trust - annual supporter contribution
- New Zealand Bio 2012
- ForestWood Conference 2012 - pan-industry event hosted by Forest Owners' Association, Wood Processors' Association, Pine Manufacturers' Association and Forest Industry Contractors' Association
- Plastics New Zealand Conference 2012
- Forest Industry Engineers' Association Wood Preservation Conference 2012.

OUR PEOPLE

Awards

Scion's strength lies in talented people and teamwork. Both are highlighted in the following awards and achievements:

Future Forests Research

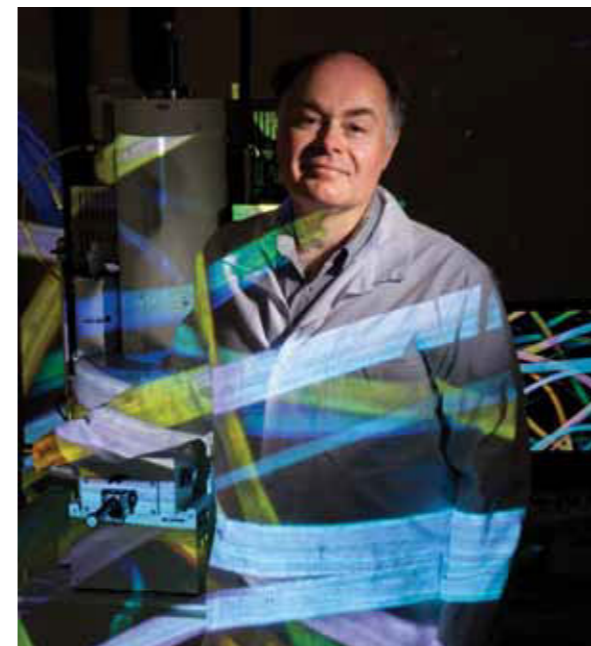
Three Scion scientists received Future Forests Research Awards in recognition of their significant contributions in their field and to shaping the forest industry. Their achievements illustrate how forest management practices are influenced by scientific endeavour over many decades.

Scion statistician Mark Kimberley received the Science of International Quality Award. During his 34-year career, Mark has undertaken ground-breaking research to develop new techniques for modelling the growth of forests. In particular, he enabled the development of a new growth index, known as the 300 Index, which predicts the productivity of radiata pine. He was also the architect of a similar model, the 500 Index, for Douglas-fir.

Awards recognising science that enhances sector value also went to Michael Watt and Carol Rolando for their research into weed control in newly planted forests.

Royal Society

Senior Scientist Dr Lloyd Donaldson received the prestigious Charles Fleming Fund from the Royal Society of New Zealand. Dr Donaldson, an internationally renowned expert on the cell wall properties and development of wood, used the award to further his research into lignin development at the University of Adelaide, Australia.



Queen Elizabeth II Technician

Scion pathologist Judy Gardner was awarded a Queen Elizabeth II Technician Award, towards travel costs to enable her to work alongside world experts in Phytophthora at the Forestry Commission, Surrey, England.

Royal Entomological Society

Entomologist Dr Nod Kay received an award from the Royal Entomological Society for the best paper published in the international journal, *Agricultural and Forest Entomology*. The paper was entitled: "Variation in the ability of larvae of phytophagous insects to develop on evolutionarily unfamiliar plants: a study with gypsy moth *Lymantria dispar* and *Eucalyptus*", which he co-authored with M.Matsuki, J.Serin and J.K.Scott.

International recognition

Scion staff received a total of 18 international awards and invitations to participate on international committees and editorial boards, for example:

- Genetic engineering specialist Dr Christian Walter was invited to participate at an experts' meeting organised by the Centre for Environmental Risk Assessment in Washington DC. The meeting developed a document for peer reviewed publication that describes key considerations relevant to environmental risk assessment of genetically engineered trees.
- Principal Scientist Dr Eckehard Brockerhoff accepted an invitation to become the coordinator of the forest health division of IUFRO (The International Union of Forest Research Organisations) and also serve on the IUFRO board. The main function of IUFRO's divisions is to support researchers in collaborative work and provide organisational linkages.
- Science Leader Lindsay Bulman was invited by the Forestry Commission of Great Britain to participate in the 2011 external review of Forest Research UK. The review group comprised international experts spanning the science areas provided by Forest Research UK.
- Biopolymer Science Leader Dr Alan Fernyhough was one of four international experts invited by the Malaysian Rubber Board (MRB) to review all its scientific proposals. The MRB's role is to develop and modernise the Malaysian rubber industry along the entire value chain from cultivation of trees to manufacture and marketing of rubber products.

