**scion**™

FORESTS ▪ PRODUCTS ▪ INNOVATION

**2016** Annual Report
*Highlights*

**scion™**
FORESTS ■ PRODUCTS ■ INNOVATION

# **2016** Annual Report
## *Highlights*

Presented to the House of Representatives pursuant to section 44
of the Public Finance Act 1989.

Our Annual Report is presented in two parts – Highlights (Part A) and Reports and
Financial Statements (Part B). Together both documents fulfil our annual reporting responsibilities
under the Crown Research Institutes Act 1992.

The Reports and Financial Statements (Part B) includes the employment and
environmental reports, core funding investment, directors' report, performance targets and
financial statements.

Our Annual Report is also available in digital format at www.scionresearch.com/annualreports

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**The Scion logo**

Our new logo has been refreshed so that it better aligns with our business
strategy and organisational values.

The logo portrays a dynamic sense of innovation and creativity, harmony and collaboration
between us and our partners and customers. At a more subtle level the logo represents the emergence
of a stylised shoot (scion). The logo shape also depicts the concepts of circular economies
and the bioeconomy. The colour palette is taken from nature.

Our name Scion encompasses how we are growing biobased opportunities for sustainable
solutions from our core forest science capabilities.

**Our vision:**
**Prosperity from trees**
*Mai i te ngahere oranga*

# Contents

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*

**$49.6m** Operating revenue

Last year: **$47.3m**

**$1.8m** Total comprehensive income

Last year: **$2.4m**

**5.2%** Return on equity

Last year: **7.3%**

Pre-reinvestment return on equity of **7.8%**

Last year: **$8.9%**

**280** Full-time equivalent staff

| **256** | **23** | **1** |
|---|---|---|
| Rotorua | Christchurch | Dunedin |

KiwiNet Research Commercialisation Award for **Woodforce partnership**

**119** Published papers

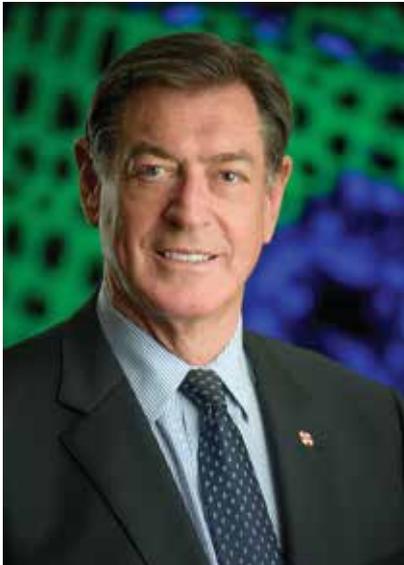| **71** | **9** |
|---|---|
| annual weighted average H-index | citations per paper (rolling 5-year average) |

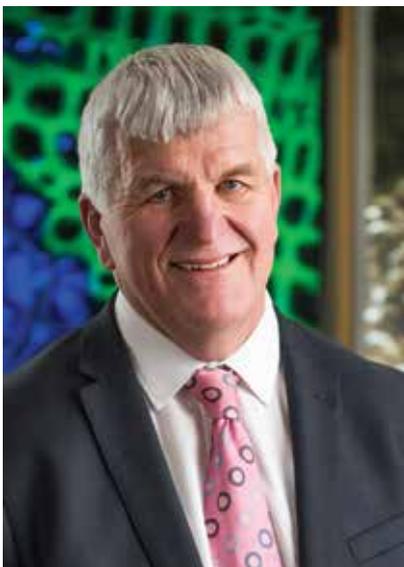Successful mill trials of our patented **bioadhesive Ligate**™

**269** Commissioned reports accepted by users

# Excellent science solutions *for customers*

**Chair and
Chief Executive**
*review*

*Tony Nowell CNZM,* Chair



*Dr Warren Parker,* Chief Executive

We are pleased to report Scion's high impact science and solid financial performance over the past 12 months.

Our science and financial success is founded on our high-quality relationships with customers, iwi partners, industry organisations and government agencies. This success is driven by the commitment of our staff to making the New Zealand forest industry more prosperous and growing a climate smart, internationally competitive bioeconomy.

Our focus on customers and value chains generates a dynamism with users and produces excellent science solutions for them. Some of last year's science highlights illustrate this:

- We intensively monitored controlled fires in wilding pines to collect information that will help rural fire fighters understand the behaviour and management of increasing forest fire risk. Our researchers used the Prometheus model to help plan and direct field operations for the teams fighting two major fires in Marlborough.

- We developed and commissioned a world-first multi-measurement instrument - 'Discbot' - providing forest growers with the first test services to help better manage wood quality properties and wood fibre characteristics.

- We completed first commercial box testing contracts in Scion's unique cyclic humidity coolroom test facility and tested new moisture barrier coatings to help exporters improve the performance of their cardboard boxes in the chilled goods supply chain.

- We scaled-up and piloted environmentally-friendly bioadhesives under commercial conditions in two wood processing plants to address growing consumer demand in high-value export markets for wood products made with natural, non-formaldehyde glues.

- We commenced a biofuel road map exercise with Air New Zealand, Z Energy, NZ Post, EECA, government agencies and other renewable energy research providers to understand how New Zealand can meet future greenhouse emission reduction targets and how forest-derived bioenergy options could help.

As well, we delivered savings in excess of an estimated $20 million to businesses through our unique science problem-solving capabilities. This commercially sensitive work maintained access to export markets, reduced mill down time and product faults, lowered waste disposal costs and lessened biosecurity threats. The ability of our scientists to solve technical problems in an advanced manufacturing plant one day, and the next day discover globally unique intellectual property in one of our laboratories, is enormously valuable to our customers and New Zealand.

This excellent science is reflected in Scion's H factor indices for our historical works increasing to H=71, three technologies winning national and international awards, and the high science H factor indices of staff joining Scion.

The New Zealand Institute of Forestry named Dr Brian Richardson Forester of the Year. Dr Eckehard Brockerhoff was recognised by the New Zealand Forest Owners Association for the international standing of his science, and he was invited to present his research on sea container risk to the governing body of the International Plant Protection Convention.

Our Te Papa Tipu Māori Plan to develop and deliver research in partnership with Māori is gaining momentum. Iwi are partners in the Specialty Wood Products Partnership Programme. Also, iwi are investing with us to improve the utilisation of their land through both exotic and indigenous trees. The latter includes breeding improved strains of mānuka, realising the commercial potential of tōtara in Northland,

restoring the critically endangered white ngutukākā, finding solutions to kauri dieback, developing a native tree nursery in Minginui and assessing how iwi in the Far North and East Coast can aggregate and best use land resources to build sustainable futures and more prosperous livelihoods.

Much work was put into ensuring Scion fully complied with the new Health & Safety at Work Act. An independent review of Scion's governance and management of health and safety confirmed we are operating at best practice and making good progress in developing a safety culture. The review highlighted areas for further improvement to achieve our goal of 'zero harm'.

We comprehensively reassessed our 10-year development plan for the 114-hectare Rotorua site. Many benefits were identified by co-locating Innovation Centre tenants in the main science and office facilities, consolidating the building footprint and providing better public access to our facilities and our science. Office renovation and construction of the new innovation hub building is scheduled to start in 2017 with cash reserves accumulated for this purpose.

Our cash reserves stood at $11.4 million at year-end having been boosted by the $7.0 million operating cash surplus for 2015-16. Revenue grew 4.8 per cent to $49.6 million (budget $49.3 million) and net profit after tax of $1.8 million (budget $1.6 million) yielded a pre-reinvestment return on equity of 7.8 (budget 7.3) per cent.

These foundations have Scion looking to the future with confidence. We will build on the strengths identified in Scion's Four Year Rolling Review, in which we were commended for our strong organisational position, values-based culture, clear management frameworks and strong external relationships. The reviewers pointed to ways we could mitigate our relatively small size and further grow non-Crown revenues from commercialisation, germplasm development and working with iwi. We acted immediately, and by year-end had completed due diligence and confirmed our strategy and the allocation of investment, developed a Māori Partnership Plan, and were in positive discussions with forest growers on the future development of *Pinus radiata* germplasm.

Our confidence in Scion's fundamental importance to New Zealand's future wellbeing is drawn also from strong alignment of our strategy to the major global economic drivers shaping the future for forestry, and the building and construction, and biomaterials and advanced manufacturing sectors. The COP21 Paris Climate Agreement will hasten countries to transition to low emissions bioeconomies, and since then carbon prices in New Zealand, an important influence on forest planting, have more than doubled to $18/tonne $CO_2$eq.

Scion is well positioned with its science and technology to capture the full economic potential of a global biobased economy, and we are attracting the interest of world-leading firms and researchers to our work in this area. Our specialist science expertise in biomaterials and biotechnologies continues to strengthen.

Indeed, discussions with our experts were the most common type of technology transfer interaction for Scion stakeholders who took part in the 2016 Scion stakeholder survey commissioned by MBIE. Ninety-four per cent of respondents said they had adopted at least one piece of knowledge or technology as a result of their interactions with us.

Local government work has reconfirmed our analysis that national and local targets for the allocation and quality of freshwater cannot be achieved unless a lot more trees are planted. Establishing an additional 1 million hectares of forest species over the next 15 years would bring multiple benefits for New Zealand. Our 2030 greenhouse gas emissions reduction target will be easier to meet, water quality will improve, biodiversity will increase, more Māori land will be generating wealth, pastoral livestock farmers' nutrient limits will be less onerous, and wood processors will have log supply security to back investment into plant and innovation. Regional jobs would be up, and export earnings would exceed those earned through prior land use.

This outcome will fulfil our vision - Prosperity from trees - and is a key reason why directors, executive and staff are all highly engaged in their work at Scion. We thank everyone who has contributed to another successful year. Special acknowledgements go to Lizzie Chambers for her services to the Board (resigned 31 December 2015); and Steve Sopora and Dr Brian Richardson for their past contributions to the executive team. We are delighted to welcome Dr Jon Ryder (from 1 January 2016) and Steve Wilson (from 1 July 2016) to the Board and Emeritus Professor Alison Stewart as General Manager Forest Science (from 14 January) and Roger Schwarzenbach as General Manager Business Development & Commercialisation (from 1 August 2016).
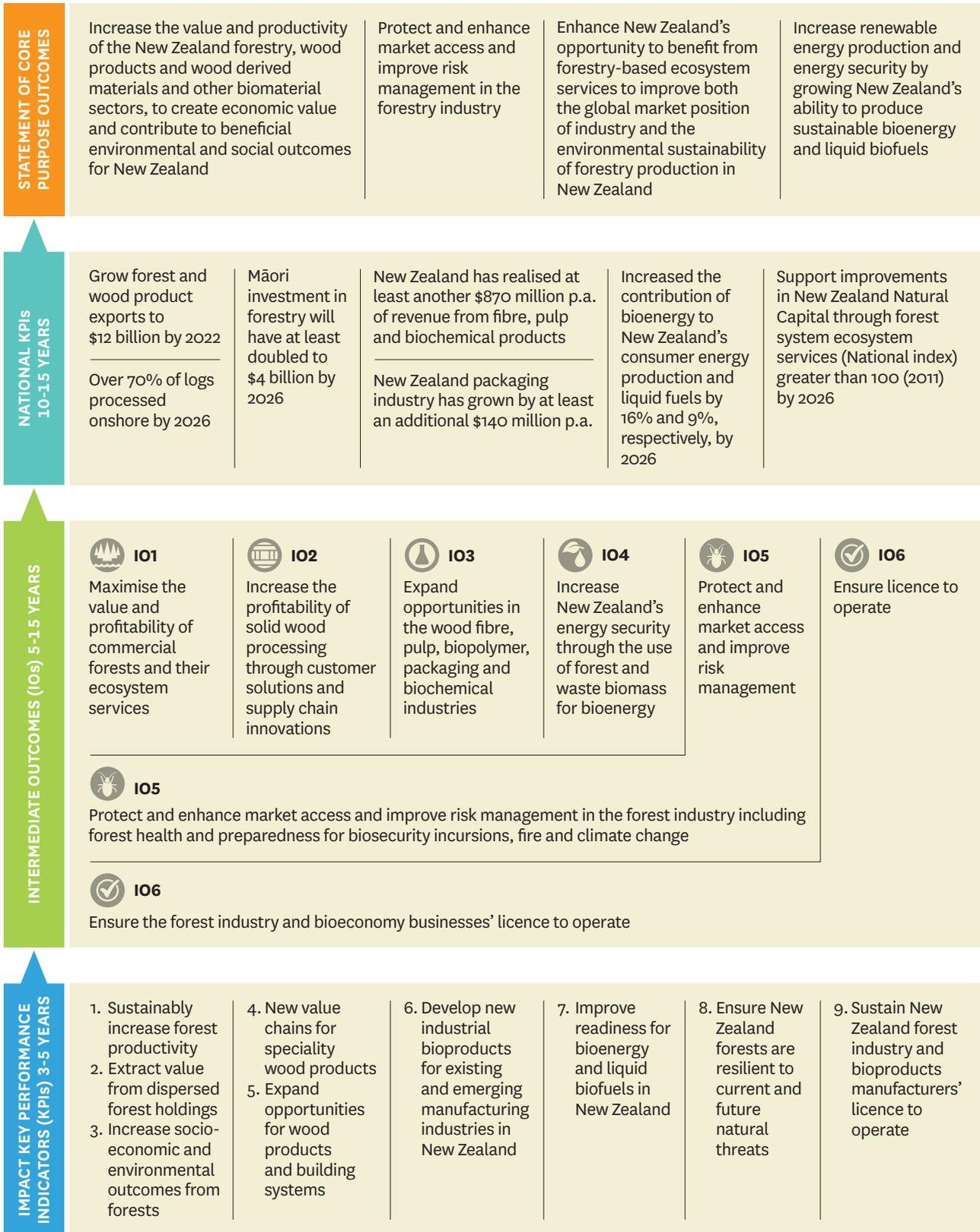
Tony Nowell CNZM
*Chair*

