Scion Connections

SCION CONNECTIONS MAGAZINE • ISSUE 41 • JUNE 2022

HOMEGROWN BIOENERGY

THINKING BIG

Future-proofing forests for 2050

PRECISION FORESTRY TECHNOLOGY

The future is here

Welcome to a new-look *Scion Connections*

This year, Scion marks its 75th anniversary. Over the coming months we'll be celebrating this milestone across our Rotorua and Christchurch campuses by looking at where we've come from, the people who have shaped our journey and the exciting future we are creating for New Zealand with our research and collaboration.

Inside this issue of *Connections*, you'll find a history of how Scion started, along with a range of innovative science, research and innovation stories that are shaping our organisation and our future direction.

This new-look publication has moved from a quarterly eight-page newsletter to a magazine, giving us a chance to share even more great stories with you in a visually stunning format.

As always, you can stay connected with what is happening at Scion on our social channels and website.

We hope you enjoy this issue.

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SCION
FORESTS PRODUCTS INNOVATION

75 years of impact

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Cover: *Working together to create resilient forests of the future – Scion silvicultural scientist Dr Yvette Dickinson and Timberlands Research Forester Alex Manig.*

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Celebrating the past while we shape the future

This year, 2022, is very significant for Scion. Firstly, we turn 75!

In these turbulent times, it's great to have a milestone like this where we can take stock and have a moment to reflect on the wealth of science conducted and the breakthrough innovation delivered by hundreds of staff to the sectors we serve.

Secondly, in this year, Scion's future state will be discussed as part of a multi-year programme on the future of New Zealand's research, science and innovation (RS&I) system.

In this editorial, I wish to focus on the next 75 years by describing our participation in the *Te Ara Paerangi – Future Pathways Green Paper*.

The green paper is a consultation document that sought wide-ranging feedback and ideas on reforming the research system.

When *Te Ara Paerangi* was launched last October, Research, Science and Innovation Minister Dr Megan Woods said, "The world is a very different place now to when our Crown Research Institutes were created in the 1990s … our RS&I system has served Aotearoa exceptionally well, but now it's time to ask whether the system is set up as well as it can be to answer today's pressing environmental, economic and social challenges, like climate change and child poverty".

Scion positively welcomed the opportunity given by the green paper to air our views about the challenges of operating in the current RS&I system. Our submission was developed with the input of staff across the organisation. First up, we agree with and support the intent of *Te Ara Paerangi – Future Pathways*. Four key points are emphasised in our submission:

- Change is necessary and overdue to address complex challenges,
- Better delivery to and with Māori and the weaving of Mātauranga Māori and our research activities,
- Co-designing clear, high-level national priorities makes sense with a focus on delivering outcomes through research being used by end users, and
- More government and private sector investment is needed.

We illustrated these points by describing the journey we embarked on to develop our Strategy to 2030 because we saw a need to change the RS&I system.

Our government-assigned purpose is to drive innovation and growth in certain sectors for the economic, social and environmental benefit of New Zealand. Unfortunately, the current funding system is not aligned to this purpose and leaves us highly constrained in how we operate.

Despite these constraints, we have delivered significant benefit to New Zealand and have been progressing our journey in partnership with Māori and tangata whenua. We are well aware, however, that we could have done much more for our sectors if the system enabled us to do so.

That's why it's important to have a say in this review process. Submissions on the green paper have closed, but we all have another chance to provide input. Next up, hopefully by the end of the year, will be the release of a 'white paper', which will be a strategy document presenting a direction for the RS&I system with opportunities for further consultation.

I strongly urge our partners, stakeholders and end users to engage with the white paper to ensure we design a system that better lets us deliver impact and to do so in partnership. Help make sure that there are clear and uncomplicated problem definitions that suggested solutions will fix. Be sure also, to help prevent dropping the current activities that are delivering well.

How we respond this year to consultation opportunities will set the path for the next generation and beyond. As we celebrate our 75th anniversary in 2022, we look forward to another 75 years of impact for Aotearoa New Zealand.

Finally, I sadly acknowledge the terrible situation in Ukraine and mention the support of PEFC (one of the two global forestry certification agencies) and its New Zealand members who have declared that all timber originating from Russia and Belarus is 'conflict timber' and therefore cannot be used in PEFC-certified products.

I wish you, your colleagues, friends and families safe and happy times ahead. Together, our people have achieved a lot as is evident in this bumper edition of *Scion Connections*. I welcome your thoughts on any story you read here.

Dr Julian Elder
Chief Executive

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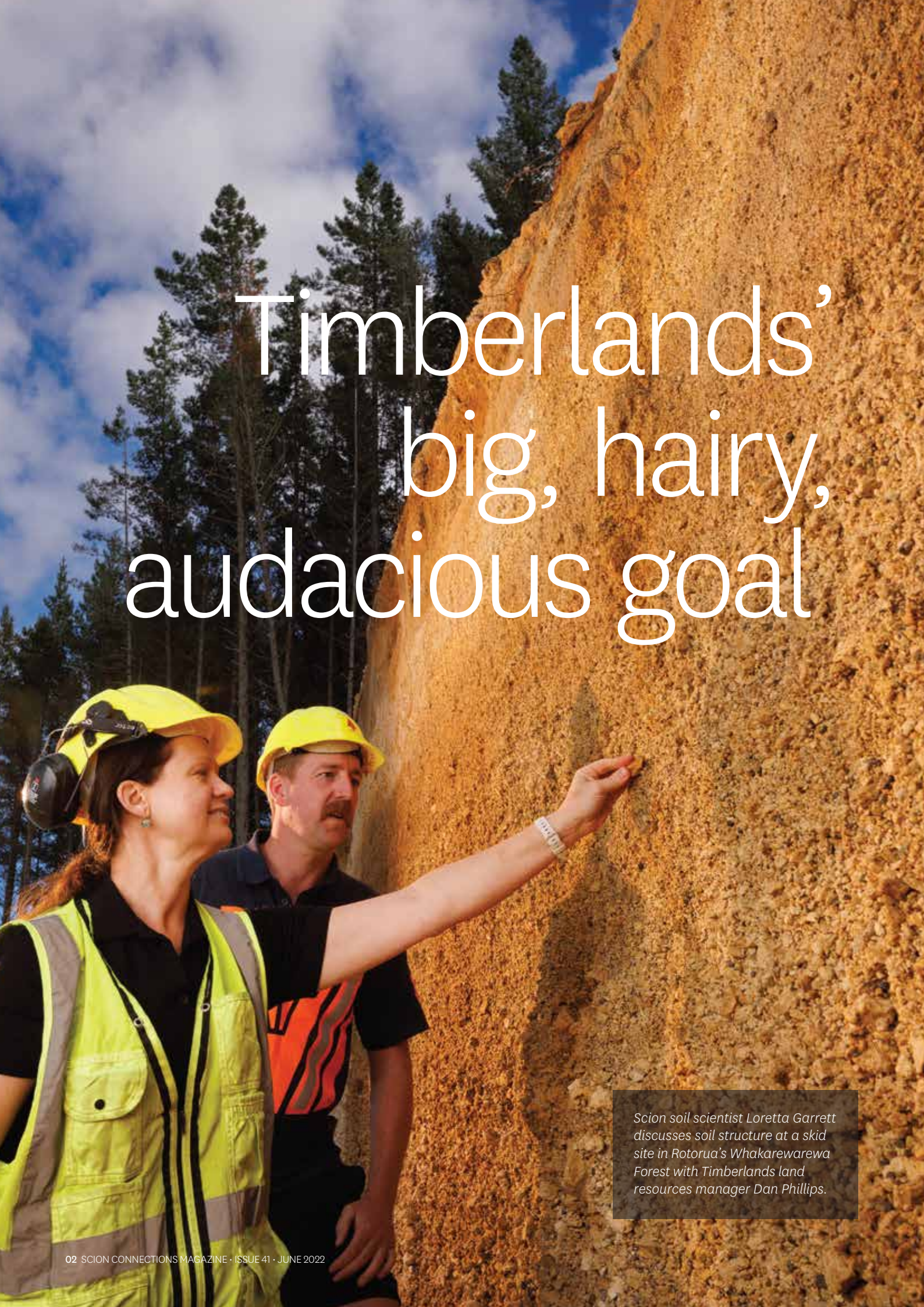
Timberlands' big, hairy, audacious goal



Scion soil scientist Loretta Garrett discusses soil structure at a skid site in Rotorua's Whakarewarewa Forest with Timberlands land resources manager Dan Phillips.

In May 2017, the Timberlands Ltd Board of Directors and senior managers toured through Puruki Experimental Forest in the Central North Island with a team of Scion scientists. As they stood on the top of a hill in Puruki they could see their own Kaingaroa Forest estate, just 20 kilometres to the east and they knew that they needed to think big. Really big.

