



RIGHT TREE, RIGHT PLACE, RIGHT PURPOSE

Annual Report 2019

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 for the year ended 30 June 2019.

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

Our Annual Report is also available in digital format at
www.scionresearch.com/annual-reports

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SCION ■ **CONTENTS**

At a glance	2
Vision, mission and strategy	3
Chair and Chief Executive overview	4

PARTNERING

Co-innovation and partnering with Māori	6
Collaborating for impact	11

DELIVERING

Research highlights	14
---------------------	----

SHARING

Outreach and technology transfer	26
----------------------------------	----

EXCELLING

Awards, achievements and accolades	27
------------------------------------	----

ACHIEVING

Meeting our science and innovation goals	29
Financial results summary	38

Operating revenue:

\$55.9m
Last year: \$56.7m

Total comprehensive income:

\$1.7m
Last year: \$2.3m

Return on equity:

3.9%
Last year: 5.7%

Full-time equivalent staff:

329 295 Rotorua
2 Wellington
32 Christchurch
(includes fixed-term, student and postdoctoral staff)

Published refereed papers:

144 76.36 rolling
5-year weighted
average H-index

Commissioned reports to users:

250



Watching our trees grow from space, p.16



Battling exotic pests in urban environments, p.15



Identifying outstanding genetics in a snip, p.18



Infusing pine with natural durability, p.21

Our core purpose

“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.”

Our vision

Prosperity from trees - Mai i te ngahere oranga

Our mission

Enhancing New Zealand’s prosperity, well-being and environment through trees - Kia piki te ora, te taiao me te whai rawa o Aotearoa mā te ngāherehere

Trees are remarkable, renewable resources. Planted as forests, and used in products and materials, trees have a powerful potential to be at the heart of a low-carbon, biobased future New Zealand.

In our new strategy released last year, *Right tree, right place, right purpose: Scion Strategy to 2030*, we set out three research impact areas that focus our expertise to deliver on our aspirations for New Zealand and supporting the Government’s goals.

Our research impact areas are:



Forests and landscapes. Development of healthy, resilient forests that are planted primarily for their standing-forest benefits.



High-value timber manufacturing and products. Development of products, manufacturing, high-value trees and healthy, resilient forests that capture an increasing share of the global high-end market for timber.



Biobased manufacturing and products. Development of products, processes, manufacturing, trees, other biomaterials and healthy, resilient forests to replace petrochemicals and non-sustainable materials.

Building blocks for a circular bioeconomy

Scion serves New Zealand’s entire forestry value chain from forest genetics to manufactured products derived from trees. Growing healthy, resilient forests for multiple purposes is at the heart of our aspirations for a low-carbon, biobased future New Zealand.

Underpinning our strategy is our commitment to the forestry sector, and we will continue to support the industry to address current and new challenges with impactful research, technology and knowledge.

We have been doing this for years, quietly and determinedly, and now this thinking is becoming visible in many sectors and talked about by many players who value sustainability enough to want to act now.

New Zealand, like other countries, must adapt to a world living with the effects of climate change and other major environmental challenges, such as water quality and plastics pollution. Scion is helping to address these eye-watering challenges, and our strategy refresh has led us to a new goal in which we see ourselves playing a major role in transitioning New Zealand to a circular bioeconomy.

We firmly believe this goal is achievable. New Zealand has natural competitive advantages in this approach because we grow trees and other biomass well, we have unproductive land and we have scope for new regional manufacturing infrastructure. This attractive context gives Scion the ingredients to create solutions that are technologically innovative, environmentally sustainable and designed for a circular bioeconomy. All New Zealanders ultimately will benefit when our goal is realised.

Underpinning our strategy is our commitment to the forestry sector, and we will continue to support the industry to address current and new challenges with impactful research, technology and knowledge.

Scion-developed technologies and bioproducts created from renewable forests are increasingly seen as

part of the solution for consumers and regulatory bodies looking beyond price and quality to seeking better environmental standards from products.

For example, our new biobased treatment to modify radiata pine gives the timber a durability that makes it suitable for outdoor uses. The eco-friendly treatment uses renewable materials from processing agricultural wastes instead of heavy metal-based alternatives. We are now working with partners to commercialise this technology and realise the potential for new regional jobs, increased export value and a wide range of indirect benefits to wood product manufacturers.

Our work on bioplastics and our collaborative relationship with the plastics industry brought about the announcement of a Scion-led ‘Roadmap for New Zealand’s New Plastics Economy’, which will guide New Zealand’s entire plastics sector to move to a new plastics economy based on circular principles.

Further demonstrating our commitment to a biobased future, we have invested in developing our Rotorua campus as a place where we, with industry and partners, can showcase scientific research and high-tech innovations that enable the circular bioeconomy.

Underway already, our ‘innovation hub’ itself includes innovative new wood products and has a timber-engineering wow factor. It will be the new entry point to Scion from mid-2020 and will include a public café and exhibition area, while also housing staff and

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innovation partners. This initiative is supported by the Bay of Plenty Regional Council as providing important regional economic development, and we have strong interest from businesses to be co-located in this collaborative hub with 37 tenants on site already.

With our new General Manager Māori Forestry Futures on board, we are continuing to build relationships with our Māori partners, working toward co-innovation, shared aspirations and growing the Māori economy. One exemplar this year was our collaboration with the kauri dieback mana whenua roopu, which enabled the biggest collection of kauri seed to date, providing an invaluable resource for tangata whenua and for future kauri dieback research programmes.

Our sound fiscal management during 2019 meant we were able to maintain profits by early identification of revenue shortfalls and implementation of cost

management initiatives despite weak revenue growth. Revenue was down on budget by 5.5 per cent to \$55.9 million (budget \$59.0 million), but our net profit after tax was on target at \$1.7 million (budget \$1.7 million).

Our strategy “Right tree, right place, right purpose” has set our path, our campus developments are creating the scene and our talented staff are energising the discussions. To our hard-working staff, we say a sincere thank you for your commitment to Scion, your colleagues and collaborators. And to our customers and partners, we thank you all for your support and contribution to Scion throughout the year.

We feel privileged to lead Scion in the movement towards new biobased economic opportunities for our country and to boldly take and help shape opportunities for forestry and biobased products to benefit all New Zealanders.



Dr Helen Anderson
Chair



Dr Julian Elder
Chief Executive

Co-innovation and partnering with Māori



Hēmi Rolleston (far left) and whānau arriving for powhiri at Scion on 27 February 2019.

GETTING EVERYONE ON THE WAKA

The highlight of the year was the appointment of Hēmi Rolleston (Ngāti Whakaue, Ngāi Te Rangi, Ngāti Ranginui) to a new position - General Manager Māori Forestry Futures.

Hēmi's experience in the primary industries as CEO of Māori kiwifruit business Te Awanui Huka Pak and the research and development sector as General Manager Sectors and Māori Economy plus nine months as Chief Executive at New Zealand's innovation agency Callaghan Innovation made him an ideal fit for Scion's own primary industry-based research and development.

Making a positive difference for Māori by using his skills, connections and experience in the Māori economic and innovation space is Hēmi's passion. With Māori a significant economic entity with forestry a key resource, Hēmi sees Scion being a perfect partner for Māori to achieve their aspirations through Scion's capability and experience in forestry science and innovation.

"The biggest potential is through creating collaborations with Māori looking at innovative

opportunities throughout the value chain. There is also potential to identify land use options for Māori in forestry and ensure that returns are maximised through use of innovation while balancing Māori values.

"Bringing the Māori world view into mainstream thinking and weaving in the Māori story will provide a unique point of difference. Indigenous forestry and Māori fibres provide a unique and exciting opportunity for Māori and Scion. We also need to take the tamariki of today on the journey and equip them with the skills and knowledge to provide an exciting future using this resource," he says.

Hēmi sees the biggest challenge will be changing the mindset and attitude from both Māori and in Scion. It begins with developing authentic relationships and the rest will follow with each party understanding the respective values and opportunities they can bring to the table.

"First, we must get everyone on the waka before we paddle off."

TŌTARA FORESTRY IN NORTHLAND

The Tōtara Industry Pilot (TIP) project is evaluating a potential industry based on regenerating tōtara in Northland. One year in, Scion has benefited from a partnership with a collective of Māori landowners known as Taitokerau Māori Forests Inc.

The collective initially set out as members of the steering group to diversify their existing forestry knowledge alongside Northland Tōtara Working Group and Tane's Tree Trust, other regional champions of tōtara. Bringing their Māori landowner experience, intergenerational values, traditional knowledge and relationships the collective has positively influenced the brand, culture and appeal of a tōtara industry by using a local narrative.

Such influence was shown when the TIP Steering Group used Northland tōtara timber donated by Scion on the restored floor of the Samuel Marsden Church in Matauri Bay. In January 2019, the community came together to dedicate the new floor.

Through TIP, Scion was also introduced to Ngāti Hine Forestry's tōtara breeding aspirations and has co-developed a research programme to deliver economic, environmental, social, and cultural breeding outcomes to New Zealand. An enduring relationship has developed, and we are working towards securing funding for tōtara breeding and future co-innovation and joint exploration of tōtara for carving, bioactives and ecosystem regeneration.