Dr Warren Parker
*Chief Executive*

# *Our* science plan

| | | | | | |
|---|---|---|---|---|---|
| **STATEMENT OF CORE PURPOSE OUTCOMES** | Increase the value and productivity of the New Zealand forestry, wood products and wood derived materials and other biomaterial sectors, to create economic value and contribute to beneficial environmental and social outcomes for New Zealand | Protect and enhance market access and improve risk management in the forestry industry | Enhance New Zealand's opportunity to benefit from forestry-based ecosystem services to improve both the global market position of industry and the environmental sustainability of forestry production in New Zealand | Increase renewable energy production and energy security by growing New Zealand's ability to produce sustainable bioenergy and liquid biofuels | |

| | | | | | |
|---|---|---|---|---|---|
| **NATIONAL KPIs 10-15 YEARS** | Grow forest and wood product exports to $12 billion by 2022 ___ Over 70% of logs processed onshore by 2026 | Māori investment in forestry will have at least doubled to $4 billion by 2026 | New Zealand has realised at least another $870 million p.a. of revenue from fibre, pulp and biochemical products ___ New Zealand packaging industry has grown by at least an additional $140 million p.a. | Increased the contribution of bioenergy to New Zealand's consumer energy production and liquid fuels by 16% and 9%, respectively, by 2026 | Support improvements in New Zealand Natural Capital through forest system ecosystem services (National index) greater than 100 (2011) by 2026 |

### INTERMEDIATE OUTCOMES (IOs) 5-15 YEARS

| | | | | | |
|---|---|---|---|---|---|
| **IO1** Maximise the value and profitability of commercial forests and their ecosystem services | **IO2** Increase the profitability of solid wood processing through customer solutions and supply chain innovations | **IO3** Expand opportunities in the wood fibre, pulp, biopolymer, packaging and biochemical industries | **IO4** Increase New Zealand's energy security through the use of forest and waste biomass for bioenergy | **IO5** Protect and enhance market access and improve risk management | **IO6** Ensure licence to operate |

**IO5** Protect and enhance market access and improve risk management in the forest industry including forest health and preparedness for biosecurity incursions, fire and climate change

**IO6** Ensure the forest industry and bioeconomy businesses' licence to operate

### IMPACT KEY PERFORMANCE INDICATORS (KPIs) 3-5 YEARS

| | | | | | |
|---|---|---|---|---|---|
| 1. Sustainably increase forest productivity 2. Extract value from dispersed forest holdings 3. Increase socio-economic and environmental outcomes from forests | 4. New value chains for speciality wood products 5. Expand opportunities for wood products and building systems | 6. Develop new industrial bioproducts for existing and emerging manufacturing industries in New Zealand | 7. Improve readiness for bioenergy and liquid biofuels in New Zealand | 8. Ensure New Zealand forests are resilient to current and future natural threats | 9. Sustain New Zealand forest industry and bioproducts manufacturers' licence to operate |

This plan (from our 2016-2021 Statement of Corporate Intent) shows how Scion's activities align to achieving the Statement of Core Purpose (National) Outcomes and the inter-dependency between National and Intermediate Outcomes and performance measures (National and Impact KPIs respectively).

# Commercial forestry and *ecosystem services*

**IO1**

### Impact KPI-1

***Sustainable forest production.*** *By 2019 tools, novel forest management approaches and new plant material will be embedded into New Zealand's forests and forestry practices to support the industry's target to increase radiata pine MAI from an average of 20 m³ ha⁻¹ yr⁻¹ to 35 m³ ha⁻¹ yr⁻¹ and in a way that enhances the sustainability of forest growing in New Zealand.*

**LEADING INDICATORS**

**ON-GOING:** the Forestry Library, Permanent Sample Plots (National Forest Tree Database), and Tree Genetic Archives remain viable and provide valuable information about the national forestry position for New Zealand.

By **2016**, Scion will have quantified the gap between current productivity and potential productivity that could be achieved if key limiting factors could be overcome. These new insights will inform industry strategies to sustainably improve productivity, including breeding for growth and quality.

A phenotyping platform has been used to identify outstanding individual trees for at least one key trait with superior germplasm and is being deployed by 2019.

By **2016** at least two new biotech trees are evaluated for traits (e.g. productivity and herbicide resistance) and reported to stakeholders.

By **2017** remote sensing technologies are being used by forest growers to obtain quantitative information on the performance of their forests, and this is being used widely to inform management practices.

By **2017** Scion will have operationalised at least two new information system technologies that will contribute to increasing forest productivity.

**2016**  **2017**

**PROGRESS**

This gap, based on soil climate and biophysical limitation, has been spatially mapped. About 18%, 317,000 ha, of existing radiata pine forest was identified as performing below its productivity potential. It is estimated that closing the gap represents a $115 million p.a. opportunity for the industry.

Excellent progress was made on the phenotyping platform and LiDAR algorithms that locate and identify individual trees. Analysis of a single genetics trial was completed and demonstrated to industry at the IUFRO Forest Genetics conference (March 2016) and GCFF conference (May 2016). Data structures for whole forest analysis were developed and initial whole forest phenotypic data were extracted. Assembly of the data for the phenotyping platform is underway in preparation for the first proof-of-concept of the platform in 2016-17.

A contained field trial of biotech trees with modified lignin was maintained and shown to numerous stakeholder groups. The modification will reduce the energy cost of processing for pulp or biofuels production. The herbicide resistant trial was completed and a manuscript prepared for publication.

GCFF phenotyping cluster group member companies used LiDAR and spectral technology to measure their trees and the information was used in a study to show optimum stocking rates. Industry began using this information in management practices.

A prototype tree diameter measurement tool was developed and is now being explored for commercialisation. Tests for machine learning technologies have been successful and we are exploring ways to operationalise these.

The Permanent Sample Plot system underpins key Scion and industry research programmes, such as GCFF, providing access to data and serving as a repository for data being collected from the next generation of forestry trials.

# Precision nutrient management *for maximum productivity*

Getting the right balance between supply and demand is at the heart of any successful business. The same applies when growing trees.

With many of New Zealand's planted radiata pine forests already in their third consecutive rotation, and some entering their fourth, Scion has been investigating the balance between nutrient supply and demand as a rotation develops, to determine if current levels of productivity can be sustained, or even improved, in future rotations.

Scion's precision nutrient management model, NuBalM, has been developed for this purpose.

NuBalM enables forest growers to predict the supply of nutrients to their planted forest estate, over multiple rotations. Soil Scientist Dr Simeon Smaill says that with a third of the country's planted forest soils classified as low nutrient soils, increased fertiliser use is a clear option to boost productivity and New Zealand's forest export earnings.

"Predicting the productivity gains from fertiliser use in planted forests is complicated, so there has been a strong industry demand for this type of model," says Simeon. "NuBalM has been incorporated into our forest growth model, Forecaster, so that growers can access forest growth data and set nutritional targets based on demand.

"NuBalM will provide growers with vital information about nutrient flux throughout a rotation. It can also be used to predict the environmental outcomes of different management practices, and is being developed as a robust regulatory tool for forest managers and regional councils. This will enable a new level of precision in forest nutrient management."

Simeon has been working on the model since 2006, expanding on a concept first introduced in 1994 to match nutrient supply with demand over the life of a rotation. NuBalM was introduced to the forestry sector in 2009, with grower interest snowballing in recent years.

Scion's *Growing Confidence in Forestry's Future* programme, launched in 2013 to double the productivity of New Zealand's planted forests, presented the opportunity to expand the model further. This year has seen improvements to the nitrogen cycling module and the addition of a new module to predict phosphorus demand.

In 2015, Scion received further funding from the Forest Growers Levy Trust (FGLT) to develop a roadmap, in consultation with the forestry sector that sets the direction for further improvements to the NuBalM platform. The roadmap was completed in March 2016, along with the addition of a water balance module designed to assess the potential for environmental risk. The

## Timeline

**2019**

By **2019** at least two major forest growers have changed their management practices and are applying new treatments designed to increase productivity of mid-rotation stands.

By **2019** next generation genetics will have delivered new trees with an additional 15% genetic gain compared with the average improvement of 2012 deployed genetic seedlots.

A novel approach was developed using Scion's track sprayer to apply foliar treatments under controlled conditions and this has greatly reduced trial costs. Drone technology is now being used to reduce costs of field testing these foliar treatments for enhanced productivity. Industry workshops have been run, which have led to forest growers initiating soil sampling programmes to assess the potential for growth responses.

**2020**

Elite radiata pine trees were genotyped for the first round of genomic selection through the RPBC Genomics Partnership. The first tranche (circa 600 clones) was analysed with strong indications that the technique will be successful. These results have increased industry's confidence in these technologies and breeding selections.

Scion hosted the Forest Genetics for Productivity Conference (March 2016) with 109 delegates from 17 countries, and the molecular genetics conference, MapNet (October 2015), with 70+ delegates.

FGLT is funding further improvements to NuBalM over the next two years.

The NuBalM model is currently being used to evaluate end-of-rotation data from long-term productivity trials, and pre-harvest data from an accelerator trial to establish the nutrient requirements needed to boost productivity up to a specified target.

**The future of NuBalM.** Future enhancements to NuBalM have already been identified in the roadmap, the most critical being the need to reduce uncertainty around the growth response to nitrogen fertiliser. Other enhancements will include predictions of nitrogen fixation by weed species, and the addition of other nutrient modules. The ability to predict how management decisions will influence nitrogen leaching is considered a key regulatory issue for stakeholders.

Kaingaroa Timberlands, NuBalM industry steering group

Investment: MBIE, FGLT

# Enhancing seedling growth *with less reliance on chemicals*

Scion is examining ways to improve the performance of radiata pine seedlings by understanding more about the mycorrhizal fungal community found in soils.

Mycorrhizae are a class of fungi that are critical to plant growth. They form associations with the roots of most plant species, increasing the surface area of the roots and enabling the plant to absorb a greater volume of nutrients and water.

Soil Scientist Dr Simeon Smaill says a key focus of the work has been to explore the impacts of fungicide use on the mycorrhizal community that associates with the seedlings, and the subsequent effects these have on growth.

"Fungicides are widely used in nurseries to control disease, incurring significant costs to both the nursery and the environment. By understanding more about how fungicides affect beneficial plant-microbe interactions, we can identify ways to enhance seedling health and vigour, and tree performance, with less reliance on fungicides."

The research is part of Scion's *Growing Confidence in Forestry's Future* programme, and expands on work initiated under Future Forests Research in 2009 to study the effects of fertiliser and fungicide use on seedling quality and the mycorrhizal community.

Findings from these, and more recent, studies have shown that seedlings treated with less fungicide had superior



*Seedlings that did not receive any fungicide (right bed) had a superior growth rate compared to those receiving a standard fungicide application (left bed).*

survival rates and growth rates, suggesting there was an opportunity to optimise the use of chemicals in seedling nurseries.

Based on the success of these trials, ArborGen is working with Scion to conduct operational-scale trials at its nursery in Tokoroa.

Findings to date have shown that a 50 per cent reduction in fungicide use has resulted in seedlings that are 7.5 per cent larger (root collar diameter), without any negative effects on seedling health.