Scion's Puruki Experimental Forest is one of the most productive radiata pine plantations in New Zealand. What the Timberlands directors saw with their own eyes at Puruki were pine growth rates twice what they were achieving in Kaingaroa Forest. This showed the Timberlands Board what was possible and helped drive the goal to double productivity in Kaingaroa Forest over the next 30 years.

That means catapulting average growth rates from 25 cubic metres per hectare per year to 50 cubic metres annually, by 2050. Fifty cubic metres by 2050 became known as '50 by 50'. By Timberlands' own admission – this is a big, hairy, audacious goal.

For Dr John Moore, research and development manager at Timberlands, 50 by 50 is the focus of several research themes.

"We're conscious that our research – and indeed everything we do at Timberlands – can have environmental and social outcomes on a large scale," says Moore. "With big, hairy, audacious goals comes big, serious responsibility."

Scion principal researcher, Dr Peter Clinton, says the Resilient Forests research programme is delivering the underpinning knowledge that will help companies such as Timberlands achieve their goals around productivity and sustainability.

At 205,000 hectares, Kaingaroa Forest is the largest planted forest in New Zealand. It covers just over 0.7 percent of New Zealand's land area. Ninety percent of that land is in productive forest, with radiata pine comprising 95 percent of trees. The company is involved in harvesting and marketing over four million tonnes of logs each year.

A century before Timberlands came up with its big, hairy, audacious goal, the New Zealand Government had equally ambitious plans of its own. It would create a forestry industry.

A history of experimentation

Up until the 1890s, forestry in New Zealand was based on logging of indigenous forests. It was becoming obvious that this type of forestry was unsustainable. The government took the first, tentative steps to finding exotic tree alternatives, and embarked on the ambitious plan of creating a plantation forest resource in the Central North Island. The first plantings in Kaingaroa Forest were seedlings that were raised in a nursery on land that would later become the Scion campus.

Plantings boomed in the 1920s and the Kaingaroa Forest became one of the crown jewels of international forestry. It is one of the oldest and largest softwood plantations in the world. From the original plantings of the 1920s, the forest (both the land and the trees) were owned as a state asset by the New Zealand Government.

On 1 July 2009, ownership of the land under Kaingaroa Forest was transferred to iwi that were the traditional landowners. The trees themselves were to be owned by a private company (Kaingaroa Timberlands), which holds a forestry licence over the land. The New Zealand Superannuation Fund owns 42 percent of Kaingaroa Timberlands, so a significant proportion of the company's profits are returned back to all New Zealanders.

The history of research in Kaingaroa Forest began in 1901 when the Lands Department planted a modest two-hectare experimental plot of Douglas-fir near Kaingaroa village. A shelterbelt of radiata pine surrounded the Douglas-fir trees. At the time, radiata pine was not considered a serious contender as a forestry species. By 1932, the height of the Douglas-fir trees were 24 metres tall, while the radiata pine averaged 39 metres and had more than twice the diameter of the Douglas-fir trees.

Radiata pine exceeded all expectations. Partially in response to managing this fast-growing forest estate, research began in 1947 with the establishment of the Forest Experiment Station (FES) where Scion's Rotorua campus is today. Two years later, FES became the Forest Research Institute (FRI), rebranding as Scion in 2005.

At FRI, great strides were made towards understanding every step of the plantation forestry lifecycle – from selecting the best trees to form the basis of tree breeding programmes, development of silvicultural regimes through to multiple end uses of timber and wood fibres. The need to manage, protect and use wood from Kaingaroa Forest influenced several strands of FRI's research programmes.

In 1949, drought and wildfire in the forest combined with dense overstocked stands of trees created a 'perfect storm' for attack by the Sirex wasp. By the mid-1950s, a third of trees in the Kaingaroa Forest were affected by this pest. This led to new research into plant health, entomology, soil science and stand management. Over the decades, FRI's research reputation grew so much that by the end of the 20th century the Institute had become a world leader in plantation forestry science. Those accomplishments were not achieved in isolation. Many of Scion's near neighbours played a large part in guiding and progressing science through the decades.

The science behind 50 by 50

Scion itself is located at Te Papa Tipu Innovation Park on 115 hectares of Ngā Hapū e Toru whenua (land) where it is surrounded by 24 organisations and businesses devoted to the forestry industry.

It's one of the few such research institutes to enjoy such close contact with end users. Endless problems related to forestry have been discussed (and solved) over a cup of tea between Scion staff and those working in the industry.

"You have those robust debates over a cuppa," says Moore. "One of those debates addressed the role of fertiliser in the forest. For years we have only seriously considered applying fertiliser to commercial pine plantations to overcome specific nutrient deficiencies," he says.

"The soils under Puruki are essentially the same as Kaingaroa but have a greater nutrient capital. If fertiliser was applied to the forest to improve growth rather than to address a deficit, the potential exists to increase pine growth rates in Kaingaroa."

To test this, in 2018 Timberlands worked with Scion to establish large, replicated fertiliser trials where different rates of fertiliser blends were applied.

The initial results are looking promising. On average, three years after fertiliser was applied there was at least a 30 percent increase in radiata pine tree growth rate in the fertilised plots compared to controls. At the more extreme end, some plots showed a 50 percent increase in growth.

There is a risk that applying fertiliser could come at a cost – wood quality. The implication is that 50 by 50 could be achieved but the benefits would be less if the marketability of this resource is reduced.

To make sure that does not happen, Timberlands is using Scion's DiscBot to

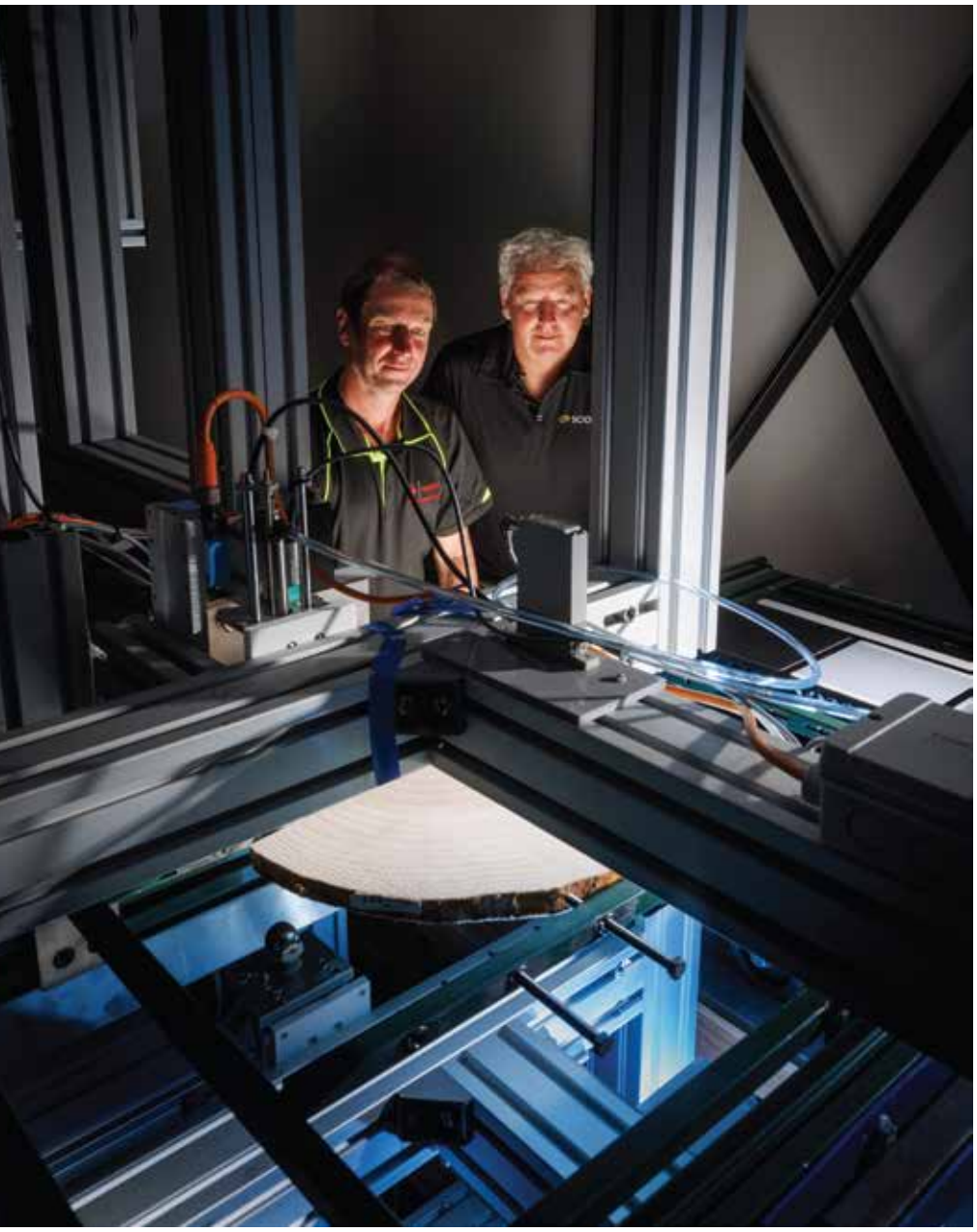
benchmark the wood that trees produce within the Kaingaroa Forest estate. The insights gained will help them to understand the impacts of different forest management practices on future resource quality.