Master of Science degrees conferred

- Marie Dennis - The role of viral systems in nutrient cycling. (University of Waikato)
- Diahanna O'Callahan - Isolation and characterisation of bacterial metabolites as potential wood preservatives. (MSc Hons, University of Waikato)
- Greg Steward - Growth and yield of New Zealand kauri - *Agathis australis*. (University of Canterbury)



Doctoral degrees conferred

Brenda Baillie - The physical and biological function of wood in New Zealand's forested stream ecosystems. (University of Waikato)

Richard Yao - The non-market value of biodiversity enhancement in New Zealand's planted forests. (University of Waikato)

Sporting achievement

New Zealand champion cyclist Garth Weinberg was placed second in the World Single Speed Championships held in Ireland.

Science in the Park

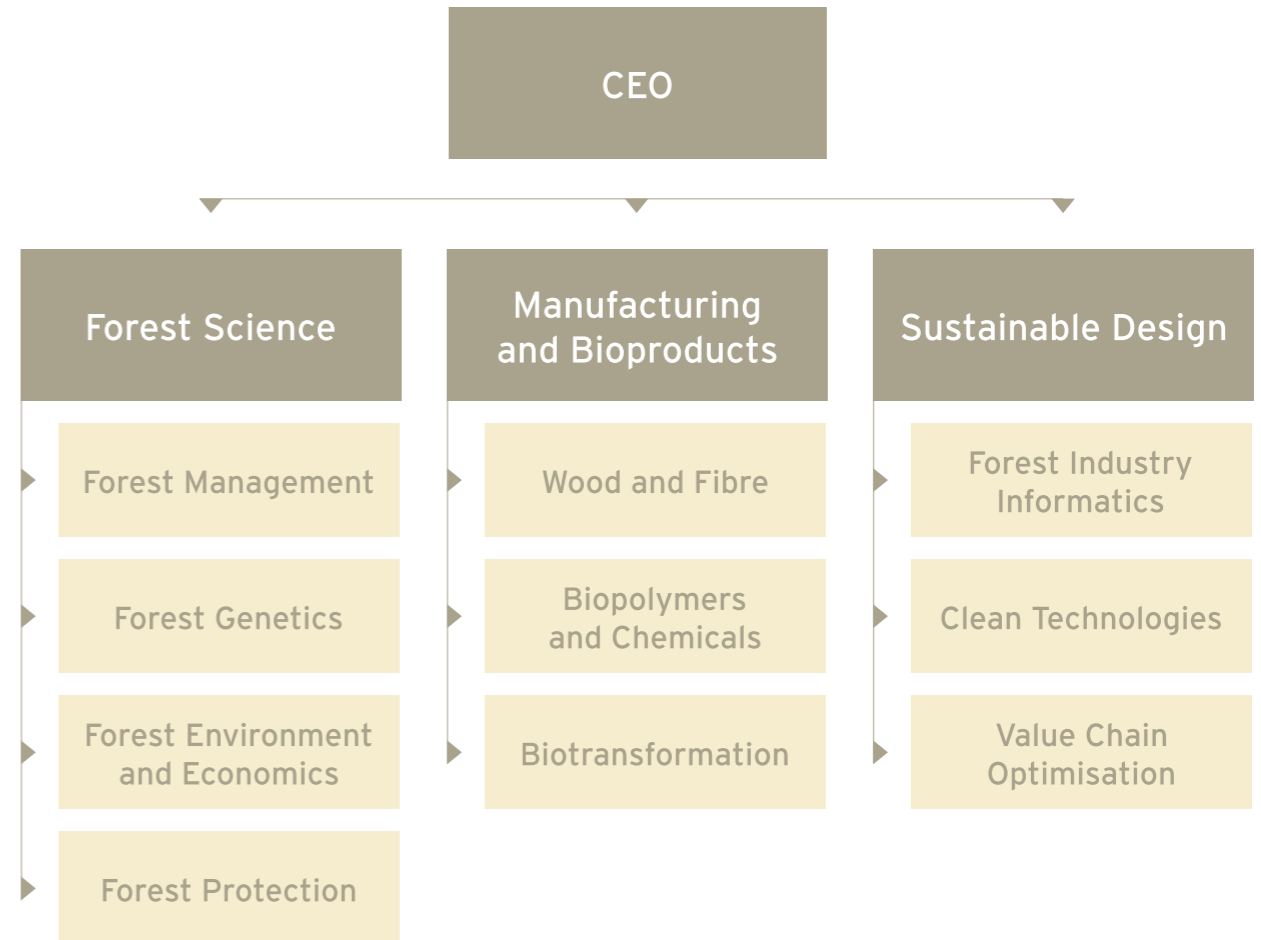
Community outreach is an important part of Scion's activities. Science in the Park 2011 received a Highly Commended Award in the special event or project category at the Public Relations Institute of New Zealand's 2012 annual awards.