Photo: © Tōtara Industry Pilot Steering Group 2019

KAURI SANCTUARY AND SEED COLLECTION

When the One Billion Trees Programme launched in February 2018 Scion was invited to carry out a kauri dieback *Phytophthora agicidicida* soil assessment on Ngāti Rēhia's culturally significant kauri sanctuary site at Takou Bay, Bay of Islands. The Scion team met with mana whenua and their neighbours to scope and carry out the project. Three workshops were held to understand their aspirations and mātauranga, transfer Scion's knowledge of the killer disease and kauri forest

establishment to the people, and co-design a sanctuary for dieback-resilient kauri seedlings.

Soil tests carried out by Takou Bay rangers (rangatahi trained by hapū leaders to work on conservation) and Scion scientists showed the pathogen was not in the site. Risks were identified and communicated. A collaborative forestry management plan was delivered in December 2018, followed in January 2019 with recommendations for seed collection, collaboration with other landowners for seed crossing to improve resilience, and ongoing best practice of site hygiene and pest management to keep the disease away.

The hapū has strengthened their relationship with a broader mana whenua roopu, a collective of kauri land owners that collaborated with Scion to carry out kauri cone collection under the Healthy Trees, Healthy Futures research programme. Cones were gathered in February 2019 across 10 different sites between Kaitiāia and Tauranga including kauri trees from Takou. Some of these seeds were germinated and are currently housed in Scion's nursery. Use of the remaining seeds depends on future funding being sought by the kauri dieback mana whenua roopu and Scion to carry out a kauri restoration research partnership using seven kauri sanctuary models.



Photo: © BioSense

Rongo Bentson collecting cones, Te Rarawa.

MINGINUI NURSERY FLOURISHES

Scion’s relationship with Ngāti Whare began in 2014 to build a business case for an indigenous nursery at Minginui that included proprietary vegetative propagation techniques for certain native trees, developed by Scion. By 2016 construction of Minginui nursery had begun, and in 2017 Scion and Ngāti Whare embarked on a Vision Mātauranga Capability Fund partnership to build on Ngāti Whare’s unique relationship with the Whirinaki Forest and Scion’s success with nursery development and forest genetics.

Over the past year, Scion Nursery Researcher Craig Ford mentored Iwi Researcher Doreen Roberts, and the nursery produced rooted cuttings of native podocarps like kahikatea *Dacrycarpus dacrydioides*, miro *Prumnopitys ferruginea*, rimu *Dacrydium cupressinum* and tōtara *Podocarpus totara*. During the first stage of the research project, Craig and Doreen monitored and adjusted the growing conditions of key podocarp growing trials in the nursery. The second stage focussed on maintenance and measuring of existing nursery trials, the design and implementation of a field trial, data cleaning, interpretation of results and scientific report writing.

Through trial success and failure, we learned about

the propagation of podocarps. Further advances were made in vegetative propagation protocols for podocarp cuttings and bilateral knowledge sharing in science and mātauranga Māori.

In 2018, \$5.8 million was granted under the Provincial Growth Fund to Ngāti Whare to expand their nursery capacity from 250,000 to 1,000,000 plants per annum. As well as employing locals, the nursery was expected to draw skilled people back to the village. Immediate ramp-up to production scale was necessary and achieved through a co-management plan, with Scion’s assistance. We were also asked to provide expansion plans for the nursery, and new facilities are now underway. A new full-time nursery manager was appointed in December 2018. This project has also supplied trees to Te Uru Rākau’s One Billion Trees Programme.

The approach used by Minginui management and Scion staff highlights the broad benefits of bringing together the worlds of science and mātauranga Māori to remote forestry communities. The sharing of data, knowledge, tools, and the value to science and the community have been greatly enhanced. Fellowship and comradery has grown between the teams as the result of an enduring partnership.



Adam Matekuare and Doreen Roberts inspecting seedlings at Minginui Nursery.

TE ARAWA RESPONDS TO CLIMATE CHANGE

The Te Arawa climate change adaptation strategy is being reviewed for inclusion in the United Nations Handbook on Disaster Risk Reduction 2019.

This achievement began with a Scion/Te Arawa Lakes Trust partnership that employed a local Māori community researcher to develop and strengthen relationships, learn about climate change, and develop a profile for the project.



Guided by Vision Mātauranga Capability Fund objectives, our community researcher has strengthened relationships and developed a presence for Te Arawa as an iwi in regional and national forums. Requests were received to join national and regional climate change projects and committees, and the Minister for Climate Change James Shaw met with Te Arawa to consult over climate change. Our community researcher also contributed to The Deep South Forum 2019.

Two Scion/Te Arawa community forums were held to facilitate the co-development of climate change research that meets the aspirations of Te Arawa community. These forums resulted in nine identifiable areas of science with the potential to be further developed.

From this work, Scion and the community have the chance to develop an integrated Endeavour research programme. Together we have developed international relations with Pasifika emergency management researchers and Northern Arizona First Nations climate change adaptation group, and we are currently in conversation with First Nations groups regarding potential future projects.

DESTINATION RĒKOHU: TOWARDS A CIRCULAR BIOECONOMY FOR A REMOTE ISLAND COMMUNITY

Hosted by the Hokotehi Moriori Trust, Scion staff spent four days with other CRIs exploring Rēkohu (also known as Wharekauri) the big island in the Chatham Islands. There they met and discussed the sustainable development challenges and opportunities in this beautiful, wild and remote part of Aotearoa New Zealand.

Project managed by Scion, the visit, dubbed “Kaunaki Kōrero”, was funded by the Vision Mātauranga Capability Fund and coordinated between Hokotehi Moriori Trust and Te Ara Pūtaiao, the CRI Māori Manager’s forum.

Farming, forestry, waste management, energy alternatives to diesel, fishing, sustainable business development and disaster response plans were on the agenda. Multiple site visits took place on farms, cultural sites, and forests with emphasis on reforestation, and the One Billion Trees Programme culminating in an evening community forum facilitated by ESR’s social research team.

A report from each CRI was collated for the trust. A road trip to the mainland is planned for an island delegation in August 2019 and will include a fisheries waste (bio and plastics) collaboration discussion, a One Billion Trees workshop, heritage site visits and an invitation

to participate in a micro-abattoir forum.

Though a young collaboration, the visit hailed the beginnings of a good foundation between the Chatham Islands and the research community of New Zealand. Scion continues to be a driving force of this relationship and initiative.



Photo: © Paul Quinlan, Tane's Tree Trust 2018

BUILDING CONNECTIONS BY UNLOCKING CURIOUS MINDS

Scion has been building its relationships with next generation Māori partners thanks to funding from the Ministry of Business, Innovation and Employment’s Unlocking Curious Minds.

The history and importance of the sweet potato kūmara to Māori is being told in a novel way in a Scion partnership with Kai Rotorua. A non-profit organisation working to reconnect people with Papatūānuku (Earth mother), Kai Rotorua’s vision is to create a more resilient, well-nourished community. Te Arawa stories tell of the kūmara voyage from Hawaiiki to New Zealand where, despite trials at sea, most of the kūmara varieties made it to Maketū, and on to Mokoia Island in Lake Rotorua. There, kūmara flourished in the gardens of Te Arawa settlers.

Three years ago, Kai Rotorua initiated a project with Rotorua Boys High School that connects learning about kūmara history and mātauranga with hands-on learning about growing and harvesting.

Te Rangikaheke Kiripatea of Kai Rotorua believes that the simple activity of harvesting kūmara can be a tool to restore connection to Papatūānuku and can help the boys to maintain a sense of themselves amongst today’s

complicated and stressful lifestyles.

Students participated in a 3D modelling workshop run by Scion at the school. Rotorua Boys High School Teacher Tiahomarama Fairhall believes that the project is of great help to the boys. “Just in this short time, I have seen the benefits of Te Kete Rokiroki, especially in regard to the boys learning to harvest kūmara, learning how their ancestors grow and plant food and the science of it.”

Two more 3D printing workshops will run in August 2019 for students to learn about 3D printing technology. They will print their own designed kūmara to be installed in Kai Rotorua’s planned kūmara museum.

Also, starting with the April 2019 school holidays, Scion offered Tāne’s Tamariki “Ngā tamariki o te waonui a Tāne” STEM school holiday programme for more than 140 tamariki from forest communities in Taumarunui, Turangi, Taupō and Rotorua in association with Lake Taupō Charitable Trust, Te Rangihakahaka and Whakarewarewa Schools. The programme is inspiring interest in the dual worlds of mātauranga Māori and science and continues into the July and October 2019 school holidays.



Dr Ali Nazmi with students participating in a Kai Rotorua project bridging mātauranga Māori and western science.

LAND USE TRANSITION AND SPECIES SELECTION ON NGĀTI AWA HERITAGE FARM

A six-month land use analysis funded through the Whenua Māori Fund was completed on Ngāti Awa Farm in 2019. The landowners wanted Scion’s help to lift the productivity of the drystock farm, a commercial asset owned by Ngāti Awa rūnanga.

The project took place in two stages: listening to and sharing ideas with the farm managers, Ngāti Awa Group Holdings Limited; and then GIS analysis applied to slope, soil, water, climate and current land use. The resulting report discussed how mosaic tree cropping in

the right place and application of the right silviculture can produce forests that have purpose providing multiple horizons of income alongside the existing farm operation.