"We are particularly interested in corewood properties, many of which aren't that easy to characterise using other methods," says Moore.

Scion's DiscBot is a wood scanning platform that scans a much greater proportion of a tree than other technologies. It is designed to assess a range of wood properties that affect the quality of sawn timber and other end products. The scanner uses different sensors to capture information on wood density, microfibril angle, chemical composition and spiral grain angle.

Moore says that the DiscBot data has already shown that some clones are correlation breakers. These are clonal lines of trees that are both superior for growth and for wood properties. DiscBot data is just starting to roll in from the 2018 fertiliser trials.

"Waiting until the trees are felled at harvest is simply too long," says Moore. "If there is going to be an adverse impact of added fertiliser on wood – we're best to know straight away before we get a 'big, hairy surprise' in the marketplace 20 years from now."



Timberlands Ltd research and development manager Dr John Moore and Scion scientist John Lee with a wood disc in the DiscBot.

Future-proofing forests for 2050

For Timberlands, climate change is already happening. Timberlands technical manager Ian Hinton brings up a diagram on his laptop showing rainfall across the Kaingaroa Forest over the last 60 years. Blue shows more rainfall than normal, orange and green show an average amount and red means drier than average. Six of the past eight years are 'fire engine red'. That raises alarm bells. Only two or three years in the previous 52 years in the Kaingaroa Forest were as dry as we are routinely experiencing now.

"What we've started seeing in the forest over the past decade are harvest volumes being less than predicted, anecdotally more dead trees observed by felling crews and growth models that appear to over-predict forest growth and volumes," says Hinton.

"Pragmatically, we don't know a lot about the future – other than the fact that a lot can happen in a 30-year pine rotation. The practices of the past, and some of the research that went into those practices may not cut it in the future. We cannot help but innovate for the future. The investment in the past Kaingaroa estate is far too important for that, as are the efforts of past generations."

The Resilient Forests Research programme was set up to address future risks and help forest managers prepare says Clinton. The programme was co-developed with Forest Growers Research, the Forest Owners Association and the NZ Farm Forestry Association and funded by the Forest Growers Levy Trust. It builds on the progress made by the Growing Confidence in Forestry's Future and the Healthy Trees Healthy Future research programmes.

Kaingaroa Forest was established at a time when New Zealand needed it. The Forest Experiment Station, Forestry Research Institute and now Scion today have been there in support with science that has helped grow Kaingaroa Forest and other planted forests around New Zealand.

For more information on the Resilient Forests research programme contact peter.clinton@scionresearch.com

Timber Design Centre to create future where timber construction leads the way

Envisioning a future where timber is used more widely in mid to high rise buildings and contributes to carbon neutral targets, is an exciting opportunity in building design. The tools to make this a reality are now coming together with the Timber Design Centre, launched in March.

The Centre's work programme will be co-designed with a wide range of people involved in the building construction process including developers, designers, council planners and consenters, architects, engineers, builders, building owners, students and researchers.

The Centre is an initiative between Te Uru Rākau – New Zealand Forest Service and a consortium comprising Scion, the Wood Processors and Manufacturers Association (WPMA), New Zealand Timber Design Society and BRANZ.

The consortium explains that greater use of timber in construction provides an opportunity for the sector to support the Government's commitment to be carbon-neutral by 2050, whilst realising the broader economic and wellbeing benefits of including wood products in multi-storied buildings.

Scion sustainability architect Andrea Stocchero says New Zealand's built environment accounts for about 20 percent of the country's carbon footprint due to the emission of greenhouse gasses over the full life cycle of buildings. This includes embodied emissions of building materials and products.

"New Zealand can maximise the use of sustainably sourced, locally grown and manufactured wood products," he explains.

Timber Design Society president Dr Daniel Moroder says the time is right for New Zealand to have a dedicated timber knowledge centre which provides advice and guidance on timber construction.

"Over recent years, the interest in engineered timber construction has increased significantly and we need to ensure that clients, designers, contractors and authorities have all the information they need to build efficiently in timber," he says.

WPMA chief executive Stephen Macaulay believes technological advancements in wood manufacturing provide an opportunity to accelerate the use of engineered mass timber products which can be showcased through the Timber Design Centre.

The new Timber Design Centre website is showcased by Te Uru Rākau New Zealand Forest Service programme delivery forest science lead Emily Telfer.

"Over recent years, the interest in engineered timber construction has increased significantly and we need to ensure that clients, designers, contractors and authorities have all the information they need to build efficiently in timber."

Dr Daniel Moroder, Timber Design Society President

"Greater use of locally harvested timber products in apartments and offices not only significantly reduce the carbon footprint of these building structures, it also offers the natural characteristic of comfort and warmth to occupants that are rarely found in other building materials."

BRANZ General Manager of Research Dr Chris Litten says the development of the centre has been a true collaboration between Government, industry and the research community.

"BRANZ is proud to support the work of the Timber Design Centre in providing evidence-based information for low-emissions construction."

The Government is funding the Timber Design Centre as part of its *Fit for a Better World* roadmap and is one of several key initiatives underway this year to help transform the forest and wood processing sector.

For more information, visit www.timberdesigncentre.co.nz

Preparing New Zealand for extreme fire

Five years of Scion extreme fire research came to an end in December 2021, changing the way knowledge is shared to stop fires starting, predicting extreme fire spread paths and developing tools for firefighters. It built on Scion's 25-year fire research programme and deep knowledge of forest ecology and forest management.

In 2016, Scion warned about the risk of extreme wildfires in New Zealand. Since then, we have witnessed large tracts of land blackened and homes destroyed in the Christchurch Port Hills (2017), Pigeon Valley (2019), Deep Stream (2019), Pukaki Downs (2019), Lake Ōhau (2020) and in the Far North (February 2022), as well as the cataclysmic fires in Australia and North America.

It was not hard to predict the higher incidence of wildfires after so many years of record global temperatures. Five out of the last six years have beaten all previous records. Higher air temperatures and more droughts naturally result in more and bigger blazes. Firefighters are struggling to manage them using conventional strategies.

Scion's general manager for Forests and Landscapes, Dr Tara Strand, says New Zealand urgently needed new methods and tools for managing extreme fire and this is what sparked the research.

"The annual average direct impact of rural fire on New Zealand's economy is over $67 million, with indirect costs estimated to be at least two to three times this, plus intangible indirect impacts as much as 30-60 times direct costs."

An article in the UK Guardian newspaper (23 February 2022) on increasing wildfires due to climate change, claimed that in relative terms, governments spend a good deal on emergency services and a tiny amount on prevention. However, in 2016, Scion received over $10 million from the Ministry of Business, Innovation and Employment's (MBIE's) Contestable Research Fund for a five-year research programme to 'identify, mitigate and adapt to' the growing threat of extreme fires.

Scion's *Preparing New Zealand for Extreme Fire* programme investigated four main areas: a new fire spread theory crucial to predicting and reducing the extreme fire risk, innovative decision support tools for providing real-time information, creating new tools for preventing extreme fire, and developing targeted protection plans for communities and taonga species.

It has delivered on its promises, as outlined in a very practical and detailed final report, released in August 2021 and available on the Scion website.

A new understanding about spread

First and foremost, experiments tested the emerging 'convective fire spread hypothesis' and development of models and data analysis that followed.

A rural fire scientist monitors a large-scale experimental burn of gorse at Rakaia Gorge in March 2020.

The world-class international team working on the project included scientists from Scion, US Forest Service Missoula Fire Sciences Laboratory, University of New South Wales, San José State University, US Forest Service Pacific Northwest Laboratory, Te Tira Whakamātaki (TTW), and University of Canterbury. Together they challenged the existing understanding of fire behaviour and formulated the 'convective fire spread hypothesis'.

Burn experiments in cereal crop stubble and gorse scrub fuels further validated findings by the Missoula Fire Science Laboratory that convection plays a large role in wildfire spread, compared to previous theory where ignition through radiation dominates fire spread. Fire spread by convection is when colder air sweeps in to replace the warm air rising at the fire front, pushing the flames forward to ignite the fuels and gases through direct flame contact.