"Reducing chemical inputs will help our nurseries to save costs, improve plant and soil health, and offer a safer working environment for our employees," says ArborGen New Zealand Operations

Manager, Mark Ryan. "This research will also assist our customers, New Zealand's major plantation forest owners, demonstrate that their wood products are grown sustainably, which is an important factor in world markets."

Seedlings from these operational-scale trials are currently being planted in multiple field trials around New Zealand for further monitoring to identify the extent to which these improvements in seedling quality enhance growth performance when planted in the forest.

Timberlands, ArborGen Australasia

MBIE, FGLT

# A century of *tree growth data*

Scion's Permanent Sample Plot (PSP) system is a comprehensive database of forest growth data that underpins New Zealand's commercial forest industry. The system contains information about the effect that factors such as environment, genetics and silviculture regimes have on the growth of stands and trees.

According to Research Leader Dr John Moore, the PSP system is arguably one of the most extensive data resources on tree growth, internationally.

"The PSP system supports much of Scion's forest growing research and we also store data for commercial forestry companies on contract. Our scientists and forest companies use this information to understand how our current forests are performing, and how future forests might grow under different conditions. These data support important forest management decisions."

The PSP system holds data dating from the 1920s, and has been in a digital format since the early 1960s. The current digital platform is a flexible relational database that holds different types of forest data for both experimental research and commercial growth plots. These data are sourced from permanent sample plots that have been established, and regularly measured, in different forest types throughout New Zealand. Today, the system holds data from 32,000 PSPs of which 11,500 are current and 20,500 historic records.

"Many of our research projects require large datasets from hundreds or thousands of PSPs," says John. "These data support one-off projects or large multi-year programmes, and can only be used in projects with the landowner and data controller's permission."

In 2015-16, Scion and Integral, with support from Wenita Forest Products, implemented the 300 and 500 Indices directly within the PSP system. The 300 Index is a measure of site productivity for radiata pine, and the 500 Index is the corresponding index for Douglas-fir. By integrating both indices within the PSP system, scientists and industry partners will be able to better understand the variation in site productivity, and the drivers of productivity.

"Having the 300 Index available for PSP reports is very useful, because it enables convenient comparison of growth potential across a range of sites using a more sophisticated measure than site index, and also allows for easy modelling of plot growth with Forecaster," says James McEwan, Technical Manager at Wenita Forest Products.

"We were particularly interested in testing sensitivity of final crop stocking to volume and grade mix, for instance, identifying how high the final stocking and volume per hectare can be, while still producing 20cm plus sawlogs and not defaulting the volume to pulp grades. This is very sensitive to having accurate 300 Index data."

Funding for the PSP system also supported the measurement of the Silviculture Traits trial series. These trials were established by the Plantation Management Cooperative between 2002 and 2004 at six sites across New Zealand. The trials contain seedlots representing three different traits: growth and form, wood stiffness and appearance managed under different silvicultural regimes. Results from these and other trials help forest managers to develop strategies to increase productivity and improve wood quality.

"In future, the PSP system will support research into climate change, new forestry systems and increasing forest productivity," says John. "In many cases data from the PSP system help us answer important questions we hadn't even considered when the plots and trials were established. And as we expand the database to cover more species, it will provide data to support potential new forestry opportunities, such as kauri and tōtara.

"This will be especially useful for Māori landowners when considering options for balancing profit and environmental guardianship over their land."

Atlas (Integral), Wenita Forest Products, forest industry

Scion Core

# IO1

## Impact KPI-2

*Dispersed forests. By 2019 tools developed by Scion and its partners will be used by New Zealand forest growers and harvesting companies to reduce harvesting costs, improve safety of tree extraction and improve supply chain logistics.*

### LEADING INDICATORS

By **2016** prototypes of new harvesting tools and value chain approaches have been demonstrated that have the potential to save the forestry industry at least $50 million p.a. over 2010 costs.

By **2017** Scion will have implemented a set of information tools that increase value recovery for the wood processing sector.

By **2018** Scion will have developed tools and models for the forest products value chain that will be in use to determine where to intervene in order to maximise benefits from the existing forest resource. This work will have created better connectivity between growers and processors, and between small-scale forest growers.

**20 16** — **20 17** — **20 18** — **20 19**

### PROGRESS

The PGP-funded FFR harvesting programme was successfully completed and has achieved:
- >70 hauler operations extracting trees with grapples (from 16 cable operations grapple extracting at programme start);
- A more than 100% increase in the number of crews mechanically felling and processing;
- A prototype fully teleoperated steepland feller buncher, which leads the way to reducing in-forest staff;
- First trialling of a remote-controlled twin winch tailhold carriage (skyshifter) in a controlled environment;
- Development of an automatic quick coupling mechanism that will increase machine utilisation and help reduce some harvesting costs;
- Development of a remote-controlled felling wedge that will help to eliminate tree felling accidents.

MPI has approved a 12-month extension of the current PGP.

A PGP bid with industry that includes traceability for the forest sector was started.

Scion was commissioned to extend the system for determining the location and age class distribution of forests to include additional attribute information. The system is based on remotely sensed data and is able to help wood processors with wood supply planning by identifying stands, including small woodlots, with suitable characteristics.

# Log price outlook *provides valuable industry insight*

Some information is better shared, and Scion's log price opinion outlook has provided a means for competing log marketing companies to share their market insight with total anonymity.

The web-based survey has been developed by the Value Chain Optimisation Team as a means of providing a speculative log price outlook based on informed opinions. This is a unique initiative in the New Zealand forestry industry that asks log traders and others within the industry to consider what is likely to happen to log prices over the coming months, and to vote confidentially online.

The surveys have been running for 18 months, and the information is adding to the wealth of data the team is gathering about performance, markets, networks and concerns from industry stakeholders.

"While the drive is towards increasing domestic processing, log exports form a substantial component of the forestry industry," says Science Leader Dr Carel Bezuidenhout. "The survey has attracted a regular client base of about 50 participants from 30-40 companies worldwide. This group represents about 60 per cent of all the logs leaving the country. Participants offer a confidential and informed opinion on how they see the market performing over the following three months.

"Once the inputs are collated, the result is made available only to those who participated in the survey."

Although the survey is informal, the log price opinion outlook is proving useful for participants for company reporting and budget projections. The survey also gives Carel and the team the opportunity to be in regular contact with key forestry industry players.

"A considerable amount of value chain research involves understanding the people who make the decisions along the supply chain, from growers, to traders and manufacturers. This work is allowing us to forge valuable relationships with forestry stakeholders."

The research is also helping the team build a solid understanding of the log supply chain. As well as seeking participants' opinions about log prices, Carel is able to source valuable business intelligence, such as identifying the main industry drivers, key export markets, the size of the domestic market in comparison to the international market, and where value may be lost.

"A supply chain is about making money by producing, moving and marketing products," says Carel. "A value chain is more about alignments where companies with similar business models can synergise and innovate to create unique long-term win-win opportunities".

Scion Core

http://www.scionresearch.com/lpo

# IO1

## Impact KPI-3

*Ecosystem services. By 2019 Scion and its partners will have compellingly demonstrated to key stakeholders (e.g. forest owners, Māori, regional councils, policy makers) the role of forests in the landscape through economic, environmental and social contributions to regional economies and provision of ecosystem services (e.g. timber, climate change mitigation, recreation).*

## LEADING INDICATORS

By **2016** a conceptual framework has been developed for the economic assessment of alternative forestry options, focused on indigenous forestry and Māori land holdings.

By **2017** at least two regional councils will be using Scion's evidence-based information that quantifies forests' economic and natural capital contributions to New Zealand's growth, regional development and environmental performance targets.

By **2017** Scion's information and capability will have contributed to New Zealand's post 2015 climate mitigation policy development and dialogue across primary industry sectors.

By **2019** at least two regional councils have integrated Scion's forest economics and ecosystem services approaches into landscape level planning for multiple land uses.

**20 16** — **20 17** — **20 18** — **20 19**

## PROGRESS

The future of indigenous forestry in New Zealand was outlined in a conceptual framework supported by rigorous analysis. The framework highlights the importance of casting a new vision, underpinned by an adaptive policy environment that encourages commercially viable market demand through a positive perception of harvesting native tree species for timber. Such a change in perception will drive investment and determine the scale and security of supply and processing capability leading to sustainable businesses that account for economic, social, environmental and cultural values.

Scion was commissioned by Oji Fibre Solutions and the Waikato Regional Council to evaluate the effects of land use in New Zealand, using the dairy and forestry industries in the CNI as a case study. The market and non-market values of the ecosystem services provided by each land use were used to complete a regional analysis of the relative profitability and value-add created by both industries.

Freshwater ecosystem services have been assessed in 22 rivers and streams in the Waikato Region for the Waikato Regional Council. A few of the sites adjoin planted and native forests, which highlighted forest ecosystem services provided by these resources such as improved water quality.

An MPI funded project used the Forest Investment Framework to estimate the profitability and production of commercial scale *Pinus radiata* and Douglas-fir plantation forestry in the Southland Region (excluding Stewart Island). The results of this analysis informed Southland's nutrient limit caps and the policy used to reach these targets.

Contributed to New Zealand's obligations and provided information and support to the 2016 UNFCCC reporting process.

Invited to work with the Marlborough District Council to develop an approach for assessing the impacts of harvesting methods and setback options on forestry in the Marlborough Sounds. This followed the Ohiwa Catchment project for the Bay of Plenty Regional Council.

Continued work with the Bay of Connections, Agribusiness Action Group to expand the mānuka industry in the Bay of Plenty area and to disseminate information from the status assessment and the Mānuka PGP more widely.

# Complementary land uses *can benefit multiple industries*

**2020**

Provided representation on the freshwater National Objectives Framework (NOF) Reference Group, which assists in testing policy proposals and options identified by the Land and Water Forum and government officials.

Over the past decade, substantial areas of land in the central North Island (CNI) have been converted from forestry to dairy. This has led to changes in the nature of rural jobs and service firms, and a subsequent reduction in water quality and long-term security of log supply for local mills.

In 2015, Oji Fibre Solutions and the Waikato Regional Council commissioned Scion to evaluate the effects of land use in New Zealand, using the dairy and forestry industries in the CNI as a case study.



Scion's Forest Systems Team conducted economic analyses of a representative farm and steady-state forest of the same size, along with their respective supply chains. This project addressed the downstream environmental effects and ecosystem services generated by both industries, and the policies supporting them such as the National Policy Statement for Freshwater Management and the Emissions Trading Scheme. By undertaking a literature review and a simple comparative analysis, the research team was able to use the market and non-market values of the ecosystem services provided by each land use to complete a regional analysis of the relative profitability and value-added created by both industries.

Using average prices for the 10-year period to 2015, the study showed that a hectare of dairy generated about 50 per cent higher returns than forest but comes with a reduction in water quality, higher methane gas emissions and a higher demand for water for irrigation purposes. These environmental costs are not currently factored into the prices charged for

dairy products. Conversely, if carbon and nitrogen payments were introduced, forestry would net $16,785/ha compared to $15,216/ha for de-intensified dairy.

The report provides evidence that profitable land use within environmental limits and with lower greenhouse gas emissions can be achieved with better catchment and regional scale planning, and with more incentives for ecosystem services. It also noted that setting appropriate nutrient limits for catchments would promote afforestation and subsequent economic regional growth in a sustainable manner.

"The aim of the study is to provoke and promote constructive discussion on how complementary opportunities can be generated at a farm, catchment or regional level that will be of benefit to both industries," says Resource Economist Dr Juan Monge. "These discussions will help industry, regional councils and central government to comply with national environmental policies, achieve economic growth within environmental limits, and effectively integrate land uses at different scales.

"We can also apply similar analyses to a wider range of land uses, such as sheep, beef cattle and horticulture."

The study was independently reviewed and validated by the New Zealand Institute of Economic Research, and the report is available to view on Waikato Regional Council's website.

Juan and the research team delivered a series of nine presentations on the study to various industry groups and conferences, one of which has been used as an example of sector complementarity analysis on the Morgan Foundation's website. A peer reviewed article has also been published in the *Journal of Environmental Management*.

The New Zealand Institute for Economic Research, Texas A&M University

Scion Core, Oji Fibre Solutions, Waikato Regional Council

http://bit.ly/2afopZX

# Solid wood processing

## IO2

### Impact KPI-4

*Speciality wood product value chains.* By 2019 Scion and its partners will have provided tools, new product options and plant material that will have supported the aspirations of growers and manufacturers to invest in new manufacturing facilities and expand plantings of Douglas-fir, eucalypts, cypresses and indigenous species. This investment will reflect increased confidence in being able to secure the highest possible value for their products along the entire seed-to-market value chain.