A third stage planting project would combine forestry science and landowner aspirations to lift farm productivity inside seven years through to 100 years, and beyond, while restoring native species and increasing landscape biodiversity. This stage would require both standard and experimental forestry methods.

Collaborating for impact

NATIONAL SCIENCE CHALLENGES

New Zealand's National Science Challenges are tackling the big science-based issues and opportunities facing the country. Scientists involved report they have been challenged to work quite differently – to be collaborative, to work across disciplines and co-develop science with a broad range of stakeholders.

Scion scientists are working on six of the challenges, along with other top scientists from Crown research institutes, universities and other research bodies.

The **Building Better Homes, Towns and Cities** challenge aims to improve the quality and supply of housing and create smart and attractive urban environments. Scion is working with Toi Ohomai Institute of Technology on its Toitū te Kāinga, Toitū te Ora, Toitū te Tangata (sustainable homes, healthy people) research project. Other partners and collaborators include the Matekuare Whānau Trust, Unitec Institute of Technology, and Tallwood (an Auckland-based design and prefabricated-construction company). The project aims to improve housing quality and functionality and thus the health and wellbeing of the Matekuare whānau.

Scion has modelled the heat and moisture flows in three case study buildings. An efficient thermal envelope helps create a healthy and comfortable home and reduces costs over a building's lifetime. The results of the modelling are being incorporated into a concept building designed by Tallwood. The final design will be tested for buildability and ultimately constructed on site by the Matekuare Whānau Trust.

The **Deep South Challenge** aims to understand how New Zealand's climate could change in the future and how this could affect key economic sectors including forestry infrastructure and natural resources.

Scion and researchers from Maanaki Whenua Landcare Research, MPI, University of Maine and He Oranga mō Ngā Uri Tuku Iho Trust have modelled the potential impact of climate change on erosion and identified the optimal areas to be afforested to achieve erosion-reduction goals in Te Tairāwhiti (East Coast). Their work showed that, over time, planting the right mix of tree species to sequester carbon and stabilise vulnerable land would bring environmental and economic benefits that would provide for future generations. It was also clear that climate change uncertainty, and its effects on future erosion patterns, need to be accounted for in policy making to ensure that public environmental investments such as the Erosion Control Funding Programme and Te Uru Rākau's One Billion Trees Programme are successful.



Annual industry day for SFTI 3D printing spearhead project.

New Zealand's big high-tech challenges are being tackled by the **Science for Technological Innovation (SFTI)** challenge. Scion is leading the Spearhead project: *Additive manufacturing and 3D and/or 4D printing of bio-composites* in the materials, manufacturing and applications portfolio.

Additive manufacturing will harness New Zealand's natural resources to create new, more environmentally friendly materials. Novel biopolymers and developing 3D and 4D printing technology has the potential to produce everything from architectural structures to furniture.

New Zealand is well-placed to play a leading role in the bioplastics revolution because of the numerous sustainable feedstocks available to us, including wood fibre, harakeke and by-products from primary industry. Our thriving manufacturing sector is also increasingly experimenting with 3D and 4D printing techniques to use natural polymers such as proteins, cellulose and lignin.

Scion is working with five New Zealand universities, AgResearch, GNS and industry. The team aims to have at least two 4D product prototypes ready to go by 2025 that support both the circular bioeconomy sector and the fast-growing Māori economy.

At the heart of **Resilience to Nature's Challenges** is enhancing New Zealand's ability to anticipate, adapt and thrive in the face of ever-changing natural hazards. The Scion-led project Resilience to Wildfire challenges involves Northland communities in wildfire-prone areas to develop risk awareness and a better understanding of Māori perspectives and practices for fire management.

Scion is also contributing to documenting and exploring the ways in which rural communities are recovering from the Kaikoura Earthquake. The insights from this work, not only with the communities but also

transient populations like tourists and seasonal workers, have the potential to inform preparedness and resilience-building initiatives elsewhere in New Zealand.

Working with the High Impact Weather team and Heritage New Zealand, Scion researchers will be mapping severe projections such as tropical cyclone paths, and cultural heritage sites on the country's landscape. The team will work with willing communities identified as highly vulnerable to future severe weather to enable them to plan, prepare and mitigate potential losses of heritage sites, homes and infrastructure. Ultimately, integrating local and traditional knowledge and values into improved natural hazard resilience strategies and solutions will benefit all New Zealand communities.

Protecting and managing New Zealand's biodiversity through improving our biosecurity is the aim of **New Zealand's Biological Heritage** challenge, as well as enhancing our resilience to harmful organisms. Scion is working collaboratively with other Crown research institutes, universities and others on several projects including combatting kauri dieback and myrtle rust, which is threatening indigenous plants, like ramarama, pōhutukawa and mānuka.

In a best-case scenario, pests would be stopped before they enter the country. A project led by post-doc fellow Rebecca Turner is using modelling and insect interception data to predict which insects are likely to invade next. Her research is partially funded by Te Pūnaha Matatini and the team includes researchers from Scion, B3 and the University of Canterbury.



Nursery technician Rob Fraser with kauri seedlings.



Myrtle rust on ramarama fruit.

Our Land and Water focuses on enhancing the production and productivity of New Zealand's primary sector, while maintaining and improving the quality of the country's land and water for future generations.

Scion is involved in an economic development project for Te Hiku lands with the objective to develop a framework to assess the socio-economic implications of land use change and investment into alternative processing infrastructure on rural Māori communities.

The land returned to Te Rūnanga o Ngāi Takoto, Te Rūnanga o Te Rarawa and Te Rūnanga o Te Aupouri (or Te Hiku collective) under treaty settlement includes 20,000 hectares of pine forests and some farms. While these assets provide regular cash flows, the collective is determined to build on them to develop a diversified resource base to meet iwi development objectives.

Scion built a prototype framework using radiata pine and a mixture of existing land use to assess current forests (exotic and indigenous) and to identify areas for forestry expansion on settlement and Te Ture Whenua land. Another model, the Primary Value Chain Model, looked at forests, wood flows, high value processing options and markets in Northland. A third piece of work is the Te Hiku Computable General Equilibrium (CGE). This is the first dynamic and multi-regional CGE model built to assess post-settlement development scenarios that explore pan-tribal ownership and management initiatives.

Beyond this initial investigation, the Te Hiku collective is interested in assessing the impacts of a diversified land use portfolio that potentially captures mānuka honey and oil, indigenous forestry, horticulture, vegetables and extending pastoral farming into higher value options (e.g. dairy sheep).

INTERNATIONAL CONNECTIONS

Scion's international reach is wide and deep, ranging from formal organisation-to-organisation agreements to scientist networks. Our scientists remain at the forefront of current knowledge, new approaches and technological advances through these collaborations and networks as the examples here show.

New biochemicals from lignin. Scion has a formal collaboration with VITO (Flemish Institute for Technological Research in Belgium) to accelerate the development of biochemicals from lignin. Lignin is a potentially rich source of aromatic chemicals currently derived from petrochemicals. As a first step, the lignin is broken into useful chemical building blocks. These need to be separated out and then rebuilt into new, high-value products.

Scion and VITO are each funding a postdoctoral fellowship following the very successful initial fellowship that was joint funded by the EU and The Flanders government. The new fellows began in January 2019 and will each spend time at both VITO and Scion continuing work on lignin processing and development of new compounds and products.

An annual face-to-face meeting is part of the Scion-VITO collaboration agreement. Scion hosted Walter Eevers, VITO Director of Research, in September 2018.

Creating new materials and products from bark. Bark biorefinery technologies provide a new economic opportunity to convert bark – an underutilised waste stream of around 2.3 million tonnes annually – into a range of high-value materials and products.

In a new five-year Scion-led bark biorefinery programme, supported by the Ministry of Business, Innovation and Employment's Endeavour Fund, we are collaborating with VTT (Finland), Fraunhofer IGB (Germany), as well as the University of Lisbon ITQB NOVA (Portugal) and Auckland University of Technology. By 2023, we aim to have made crucial steps towards the development of a demonstration plant. The vision is for the biorefinery concept to be applied to many of New Zealand's biomass streams with regions running their own biorefineries producing high-value environmentally friendly products. Both VTT and Fraunhofer have organisational collaboration agreements with Scion.

International Plant Phenotyping Network. Scion became a member of the International Plant Phenotyping Network (IPPN) in 2018. The IPPN is a global network with the aim of promoting joint science and research in plant phenotyping, increasing the visibility and impact of plant phenotyping and fostering communication between stakeholders and the public. Scion is to lead a global forest working group and will contribute to the development of remote phenotyping skills.

Working with Ellen MacArthur Foundation. The Ellen MacArthur Foundation is a UK-based charity that aims to build a positive future through the framework of a circular economy. The foundation co-hosted its first Pacific Summit with the Ministry for the Environment in partnership with Scion and Te Arawa in early April 2019.

The Ōhanga Āmiomio Pacific Summit was held at Te Puia in Rotorua and focused on the new approaches to a circular economy that could be unlocked when economics meets mātauranga Māori and other indigenous worldviews. Kōrero on mātauranga focused on shifting emphasis from caring about the environment, to caring for the environment, moving from a human-centric view point to one incorporating wairua and discussing if circular economy would be better described as a spiral economy with regeneration and growth.