Analyses of the data collected during the experimental burns started to explain the role of atmospheric turbulence in the transition to extreme fire behaviour.

This new knowledge has already been included in New Zealand's fire behaviour training, supported by videos showing real flame-front dynamics. It is hoped that in the near future it will lead to greater safety for firefighters and communities, and improved decision-making strategies and tactics around where and how to safely and effectively suppress extreme fires.

Safer burns by farmers and landowners

Over the years, a number of farmers and firefighters have been killed or injured by planned burns getting out of control or suddenly moving in unexpected directions and trapping them.

Unfortunately, COVID-19 prevented live-burn training sessions. But with input from international experts from The Nature Conservancy, based in Virginia, USA, who have significant experience in burning on private lands, Scion produced online 'best practice' training materials for farmers and land managers, which Fire and Emergency NZ (FENZ) and Federated Farmers have been promoting since August 2021.

Swapping knowledge with the firefighting community, Māori, the forestry industry, Department of Conservation and other kaitiaki

A very rewarding part of the programme, led by TTW, was bringing together the scientists, FENZ, Māori, and other interested parties to learn from one another at several hui, and a Fire Fair in Northland. The group discussed values and potential risks around fire, protection priorities, mitigation strategies and developed targeted fire protection plans. These are now templates that can be used by other communities and iwi.

Meetings and interviews with communities were cut short by COVID-19, but enough progress was made to draw some useful conclusions and mutual understandings.

Two preventive strategies were of particular interest: the newly developed heat sensors/automatic sprinkler systems and creating low flammability buffer zones using native plant species – the ones with big shiny leaves such as coprosmas, broadleaf and karaka.

Other new firefighting tools

Using existing technologies, the research team developed and tested fire alert heat sensors. This technology can warn forest managers and landowners of imminent danger from burn escapes and re-ignitions, and could automatically switch on sprinklers. The sensors can also be used to monitor heat build-up and possible spontaneous combustion in forestry slash piles and will be explored further in the next research programme.

Prototypes for several new firefighting tools were developed, including a smouldering hotspot temperature probe and a battery-powered backpack spray unit for preventing fire re-ignition and burn escapes.

Predicting fire and smoke behaviour

Fire and smoke behaviour prediction tools have been integrated into a new NZ Fire Registry – an online public information and planning resource that supports operational decision-making for wildfires and prescribed burning. For example, the Fire Registry tool was used to predict fire spread during the 2020 Pukaki and Lake Ōhau wildfires, and to predict smoke movement and health risk from the recent large wildfires and the February 2021 Amberley tyre storage facility fire. The prototype wildfire smoke prediction tool can be used to assess potential smoke impacts from wildfires. Find the tool at www.ruralfireresearch.co.nz/tools

Using the opportunity to learn from the Lake Ōhau fire, where 48 homes were destroyed at frightening speed, Scion reconstructed fire spread pathways and mechanisms of fire-attack to fire damaged properties. Scion surveyed over 60 homes for contributing factors such as nearby vegetation, lack of defensible space, construction materials, glazing, and presence of exposed wooden decks, outdoor furniture, firewood or other flammable materials. Visits were conducted to the affected sites within a week of the fire and analysis was conducted over the following six months.

FENZ is using the results of this work to develop improved guidance information on how homeowners can reduce wildfire risk. FENZ and MBIE are also using the results around building design and construction materials to produce guidelines for building in these fire-prone areas.

What next?

FENZ wildfire scientist Grant Pearce says there were many great achievements right across the research programme, and these were a major factor in the successful 2021 funding of the follow-on 'Extreme Wildfire: Our new reality' bid by Scion.

"This now means the convective theory can be fully validated through the planned crown fire experiments, and findings and tools adopted by FENZ and other end-users can really make a difference in protecting communities and the environment," he says.

For more information, contact tara.strand@scionresearch.com or visit www.ruralfireresearch.co.nz

Three Scion projects receive $33.7 million of Endeavour Fund investment

Three Scion research projects will receive investment totalling $33.7 million over five years through the Ministry of Business, Innovation and Employment 2021 Endeavour Fund.

The successful science projects were announced on 7 September 2021 by Research, Science and Innovation Minister Hon Dr Megan Woods.

The projects funded are *Seeing the forest for the trees: Transforming tree phenotyping for future forests*, ($9.63 million), *Extreme wildfire: Our new reality – are we ready?* ($11.25 million), and *Vive la résistance – achieving long-term success in managing wilding conifer invasions* ($12.85 million).

Dr Woods announced the recipients will help to tackle the big issues that New Zealanders care about, like boosting economic performance and climate change.

Seeing the forest for the trees: Transforming tree phenotyping for future forests

Forest-scale phenotyping (i.e. characterisation or measuring) of millions of trees will enable forest growers to optimally match different tree genotypes to site conditions under current and future climates, increasing indigenous and exotic plantation productivity, and forest health and resilience.

New planted forests are an essential component of New Zealand's transition to a carbon-neutral bioeconomy. However, our ability to grow the right tree in the right place is at risk due to uncertainty around a quickly changing climate.

New ways of collecting and analysing phenotypic data will allow tree species and genotypes of interest to be identified quickly. High-throughput tree phenotyping using remotely sensed data will inform Scion on structural plant traits and biochemical processes reflecting plant health, nutrition and drought tolerance, and will also characterise trees in three dimensions. Combined with genomic data, Scion will be able to select and breed trees with desirable traits such as high carbon storage and resistance to disease and drought.

The project will explore how Māori select and value trees for cultural purposes (e.g. whakairo, rongoā, fragrance, food flavouring, and gifting). Co-developing a hapū-level framework for culturally phenotyping tōtara and kauri cultural traits will incorporate what Māori value in taonga species into future forestry research. The team will leverage the methods developed for radiata pine and will develop specialised remote sensing indicators for this purpose.

This multidisciplinary project brings together collaborators from New Zealand and overseas, including the University of Melbourne, University of Trier (Germany), University of Sydney and PlantTech Research Institute.

For more information, contact michael.watt@scionresearch.com

Extreme wildfire: Our new reality – are we ready?

Extreme wildfire events are increasing at a faster than predicted rate, with research and operations worldwide struggling to keep ahead of the fire front.

Scion will challenge existing understanding of the transitions between linear (predictable) and extreme (unpredictable) fire, especially in relation to fuels. Predicting the physical processes driving fire-spread is central to all fire readiness as it allows effective tools and strategies to be developed to keep firefighters and communities safe.

A changing climate is increasing the frequency and severity of wildfires and our indigenous forests, once considered safe from fire, are under threat. The risks are escalating too – especially for those living within the rural-urban interface. For example, the 2020 Lake Ōhau wildfire is the country's most damaging wildfire in living memory. It destroyed most of the houses in the Mackenzie Basin's Lake Ōhau Alpine Village, burning through more than 5000 hectares. The costs were huge too – fighting the fire from the air cost $1.2 million, while insurance losses were around $35 million.

The predicted future annual direct impact of rural fire on New Zealand's economy is around $140 million, with indirect costs estimated to be at least two to three times the direct cost, plus indirect impacts as much as 30-60 times direct costs. The direct costs alone are predicted to rise to around $550 million per year by 2050, under a likely climate change scenario.

A world-class international team will work on the programme, including Scion, US Forest Service Missoula Fire Sciences Laboratory, San Jose State University, US Forest Service Pacific Northwest Laboratory, US Forest Service Rocky Mountain Research Station, Karlsruhe Institute of Technology (Germany), RMIT University (Australia), Canterbury University and Lincoln University.

For more information, contact richard.parker@scionresearch.com

Vive la résistance – achieving long-term success in managing wilding conifer invasions

Wilding conifers are an economic and environmental disaster that already affect 1.5 million hectares of New Zealand.

A further 7.5 million hectares of productive or iconic conservation land are threatened by invasion in the next 30 years. In response, the government has established a National Wilding Conifer Control Programme to deal with the problem.

The science team will develop effective strategies to create long-term resistance to conifer re-invasion on treated land. The Scion programme will transform current conifer wilding management practices by breaking an otherwise inevitable cycle of treatment, re-invasion and re-treatment. Scion will also work with Māori around management of wilding conifer re-invasions, to help restore Māoritanga to affected land.

Existing wilding conifer populations are currently being treated, but control efforts do not consider that cleared land is more likely to be re-invaded due to incomplete initial control, soil legacy effects, seed banks and other causes. Re-invasion processes are significantly different from those of initial invasion and there is a critical international knowledge gap on how various factors interact to drive this.