## LEADING INDICATORS

By **2016** Scion and iwi and other partners will have identified the current and future economic opportunity for using some indigenous species, and have external investment supporting realisation of the commercial opportunity associated with those species. Particular focus will be given to support the economic and social development of Northland, East Coast/Hawkes Bay and central North Island.

By **2017** Scion's technical outcomes will be used in the development of at least one market ready product from Douglas-fir or a eucalypt. This product will have international market potential.

By **2017** Scion will have demonstrated to pre-commercial stage the potential to first extract chemicals and second, formulate valuable compounds using a whole-of-tree approach for three species.

By **2019** Scion will have provided tools, new plant material (e.g. germplasm) and competitive niche wood products that will increase the confidence of growers of Douglas-fir, eucalypts, cypresses, redwoods and indigenous species to increase plantings of these species by at least 5% over 2014 plantings.

**2016** — **2017** — **2018** — **2019**

## PROGRESS

Scion, Northland Tōtara Working Group, Te Tai Tokerau Forestry Cluster, MPI and Northland Inc worked together to develop the concept of an indigenous wood products industry based around tōtara. The group is working to secure additional investment to de-risk key areas, particularly timber grade recovery in the mill and customer acceptance and willingness to pay.

Ngāti Whare Holdings Ltd committed to building an indigenous nursery at Minginui with Scion's guidance and expertise in plant propagation. The new nursery will grow indigenous forestry species and indigenous plants for restoration or riparian plantings next year.

Economic comparisons confirmed the superior results of using Optimised Engineered Lumber (OEL) technology in converting 18-year-old production thinning Douglas-fir logs into SG8 structural lumber (glulam) compared with a sawn log from full 30-year rotation radiata pine.

Extracts from leaves, needles, bark and wood from tōtara, *Eucalyptus nitens* and Douglas-fir were analysed and a chemical profile defined for each.

The Specialty Wood Products Research Partnership was launched (March 2016), funded by MBIE and the forestry industry, and is a collaboration between Scion, the University of Canterbury and the Marlborough Research Centre. Investigation of gene flow in a *Eucalyptus fastigata* seed orchard has started.

## Improving the value of *Eucalyptus nitens*

*Eucalyptus nitens* has great potential as a resource for solid wood production and high-value appearance products. A downside to this, however, is that the species is known to suffer ill-effects from fast growth and wood drying, including growth strain, cell shrinkage and collapse, and associated internal checking. All of these current problems can be addressed through a targeted breeding programme to produce improved germplasm.

Scion has been instrumental in overcoming these issues by developing improved *E. nitens* germplasm that will provide a more consistent quality of wood and better pulp wood properties for the manufacture of high-value paper products. The research project is part of the seven-year 'Specialty Wood Products Research Partnership' between central government and industry to investigate new wood products derived from specialty species, such as eucalypts, cypresses and Douglas-fir.

The work also expands on Scion's ongoing diverse species research to develop improved breeding stock for commercial species other than radiata pine.

The first stage in the programme involved phenotyping a seven-year-old progeny trial, by quantifying the current wood quality issues that need to be addressed.

Breeding selections were made based on genetic analyses of these wood quality data, which are being used by Scion's industry partner Southwood Export Ltd (SWEL) in two new seed orchards that target seed production for their planted forests. One seed orchard will produce germplasm for consistent wood quality for use in high-value wood products, and the other will focus on providing high-quality pulp.

"This year, we were able to quantify the overall genetic variation of the traits important to both of these breeding objectives, and have developed initial genomic predictions of these traits for future breeding purposes," says Geneticist Dr Mari Suontama.

"We will continue to develop an application for future use so that we can benefit from these genomic estimated breeding values and boost further genetic improvements of the population."

The breeding programme will help develop improved breeding stock for *E. nitens* and other specialty species that will expand New Zealand's range of exported wood products. The Specialty Wood Products Research Partnership expects the export benefits to New Zealand to reach $350 million by 2030, and rise to $3.6 billion per annum by 2050. The programme will also provide regional opportunities for employment, Māori forestry and wood manufacturing.

SWEL and other SWP partners

MBIE, Scion Core, forest industry partners



*The large phenotypic variation in internal checking found in* Eucalyptus nitens *discs is due mainly to genetics, and can be improved by breeding.*

By **2019** solutions for novel pre-drying/drying for three difficult to dry species have been identified then trialled at full-dimension material scale to produce dry, check/collapse-free full-size timber. Processing costs have been estimated. The information is being used by a partner company to establish the commercial feasibility of this new approach to drying.

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A novel approach to pre-drying using freeze drying was attempted, and testing completed. None of the treatments showed differences in drying rate compared to the controls. Indications are timber supplied was abnormally good, hence the trials are to be extended and enlarged.

# IO2

## Impact KPI-5

*New wood products and building systems.* By 2019 Scion will have supported wood processing and manufacturing companies by delivering new value enhancing tools and technologies that assist them to meet their growth targets and encourage increased investment in wood-based manufacturing and more productive timber-based construction techniques in New Zealand.

### LEADING INDICATORS

**By 2016** Scion will have demonstrated to a pre-commercial stage at least one new wood preservation/protection system that supports New Zealand wood products in the most environmentally discerning markets.

**By 2017** Scion will have demonstrated and secured external investment to enable at least one new modified wood product to compete in high-margin market segments.

**By 2018** Scion will have produced thermally modified wood samples from at least three species, large enough for market place testing. Durability, stability and structural performance have been assessed and commercial feasibility explored. The information is being used by an investor company to establish the commercial feasibility of the modified wood process.

**By 2019** WoodScape has been upgraded to reflect both new products and new knowledge developed for current technologies. Assessments have been made to the business case stage, and for the development of a new or substantially enhanced wood manufacturing operation.

### PROGRESS

**2016**

Outdoor trials (decking, flat panel, L-joints) of up to 30 months exposure showed no sign of decay in timber treated with the new preservative. Framing tests carried out in the accelerated fungus cellar were in good condition with no decay observed. This was unlike the untreated controls that had completely decayed.

**2017**

Progress has been slower than expected, with scale-up trials to demonstrate a new timber modification treatment not completing the outdoor trials until late 2016. All other aspects were collated and are being shaped for external investment.

**2018**

Silver beech, tōtara and Douglas-fir boards (heartwood and sapwood) were thermally modified and durability screening test results are due in July 2016. The scale-up trial on *Eucalyptus nitens* was completed; a preliminary feasibility study at pilot scale was less promising than lab-scale results.

**2019**

The WoodScape model supported the MBIE-funded Wood Energy Industrial Symbiosis (WEIS) project with addition of nine processing technology options and calculations for: GHG emissions, energy return on energy investment for bioenergy technologies, IRR and NPV. A paper was published in *NZ Journal of Forestry* (Vol.61, No.1 May 2016) "The impact of operating scale and exchange rate on the profitability of some major wood processing options – analysis using the WoodScape model." The @Risk analysis tool was purchased for Monte Carlo risk analysis; preliminary results were presented to the WEIS workshop in June 2016. Monte Carlo analysis will be embedded into the model in 2016-17.

## Wood graveyard provides foundations for timber industry durability studies

Scion's Whakarewarewa graveyard is not the typical resting place. Originally established in 1947 when scientific research first commenced on campus, the wood field test site, or graveyard as it is better known, has become a national database for timber durability and product evaluation.

The graveyard allows wood and wood products to be field tested in a high decay-hazard situation, over a lengthy period of time. It contains ground-contact stakes, poles and posts, as well as above-ground and simulated commodity tests such as decking, cladding and joinery. It also provides information about naturally durable species, and non-wood based products like wood composites and plastics.

The Whakarewarewa field test site is one of four Scion graveyards around

**20 20**



New Zealand that, collectively, represent a variety of climate, soil types and ground contact hazards. The information derived from these graveyards is unique and irreplaceable, and provides a foundation for the timber industry.

Scion works with industry in New Zealand and internationally to test the durability of wood products and set national and international standards for good building practice. Graveyard testing is an integral part of a durability assessment, which starts with laboratory pure culture decay tests, then to accelerated fungal cellar tests, and ultimately to the in-service graveyard tests.

A preservative treated, or naturally durable, timber that performs satisfactorily at these sites is considered suitable for use throughout New Zealand. Currently, we are also testing products for clients in Germany, the Netherlands, USA and Australia.

"Existing wood product technologies are largely mature," says Wood Durability Specialist Dr Tripti Singh. "Our graveyards allow the industry to grow and diversify value-added exports from forest resources.

"As a result of the proprietary technologies we develop through our wood protection research, the industry will be able to develop and export technologically differentiated high-value building and construction product streams."

One such technology is a wood protection treatment made from natural bioactive compounds.

As Tripti explains, this technology responds to consumer demand for healthy living environments, and the regulatory demand for building and construction products that do not create an end-of-life disposal problem.

For the past six years, Tripti and the research team have been conducting an intensive screening programme from a range of sources, including agricultural and horticultural waste, essential oils, medicinal and native plant extracts, natural biocides and other compounds generally recognised as safe, such as food preservatives.

The team has identified a number suitable bioactives, and further developed one into a water-based formulation for treating timber. Following successful laboratory trials to evaluate its antimicrobial activity and stability, long-term field trials have now been established for treated cladding, decking and exterior joinery at both the Whakarewarewa graveyard and the Oregon State University's graveyard in Hawaii. These field trials will be assessed on an annual basis. The team has also developed and validated a method of quantifying this novel bioactive in treated wood for quality assurance purposes.

Our graveyards are listed at IRG/WP (International Research Group on Wood Protection) website http://www.irg-wp.com/index.html

Farm Forestry Association, Oregon State University (USA), eight from industry

Scion Core, industry partners

# Wood fibre, pulp, biopolymer, packaging and *biochemical industries*

## IO3

### Impact KPI-6

*Industrial bioproducts. By 2019 new capital investment will be occurring in new and existing manufacturing industries in New Zealand as Scion's developments in new high-value and performance focused products derived from forest materials and biomass side streams are being adopted.*

**LEADING INDICATORS**

By **2016** Scion will establish two lines of biotech trees in a field containment trial: altered biomass utilisation aiming at biorefinery feedstocks, and lignin modified for pulp processibility.

By **2016** Scion will have developed at least one new high-value product derived from forest or other biomass side streams (wood, fibre, pulp, biopolymer and chemical) to prototype stage that has been reviewed by a commercial partner for potential investment.

By **2017** Scion will have aligned a cluster of organisations (including industry, government and research organisations) to pursue an integrated biorefinery concept (combining bioenergy and bioproducts) and together developed a joint roadmap.

By **2017** Scion will have identified two potential biochemical opportunities from hydrothermal liquefaction (HTL) processing of biomass.

By **2018** at least six new polymeric material products with renewable content have been developed to prototype stage using existing (e.g. extrusion, injection moulding) and emerging technologies (e.g. 3D-printing or electrospinning).

**2016**  **2017**  **2018**

**PROGRESS**

New lines of biotech trees for altered biomass utilisation were established in the field trial and monitored and maintained. New lines of biotech trees were produced in the GM glasshouse ready for transfer to the field trial during winter 2016. The new lines incorporate an alternative modification of lignin for improved processing.

Projects looking at the feasibility to produce animal feed and slow release fertilisers were successfully completed with BPA funding with review by potential commercial partners. A commercial product development contract has targeted accessing lignin as a substitute for a petroleum product.

A high level bark biorefinery concept pack was developed outlining potential business cases, technical validation of product opportunities, market validation of product opportunities and demonstration plant deployment. Discussions with Fraunhofer IGB and VTT on potential bark biorefinery collaborations commenced.

Scion's research focus was defined as: 1) HTL of pulping black liquors for fuels and chemicals; 2) HTL of woody feedstocks for marine biofuels. Funding opportunities were explored through the Catalyst fund in collaboration with KIER and a MBIE Targeted Research Programme with Fraunhofer UMSICHT.

A memorandum of understanding was signed between KIER and Scion for the development of research cooperation in the field of energy technology.

Four sets of 500 biodegradable net clips containing red grape pomace and biodegradable polymers were produced by extrusion and injection moulding. These were trialled at Villa Maria vineyards in Hawkes Bay during the run up to the 2016 harvest. None of the clips holding the nets gave way prematurely and the clips were all brittle enough to break when the nets were removed. Biodegradation of the clips in the vineyard is being monitored. The Zespri biospife is being scaled-up for export. The compostable spoon-knife contains kiwifruit waste intended for use in compostable punnets of organic kiwifruit in the EU and Japanese markets, which have infrastructure for industrial composting. The formulation was finalised with both Zespri and Alto, who injection moulded the biospife. Incorporation of kiwifruit waste into an injection moulded product is novel.

# Packaging *for the future*

Scion's Packaging Team is developing a range of innovative paperboard packaging technologies that could potentially save produce industries worldwide, millions of dollars a year.