Scion has long been promoting the benefits of a circular bioeconomy. A sign of our growing relationship with the Ellen MacArthur Foundation was the invitation to Dr Florian Graichen, Scion Science Leader Biopolymers and Chemicals, to present at the annual Ellen MacArthur Summit in London, June 2019.

Bioeconomy forums. Dr Elspeth MacRae is a member of the international advisory council for the Global Bioeconomy Summit 2020 (led by Germany) that is currently planning the 2020 meeting in Berlin. The EU-led International Bioeconomy Forum has also progressed its interest group activities. Scion, representing New Zealand, has joined Canada as co-chair of the forest working group. The Ministry of Business, Innovation and Employment is leading the precision in food activity, and New Zealand is participating in the microbiome activity (led by EU) and bioeconomy indicators group.



Growing forest productivity using remote sensing and data science

Understanding the drivers of productivity is essential for forest managers. A forest phenotyping platform has been developed that allows forest managers to do just that.

The platform is a group of technologies that form a base to create new and meaningful information about genetics, environment and site. Scion's phenotyping platform includes forest management data, remotely sensed data from whole forests, machine learning and modelling approaches.

Using this platform, Scion has determined that the underlying genetics of a forest stand is one of the major factors that underpins the stand's productivity.

The remotely sensed data within the platform can also be used to identify individual high-performing trees in a forest. This is a unique and important tool that could help optimise tree management and select resistant trees in the event of a major pest or disease incursion, for example.

Results also show that forest productivity can be improved by identifying and breeding more of the best performing trees and eliminating the worst performing trees.

This tool has already influenced how forests are managed in New Zealand, and the concept can be applied to smaller forests using available forest inventory data.

Read the full story at scionresearch.com/2019phenotyping

Funders Ministry of Business, Innovation and Employment, Forest Growers Levy Trust

Collaborators Forest Growers Research, Kaingaroa Timberlands



Step change in biosecurity tools for urban environment

Urban environments are arguably the toughest battlegrounds in the war for biosecurity. Scion has recently created new concepts and a suite of tools for the busy urban environment.

The team built a portable, lightweight, live insect electroantennogram (EAG). It can sense pest insect pheromones and send data in real time to a laptop located up to several hundred metres away. The EAG has the potential to dramatically improve likelihood of eradication by finding individual infestations.

Reducing pesticide use is a priority in the urban environment, and new tools are needed for precision spraying. A new protocol has been created for helicopter spot spraying that can deliver pesticide to a single tree at a time. The team has also been developing similar protocols for UAVs (unmanned aerial vehicles).

A model that simulates an incursion is another output. The model identifies how many and which host plants need to be treated or removed to drive a pest towards eradication. This knowledge will inform early incursion response strategies and enable strategies that minimise pesticide use, while increasing the probability of eradication.

Community communication and engagement is key during incursion responses. New models to improve community engagement were co-developed and tested with Ministry for Primary Industries' (MPI) Surveillance and Investigation Team and supported MPI's response during the myrtle rust outbreak.

Read the full story at scionresearch.com/2019urbanbattlefield

“We’re [MPI] very interested and supportive of this work, and the programme as a whole, as it will enable more effective biosecurity responses in very challenging environments.”

Dr Veronica Herrera,
Director Diagnostic and Surveillance Services at Biosecurity
New Zealand, Ministry for Primary Industries

Funders Ministry of Business, Innovation and Employment, Better Border Biosecurity

Collaborators Institut national de la recherche agronomique (INRA), Chargé de recherche CNRS, Canadian Forest Service, Forest Research UK, US Forest Service, Agricultural Research Service, Continuum Dynamics, University of Auckland, Manaaki Whenua Landcare Research, PPCNZ





InSAR remote sensing data fills niche for forest inventory

Remote sensing is a great way to learn more about our forests and manage them accordingly.

Scion is exploring new methods to capture information, such as SAR (Synthetic Aperture Radar).

Remote sensing involves recording data about an object, without making contact with the object. Interferometric SAR (InSAR) satellite technology is one method that has been used to perform forest inventory overseas, but this study is the first time it has been used on the challenging, dense canopies of radiata pine in New Zealand's mountainous terrain.

The study found that while lidar is still much more precise for predicting forest attributes, InSAR has several other benefits to consider.

InSAR uses radar to sense data and as such, data capture isn't affected by cloud cover and can take place day or night. InSAR is also very cost effective at \$0.16 per hectare to gather data, whereas lidar is between \$3-16 per hectare.

Results shows that InSAR could fill a niche for forest managers for whom very high precision is not a primary concern or for large-scale assessment of areas where other data sources are unavailable or too expensive. There is also room for the models to improve with future optimisations that the team are working on.

Read the full story at scionresearch.com/2019remotesensing

Funders Forest Growers Levy Trust
Collaborators Swedish University of Agricultural Sciences





Search for kauri resistant to dieback grows with landmark seed collection

The search for kauri resistant to kauri dieback reached new heights this year, with a momentous collection of kauri seed. Seed (encased in cones) was taken from 650 trees, making it the biggest collection that has taken place as part of the Healthy Trees, Healthy Future programme (HTHF).

The coordinated collection involved 14 mana whenua groups working with researchers and BioSense to climb into the canopy and harvest seed from trees across the upper North Island.

Following the protocols established through the HTHF programme, the kauri seed is being raised in Scion's specially designed kauri polyhouse where strict hygiene precautions ensure it stays free of kauri dieback. At 15 months of age plants are transferred to Manaaki Whenua Landcare Research's Auckland campus where they are exposed to *Phytophthora agathidicida*, the kauri dieback pathogen. Researchers monitor the plants closely to see how the disease takes hold and how long they survive after infection. The plants are also analysed to see what chemical reactions are triggered, with researchers hoping to find one that can neutralise the disease.

Screening of plants from seed collected in 2016 and 2017 have begun to show promising results with some families having an 80 per cent survival rate 177 days after repeated exposure. While there is a big difference between understanding what happens in the glasshouse and the forest, these results still provide hope for the future of kauri.

Read the full story at scionresearch.com/2019kauridieback

“Through the Healthy Trees, Healthy Future programme mana whenua across kauri land regions have diligently collected seed samples from their rohe. This research forms a vital part of the effort to ensure their vision of healthy kauri seedlings for future generations becomes reality.”

Kevin Prime,
HTHF Programme Overview Committee

Funders Ministry of Business, Innovation and Employment Kauri Dieback Programme

Collaborators Plant and Food Research, Manaaki Whenua Landcare Research, Massey University, Auckland University of Technology, Oregon State University, USDA-ARS





World first technology can predict the best performing radiata pine

Breeding new, commercially valuable traits into radiata pine is a slow process – but not for much longer. Scion and the Radiata Pine Breeding Company developed a test that can identify those traits quickly and cheaply using a set of DNA markers. It is the first commercially available genotyping array for radiata pine.

The test contains over 36,000 DNA markers that will be used to breed trees that are tall, straight, strong and fast growing.

It is consistent (99.9 per cent reproducible) and cost-effective to run, making it ideal to begin the commercial uptake of genomics-based breeding programmes. Benefits include enabling radiata pine breeders to identify clonal trees, reveal related trees and establish pine pedigrees for the thoroughbreds of the pine growing industry.

Next steps are to integrate this technology into the breeding cycle and create a step change in radiata pine breeding. The test is nearly 10 times cheaper (per sample) than the only other test on the market, making it more accessible than ever before.

Read the full story at scionresearch.com/2019DNAtest

“This work is the culmination of more than five years of collaborative effort and is a credit to those who had the original vision for the programme, as well as those who have delivered the result. We are excited at the prospect of moving to the deployment phase of the new technology, and ultimately seeing the promise of speed and accuracy delivered to forest owners utilising RPBC germplasm in New Zealand and offshore.”

Brent Guild,
CEO at the Radiata Pine Breeding Company

Funders Ministry of Business, Innovation and Employment, Radiata Pine Breeding Company, Strategic Science Investment Fund
Collaborators Radiata Pine Breeding Company



Deep learning algorithm can identify seedlings



Scion has pioneered a new artificial intelligence (AI) based system that uses low-cost RGB imagery from UAVs (unmanned aerial vehicles) to identify radiata pine seedlings. The algorithm they have created could soon replace manual surveys, which are laborious, sometimes dangerous and only suited to small areas.

Surveys are traditionally carried out after planting to ensure the right number of trees have been planted and survive to reach the target for each site. Scion's advanced AI-system can detect seedlings with extremely high accuracy, detecting between 94-98 per cent of seedlings in a range of test sites and landscapes.

The next steps are to trial the method with industry partners and explore expanding the algorithm to detect native tree species.

All afforestation efforts in New Zealand stand to benefit from this work as it unlocks the potential for large-scale automatic assessments of newly planted sites for density and survival.

Read the full story at scionresearch.com/2019seedlingAI

“This work is a highly innovative combination of drone imaging and machine learning technology. It opens up entirely new possibilities for forest and land management - monitoring seedlings is only a start.”

Prof. Dr. Matthias Franz
University of Konstanz

Funders Strategic Science Investment Fund, Ministry of Business, Innovation and Employment, Forest Growers Levy Trust

Collaborators University of Konstanz





Solving complex problems with tools that promote understanding and empathy

We need imaginative and innovative approaches to tackle the complicated environmental problems of today. One such approach is 'adaptive governance.'