Addressing this knowledge gap will have significant benefits for New Zealand with a projected $6.3 billion of benefits by 2050 from the current $100 million investment in wilding control. Scion estimates there will be substantial benefits of around $750 million (benefit-to-cost ratio is around 54:1) by reducing wilding conifer treatment costs and avoiding multiple re-treatments by preventing or reducing re-invasion cycles.

This highly collaborative research project is underway and researchers from Scion, Lincoln University, University of Canterbury, Manaaki Whenua, Australian National University and the National Centre for Atmospheric Research (USA) will work together to support the National Wilding Conifer Control Programme.

For more information, contact thomas.paul@scionresearch.com

Tools for Foresters launches a collaborative new website

Researchers and those deploying unmanned aerial vehicles (UAVs) in the forest will now be able to collaborate more closely using the new Tools for Foresters website as a central hub, which launched in March 2022.

The new website is designed to help develop UAV technology, as well as provide a digital platform for UAV-related research, knowledge and resources for industry users.

Scion autonomous systems scientist Robin Hartley says the Tools for Foresters group is comprised of UAV enthusiasts who have a range of research, technical skills and forestry knowledge.

"We're happy to devote our expertise, time and energy to developing standard operating procedures (SOPs) for New Zealand forestry practices. We also help with troubleshooting, informing best practice and there's an online forum for discussion.

"The website will be especially useful for young foresters to get up to speed with technology and to gain confidence in its use," he explains.

Port Blakely Essential Oils project director Mitch Cooke says, "It's not in our job description as foresters to do trial and error with new technologies – we just don't really have the time.

"There's a lot of groundwork to get where you want to be and there has never been a good way to share this with the rest of industry until we started Tools for Foresters."

The Tools for Foresters group is steered by a committee of 10 members from across forestry, research, firefighting and government. Group membership is open to anybody who has an interest in the forest industry. Hartley encourages people to get involved to help the industry progress the use of UAVs, with an objective for the group to eventually expand and include other new technologies.

Scion thanks the following organisations for supporting Tools for Foresters: Port Blakely Forest Management, Timberlands, Pan Pac, Te Uru Rākau Forest Products, FPS Geospatial, Envico Technologies and City Forests.

For more information, visit www.toolsforforesters.co.nz

Slash pile probes seek the heat

Pushing a 2m long temperature probe into the slash pile at Wenita Forestry, Otago.

Spontaneous ignition of a forestry slash pile fire can cost forest companies up to $200,000 or more, so the development of a probe tool to monitor temperatures before piles catch fire is a game changer.

In logging operations, the process of creating logs from trees results in debris – sawdust, broken branches and logs, needles and cut-off ends of logs. This debris is swept into a slash pile that decomposes into soil over time. Occasionally however, decomposition results in the debris pile reaching very high temperatures and spontaneously igniting.

Concerned about a repeat of slash pile fires, and with no way of knowing which piles were hot, Wenita Forest Products (an Otago-based timber producer) sought assistance from Scion.

With funding through MBIE's Extreme Fire research programme, Scion's rural fire research team, together with industrial design company inFact, developed a slash pile temperature monitoring system that sends real-time temperatures to the internet via a satellite.

John Kerr, forester at Wenita, says the probes are a practical solution that perfectly suited Wenita's needs.

"The probes have been extremely useful and they're easy to use.

"Most slash piles don't cause any problems, but the odd one does and monitoring them the old way, by driving out to inspect them, used to be very time-consuming. These probes mean the suspicious piles can be monitored anytime from almost anywhere, which is brilliant."

The system is made up of long temperature probes that are pushed into the slash piles and connected to a satellite transmitter. The slash pile temperature can be monitored by a smartphone app or website from anywhere in the world that has an internet connection.

Wenita staff deployed and monitored the prototype probes in their forests from November 2021 to assess the risk of spontaneous combustion in 11 slash piles. The probes found six very hot piles with the hottest internal pile temperature in excess of 90°C with a high risk of spontaneous combustion.

Scion's rural fire experts, Veronica Clifford and Grant Pearce, consulted on how to manage these high-risk areas, including safely opening up and reducing the height of the piles.

In a recent report commissioned by Fire and Emergency NZ (FENZ) and prepared by Scion, forest companies reported that the costs associated with suppressing even relatively small skid site fires can range from $30,000 up to more than $200,000.

Senior scientist Dr Richard Parker says the economic, environmental and social impacts of wildfires are huge and any technology that reduces the risk is highly beneficial.

"This new slash pile temperature monitoring system can help remove the risk of spontaneous ignition of slash fires in forestry operations around the country and prevent fire outbreak.

"Now, Wenita can gain real-time knowledge of the temperature deep within their slash piles. They can monitor piles on wet, dry and warm days and take action if the temperatures rise. They can also look at long-term trends in temperature and discontinue monitoring when the piles have cooled," he explains.

Following the successful trial with Wenita, the Scion team is investigating opportunities to work with a commercial partner to develop the system into a market-ready product.

For further information on this work, contact richard.parker@scionresearch.com

Temperatures detected by probes are also able to be monitored remotely.

Shipping containers and imports are a major source of insect interceptions in New Zealand.

Have insect, will travel

Thousands of different insect species accompany humans almost everywhere we travel. For the first time, a global picture has emerged about the extent to which insects are intercepted at international borders.

A study published in July 2021, led by Scion mathematical biologist Dr Rebecca Turner, collated and analysed data of insect interceptions at international borders for nine regions of the world spanning 25 years.

Collectively 8,716 insect species were identified from 1.9 million interception events at ports of entry such as container ships and passenger bags at airports. The regions studied were New Zealand, Australia, South Korea, Japan, Canada, mainland USA, Hawaii, the UK and an additional region comprising 52 European and Mediterranean countries.

Dr Turner's initial project explored the potential of using border interception data to predict arrivals and establishments of invasive pests in New Zealand. However, to provide a truly global perspective on insect travel, the project grew to include international interception data.

"Although we're really good at biosecurity in New Zealand and we've got a really good rate of interceptions, we're still a small country, and we can only collect a certain amount of information. When it comes to biosecurity, knowledge is power," says Dr Turner.

"The international data gives us a much more complete picture of insect movement and establishment. This is useful for predicting local establishment."

Within New Zealand, the data provided by Biosecurity New Zealand (MPI) covered border interceptions from 2000 to 2017. For this period there were 71,588 interception events for 1,477 different species. Of the regions analysed, New Zealand had the highest number of interception events relative to import values, emphasising the importance we place on biosecurity. All found insects are destroyed at the port of entry although most insects that arrive in New Zealand are already dead due to the phytosanitary measures put in place abroad or locally.

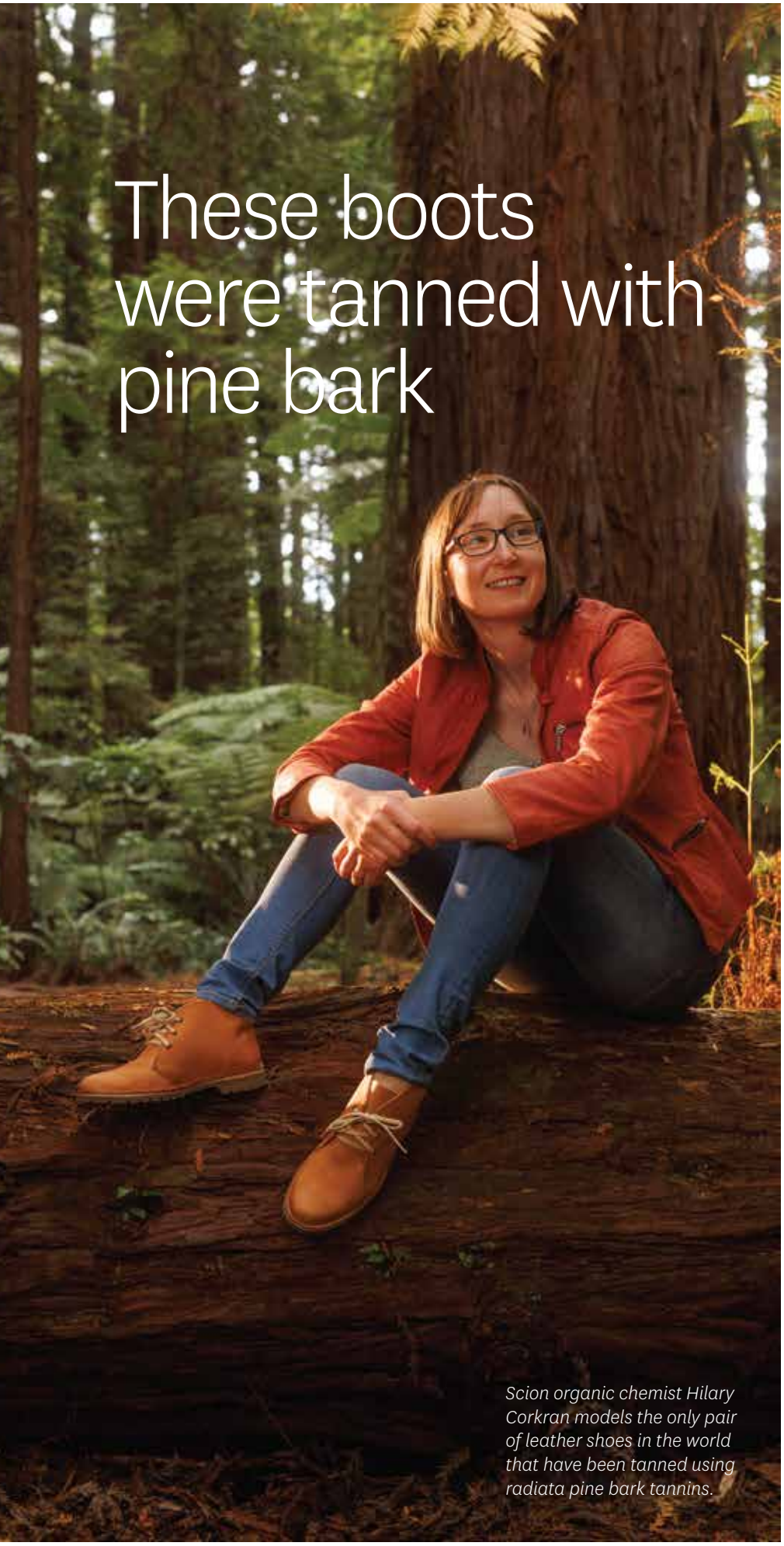
Some insect species that reach our shores will eventually settle here. While most have little or no notable effect, species such as the pine bark beetle and granulate ambrosia beetle can pose serious problems for forestry or horticulture once they establish.