An estimated 2 per cent of all corrugated boxes fail in supply chains, costing around US$50 billion to the produce industry alone. New Zealand's primary industries, including kiwifruit, seafood, dairy, beef and lamb are typically packaged in corrugated boxes, which are continuously exposed to fluctuating relative humidity throughout the chilled supply chain. This can result in moisture accelerated creep, one of the major causes of box failure.

Central to Scion's box research has been the construction of the WHITE room, a unique purpose-built coolroom designed to test box failure under controlled conditions.

The WHITE room (an acronym for weight, humidity intervals, temperature and experiments) enables our packaging scientists to study the causes of box failure, and to develop solutions that both protect and add value by reducing the amount lost through package failure. *(Continued over page)*

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By **2019** at least two of these polymeric material prototypes are incorporated in new product offerings by firms.

By **2019** Scion will have assisted a commercial packaging company to develop boxes with improved performance in coolstores.

By **2019** new high performance products (packaging, composites and new compounded materials containing biopolymers) developed by Scion in collaboration with commercial partners are supporting the development of new industries in New Zealand and providing direct revenue to New Zealand.

By **2019** two lines of biotech trees will be harvested and processed to determine their viability as alternative biorefinery feedstock (production of high value chemicals and/or processability for fibre or bioenergy). The investment case will have been presented to potential commercialising parties.

By **2019** Scion will have developed processes to produce unique natural fibres that, when used in Scion-developed packaging and wood composite applications, show improved product performance over 2014 materials.

By **2020** Scion and commercial partner(s) have developed a viable and New Zealand specific biorefinery business case based on Scion-developed high value bioproducts and cost efficient technology platforms for commodity fibres and bioenergy.

**2019** — **2020** — **2021**

See 2018.

Scion's WHITE (weight, humidity intervals, temperature and experiments) room became fully operational. The facility is a purpose-built coolroom to test and develop boxes with improved performance. Several commercial contracts with international and national partners were completed.

Tonne-scale manufacture of the lignin-based patented bioadhesive and plywood trials were completed. A successful bioadhesive preparation (1.6 tonnes) was undertaken with a company. At another company plywood was prepared over 3 hours, varying the open and closed assembly times and press schedules.

Other than the New Zealand companies participating in the trials, a range of commercial partners for our Ligate™ technology (bioadhesive technology utilising 100% renewable resources for wood panel products for homes and offices) have been defined and meetings planned.

A joint project with a major roading and infrastructure company progressed to develop renewable New Zealand-derived bitumen modifiers to replace imported petrochemical-based modifiers. When successful the modifiers will be scaled-up within the next two years.

Biotech trees grown in the field trial and under glasshouse containment will be harvested once sufficient biomass has been produced to undertake experiments.

Laboratory work began with large paper sheets produced using additives derived from pulp material; testing of sheets is underway for enhanced fibre bonding, particularly the stiffer mechanical pulp component that would enable greater use in packaging-grade papers/board.

Product targets under development.

The coolroom facility accurately cycles relative humidity between 50 and 90 per cent while maintaining a constant temperature, enabling scientists to characterise box performance under accelerated conditions. Up to 25 corrugated boxes can be tested at once, at constant loads.

The WHITE room was commissioned for commercial testing this year, and validated for research capability. According to Project Leader Dr Saad Hussain, it is likely the only independent facility of this size in the world, and has been running back to back experiments since it opened one year ago.

"The facility has helped us understand how boxes perform under cyclic humidity. It also enables us to test the performance of innovative packaging additives, such as high performance moisture barrier coatings designed to protect packaging.

"The demand for this service is global. Leading American and European packaging companies have used the WHITE room this year to understand how their corrugated boxes perform over an accelerated period.

"Packaging end-users are also showing considerable interest in participating in testing and research."

While much of this cutting edge research is still in the early stages of development and therefore confidential, Saad anticipates that it will result in a significant reduction in the 2 per cent box failure rate.

"Paper producers and box converters are looking to create the best package for the market, and end-users require boxes that won't fail in their supply chain. Our packaging team is working towards developing an improved corrugated box that can withstand failure in real supply chains."

Massey University, Miami University (USA) and four from industry

Scion Core

http://bit.ly/29KhxFD

# Unique wood reinforced plastic *going global*

Scion and licensing partner Sonae Indústria received a KiwiNet Award in June for their partnership to commercialise a wood reinforced plastic product that can be used in cars, appliances and a range of consumer products.

The annual KiwiNet Research Commercialisation Awards celebrate the achievements of individuals, teams and organisations actively commercialising publicly funded research.

Scion and Sonae Indústria won the MinterEllisonRuddWatts Research & Business Partnership Award for their long-term working relationship, which has successfully established a commercial value chain for wood fibre reinforced plastics. The key enabling technology is embedded in wood fibre dice, known as Woodforce, which is sold by Sonae Indústria to plastics processors.

Plastics with wood fibre are stronger and stiffer than plastics alone, but until recently, handling the bulky fibre has not been commercially feasible. Scion's patented process forms wood fibre into 'dice' that can be made in existing MDF plants and easily added to a range of plastics. The non-seasonal and sustainable supply of wood fibre adds further advantage over other agricultural and glass fibres.

Scion has been working closely with Sonae Indústria for eight years in order to refine Woodforce to the point where it is starting to make inroads into the market. Scion granted Sonae

Indústria an exclusive licence for the wood fibre dice technology in Europe in 2011, and North America in 2013. Sonae owns and has developed the Woodforce brand.

Both partners have been committed to optimising Woodforce and the compounding process. End products that are lighter weight, thermally stable and sustainable are now being trialed and approved by major automotive manufacturers. A wide exposure to companies along the full length of the Woodforce value chain has also led to relationships being developed with other manufacturing industries to develop new products.

Business Development Manager Jeremy Warnes sees the commercial potential for Woodforce as being in the $100s of millions in business generated on a global scale, depending on uptake in a competitive environment.

Scion developed and patented the technology with funding from New Zealand's former Foundation of Research, Science and Technology (now the Ministry of Business, Innovation and Employment).

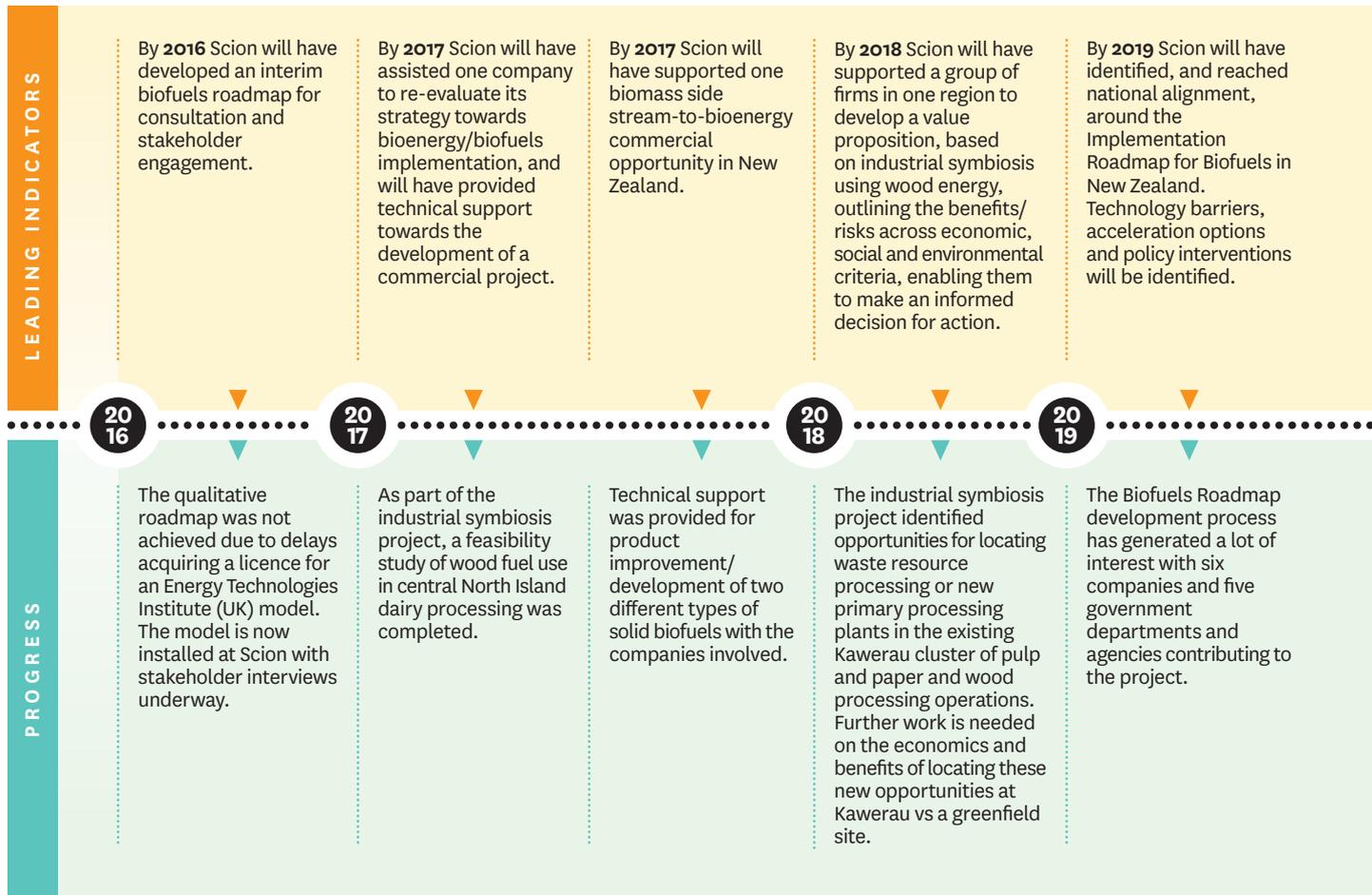👥 Sonae Indústria and Sonae Arauco

💲 MBIE, Scion Core

🌐 http://bit.ly/2c4SQKo



*Business Development Manager Jeremy Warnes receiving the KiwiNet Award on behalf of Scion and Sonae Indústria.*

# Energy security

**IO4**

***Bioenergy and liquid biofuels.*** *By 2019 Scion will have identified the key barriers towards more widespread use of biomass for heat and the production of transport fuels and proposed solutions.*

## LEADING INDICATORS

By **2016** Scion will have developed an interim biofuels roadmap for consultation and stakeholder engagement.

By **2017** Scion will have assisted one company to re-evaluate its strategy towards bioenergy/biofuels implementation, and will have provided technical support towards the development of a commercial project.

By **2017** Scion will have supported one biomass side stream-to-bioenergy commercial opportunity in New Zealand.

By **2018** Scion will have supported a group of firms in one region to develop a value proposition, based on industrial symbiosis using wood energy, outlining the benefits/ risks across economic, social and environmental criteria, enabling them to make an informed decision for action.

By **2019** Scion will have identified, and reached national alignment, around the Implementation Roadmap for Biofuels in New Zealand. Technology barriers, acceleration options and policy interventions will be identified.

**2016** — **2017** — **2018** — **2019**

## PROGRESS

The qualitative roadmap was not achieved due to delays acquiring a licence for an Energy Technologies Institute (UK) model. The model is now installed at Scion with stakeholder interviews underway.

As part of the industrial symbiosis project, a feasibility study of wood fuel use in central North Island dairy processing was completed.

Technical support was provided for product improvement/ development of two different types of solid biofuels with the companies involved.

The industrial symbiosis project identified opportunities for locating waste resource processing or new primary processing plants in the existing Kawerau cluster of pulp and paper and wood processing operations. Further work is needed on the economics and benefits of locating these new opportunities at Kawerau vs a greenfield site.

The Biofuels Roadmap development process has generated a lot of interest with six companies and five government departments and agencies contributing to the project.

## From wood, *to fuel*

Scion has been involved in bioenergy and biofuels research for many years. The focus of this research currently centres on developing the technologies to convert softwood into liquid biofuels and other chemicals.

New Zealand's transport sector alone is 99 per cent dependent on fossil fuels, and responsible for 17 per cent of the country's carbon dioxide emissions. Most of the oil used to produce these transport fuels is imported, making it the country's biggest import.

Replacing just some of this imported oil with locally produced biofuels would significantly improve our balance of trade and reduce our reliance on fossil fuels. It will also generate numerous business and employment opportunities, boosting regional growth as well as lowering greenhouse gas emissions and delivering on our commitment to the Paris Climate Change Agreement.

This year Scion started using a newly acquired fast pyrolysis plant to convert wood into bio-oils, which can then be further refined into transport fuels or bio-chemicals.