Adaptive governance is founded on recognising the complexity of socio-ecological problems and advocating for a flexible and collaborative approach to help solve them.

Scion, in partnership with He Oranga mō Ngā Uri Tuku Iho Trust, has developed a toolkit for using adaptive governance techniques based on a three-year research project using the example of ecological restoration in the Waiapu Catchment on the East Coast of the North Island.

The Waiapu Catchment is facing some of the most severe erosion rates in the world. To combat the erosion, central and local government and iwi have agreed to work together to meet shared aspirations. The research team used adaptive governance approaches to help accelerate the implementation of the partnership's long-term goal of 'healthy land, healthy rivers, healthy people'.

Their findings were summarised into tools for monitoring and evaluation, social network analysis and role-playing simulations. These tools are suitable for anyone looking to break down complex problems and build empathy, relationships and, in time, a shared approach to decision-making.

Read the full story at scionresearch.com/2019adaptivegovernance

“Achieving intergenerational growth across many forms of capital comes down to how we make our decisions. I’ve been privileged to act as an adviser to Scion’s adaptive governance team. The tools they’ve created will make a difference.”

Dr Dave Moore,
Adaptive Governance Advisory Board Member
Programme Leader, Master of Engineering Project Management,
Auckland University of Technology

Funders Ministry for Primary Industries, Ministry of Business, Innovation and Employment

Collaborators He Oranga mō Ngā Uri Tuku Iho Trust, University of Melbourne and one company



Eco-friendly treatment gives radiata timber durable properties for outdoor uses



Scion has developed a new biobased treatment technology that can give softwood radiata pine durable properties. The treatment increases the performance of radiata pine timber in outdoor uses including decking, cladding, outdoor furniture and exterior joinery.

Unlike conventional preservative treatments, which generally contain heavy metals, our new stability treatment technology is eco-friendly, using renewables obtained from processing agricultural wastes.

Wood modified with our new treatment has considerable advantages for consumers, industry and the environment. The treatment adds hardness and stability (resistance to shrink/swell) as well as some durability (resistance to fungi) that rival and outperform some popular naturally durable hardwoods.

This technology creates an alternative for customers who do not want threatened tropical hardwoods, or wood treated with heavy metals. It also offers a range of natural wood colours providing options for designers and architects wishing to profile wood in their designs.

The potential to increase export value with this technology is significant. For example, adding treatment before export of New Zealand's sustainably grown radiata is projected to add 3 to 4 times the value of the timber product.

Scion is now working with partners in New Zealand and beyond to bring this technology to commercialisation.

Read the full story at scionresearch.com/durableradiata

Funders Strategic Science Investment Fund, Ministry of Business, Innovation and Employment's PreSeed Accelerator Fund





Fibres dominant in microparticle contamination on Auckland beaches

Evidence of plastic microparticles were first found on the New Zealand coastline in the 1970s, and they have been found in many places since. The Scion project 'Turning the tide on plastic microparticles' saw a team of researchers sample the waterways and coastlines of the Auckland region to get a snapshot of the plastic microparticle problem in New Zealand's most populated city.

Results showed that most of the microparticles in Auckland's waterways are fibres (88 per cent), with small amounts of fragments and films. The sources of two-thirds of fibres were identified as the common plastics polyethylene, polyethylene terephthalate and polypropylene. The remaining third was not plastic but plant-based cellulose or regenerated cellulose like rayon. These findings indicate a major source of microparticle pollution could be the washing of clothing.

These results are aligned with international trends and similar plastic microparticle levels were found in Christchurch waterways and beaches.

With this baseline, New Zealand can start to look at ways to reduce and remove plastic pollution from our environment.

Read the full story at scionresearch.com/2019plasticmicroparticles

“Establishing a sense of the scale of the issue and evidential data looking at the sources, are crucial first steps if we want to design enduring solutions which will successfully reduce and remove plastic pollution from New Zealand's environment.”

Sharon Humphreys,
Executive Director, Packaging New Zealand

Funders Ministry for the Environment (Waste Minimisation Fund), Packaging New Zealand

Collaborators Packaging New Zealand, University of Canterbury, Auckland Council, WaterCare, University of Auckland, Sustainable Coastlines



Green exemplar products pave way for a sustainable future

Across the planet the shift from a linear, fossil-fuel based economy to a circular biobased economy is accelerating. Consumers and regulatory bodies are looking beyond price and quality – they are also seeking better environmental standards from products. Through the Scion-led landmark Extrusion Plus research programme, a technology platform has formed to create products that have replaced fossil fuel-based components with renewable natural materials.

The technology takes biomass fillers, such as sander dust, kiwifruit hair and skin, seashells, grape marc, bark or casein and combines them with biobased polymers. Compounding the filler with the polymer creates a biocomposite which is then extruded or reshaped into a new form that can be used in other manufacturing equipment, such as injection moulding.

A big advantage of the technology is its versatility. Product examples include biodegradable vine net clips for the wine industry using grape marc (winemaking waste) composite, a biodegradable utensil for Zespri utilising kiwifruit skin, and a wood compound for a fully biobased and compostable 3D printer filament, now sold by Imagin Plastics.

Considerable effort has also gone into engaging with manufacturing companies. Out of their work has emerged an industry now interested in a shift to using biomaterials.

Described as being ahead of its time, the research generated in this programme has created an important legacy that will continue to help New Zealand transition to a circular bioeconomy.

Read the full story at scionresearch.com/2019extrusion

“Scion is an excellent partner for the plastics industry. The quality of their work was highlighted by their having two finalists in the recent NZ Plastics Industry Design Awards, and gaining a highly commended accolade in the Best Supplier Partnership category. Scion plays an important role in the future of plastics in New Zealand and we look forward to collaborating further on the New Plastics Economy Roadmap project.”

Rachel Barker,
CEO, Plastics NZ

Funders Ministry of Business, Innovation and Employment
Collaborators University of Auckland, University of Waikato, Massey University and Auckland University of Technology





A toilet that eliminates its own waste

Scion has built a prototype toilet with attached waste treatment system that eliminates waste on the spot. Based on using circular bioeconomy design principles, the toilet uses wet-oxidation technology developed initially for the pulp and paper industry to destroy the solid components of toilet waste and kill disease-causing microorganisms.

This toilet technology could be used to replace unsafe sanitation practices such as pit latrines in developing countries. The technology could also be common place in future circular cities. As disaster-vulnerable, centralised infrastructure ages, new decentralised waste treatment systems could be installed in apartments or city blocks.

This research is part of the Reinvent the Toilet Challenge supported by the Bill and Melinda Gates Foundation. Their aim is to create a toilet that is safe for humans and the environment, is sustainable, cheap to use (less than US\$0.05 per user per day) and works 'off the grid'.

Our wet-oxidation technology shows promise and has been selected to advance to a new phase of work 'Generation 2 Reinvented Toilet.' Scion will join an international team to investigate the most promising technologies developed so far.

Read the full story at scionresearch.com/2019toilettchallenge

Funders Bill and Melinda Gates Foundation
Collaborators University of Western England, Swansea University, The Helbling Group



Primary processors working together creates efficiency

Establishing wood processors close to forestry allows wood processing and forestry residues to be used as an energy source, with any surplus able to be used by other nearby industries. Other primary processing (such as dairy and meat processing) could also benefit from this strategy, and there is potential for a shared energy plant to service multiple factories.

This strategy of clustering industries around an energy source and utilising production waste streams is called industrial symbiosis. Applied in regional New Zealand it could create jobs, increase GDP and reduce greenhouse gas emissions.

Researchers have mapped New Zealand's forestry, energy resources and fossil energy-using industries to identify regions where clusters of wood processing operations could be co-located with meat and dairy processing, for example.

Gisborne, Hawkes Bay, Northland and Southland/Clutha are well suited to industrial symbiosis. Each is forecast to have a long-term supply of surplus logs, forestry and other woody waste to contribute.

If each of these clusters were established, the increase in onshore processing would provide an additional ~1000 jobs in each region, add a total of \$2 billion to New Zealand's bottom line and reduce carbon dioxide emissions by 67,000 tonnes a year by replacing fossil fuels with biomass.

Data produced by this project has now been supplied to the Ministry of Business, Innovation and Employment and the Energy Efficiency and Conservation Authority for their continued analysis.

Read the full story at scionresearch.com/2019industrialsymbiosis

“We were proud to be involved in this research and were encouraged by the activities that it triggered. The research provided opportunities for leaders from the clusters, especially from the companies and government agencies that develop and market wood energy and the technology needed to generate it, to meet regularly to create a platform for collaboration.”