This research was made possible through the collaboration of multiple national and international researchers and government agencies. The research collaboration was funded by the Biological Heritage National Science Challenge, Te Pūnaha Matatini and the Strategic Science Investment Fund (MBIE).

For more information contact
rebecca.turner@scionresearch.com

Data obtained from Biosecurity New Zealand (MPI) and international counterparts helped shed light on the magnitude and types of insects intercepted at borders for several countries.

These boots were tanned with pine bark



Scion organic chemist Hilary Corkran models the only pair of leather shoes in the world that have been tanned using radiata pine bark tannins.

"Has the New Zealand leather industry been barking up the wrong tree?" quips Geoff Holmes, director of the Leather and Shoe Research Association of New Zealand (LASRA).

Holmes and other industry representatives started talking to Scion two years ago about developing a local replacement for imported tanning agents. Holmes says the use of vegetable tannins to tan leather dates back centuries.

"They produce leathers of rich texture and a fine patina which only develops further over time and are used in luxury leather goods made by brands such as Louis Vuitton, Hermès and Burberry."

Scion did not have to look far to find a local source. The New Zealand pine industry produces two million tonnes of pine bark a year, most of which goes to waste. When radiata pine trees are felled for export, the bark has to be removed for biosecurity reasons prior to export, and the bark is discarded, with just a fraction used for low-value applications such as garden mulch.

In 2018, Scion won an $11.4 million Endeavour grant across five years from the Ministry of Business, Innovation and Employment (MBIE) to pioneer the feasibility of a bark biorefinery that would extract tannins and potentially create a range of valuable chemicals, nutraceuticals, cosmeceuticals, pharmaceutical intermediates, and green adhesives for building products.

New Zealand currently imports all its tanning reagents based on plant tannins or heavy metals (chromium). The latter account for 85-90 percent of tanning agents used. There is a growing demand for plant tannins globally and the COVID-19 pandemic has shown us there are many advantages to having local and sustainable supply chains. Using pine bark tannins will reduce New Zealand's carbon footprint and transport costs by reducing imports (usually by ship) of tannins. Furthermore, it will utilise a plentiful local resource, otherwise wasted, create a range of new jobs, and will free industry from worries about disrupted supply lines.

Scion High Value Biorefineries portfolio leader Dr Stefan Hill says this research has represented a combination of government and private research institutes working with industry.

"It demonstrates New Zealand products that reduce our dependence on imports and provides new exciting opportunities, building towards a sustainable circular bioeconomy."

The boots pictured – the first pair to be made with leather tanned using Scion's New Zealand pine bark tannin – are the first proof of concept. They were handcrafted in late 2021 by McKinlays Footwear in Dunedin – New Zealand's only remaining domestic shoe manufacturer of any scale, according to LASRA.

Graeme McKinlay, the owner of McKinlay's Footwear, says, "The bark-tanned leather cuts and handles in the factory as well as any chrome tannage, and we look forward to seeing more in the future."

Holmes adds, "Their distinctive natural colour may appeal to leather fashionistas and open a new niche market for the New Zealand leather industry."

Most of New Zealand's 2.4 million animal hides (a by-product of the beef industry) are exported for others to finish and craft into high-value products. The only remaining finished leather tannery in New Zealand is Tasman Tanning in Whanganui, which employs 250 people to finish 7,000 hides a week. The material used for the trial run was sourced from the company part-processed, ready for tanning with Scion pine bark tannins.

There is still a way to go with the Scion feasibility study. Organic chemist Dr Hilary Corkran is perfecting the extraction process, and the team, led by Dr Marie Joo Le Guen, is fine-tuning the economics of a biorefinery with industry. It would compete with other tannin sources, particularly wattle tannins from South America and Africa. The fact that the tannins are produced locally and sustainably, and are part of a complete New Zealand story, adds value.

Economic factors include the siting of one or more refineries to minimise bark collection and transport costs. After chemicals are extracted from the bark, the 85 percent mass leftover can be compressed into fuel briquettes as a coal replacement or used as specialty medium in horticulture.

For more information please contact mariejoo.leguen@scionresearch.com
To see more images head to www.scionresearch.com

Scion joins Genomic Aotearoa partnership

Scion's expertise in tree genomics will be valuable as a new partner with Genomics Aotearoa, adding to the cutting-edge of national and international collaboration opportunities.

Scion signed the partnership with Genomics Aotearoa in September 2021, joining nine other partners from New Zealand Crown Research Institutes and universities. The aim is to ensure New Zealand is internationally participating and leading in the rapidly developing fields of genomics and bioinformatics.

Scion is using genomics technologies to assemble the *Pinus radiata* genome and is developing molecular tools to assist the genetic improvement of new *Pinus radiata* varieties.

Genomics Aotearoa director Professor Peter Dearden is delighted Scion has joined the partnership, extending the collaboration Scion researchers already have with Genomics Aotearoa.

"We welcome Scion's expertise in tree genomics and look forward to the opportunities this will provide in further extending genomics into New Zealand's primary production sector."

A forest of one

A single tree does not make a forest – just yet. Scion is developing and testing a range of precision forestry technologies with Hawke's Bay forestry company Pan Pac Forest Products to make a 'forest of one' a reality sooner rather than later.

A forest of one means that we are effectively able to apply forestry management decisions to individual trees, explains Scion autonomous systems scientist Robin Hartley. The idea is not just conceptual – it is at or very near reality for a surprising number of forestry management operations.

"The future of precision forestry is not just sitting on a lab bench – it's being used in the forest now," says Hartley.

Pan Pac is moving to a precision forestry management model at a rapid pace. Managing 35,000 hectares of forestry, Pan Pac is a vertically integrated forestry products company. It uses 725,000 tonnes of logs in its own sawmill and 670,000 tonnes of residual and pulp logs are sent to the pulp mill. Consistently supplying the right type of log to its own mills is crucial and anything that can potentially interrupt that log supply is treated seriously.

Pan Pac forestry manager Sean Wright explains that current precision forestry technologies, when used together, will result in a seven percent improvement in final crop value per hectare across Pan Pac's forest estate. These sorts of efficiency gains and the ability to de-risk possible future labour shortages will be crucial to help forestry companies thrive and innovate in the future.

"The reality of our industry is that there are not enough skilled labourers willing to take up work in our forests year-round.

"We need crews working in planting, pruning and thinning at different times of the year and it's getting harder to source labour in the Hawke's Bay. If allowed to continue, a shortage of skilled labourers could put future profitability of our processing operations at risk," he says.

Scion New Value from a Digital Forest and Wood Sector portfolio leader Claire Stewart says it's heartening to see a forestry company such as Pan Pac, who have a willingness to see things differently, put their own funding towards operationalising precision forestry.

"There is an openness to work in partnership to change the way things have traditionally been done," she says.

Pruning decisions for individual trees

The Pan Pac sawmill requires a consistent supply of quality pruned logs and this means the management of pruning operations is critical. All decisions related to the timing of pruning, which trees to prune, as well as pruning height impact on clearwood volumes.