The fast pyrolysis plant has been designed and built by the University of Twente in the Netherlands, a

**20 20**   **20 21**

In progress. A New Zealand-relevant biorefinery concept is currently in development.



recognised leader in pyrolysis research and development since the 1970s. The plant is capable of converting 1 kg of wood at a time into about 750 mls of raw pyrolysis oil each hour, using sand as the thermal conductor. By rapidly heating small wood particles to approximately 500°C in the absence of oxygen, the pyrolysis reactor creates vapours that are then quenched, producing the oil. The whole reaction and quenching takes place in seconds.

The plant is an essential part of Scion's research programme. It is specially designed to obtain accurate and reproducible results that will provide comprehensive information on the performance of New Zealand specific feedstocks in this type of process.

"We are focusing on developing our capability in thermochemical conversion technologies such as pyrolysis to convert wood directly to bio-oils," says Research Leader Dr Ian Suckling. "These oils can then be upgraded to drop-in fuels that can be blended directly with fossil fuels.

"There is a lot of variation in wood and how it could be pre-treated before being put into fast pyrolysis. Each treatment might result in different qualities of bio-oil, which in turn, may affect its suitability for conversion into fuels.

"We've developed a range of analytical methods to characterise the experimental bio-oils we produce, and are currently using the plant to trial various temperature settings, feedstocks and pre-treatments to identify the best combination for fuels."

Ian says that while the pyrolysis of wood to oil is already at a commercial stage internationally for industrial energy and heating use, Scion's research focuses on converting it to fuel and generating New Zealand specific solutions. The research is already attracting interest from industry, government and Māori groups.

Ian and the research team have been applying this capability in a joint programme with the Korea Institute of Energy Research (KIER) for the past three years, to complete techno-economic and thermodynamic performance analyses of their pyrolysis plant. Ian recently presented the findings to KIER's funding agency along with submissions to fund further collaboration in bio-oil production and refinement.

Scion scientist Dr Ferran de Miguel Mercader has also joined the International Energy Agency's Task 34 (Direct Thermochemical Liquefaction) as New Zealand representative. The IEA works to ensure reliable, affordable and clean energy for its 29 member countries and others.

National and international research organisations and industry

Scion Core

# Market access and *risk management*

## IO5 — Impact KPI-8

*Forest protection and market access.* By 2019 new tools and technologies will have been developed to quantify and mitigate impacts from the increasing risk to New Zealand's forests from pests, fire and wind, and climate change, and will have been adopted by forest industries, land owners, and central and regional government.

**LEADING INDICATORS**

**ON-GOING:** the National Forest Herbarium and the Forest Health Collections and Databases remain viable and provide valuable information on the national forestry position for New Zealand.

By **2016** Ministry for Primary Industries or forest growers will have adopted a new tool or method developed by Scion and Scion's research partners to enable early detection and/or eradication, or improved control of a pest to New Zealand's forests.

By **2016** Scion will have identified radiata pine germplasm with improved resistance to at least one foliar disease.

By **2016** Scion, with its research and industry partners, will have defined a strategy to reduce the use of phytosanitary treatments, specifically methyl bromide, by at least 30%, and this will be presented to the Ministry for Primary Industries for evaluation and subsequent adoption by industry.

By **2016** Scion will have: 1) supported forest industries to maintain access to cost effective herbicides and management options for the environmental certification of New Zealand forests, and 2) agreed with stakeholders research priorities for reducing wilding conifer impacts.

By **2016** rural fire stakeholders through the Rural Fire Research Advisory Committee will have adopted new fire behaviour models or adopted enhanced data collection systems that lead to both improved firefighter safety and intelligence for making firefighting decisions.

**20 16**

**PROGRESS**

A test forest biosecurity model that allocates surveillance effort to plantations and high-risk urban areas was developed. The model will be used to allocate surveillance in three regions on a trial basis in latter 2016, to be fully adopted in January 2017 if successful.

Working for RPBC, Scion is screening 50 *Pinus radiata* genotypes to determine resistance to multiple pathogens. Potted grafts will be put in two or more forest sites with at least two different needle pathogens. Multiple-resistances or tolerances of clones to multiple needle diseases will be evaluated with the aim of identifying the most resilient clones for deployment in disease-prone areas.

Analysis of host metabolites produced after artificial inoculation with pathogens showed chemical responses that may differentiate hosts resistant or susceptible to attack from red needle cast (RNC). Laboratory and field tests to screen *P. radiata* clones against RNC produced broadly consistent results, showing promise for eventual operational deployment of breeds resistant to RNC.

Data from ~900 forest insects trapped since 2013 may support a fumigation-free period in cooler parts of New Zealand over winter when the likelihood of pest infestation of export forest produce is low. Tests by sub-contractor Plant & Food Research indicate that methyl bromide rates can be significantly reduced, perhaps by up to 40%, while still maintaining acceptable efficacy. Confirmation requires further work with infested logs.

Meeting with forest growers highlighted key outcomes of the weeds research programme and identified future research priorities for forest weed management. The highest priority is 'Licence to Operate'. Other priorities included reducing the risk of Douglas-fir spread and models that can better characterise spray drift in complex terrain.

A review of the Nelson/Marlborough forestry operations fire danger codes was completed and new guidelines are with forestry and rural fire managers.

The first area plans in each of the Nelson and Marlborough regions produced using the Strategic Tactical Fire Management Planning process were completed, and work has started on the second-year area plans.

An integrated framework was developed to assess after-fire economic impacts and is with the New Zealand Fire Service Commission.

Herbarium additions included 653 new specimens, 1274 specimens imaged and 1548 nomenclature edits to species. An interactive identification key for wilding conifers in NZ was developed in collaboration with Landcare Research and DOC. The key contains 10 common wilding pine species plus macrocarpa, European larch and Douglas-fir. It will be available soon as a smartphone app.

# Understanding the fire risks *posed by wildings*

Wilding conifers cover an estimated 1.8 million hectares of land in New Zealand, and are spreading at a rate of about 5 per cent a year. They pose a major threat to our ecosystems, farmlands and conservation estate.

While there is an increasing need for wilding control treatments, these are likely to increase the risk of wildfire as sprayed trees die and decompose.

Scion's Rural Fire Research Team is studying the fire risks and behaviours of wildings and their associated control treatments in order to improve our range of existing fire prediction tools, such as the New Zealand fire behaviour manual and Prometheus fire growth simulation software.

These tools are widely used by rural fire agencies, such as councils, the Department of Conservation, and the New Zealand Fire Service to control wildfires in affected areas. Improved data will help agencies plan the safe use of wilding control treatments without risk to nearby communities.

The research project has been running since 2012, initially as a literature review and desktop hazard assessment. In 2014, our fire scientists, with assistance from rural fire agencies, planned a series of experimental burns in South Canterbury to validate international models for similar tree species, and to obtain data on fuel loads and fire behaviour in both treated and untreated wildings.

Six experimental burns were conducted over the 2015-16 fire season at two adjacent sites near Twizel containing young, open wilding stands, to compare the effects of spray treated versus untreated trees.

Senior Fire Scientist Grant Pearce says the burns helped characterise fuel loads both pre- and post-fire, measure fuel consumption, and gather data on weather and fire danger conditions, fuel moisture content and fire behaviour including fire spread rates, flame lengths and fire intensity, in-fire temperatures, and fire induced turbulence.

"We also collected photos and videos of fire behaviour for further analyses, using ground-based cameras placed in novel fire-proof boxes within the fire, and visual and infra-red aerial imagery collected from a drone hovering above the burns."

Grant says this is only the first stage of the project, and it is already helping fire managers to understand the sorts of fire behaviour they can expect from wildfires in young wilding affected grasslands.

"The burns have helped us identify the tree spacing and grass continuity required for fires to spread in these fuel types, and when fires can spread as grass fires with the intermittent

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**2017**

By **2017** there will be examples for policy makers and forest growers using Scion's knowledge of climate change impacts and resultant implications that provide guidance in managing risk and adapting to impacts of climate change.

Scion led the development of a climate change digital library called the Climate Cloud (www.climatecloud.co.nz) that holds ~1600 policy and end-user oriented climate change resources. The resource is used by both government and industry and is becoming the primary repository for climate change information in New Zealand.

Scion's involvement with the Climate Change Impacts and Implications (www.ccii.org.nz) MBIE research programme has developed interview-based evidence of sector awareness and used Scion's core SLMACC funded research to analyse risk, impacts and adaptation options.

**2018**

By **2018** options to reduce the impact of *Phytophthora* on radiata pine, kauri and one horticultural species have been identified.

Phosphite application in a spray trial carried out in 2011 and 2012 did not affect long-term spore release. There was no difference between sprayed and unsprayed treatments in the presence of *Phytophthora* in spore traps. Over 2015-16, a new phosphite/adjuvant combination was shown to significantly increase uptake by the plant. This should increase efficacy of phosphite for RNC control and will be confirmed in 2016-17. Copper has shown significant promise as an operational RNC control option and experiments will be done to test that potential.

torching of wildings, as opposed to crown fires in areas with denser cover.

"We have also been able to identify the weather and fire danger conditions under which fire will spread in both sprayed and unsprayed wildings."

The research team also took the opportunity to explore the use of LiDAR data captured using a drone, to estimate the fuel loads and biomass for different aged stands. If this method proves successful, it will make it easier to assess fuel loads and fire risks, as well as stored carbon, across large tracts of wilding affected lands.

Further burns are required to model fire behaviour across the full range of fuel and fire danger conditions in young wilding trees. Experimental burns will also be conducted on treated and untreated mature wilding stands at a later date.

The rural fire industry has been actively involved in this research, helping to identify suitable burn sites, and providing firefighters and equipment to ensure the experiments are safely managed. Scion's research also contributes to a broader international understanding of fire behaviour in wilding tree species, and of crown fire

development, as well as fire behaviour in health-impacted stands.

University of Canterbury Geography Dept, DOC, NZFS, Mid-South Canterbury RFA, Canterbury RFAs, Pukaki Downs and Aoraki Downs station landowners

MBIE, Scion Core, rural fire end-users, Mid-South Canterbury RFA

http://bit.ly/2bPSW8t
http://bit.ly/2bTWFiI
http://bit.ly/1Xavcsk

# Protecting New Zealand *from invasive 'hitchhiker' pests*

Around 90 per cent of international trade today is carried by sea, mostly in sea containers. This amounts to a worldwide total port throughput per year of some 300 million containers.

The downside to this unprecedented level of global trade is the transport

of unwanted contaminants, including 'hitchhiker' pests that are transported on, or in, the actual containers themselves, irrespective of cargo.

Well-known contaminating pests found on containers include the gypsy moth, giant African snail, Argentine ant and brown marmorated stink bug. Such pests threaten agriculture, forests and urban environments and cause substantial economic and environmental damage in many countries.

The increase in biological invasions observed in the last century has been clearly linked to the growth in international trade. Principal Scientist Dr Eckehard (Ecki) Brockerhoff says that inspection records from the United States, Australia, China and New Zealand indicate that thousands of organisms from a wide range of taxa are being moved unintentionally with sea containers.

He says that inspection records of

116,701 consignments of empty sea containers arriving in New Zealand between 2010 and 2015 indicated a 9.7 per cent exterior contamination rate and 5 per cent interior contamination. Soil residues were the most common contaminant and contained the seeds of invasive plants, nematodes and plant pathogens. The contamination rate was even higher in other countries.

In 2006, the Ministry for Primary Industries (MPI) implemented a hygiene system for sea containers coming into New Zealand from several Pacific Island countries that has since reduced the rate of contamination of containers from those countries by 90 per cent. This hygiene system involves inspection, cleaning, verification, training and prevention of contamination, and has resulted in a considerable reduction in infestation rates and an overall cost savings. Prior to this system, one in two empty containers arriving in New Zealand from these sources were contaminated.

Ecki has been working with MPI and the Better Border Biosecurity Collaboration to advance the development of an International Standard for Phytosanitary Measures (ISPM) to reduce the incidence of hitchhiking pests on sea containers worldwide.

In May 2016, Ecki presented a paper on his work to the Commission on Phytosanitary Measures (CPM), the governing body of the International Plant Protection Convention (IPPC), when it met in Rome. The IPPC, hosted by the Food and Agriculture Organisation of the United Nations, is responsible for setting phytosanitary standards for international trade in plants and plant products.

"We demonstrated there are considerable risks associated with sea containers moving pests and other contaminants around the world, and that the development of an international phytosanitary standard for sea containers is likely to reduce pest arrivals and establishments substantially," says Ecki. "An international standard is likely to provide economic net benefits as a result of avoided damages caused by invasive species and other contaminants being transported with sea containers.