Kennie Tsui,

Assessor Manager, Investment Operations, Science System Investment and Performance, Ministry of Business Innovation and Employment

Funders Ministry of Business, Innovation and Employment, Wood Processors and Manufacturers Association of New Zealand, Kawerau District Council, Bay of Connections, Grow Rotorua and six companies

Collaborators GNS, University of Waikato



Science papers:

144 Refereed papers published

76.36 Rolling 5-year weighted average H-index

www.scionresearch.com/ar19publications

Collaborations:

26 Formal collaborations with Māori

108 Publication collaborations with New Zealand and international research institutions

6 National Science Challenges

Tech translation:

9,772 Research-specific website visitors

201 Presentations on technical information and research results

250 Commissioned reports

30 Popular articles and videos

211 Publications on technical information and research results

11 Research specific newsletters

Communications:

406 Media mentions

4,514 LinkedIn followers

1,290 Subscribers to *Scion Connections*

30,492 Minutes watching Scion YouTube videos

1,840 Twitter followers

56,269 Visitors to the Scion website

OCTOBER 2018 - FOREST GROWERS RESEARCH CONFERENCE RESEARCH AWARDS

Winner of the Innovation that Enhances Sector Value Award – Dr Simeon Smaill for his work examining novel methods and nutrient models to improve the growth and vitality of radiata pine.

Winner of the Contribution to a Science Team Award – Dr Rebecca McDougal for her part in revolutionising how diseases are diagnosed, using new molecular techniques.

Winner of the Science of International Quality Award – Jessica Kerr, Brooke O’Connor and Dr Stephen Pawson were recognised for their world-leading research in the Urban Battlefield Biosecurity programme.

NOVEMBER 2018 – SCIENCE NZ NATIONAL AWARDS

Dr Ian Suckling was acknowledged for his 40 years in science as the Scion recipient of the **Individual/Lifetime Achievement Award**.

Andrea Stocchero received the **Emerging Scientist or Engineering Award** for Scion, in recognition of his significant contribution to the timber, building and design industries.

The **Science Impact Award** for Scion was presented to the **Ligate™ Team** represented by Dr Warren Grigsby and Armin Thumm.

From left: Dr Ian Suckling, Dr Warren Grigsby, Andrea Stocchero and Armin Thumm.



NOVEMBER 2018 - NZ BIOSECURITY AWARDS

Our entry ‘**Protecting New Zealand’s primary sector from plant pests; a toolkit for the urban battlefield**’ took home the **Biological Heritage Challenge Science Award**.

Receiving the award for the project team were Dr Brian Richardson and Dr Stephen Pawson (Scion), Melanie Mark-Shadbolt (Te Tira Whakamātaki) and Dr Nick Waipara (Plant and Food Research).



MAY 2019 - NZ PLASTICS INDUSTRY DESIGN AWARDS

Our eco-friendly bioadhesive technology, **Ligate™**, won the **Research and New Innovation** category.

Our work and partnership with EPL on **biodegradable vine net clips** earned highly commended in the categories of **Best Environmental Product** and **Best Supplier Partnership**.

Jeremy Warnes and Dr Dawn Smith received the awards for Scion.



JUNE 2019 – NZ NATIONAL FIELDDAYS AWARDS

Scion teamed up with Manaaki Whenua Landcare Research, ESR and AgResearch to create a ‘science alley’ at Fieldays. Our group effort took home the **Best Agribusiness Indoor Site Award** and the **Fieldays 2019 Supreme Site Award**.



2018 SCION EMPLOYEE RECOGNITION AWARDS

Values Award
Ross Anderson

External Customer Engagement Award
Dr Ferran De Miguel Mercader, Dr Ian Suckling, Dr Juan Monge, Dr Paul Bennett, Peter Hall, Dr Sandra Velarde, Dr Steve Wakelin, Christl McMillan, Dr Michelle Harnett and Greg Scott

Support Excellence Award
Marketing and Communications Team: Christl McMillan, Greg Scott, Lisa Tovey, Dr Michelle Harnett, Dale Corbett, Rina Joy and Kylie Gunn

You Make a Difference Award
Marc Gaugler

Science Impact Award
Ligate™ Team: Ross Anderson, Sylke Campion, Dr Nancy Garrity, Dr Warren Grigsby, Rob Lei, Dr Kelly Melia, Dr Karl Murton, Dr Bernadette Nanayakkara, Maxine Smith, Ian Simpson, Armin Thumm, Daniel van de Pas

Science Eminence Award
Dr Eckehard Brockerhoff

Emerging Scientist or Engineering Award
Andrea Stocchero

Individual/Lifetime Achievement Award
Dr Ian Suckling

Roger Newman Award for Science or Engineering Excellence
Dr Grant Pearse

MEETING OUR SCIENCE AND INNOVATION GOALS AS SET OUT IN OUR 2018-2023 STATEMENT OF CORPORATE INTENT



Impact Area 1

Forests and landscapes

Goal: To grow healthy, resilient forests that are planted primarily for their standing-forest benefits

Key performance indicators	Achievements
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<p>By 2019, Scion, in conjunction with key industry, government and Māori, has developed an R&D programme that underpins the One Billion Trees Programme to ensure the right tree (exotic and indigenous) is planted in the right place for the right purpose, including: fit-for-purpose forest systems; accelerating propagation; forest establishment and silvicultural regimes; growth modelling; resilience to biotic and abiotic stresses; economic returns (e.g. from payments for ecosystem services, under-cropping or selective harvesting) and social acceptance.</p>	<p>In 2018-19 Scion and Ngāti Whare Holdings Ltd received two-year funding for an MBIE Vision Mātauranga project. Now into its second year the project is building on the science and innovation potential of Māori knowledge, resources (Whirinaki Forest), and people (Ngāti Whare).</p> <p>Ngāti Whare are kaitiaki of the nationally renowned Whirinaki Forest, which has enormous cultural and spiritual value for them. A 10-year Regeneration Plan will return 640 hectares to indigenous species from exotic species, restoring the identity of Ngāti Whare and enhancing the value of Whirinaki for New Zealand. Sourcing the podocarps required for such an extensive block of land is difficult and expensive. Since 2013, Scion and Ngāti Whare have worked together in a strong relationship with a shared vision to restore and protect this forest.</p> <p>In 2016, Ngāti Whare built their \$1m indigenous nursery in Minginui initially to provide trees for their Regeneration Plan and also create employment for Minginui. Under licence, Scion's proprietary podocarp propagation research is being continued while at the same time being applied commercially – there are plans to support other iwi interested in nurseries, for example in Northland and East Coast.</p> <p>In the programme's first year, the primary focus was the transfer of basic scientific methodology and critical horticultural knowledge. Scion is helping Minginui staff to develop these new skillsets and explore new ways to improve tree health and size for out-planting and commercially scale-up production. At Minginui Nursery, Scion scientists are mentoring, teaching, and working closely with nursery staff on plant husbandry. In turn, Scion scientists are being mentored by kaumātua and hāpu to explore and understand Ngāti Whare mātauranga for integration into the research.</p> <p>At meetings with Minister of Forestry Shane Jones in October 2018 Scion reiterated the need for a regional multi iwi approach to the One Billion Trees Programme, underpinned by tools to assist Māori landowners to position themselves with regional councils, MPI, MBIE and Te Uru Rākau for funding.</p> <p>Myrtle rust monitoring showed that infection significantly reduced germination of <i>Lophomyrtus spp</i> and that seeds from infected fruits were</p>
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	<p>contaminated by myrtle rust spores. Myrtle rust significantly affects these species in native stands, causing significant dieback, premature fruit drop, and seedling death. One fungicide combined with a spreader showed promise in controlling myrtle rust on pōhutukawa.</p> <p>The three-year MBIE Weaving the Korowai research programme was completed in October 2018. The programme developed tools and approaches to support agency and community interactions in its delivery of the 100-year accord signed by the Crown, the regional council and Rūnanga to restore the Waiapu Catchment. These tools have been welcomed by parties outside the research programme including regional councils and government partners.</p>
<p>By 2019, Scion has developed a national ecosystem services-based investment framework for forests and an associated implementation plan that considers links to other national ecosystem services' modelling systems.</p>	<p>Scion has recently published the foundation paper of its Forest Investment Framework (FIF) where FIF is described alongside other related spatial economic tools for forest ecosystem services. The paper also presents the 17 applications of FIF across New Zealand between 2014 to 2019.</p> <p>In addition, Scion's FIF now includes water value functions: (1) water footprint model with the radiata water use model; and (2) water yield/supply/scarcity functions, which were developed through the application of InVEST Water Yield model in the Ohinemuri catchment, Waikato.</p>
<p>By 2020, working with Māori entities, cultural values have been integrated with Forest Investment Framework output to make land use decisions.</p>	<p>Scion's FIF tool was deployed as part of a project with Rotomā No. 1 Committee of Management. This work led to a decision not to plant gevuina trees, which were the original preferred planting option but did not adequately reflect the cultural needs of the committee.</p>
<p>By 2021, Scion, in partnership with Māori, has co-developed a breeding plan for at least one indigenous forest species.</p>	<p>Several hui were held to advance a breeding programme in either kauri or tōtara. The intent is for the key Healthy Trees, Healthy Future (HTHF) partners to move into the breeding and/or kauri planting stage.</p> <p>Scion's tōtara breeding concepts were submitted as part of an unsuccessful MBIE proposal. As part of the process Scion gained full support from iwi (Ngāti Hine), and Scion will continue to look for opportunities to progress this important piece of indigenous forestry research via alternative channels.</p>
<p>By 2020, Scion has co-developed, in partnership with Māori, a Māori Forestry Roadmap and this is formally acknowledged by government.</p>	<p>With the appointment of the General Manager Māori Forestry Futures the Māori Forestry Roadmaps are being developed and planned for completion by June 2020.</p>
<p>By 2023, the Forest Investment Framework has been implemented to span three dimensions (time, space</p>	<p>In 2018-19 Scion reviewed the Forest Investment Framework (FIF) and developed a baseline tool to which new products (ecosystem service values) may be added. As part of this process potential clients were canvassed</p>

span three dimensions (time, space and risk), integrated with other land use models, and includes at least three new ecosystem services and five new forest productivity surfaces. The framework includes a protocol to integrate Māori cultural values in the decision-making process.

may be added. As part of this process potential clients were canvassed to determine their needs and to embed them in a co-innovation approach for the expansion of the FIF concept.