Increasingly, these decisions will soon be able to be made from remote sensing data and powerful algorithms that consider

Planting crews in the future could turn up to a site looking like this. This is one of Pan Pac's recently afforested stands in the Hawke's Bay.

individual tree qualities, such as tree height, their position relative to other trees in the stand and location. At individual tree level, pruning decisions are virtually impossible to make from the ground. A silviculture work crew cannot effectively evaluate all the factors to choose the ideal tree to prune in a stand, given they are swamped in undergrowth and surrounded by branches. They literally cannot see the wood for the trees.

This means that, by necessity, forestry management works to the average tree.

"Average is rarely, if ever, optimal," says Wright. "Some trees will be pruned too early and others too late and often the wrong trees are pruned."

To increase the volume of pruned logs from these remotely selected trees, pruning will move from an average of around six metres (the height crews can reach from the ground) to 10 metres, which can be pruned by robots. This increase in pruning height means that Pan Pac can harvest two pruned logs per tree. Ten metre pruning height is at the upper limit of where it is safe and practicable to prune using silvicultural crews, so robotic pruning is a future reality.

Photo: Envico

An Envico-developed UAV with a 20kg bait applicator being flown over farmland and native forest in the western Bay of Plenty.

Scion and Pan Pac are currently working on a model that uses spatial layers, derived from remotely sensed and other data, to predict the optimal planting locations for planting a 750 hectare radiata pine stand.

Planning where to plant

Scion and Pan Pac are currently working on a model that uses spatial layers, derived from remotely sensed and other data, to predict the optimal planting locations for planting a 750 hectare radiata pine stand. The next step, spraying the site with herbicide, requires some heavy lifting (literally) and that's where Tauranga-based R&D company Envico come in.

Envico has many years of experience using unmanned aerial vehicles (UAVs or drones) for pest control work. Envico director Cameron Baker says they have been trialling a drone capable of applying 20 litres of herbicide in one flight. That would spray about 900 trees per flight. A larger model UAV, which they intend to use with Pan Pac, will spray around 2,000 trees per flight, or around 2.5 hectares. The repeatability of the technology is where it really comes into its own, says Baker.

"The ability to perform follow-up release spraying at the same points is automated by having one set of GPS coordinates for the tree locations."

Precision aerial application of herbicide greatly reduces the total volume applied per hectare when compared to broadcast application by helicopter or potentially spot spraying on foot. There are also significant efficiency gains to be made using UAVs compared to the traditional knapsack spraying methods. When combining remote sensing tools with powerful computer analytics to detect species like blackberry, the same technology can be used to control competing grass or weed growth around individual trees following planting.

Hartley says aerial sensing from UAV and fixed-wing planes, with precision GPS location, lays the groundwork for a range of measures to be made at individual tree level. These include tree health and drought stress status, prediction of soil and crop nutrition, competition and weed infestation, height analysis and growth rate optimisation.

"The combination of new precision forestry tools means that the forester of the future will increasingly be using their laptop and will be intimately familiar with remote sensing technology, GPS and machine learning.

"Battle scars from wading through dense thickets of blackberry might become a distant, albeit fond, memory," he explains

One of the biggest hurdles to implementing precision forestry technologies is the large volume of data that is generated. Technology such as aerial imaging is so sensitive that it can capture forest information at the sub-centimetre scale. The terabytes of data combined across all trees in a stand and all stands in a forest require new expertise in algorithm development and big data management.

Wright expects there will be a high demand in the forestry industry for more digital-led skills. Digitalisation will provide the ability to virtually see, hear, understand and manage our forests in ways that have not been possible before. The multiple dimensions that boundary-less data can provide to our forestry sector and nation will impact all levels and generate new jobs, new platforms and services, new ways of working, and new insights to drive and enhance productivity.

This research is funded by Pan Pac Forestry. See more images of the technology in action at www.scionresearch.com

For more information about this project, contact robin.hartley@scionresearch.com

Collaboration agreement with Māori Carbon Collective

Chair Tā Mark Solomon (left) and Dr Julian Elder signing the Māori Carbon Collective Collaboration Agreement at Te Whare Nui o Tuteata in Rotorua, December 2021.

The signing of a collaboration agreement between Scion and the Māori Carbon Collective in November 2021 means Māori landowners will have new opportunities to engage with scientists to create intergenerational pathways for whenua and whānau.

Māori Carbon Collective (MCC) founding chairman Tā (Sir) Mark Solomon believes a lot can be done for Māoridom using collaborative research to understand the current and future Māori position relating to carbon sequestration activities on whenua.

"One of the projects I'm most excited to work on with Scion is trialling the planting of a mix of *Pinus radiata* and native trees on whenua for carbon farming, where eventually the native species takes over to become fully native again," he says.

"My heart always tells me that the best way to move forward with our whenua is using native trees, but if you are doing it as an economic return at this stage, the best process is using exotics.

"I would like business collaboration with Scion to prove we can do it with the native trees – this is our country and we should be planting with our trees."

Scion chief executive Dr Julian Elder says the agreement will make innovation accessible for landowners working through the Collective.

"As a research organisation, our purpose is to make economic, environmental and social impacts for Aotearoa, New Zealand – we can't do this on our own and we need to help enable others. Entering a partnership with the Māori Carbon Collective is a real opportunity to help the Collective do the things we think are possible to benefit their whenua," he says.

"One of the projects I'm most excited to work on with Scion is trialling the planting of a mix of Pinus radiata *and native trees on whenua for carbon farming, where eventually the native species takes over to become fully native again."*

Tā Mark Solomon, Māori Carbon Collective founding chair

"Scion has a lot of knowledge from operating for 75 years. We want to apply this for the benefit of all New Zealanders, particularly around carbon sequestration and indigenous trees. With the signing of this agreement, we can contribute a lot to these spaces that require science and innovation."

Scion is working with the Māori Carbon Collective to enable pathways that lead to outcomes in widening exotic and indigenous carbon forestry options, carbon forestry value chain development, emissions accounting and certification, carbon credentials, and improvements to indigenous trees for carbon sequestration.

The Māori Carbon Collective was formed to ensure land trusts are provided with guidance to participate in the carbon trading market.

Find out more at www.maoricarboncollective.com

ABOUT MĀORI CARBON COLLECTIVE

Māori Carbon Collective was formed with a core focus to ensure that Māori would be able to participate in the carbon market. This has been achieved through a primary offer that encourages mana whenua to enter into an equal sharing partnership model, designed by founding Chairman Tā (Sir) Mark Solomon.

The partnership eliminates the need for mana whenua to have access to any risk capital or ability to obtain any sort of financing from traditional institutions. This is all done while acknowledging the role partners have as kaitiaki, ensuring the protection of the whenua by making sure there is never any risk or threat to losing the land.

Scion diagnostic used in English disease detection

The first occurrence of the pathogen *Phytophthora pluvialis* in Europe was discovered in Cornwall, England in August 2021, thanks to a diagnostic test developed at Scion.

Staff from England's Forestry Commission were surveying forests in south-west England for the presence of another Phytophthora disease, *Phytophthora ramorum*, when they discovered decline in a stand of western hemlock trees. The affected trees showed crown dieback, needle drop, branch and stem cankers. Both mature trees and the naturally regenerated understory were affected.

Dr Ana Pérez-Sierra from the Tree Health Diagnostic and Advisory Service at Forest Research says they worked quickly to establish the potential cause of the decline in this stand of trees, to ensure that any required control measures were put in place as soon as possible. Using a quantitative polymerase chain reaction (qPCR) diagnostic test developed at Scion several years ago, they identified *P. pluvialis*. This was confirmed with DNA sequencing of samples tested in the UK and further confirmed by analysis at Scion.

To assist their English colleagues as quickly as possible, Scion microbiologist Dr Rebecca McDougal sent a newly developed qPCR assay for *P. pluvialis* to Dr Perez and her team. She says the development of this new assay had only been completed weeks before.

"It has 10 times the sensitivity of the previous test which means that it can detect extremely low levels of the pathogen in a sample. This is crucial for early detection of a disease outbreak," she explains.

This new highly sensitive assay is now routinely used in New Zealand to help detect *Phytophthora pluvialis* which causes red needle cast in radiata pine and Douglas-fir. The collaborators from Scion, Oregon and Forest Research UK will work together to publish the diagnostic assay, with its validation from these overseas forests.

Dr Pérez-Sierra says, "We have benefitted greatly from ongoing collaboration with colleagues in New Zealand and Oregon who have been working on *P. pluvialis*, developing diagnostic tests and other assays that are now in routine use in our laboratories."