Science in the Park 2011

SCION'S SCIENCE STRUCTURE

Scion's science capability is divided into three groups and ten teams.



FINANCIAL RESULTS SUMMARY

	2010 Actual	2011 Actual	2012 Budget	2012 Actual	2013 Budget
Revenue, \$m	43.49	43.35	45.82	44.06	46.08
EBIT, \$m	3.08	2.60	1.77	2.07	1.94
EBIT Margin	7.1%	6.0%	3.9%	4.7%	4.2%
EBIT-R, \$m	3.44	2.94	2.84	2.89	3.09
EBIT-R Margin	7.9%	6.8%	6.2%	6.6%	6.7%
Total Assets, \$m	36.35	37.70	38.77	40.01	41.02
Return on Equity	-3.9%	7.3%	4.9%	6.0%	4.8%
Equity Ratio	68.3%	67.6%	68.4%	68.8%	69.7%
Dividend, \$m	1.109	-	-	-	-
Gearing	0.0%	0.0%	0.0%	0.0%	0.0%

Revenue: Includes science research, contract work for government and commercial clients, royalties and licence fees.

EBIT: Earnings before interest, tax and restructuring costs.

EBIT Margin: EBIT / revenue.

EBIT-R: EBIT before reinvestment where reinvestment are amounts approved by the shareholder.

EBIT-R Margin: EBIT-R / revenue.

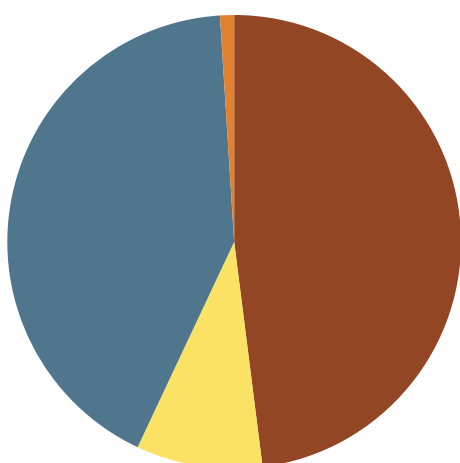
Return on equity: Net profit after tax / average shareholders' funds, expressed as a percentage.

Equity ratio: Average shareholders' funds / average total assets.

Gearing: Financial debt / financial debt plus shareholders' funds.

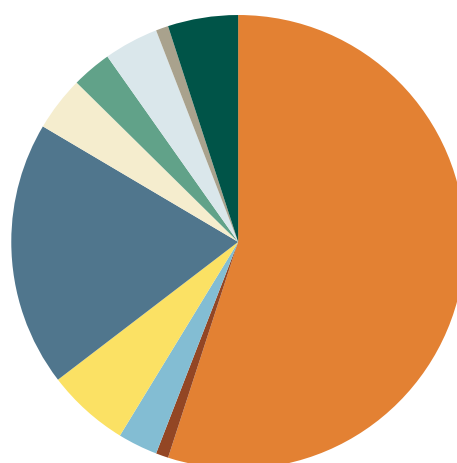
(The Minister of Finance and the Minister of Science and Innovation each hold 50% of the shares on behalf of the public.)

Our revenue



	%
MSI (incl. FRST and MRST)	48
Government Departments	9
Other Commercial	42
Interest	1

How our revenue is spent



	%		%
Employee Remuneration	54	Premises Costs	4
Training and Recruitment	1	Travel	3
Consumables	3	Other Operating Costs	4
Depreciation and Amortisation	6	Non Operating Costs	1
External Services and Contractors	19	Net Profit before Tax	5