Impact Area 2

High-value timber manufacturing and products

Goal: To grow healthy, resilient forests that produce high-value trees for manufacture into products that capture an increasing share of the global high-end market for timber.

Key performance indicators

By 2019, Scion has delivered a genotyping technology (e.g. SNP Chip) to the Radiata Pine Breeding Company (RPBC) that will initiate the inclusion of genomics into breeding programmes.

By 2019, the full value of planted forests, including key ecosystem services will have been communicated to forest managers, regional and central government agencies at the National Forest Ecosystem Services Forum.

Achievements

In 2018-19 Scion developed a unique genome array containing 36,285 single nucleotide polymorphisms (SNP) that are well distributed across the genome. The array was tested on >8,000 samples, including material from archival progenitors, current RPBC breeding trials, nursery material, clonal lines, and material from Australia. Initial analyses indicated that the array is performing very well, with over 98% of data captured and reproducibility of 99.9%. A major achievement by Scion and the RPBC, this is the world's first SNP array for radiata pine. RPBC is operationalising the use of this 'array' in its breeding programme during 2019-20.

A collaborative agreement was signed between Scion and the RPBC to enable greater science impact across all Scion research using RPBC germplasm as a conduit. The agreement will significantly benefit Scion's forest growing outcomes in the next 20 years.

By financial year end, an Oceania Ecosystem Services Forum, organised by Scion for September 2019, had attracted >50 abstracts and workshop proposals, which were sent for review by the OESF programme committee whose members are from New Zealand (AUT, StatsNZ, WRC, Maanaki Whenua Landcare Research) and Australian (ANU, UTas, IDEEA) institutions. The forum includes the Forest Ecosystem Services Forum and results from the related System of Environmental-Economic Account international framework application to forestry.

By 2019, the key outcomes from the multi-year GCFE programme (i.e. new knowledge on optimising right tree, right place, right purpose, improved genetics, silvicultural models and management methods) will have been communicated at national industry events to large-scale forest owners and the many small-scale Farm Forestry Association members.

By 2019, options to reduce the impact of *Phytophthora* on radiata pine, kauri or one horticultural species have been identified and one option has been adopted.

By 2019, Scion has progressed a novel wood modification process that shows improved durability, stability performance along with new colour options on radiata pine to pilot scale and has completed a commercialisation strategy.

Scion scientists attended the annual Forest Growers Research Conference in October to present an overview of GCFE outcomes to forest growers and other industry bodies. Feedback about the progress was positive and there was a strong desire from within industry to see many of the research findings be made available in practical terms, especially tools such as FIF.

The soils team had a paper* published in the top ranked journal in soils discipline. The paper used Long Term Site Productivity trial data that spans >25 years to assess the impacts of forest management practices on site sustainability (through the lens of microbial community and diversity). The findings are important because they demonstrate enduring (multi-decade) impacts of management on the wider microbial ecosystem. How sustainable is fertiliser addition, residue management, and other forest practices?

*S.L. Addison, S.J. Smaill, L.G. Garrett, S.A. Wakelin (2019). Effects of forest harvest and fertiliser amendment on soil biodiversity and function can persist for decades. *Soil Biology and Biochemistry* 135, 194-205.

The 2019 kauri seed collections were completed with collections made from 650 kauri over 14 rohe. Over 20,000 kauri are being grown in the *Phytophthora*-free production facility with the intention of either screening for resistance in the laboratory or planting back in their rohe for testing in the forest. A mana whenua partnership with the 14 partners was developed to continue the kauri work currently done under the MBIE Healthy Trees, Healthy Future research programme.

Red needle cast (RNC) epidemiological models were updated to integrate disease rankings from RPBC genotypes, copper treatments, environmental and on-site climatic data. The model was presented to the Forest Growers Levy Trust and a user interface developed to help growers understand historic RNC risk and expected response to copper treatment and selection for RNC resistance in their forests.

In 2018-19 Scion implemented two commercialisation approaches for its Furfurylation (FA) technology, which gives radiata pine hardwood properties:

- approach New Zealand companies to develop the FA technology and build a modification plant in New Zealand, and
- approach an overseas company who might want to partner to build a plant in New Zealand.

We engaged with multiple New Zealand and international partners and shared technical data on formulation development and performance, as well as some patent details. We noted increased interest from New Zealand-based companies and entered into a collaborative agreement with an international partner. As part of this agreement, Scion undertook pilot plant trials. The trial process was productive, and we are continuing conversations with the partner about how best to progress this opportunity further.

By 2020, an integrated land use framework including timber and non-timber values has been proved and used in validating forestry investments under the One Billion Trees initiative.

By 2020, Scion has worked with Māori, and at least one Māori entity is active in building a new vertically integrated high-value wood manufacturing enterprise.

By 2021, Scion, with science collaborators, government, and industry partners with non-traditional urban stakeholders, has developed a platform of high-value wood products to provide better performing, higher amenity built-environments in terms of affordability, performance and sustainability, e.g. tall timber buildings, prefabrication etc.

By 2023, Scion has provided the underpinning science to support and enhance licence to operate through environmental certification and to meet regulatory requirements, particularly in relation to Douglas-fir wilding spread and pesticides use.

By 2023, 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 to 35 m³ ha⁻¹ yr and in a way that enhances the sustainability of forest growing in New Zealand.

Scion continued the development of its integrated land use modelling tools as part of a Northland case study. The results of this work were presented at the International Boreal Forest Research Association (IBFRA) hosted by the International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria. Acceptance of the model led to IIASA interest in collaborating with Scion in this area.

With the appointment of the General Manager Māori Forestry Futures the targets are now being reviewed.

With Toi Ohomai in the Building Better Homes, Towns and Cities National Science Challenge project Toitū te Kainga, Toitū te Ora, Toitū te Tangata, we have developed building designs targeting life time affordability resulting in positive health outcomes for the community of Te Whaiti.

Scion's work on herbicides has added to the good practice guides for MPI's national wilding control programme - a critical step to improve the efficiency of wilding control. Our close collaboration with DOC and MPI led to development of a prototype detection system by DOC which we will continue to improve with the aim to operationalise our detection research over the next two years. We are also progressing work using new algorithms to detect major conifer infestations to help shape conifer management and control.

An outcome expected from Scion's phenotyping platform is the ability to search for and identify outstanding trees in a forest, identify parentage and inform future deployment (and breeding) programmes.

A proof of concept 'search' for outstanding trees was undertaken. DNA fingerprinting work on several 'exceptional trees' is underway. This technique can be used to select genotypes that grow well on forest growers' estates, informing their preference for certain parents to deploy to maximise forest productivity. Equally, the technique can be used to identify poor performers, removing them from deployment plans and thereby increasing forest performance.

Owing to the long-term nature of this research and ability to translate

By 2023, the forestry industry, land owners, and central and regional government have adopted new tools, approaches and technologies developed to mitigate impacts from the increasing risk to New Zealand's forests from pests (insects, pathogens, weeds), fire and wind in our changing environment (climate, trade and tourism), and to mitigate risks and take advantages of opportunities from climate change.

By 2023, the improved Forest Investment Framework has been used by at least five regional councils, forestry companies and Māori entities to develop landscape-level plans

into value, it is expected to have a small contribution to valuations using lidar and real-data approaches, and on very young stands. The value of the approach will increase with time and will facilitate better site and genotype matching. By 2023 the estimated contribution to forestry = 1%, and the estimated long-term potential is up to 50%.

Scion completed an assessment of the challenges to catchment level that arise from climate change impacts. Key challenges were identified from the systems and the vulnerability analyses from which draft adaptation pathways were developed: integrated environmental planning, low carbon technologies, local empowerment, multi-level governance, social equity, sustainable lifestyles, resilient water management, education, rural development/local economies/circular economies, agriculture within limits, leadership.

Pre-testing and sensitivity analysis of up-scaled qPCR for detection and quantification of *Phytophthora agathidicida* (cause of kauri dieback) was completed in collaboration with Slipstream Automation.

Models to help biosecurity managers make informed decisions about optimal interventions and investment across prevention, surveillance, incursion response and pest management were developed and a first draft of the local biosecurity risk framework was presented for feedback from end-users at a workshop in late May.

In addition, an assessment of risk of biological control agents on non-target species model was developed and shown to EPA and DOC in June demonstrating the value of this approach.

A phone app to report suspect new forest pests and pathogens was developed and released in February. By April it had over 500 downloads. This software system has the potential to reduce MPI's workload and improve biosecurity outcomes by screening out zero risk reports before they reach MPI.