"This would be of considerable benefit to MPI, shipping companies and exporters not only in New Zealand but worldwide."

While the CPM delegates made the decision to take more time to develop an ISPM, they agreed the risks warranted action. In the meantime the effectiveness of voluntary measures will be explored, and the ISPM will be revisited in five years.

The MPI Director for Plants, Food & Environment, Peter Thomson says, "While the risk from sea container contamination is obvious to New Zealand, many countries either don't understand the risk, or believe it's just too hard to manage. Having Dr Brockerhoff present his findings to the 182 member countries of the IPPC was instrumental in gaining sufficient support to continue the work to better manage this risk at an international level".

MPI, Australian Department of Agriculture and Water Resources, USDA Animal and Plant Health Inspection Service (APHIS) and Forest Service (FS), China Inspection and Quarantine Service

MPI, MBIE, Scion Core



*Dr Eckehard Brockerhoff presenting to the Commission on Phytosanitary Measures, in Rome.*
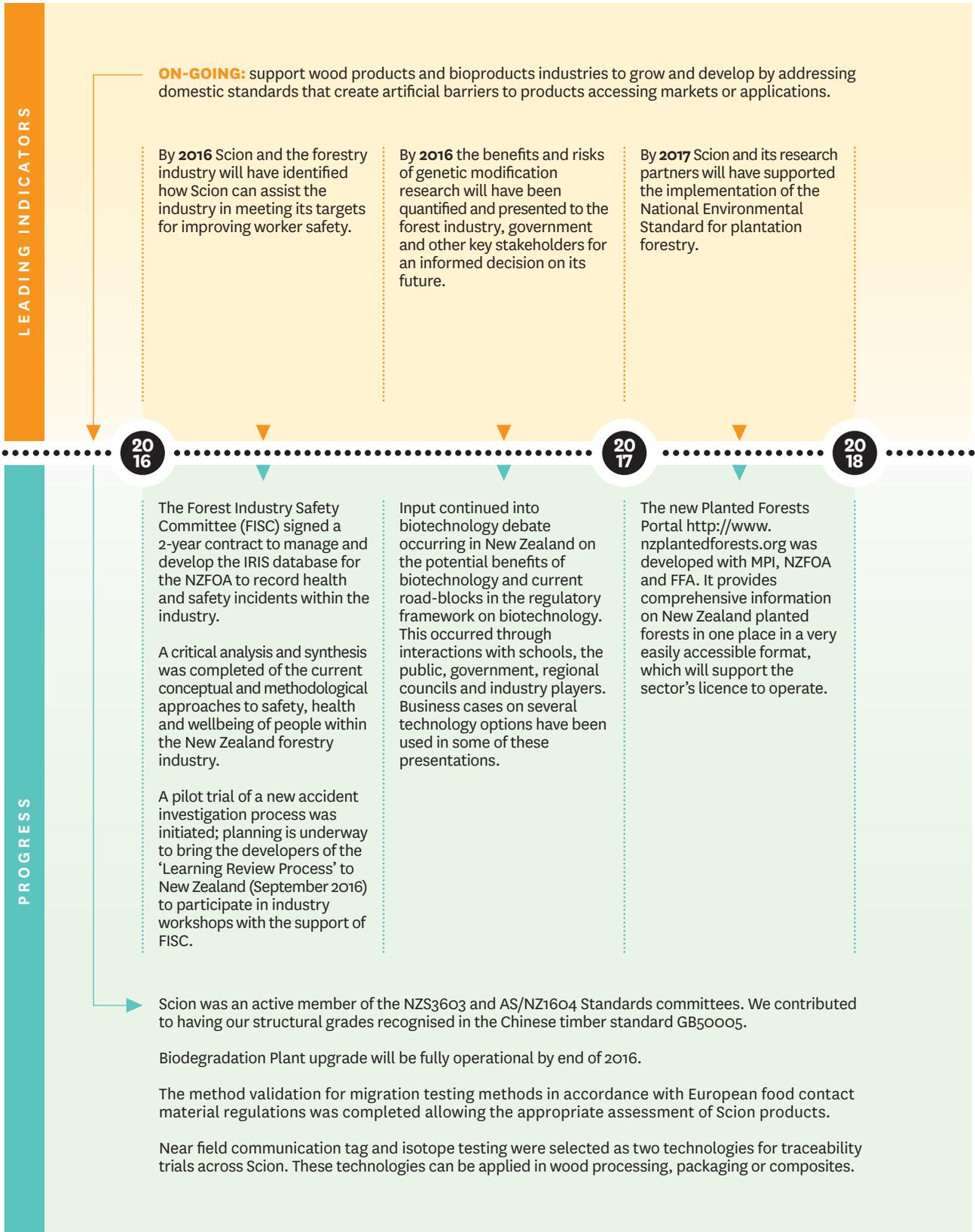
# Licence to operate

**IO6** Impact KPI-**9**

***Social licence to operate, standards and traceability.*** *By 2019 Scion has supported the industry to enhance its social licence to operate.*

## LEADING INDICATORS

**ON-GOING:** support wood products and bioproducts industries to grow and develop by addressing domestic standards that create artificial barriers to products accessing markets or applications.

By **2016** Scion and the forestry industry will have identified how Scion can assist the industry in meeting its targets for improving worker safety.

By **2016** the benefits and risks of genetic modification research will have been quantified and presented to the forest industry, government and other key stakeholders for an informed decision on its future.

By **2017** Scion and its research partners will have supported the implementation of the National Environmental Standard for plantation forestry.

**2016** — **2017** — **2018**

## PROGRESS

The Forest Industry Safety Committee (FISC) signed a 2-year contract to manage and develop the IRIS database for the NZFOA to record health and safety incidents within the industry.

A critical analysis and synthesis was completed of the current conceptual and methodological approaches to safety, health and wellbeing of people within the New Zealand forestry industry.

A pilot trial of a new accident investigation process was initiated; planning is underway to bring the developers of the 'Learning Review Process' to New Zealand (September 2016) to participate in industry workshops with the support of FISC.

Input continued into biotechnology debate occurring in New Zealand on the potential benefits of biotechnology and current road-blocks in the regulatory framework on biotechnology. This occurred through interactions with schools, the public, government, regional councils and industry players. Business cases on several technology options have been used in some of these presentations.

The new Planted Forests Portal http://www.nzplantedforests.org was developed with MPI, NZFOA and FFA. It provides comprehensive information on New Zealand planted forests in one place in a very easily accessible format, which will support the sector's licence to operate.

Scion was an active member of the NZS3603 and AS/NZ1604 Standards committees. We contributed to having our structural grades recognised in the Chinese timber standard GB50005.

Biodegradation Plant upgrade will be fully operational by end of 2016.

The method validation for migration testing methods in accordance with European food contact material regulations was completed allowing the appropriate assessment of Scion products.

Near field communication tag and isotope testing were selected as two technologies for traceability trials across Scion. These technologies can be applied in wood processing, packaging or composites.

## The choice to use *new genetic techniques*

New Zealand has a restrictive regulatory environment governing the development and use of genetically modified organisms (GMOs). In comparison to many other advanced countries, the current legislation in New Zealand does not support recent technology developments, such as gene editing, and is out of step with global regulatory trends.

Genetically modified organisms are defined differently around the world. New biotechnology techniques that have been defined as GMOs in New Zealand, and are therefore heavily regulated, are not always considered GMOs in other countries. This results in biotechnology products - many of which cannot be distinguished from naturally occurring products - being produced and exported from some countries and not being identified as GMOs upon importation into New Zealand, but New Zealand producers are unable to produce, sell or export the exact same product.

Internationally, genetically modified forest crops are beginning to be released and grown, with impressive benefits demonstrated. Suzano and Futuragene's modified eucalypts have demonstrated a 20 per cent productivity gain and have been approved for release in Brazil. These trees are produced for fibre that competes in the heavily competitive pulp and paper industry against New Zealand manufacturers.

The New Zealand Forest Owners Association has indicated publicly through the media and council submissions that the forest industry

has immediate need for several traits that would be available through GMO or gene editing technologies. In particular, the association supports the decisions concerning the testing and release of new genetic technologies being made by the Environmental Protection Authority (EPA) rather than by regional bodies under the Resource Management Act.

Scion's activities in this area primarily support evidence-based decision making that is in tune with global regulatory trends. Our prime motivation is to support the New Zealand forest industry's freedom to operate and remain internationally competitive with respect to GMO options and to ensure New Zealand has options for the future.

Findings of a report recently commissioned by Scion, show that genetically engineered trees with a range of traits, such as faster growth, improved wood quality and herbicide tolerance, could transform New Zealand's plantation forestry and add over $6.5 billion to the country's GDP by 2051.

The ability to generate sterile trees as a solution to the rising wilding pine

problem is also of interest to the industry, and one that could significantly offset the estimated $750 million cost of restoring wilding affected ecosystems.

Input continues into the biotechnology debate in New Zealand around the potential benefits and the current road blocks in the regulatory framework. Scion's engagement with industry, Māori, government and regulatory bodies in this matter is ongoing, and we support industry in their discussions with Government and regulatory authorities, such as the EPA.

This year, Scion has also provided evidence to the Auckland Unitary Plan hearing on GMOs and the Hazardous Substances and New Organisms Act (HSNO), and made a number of high level submissions to other councils and regulatory authorities regarding the inclusion of genetic engineering options in national forestry standards, regional development plans and in updated HSNO Act regulations.

$ Scion Core

## Helping industry with a *slippery problem*

A proactive and innovative approach by NMR Scientist Dr Stefan Hill helped a major New Zealand fruit exporter overcome a slippery manufacturing glitch that may have resulted in a financial loss for the company, and possible health-related issues for consumers.

When asked by the exporter to identify a greasy substance found on some of the packaging, and its potential to contaminate the fruit, Stefan developed an easy screening approach using UV light that the exporter was able to adapt for use in the packhouse. This enabled large volumes of product to

be screened and segregated quickly on site. Further chemical testing identified the contaminant as machine grease, and ascertained that it had not penetrated the skin of the fruit.

Scion's innovative science meant the whole shipment of fruit was subsequently able to be sorted and cleared for export.

# Working in *partnership with Māori*

Scion continues to build and develop robust partnerships with Māori stakeholders whose interests are growing across the forestry value chain.

Māori own some 40 per cent of the land on which commercial forests are planted and want to participate more actively with forest growing and wood processing in order to achieve greater economic returns and social benefits.

Māori are keen to explore forestry options for under-developed land including new forestry opportunities based on indigenous species, either through new forest plantings of, for example tōtara or kauri, or through the sustainable management of existing indigenous forests on their land.

The emerging bioeconomy provides new prospects for Māori to utilise their renewable energy resources; realising the synergies between Māori owned forests, food and tourism businesses (food packaging); and the opportunity to play a direct role in the development and manufacture of industrial bioproducts.

Highlights from our partnerships with Māori in 2015-16 included:

- Working closely with Tangata Whenua Roopu Te Tai Tokerau to develop solutions for kauri dieback disease.

- Continuing to build our partnerships in Northland, providing new forestry investment opportunities through tōtara, mānuka and alternative exotics such as Douglas-fir and eucalypts.

- Supporting capability building with a Māori forestry operation to facilitate a GIS specialist from Ngāti Tuwharetoa to design and undertake precision forestry research to assist commercial decision making.

- The development of a commercial partnership with Ngāti Whare focussed on the vegetative propagation of podocarps for indigenous forest restoration.

- A significant multi-year research programme with Ngāti Porou to develop adaptive governance tools to improve land resilience for at-risk Māori land within the Waiapu Catchment. We are also working with East Coast iwi to develop assessment tools to identify land suitable to grow mānuka for honey and oil.

The Scion Māori Partnership Plan 2016-17 provides the framework for our work with Māori for the year ahead, and pathway to achieving three overarching strategic goals:

1. To increase land utilisation and productivity.
2. To derive benefit from diversification and indigenous species.
3. To grow Māori participation in the bioeconomy.

Our partnerships with Māori are built on trust, understanding, regular communication and the delivery of services that solve problems and discover valuable new opportunities.
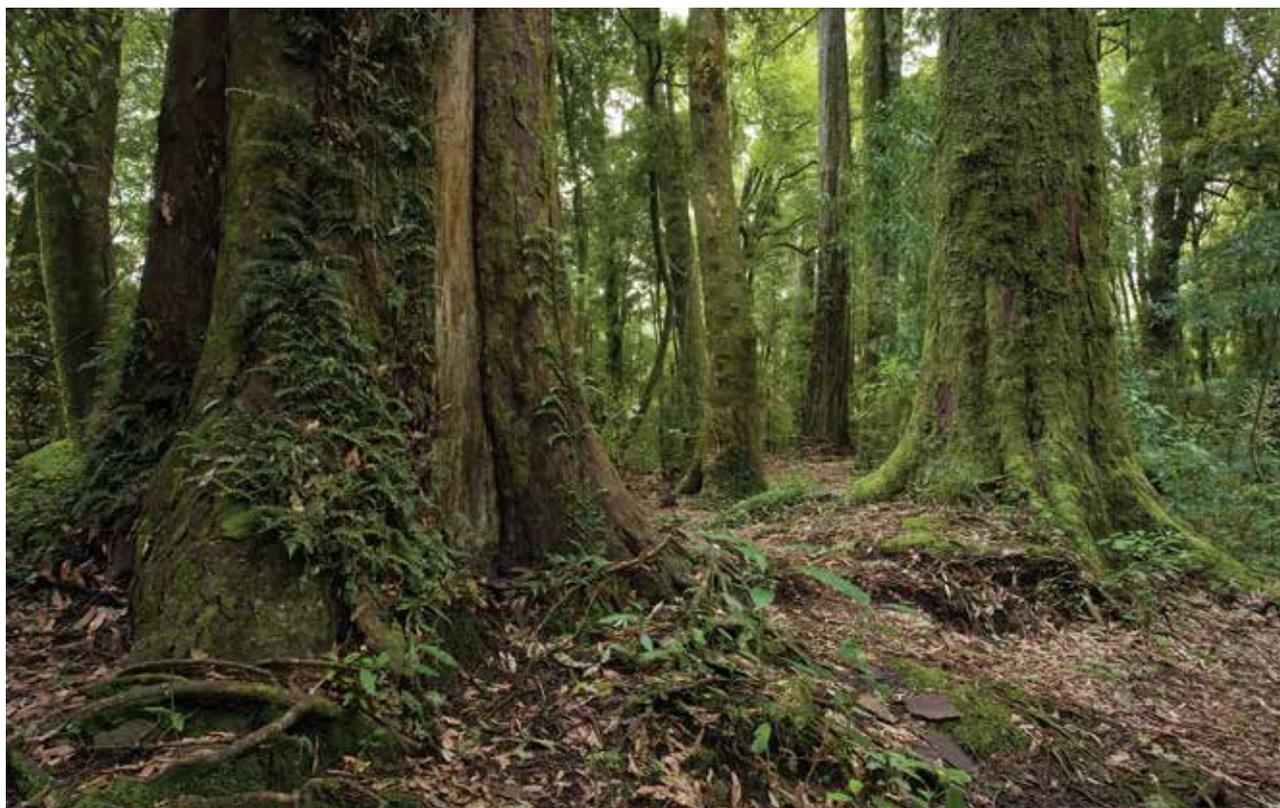
# Research *collaborations*

Scion is adept at assembling multi-disciplinary teams through strong national and international collaborations. Our international reach is extensive and through such collaborations and networks our scientists stay at the forefront of the latest thinking, novel approaches and technology advances. Building on these linkages is critical for Scion to remain at the forefront of innovation and competitive in the global market. Our presence and influence in key networks and collaborations locally is well recognised and embedded in our research programmes.

**On the global stage.** Scion and the VTT Technical Research Centre of Finland are collaborating on exciting research at the leading edge of global trends, such as novel carbon materials, nanocellulose applications, biorefineries and pulp, paper and packaging – areas of huge interest to high-value manufacturers and the bioeconomy opportunity.

To cement the collaboration, Scion signed a research collaboration agreement with VTT in March 2016. The agreement sets a clear path for Scion to focus on co-invention and commercialisation of technologies that will contribute to increased use of climate friendly, lightweight, high performance materials made from forest biomass.

New Zealand, through Scion, will get better access to global opportunities in the bioeconomy. Both organisations have complementary science and technology capabilities and a good history of joint work. Under the agreement, we will also jointly target EU funding and approach global opportunities in the bioeconomy, particularly in Asia.

The first project conducted under the agreement will adapt VTT technology for hardwood trees and apply it to New Zealand radiata pine to develop a new biobased film for the packaging industry.



*Dr Elspeth MacRae signing a partnership agreement with Belgium-based VITO.*

VTT CEO Dr Antti Vasara said, "The bio and circular economy are global hot spot areas with huge technology potential where VTT and Scion can combine their competencies and work together to open up new commercialisation opportunities. With this agreement we are also happy to see Scion as our partnering organisation in New Zealand better serving industry for the benefit of all."

🌐 http://www.vttresearch.com

Scion became one of the first international partners in 'Brilliant', an online portal for innovative clean technologies established by Belgium-based research organisation VITO. The portal is the first of its kind, designed to connect companies with developers of innovative technologies addressing sustainable business needs.

General Manager Bioproducts and Manufacturing Dr Elspeth MacRae says

that Scion was selected by VITO as one of the first international partners for Brilliant because of our innovative mindset and our ability to operate internationally. "We are very excited to be part of this community of innovation-driven organisations. The portal will provide an excellent shop window to the patents and technology developments we list there and bring us closer to each other's markets."

Brilliant was set up by VITO in late 2015 to offer entrepreneurs new technologies and products developed and protected by VITO itself or in partnership with other Flemish research centres.

"Joining Brilliant is a good move for Scion," said Elspeth. "It will hugely increase our exposure to European markets and provide a new route to commercialisation for our bio-based products and clean technologies, such as our coatings technologies."

🌐 https://brilliant.vito.be/en

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# Reaching out

## Publications and Collaborations

**119** Scientific papers published

**26** papers published in Vol 45 of the *New Zealand Journal of Forestry Science*
**109** collaborations with universities and research institutions internationally
**15** formal collaborations with Māori
**5** National Science Challenges

www.scionresearch.com/ar16/collaborations

## Tech Translation

**362** External presentations

**269** commissioned reports
**9** programme newsletters
**149** conference papers (written and verbal)
**10** Forest Health News
**12** popular articles and videos
**12** events sponsored
**4** issues of *Scion Connections*

www.scionresearch.com/ar16/techtranslation

## Outreach

**200** Rare white ngutukākā raised

**45** interns and students hosted
**300** interactions with students at school or on campus
**5** winning students hosted for a day
**46,007** unique visitors to our website
**1892** followers on LinkedIn
**1180** subscribers to *Scion Connections*
**452** followers on Twitter

www.scionresearch.com/ar16/outreach

## Awards and Accolades

**4** Major industry awards

The 'Paua Power' video about Scion's novel 3D-printed paua biocomposite won the biobased products video challenge at the inaugural ECO_BIO 2016 conference

**1** John Lloyd received the Appita LR Benjamin Medal for his notable contribution to the Australian and New Zealand pulp and paper industry

**2** TERAX® 2013 Ltd won a 2015 New Zealand Innovators Award

**3** Scion and Sonae Indústria won a 2016 KiwiNet Research Commercialisation Award

**4** Dr Brian Richardson received the New Zealand Institute of Forestry (NZIF) Forester of the Year Award

www.scionresearch.com/ar16/achievements

# Financial results *summary*

**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 Minister.

**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.)

|  | 2014 Actual | 2015 Actual | 2016 Budget | 2016 Actual |
|---|---|---|---|---|
| Revenue, $m | 48.14 | 47.34 | 49.33 | 49.60 |
| EBIT, $m | 4.28 | 3.27 | 2.20 | 2.28 |
| EBIT Margin | 8.9% | 6.9% | 4.5% | 4.6% |
| Reinvestment, $m | 0.75 | 0.80 | 1.30 | 1.35 |
| EBIT-R, $m | 5.03 | 4.07 | 3.50 | 3.63 |
| EBIT-R Margin | 10.5% | 8.6% | 7.1% | 7.3% |
| Total Assets, $m | 43.70 | 46.31 | 48.01 | 48.11 |
| Return on Equity | 9.4% | 7.3% | 4.7% | 5.2% |
| Pre-reinvestment Return on Equity | 11.1% | 8.9% | 7.3% | 7.8% |
| Equity Ratio | 72.0% | 74.1% | 73.6% | 75.1% |
| Dividend, $m | 0.0 | 0.0 | 0.0 | 0.0 |
| Gearing | 0.0% | 0.0% | 0.0% | 0.0% |



**Where our revenue comes from**

- 25% Ministry of Business, Innovation and Employment (other)
- 36% Ministry of Business, Innovation and Employment (core)
- 8% Government departments
- 31% Other commercial
- 1% Interest



**How our revenue is spent**
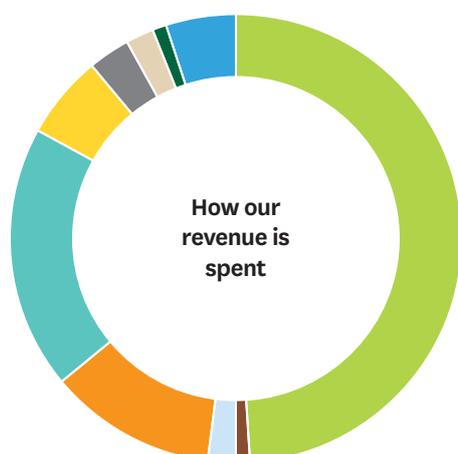
- 49% Employee remuneration
- 1% Training and recruitment
- 2% Consumables
- 11% Depreciation and amortisation
- 19% External services and contractors
- 6% Premises costs
- 3% Travel
- 2% Other operating costs
- 1% Non operating costs
- 5% Net profit before tax

# Glossary

| | |
|---|---|
| BPA | Bioresource Processing Alliance |
| CNI | Central North Island region |
| DOC | Department of Conservation |
| EPA | Environmental Protection Authority |
| EU | European Union |
| FFA | New Zealand Farm Forestry Association |
| FGLT | Forest Growers Levy Trust |
| FFR | Future Forests Research Ltd |
| FIF | Forest Investment Finder |
| FISC | Forest Industry Safety Committee |
| GCFF | Growing Confidence in Forestry's Future research programme |
| GDP | Gross Domestic Product |
| GHG | Greenhouse gas emissions |
| GIS | Geographic Information Systems |
| GM | Genetic modification |
| GMO | Genetically modified organism |
| HSNO | Hazardous Substances and New Organisms Act |
| IPCC | Intergovernmental Panel on Climate Change |
| IPPC | International Plant Protection Convention |
| IRIS | Incident Recording Information System |
| IRR | Internal rate of return |
| IP | Intellectual Property |
| IUFRO | International Union of Forest Research Organizations |
| LiDAR | Light detection and ranging |
| KIER | Korea Institute of Energy Research |

| | |
|---|---|
| MAI | Mean Annual Increment |
| MBIE | Ministry of Business, Innovation and Employment |
| MfE | Ministry for the Environment |
| MPI | Ministry for Primary Industries |
| NuBalM | Scion's Nutrient Balance Model |
| NOF | National Objectives Framework |
| NPV | Net present value |
| NRFA | National Rural Fire Authority |
| NSC | National Science Challenge |
| NZDFI | New Zealand Dryland Forests Initiative |
| NZFOA | New Zealand Forest Owners Association |
| NZFS | New Zealand Fire Service |
| PGP | Primary Growth Partnership |
| RFA | Rural fire authority |
| RNC | Red needle cast |
| RPBC | Radiata Pine Breeding Company |
| Scion Core | Scion Core Funding |
| SLMACC | Sustainable Land Management & Climate Change Research Programme |
| SWEL | Southwood Export Ltd |
| SWP | Specialty Wood Products Research Partnership (FGLT, SWEL, JML, NZDFI, FFA, Ernslaw One, Te Tumu Paeroa, Timberlands, City Forests, Blakely Pacific, Wenita Forest Products, Forest Products Commission of Western Australia) |
| UNFCCC | United Nations Framework Convention on Climate Change |
| USDA | United States Department of Agriculture |
| WEIS | Wood Energy Industrial Symbiosis |

Collaborators/Partners          Investment          Website

# Science

## Science
New Zealand

New Zealand's
Crown Research Institutes

**Grant Pearce**
Fire Scientist
and Scion Rural Fire Research
Team

# Science
## working for
## New Zealand

**SCION** is proud to be a
Crown Research Institute. Together we represent the insight
and commitment of 3,500 people - using science for a more
prosperous, sustainable and innovative New Zealand.

**ag**research

Ξ/S/R THE SCIENCE BEHIND THE TRUTH

GNS SCIENCE TE PŪ AO

Landcare Research
Manaaki Whenua

N-I-WA
Taihoro Nukurangi

Plant & Food
RESEARCH
RANGAHAU AHUMĀRA KAI

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FORESTS ■ PRODUCTS ■ INNOVATION