Smoke modelling tools were used in the Nelson fire response and a Scion Rural Fire team member worked in Incident Command to assist with development of triggers that initiated or cancelled evacuations and returns, thus helping to reduce risk and deploy resources effectively.

A Pest Incursion Economic Calculator was developed and introduced for the industry to support fast decision making.

A minimum viable product concept has been developed for the Forest Investment Framework. The future expansion and uptake of this concept will be driven by the outcome consultation with key client groups.

for new forests targeting high-value wood products as well as other ecosystem services.

By 2023, Scion has provided tools, new biotech and genetic solutions, 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 50% over 2018 plantings.

As part of the MBIE-funded Speciality Wood Partnership Scion has:

- evaluated a new structural product Optimised Engineered Lumber (OEL) on *Eucalyptus nitens* and Douglas-fir thinnings;
- developed an LVL model linking log properties to LVL product requirements;
- undertaken multiple novel drying trials on *E. nitens* that show improved results;
- kept trees for trials in the nursery as well as genetics trials for Douglas-fir and *Cupressus macrocarpa* breeding programmes.

Scion initiated analysis of the Douglas-fir breeding programme using genomics with approximately 2,000 individuals genotyped. Scion used this information to analyse a provenance/progeny trial where the original provenances of the material are known and clearly identifiable, and this can be accounted for in the application of the technology and analytical approach. This knowledge will also be transferable to radiata pine and other species.

The EPA approved full release of an insect to control a major eucalypt pest. A release is planned for late summer 2020. Host specificity testing with another insect intended to control giant willow aphid was favourable and received unanimous stakeholder support for its release. An application was submitted to EPA, the result is pending.



Impact Area 3

Biobased manufacturing and products

Goal: To grow healthy, resilient forests that replace petrochemicals and non-sustainable materials with products from trees and other biomaterials.

Key performance indicators

Achievements

By 2019, 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), and two of these prototypes have been incorporated into new product offerings by firms.

By 2019, two different genetically modified trees have been evaluated to determine their viability as alternative feedstocks to produce high-value chemicals and/or processability for fibre or bioenergy.

By 2019, Scion has identified, and reached national alignment, around the implementation of the New Zealand Biofuels Roadmap. Technology barriers, acceleration options and policy interventions have been identified. Large commercial projects have been scoped out for final definition.

By 2020, Scion and commercial partner(s) have developed a viable and New Zealand-specific biorefinery business case including Scion-developed high-value bioproducts and cost-efficient technology platforms for commodity fibres and bioenergy, including criteria for new short-rotation forest trees systems.

Five different bioplastic samples prepared at Scion were compression moulded to enable mechanical testing. The test results enabled Scion to identify potential prototype applications for these materials.

Scion undertook a large-scale electrospinning trial that provided enough lignin nanofibre for the printed electronics proof-of-concept work to be completed in collaboration with a large multinational organisation, which is currently assessing the material for use in its commercial applications.

We also worked with industry to produce biodegradable vine net clips. The net clip samples were produced at scale and field trialed by wine growers who provided positive feedback about product performance. Scion is continuing its commercialisation conversations with the industry partner concerned.

Two lignin modified lines were harvested from the field trial and are being processed to evaluate the impact of the modification in processing for fibre and sugar syrup production.

The Biojet project presented a pre-feasibility level study to Ministers. Unfortunately, the high level of investment risk has meant that the commercial partners are not currently prepared to progress the project.

Scion undertook short rotation forest analysis, based on high growth and high-density clones data identified from trialling in Rotoehu Forest. Early results suggest that high tree density can be achieved. The greater density will give more oven dry tonnes per hectare (rather than more cubic metres per hectare), which is highly desirable in a bioenergy forest.

By 2022, New Zealand has new industries using new high-performance products enabled by Scion-developed technologies (on-demand degradable plastics, green electronics, biobased composites, lignin products and new compounded materials containing biopolymers), using existing (e.g. extrusion, injection moulding) and emerging technologies (e.g. 3D-printing or electrospinning).

By 2023, Scion and commercial partner(s) have progressed the New Zealand-specific biorefinery business case to progress this to demonstration/pilot scale.

By 2023, Scion has demonstrated the feasibility of converting forest and other biobased materials through distributed and mobile processes into chemicals and biopolymers and has identified a group of interested industrial partners to progress one of the technologies to pilot/demonstration scale.

By 2020, Scion has worked with Māori, and at least one Māori entity has included new biobased materials in their product portfolio.

In 2018-19 Scion performed different extraction and analytical processes to derive high-value products from bark. Extractions were undertaken with a New Zealand-based commercial partner. Pre-treatment and processing conditions were refined at pilot-scale extraction and then applied in large-scale extraction. The trial produced >12 kg of waxy material as well as water-soluble extract material.

Also, Scion initiated a project attempting to develop high-value thermal conductive materials from nanocellulose extracted from New Zealand seaweeds. Staff visited the Australian Synchrotron where X-ray patterns (some 15,000 datasets) were processed. The seaweed-derived nanocrystals were shown to be significantly larger than those made from land plants (including commercial CNCs). It is believed that chemical pulping will allow for even larger crystals.

Scion's five-year MBIE funded Bark Biorefinery programme started in October 2018. Already significant volumes of bark have been processed through our partners Pharmalink (Nelson, New Zealand) and Fraunhofer IGB (Leuna, Germany) delivering sizable amounts of polyphenols, polysaccharides, terpene and resin acids that are explored for industrial applications.

In pioneering research, we demonstrated the use of an extruder as a chemical reactor to modify sander dust for further use. This novel use of an extruder shows proof of concept for what is possible with mobile distributed manufacturing. To implement this technology, an extrusion set-up could be run by a wood processor or even a juice manufacturer as another way to use their resources. Alternatively, a mobile plant operator could move to the biomass resource as it becomes available, e.g. seasonal food processing.

With the appointment of the General Manager Māori Forestry Futures targets are now being reviewed.

SCION ■ FINANCIAL RESULTS SUMMARY

	2017 Actual	2018 Actual	2019 Budget	2019 Actual
Revenue, \$m	51.90	56.74	59.17	55.94
EBIT, \$m	3.01	3.03	2.09	1.88
EBIT Margin	5.8%	5.3%	3.5%	3.4%
Reinvestment, \$m	1.37	1.43	1.10	1.12
EBIT-R, \$m	4.38	4.46	3.19	3.00
EBIT-R Margin	8.4%	7.9%	5.4%	5.4%
Total Assets, \$m	54.20	57.13	56.48	55.25
Return on Equity	6.2%	5.7%	4.0%	3.9%
Pre-reinvestment Return on Equity	8.7%	8.2%	5.9%	5.7%
Equity Ratio	73.5%	71.6%	75.2%	74.5%
Dividend, \$m	-	-	-	-
Gearing	0.0%	0.0%	0.0%	0.0%

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

EBIT: Earnings before interest, tax and restructuring costs.

EBIT Margin: EBIT ÷ revenue.

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

EBIT-R Margin: EBIT-R ÷ revenue.

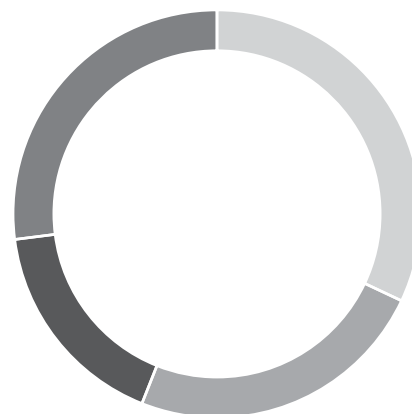
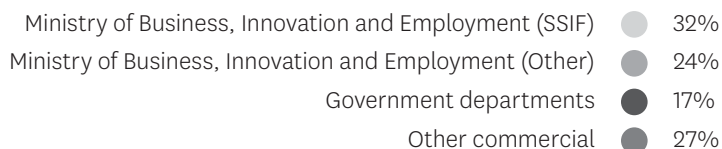
Return on equity: Net profit after tax ÷ average shareholders' funds, expressed as a percentage.

Equity Ratio: Average shareholders' funds ÷ average total assets.

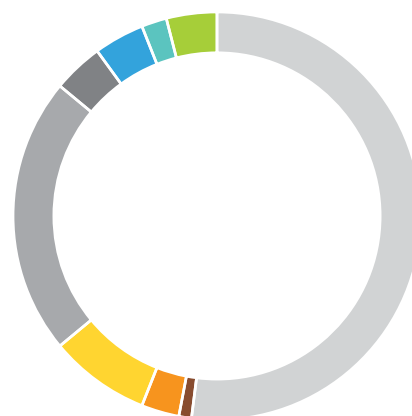
Gearing: Financial debt ÷ financial debt plus shareholders' funds.

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

Where our revenue comes from



How our revenue is spent



Our full Reports and Financial Statements are presented in Part B of the Annual Report. www.scionresearch.com/annual-reports

Science working for New Zealand

The Crown Research Institutes (CRIs) proudly work, individually and collectively, to create a more prosperous, sustainable and innovative New Zealand



www.sciencenewzealand.org

3,600

SMART AND
PASSIONATE PEOPLE

50

SITES ACROSS
NEW ZEALAND

6,000

SCIENCE PROJECTS
EACH YEAR

40

NATIONALLY SIGNIFICANT
DATABASES & COLLECTIONS