The test was developed by Dr Rebecca McDougal, Renelle O'Neill and Luciano Nunes Leite from Scion's ecology and environment team as part of the Resilient Forest Programme through Scion's Strategic Science Investment Fund (MBIE) and the Forest Growers Levy Trust.

Photo: Ana Pérez-Sierra, Forest Research.

Example of Phytophthora pluvialis *lesions on a tree stem.*

For more information, contact rebecca.mcdougal@scionresearch.com

A Phytophthora pluvialis *affected western hemlock stand of south-west England. Photo: Ben Jones, Forestry Commission.*

Photo: Fonterra

Fonterra employees Jonathon Milne and Kevin Liao during the wood pellet trial at the Te Awamutu milk processing plant.

Home-grown bioenergy

There is enough energy left over in forestry residues and other woody waste, such as from orchards, surplus pulp logs, and sawmill chip, to entirely replace the heat and energy demands of all New Zealand's dairy factories, six times over.

New Zealand, with its abundance of hill country, is suitable for growing forests and its expertise in fast-growing plantation forestry could become a world leading example of sustainable bioenergy. A pair of Scion studies titled *Strategic Review of Short Rotation Bioenergy Forests* (December 2021) and *Residual biomass fuel projections for New Zealand* (January 2022) tackled the big questions of where our woody bioenergy reserves currently are, how we can grow the supply using short rotation forestry and where that energy is best used.

Having enough feedstock to fuel a bioenergy industry is essentially the green light at the start of a national bioenergy roadmap.

Under the Climate Change Response (Zero Carbon) Amendment Act 2019, the Government has set a 2050 target of net zero greenhouse gas (GHG) emissions (other than biogenic methane). Planting trees is a proven and immediately available way of removing carbon from the atmosphere. If managed on a sustained yield basis (i.e harvested timber volumes are replaced by new growth) and using best practice forestry, these trees are both a carbon store and a source of endlessly renewable low carbon bioenergy.

Scion bioenergy researcher Peter Hall says replacing fossil fuels with bioenergy alternatives from trees and other biological

sources will not only help New Zealand meet our greenhouse gas emission targets and meet international obligations, it will also rejuvenate regional economies and make us less dependent on imported fossil fuels.

Large industries look for sustainable alternatives

While pastoral agriculture and transport are largely visible greenhouse gas emitters, few people give much thought to the energy that is used to power our largest industries. Much of that energy is process heat. That is, any heat generated in the manufacturing of a product. It accounts for 35 percent of our total energy consumption.

This energy is mainly used to power dairy factories, meat processing plants, sawmills, pulp and paper mills and other food processing plants. Process heat makes up around nine percent of our total greenhouse gas emissions. It may not seem like much, but those emissions tend to be clumped around a few large manufacturers rather than distributed over millions of vehicles or livestock. Some of those larger industries are making the switch away from coal and toward more sustainable alternatives.

In September 2020, Fonterra announced that its Te Awamutu dairy processing factory switched from using coal to fuelling the boiler with wood pellets. This is the largest coal to biofuels conversion project to date in New Zealand. The move away from coal at Te Awamutu is part of Fonterra's plans to have net zero emissions at its manufacturing sites by 2050. It has reduced the co-operative's national coal consumption by almost 10 percent, saving more than 84,000 tonnes of carbon emissions per year – the same as taking 32,000 cars off the road.

Sixty percent of New Zealand's process heat demand is met by burning natural gas or coal. Coal is especially problematic. Burnt in boilers, coal is responsible for 26 percent of New Zealand's process heat greenhouse gas emissions. This is due to coal holding the highest carbon content of any fossil fuel and being more emissions intensive per unit of industrial output than any other source.

Using coal in process heat in New Zealand will come to an end. In April 2021, the government announced that new low-to-medium temperature coal burners are banned in New Zealand from December 31, 2021. This is in line with the Climate Change Commission's advice on decarbonising New Zealand's economy.

The ban on new coal boilers did not cover new large sized ones. That was because industries with high-temperature requirements generally use energy in a way that is highly integrated into their plants, meaning there are fewer low carbon opportunities. High temperature boilers used by industries such milk drying plants in dairy factories will remain in place until a 2037 deadline, provided they meet emissions standards. Nevertheless, their lifetime is limited, and alternative fuel sources need to be found as businesses move away from coal and gas and new processing plants are built. Where do those bioenergy sources currently exist and how can we grow the supply?

Residual biomass resources

In January, Hall released a Scion report estimating the potential for woody biomass to fuel New Zealand industry using process heat.

Hall calculated that the biomass from all woody sources in New Zealand is significant and amounts to 181 petajoules (PJ) produced each year. This is more than enough to replace all fossil fuels used in process heat in New Zealand – which is about 109 PJ worth. Hall's bioenergy estimate includes excess pulp and K grade logs as well as sawmill chip, for which there is already a market, so excluding these sources from the analysis reduces the biomass energy supply to 62 PJ or around 55 percent of the energy needed to displace coal and gas from process heat.

For a range of financial, quality, and environmental reasons, not all woody biomass is recoverable. For example, slash left at a remote and extremely steep skid site may be impractical to extract, or is required to maintain soil heath, biodiversity and productivity. Given reasonable rates of recovery, Hall estimates that 21 to 25 PJ of energy can be supplied each year from forest residues – or around a quarter of the energy currently supplied by coal and gas. Creating bioenergy from other sources such as wood discarded at

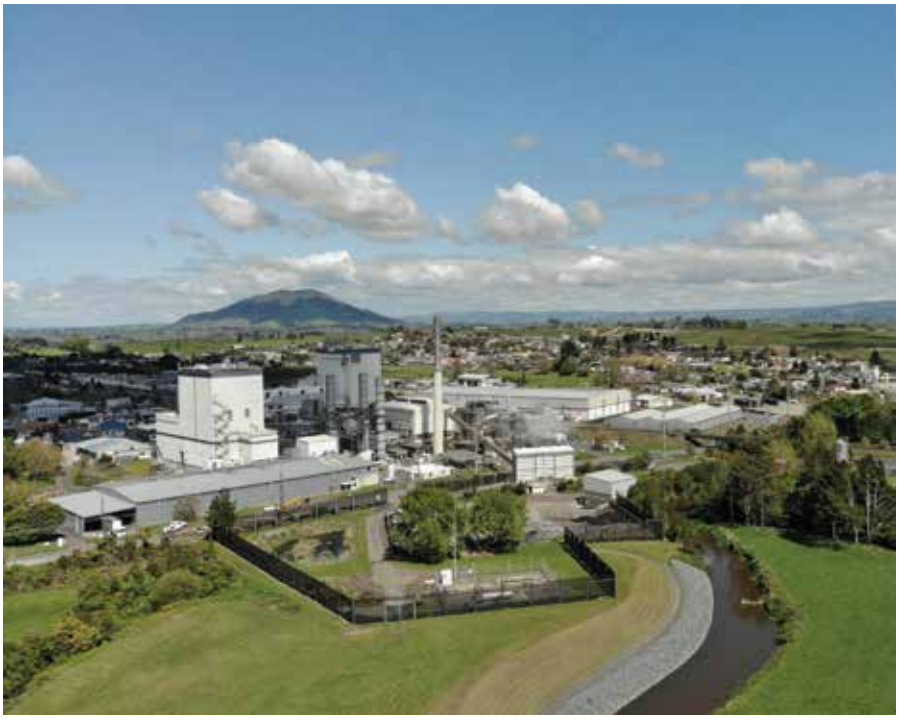


Photo: Fonterra

Following successful trials, Fonterra will replace coal used at its Te Awamutu milk processing plant with domestically produced wood pellets from Nature's Flame.

Scion scientist Alan Jones with four-year-old eucalyptus growing on a highly productive site near Paengaroa in the Bay of Plenty.

landfills, bark removed from logs at ports, crop and straw residues, shelterbelt trimmings and orchard waste would add another 8-10 PJ of energy into the national supply. While these sources do not meet all the energy demand currently supplied by fossil sources, these biomass resources lock away carbon over their lifetime, are domestically grown and renewable. With increasing energy and carbon prices, the resources excluded from this analysis, K grade logs and excess pulp logs, may become economically viable for bioenergy use.

If we efficiently use available residual forestry waste to generate process heat, we will still need to grow new forests to keep up with increased demand for process heat in the future and to supply liquid biofuels for transport. The bioenergy forest of the future will need to be harvested at around 14 to 16 years, much sooner than the traditional 26 to 28-year time horizon. These are called short rotation forests.

Short rotation forestry is a solution.

Short rotation forests

Meeting our emissions reduction targets is a race against time – and time is currently winning. More electric cars on the road, reducing livestock numbers and changes in our consumption behaviour will all help. So too will planting more trees and diverting away from fossil fuels to renewable sources of energy.

New quick-growing forests on a large scale are a way to generate biomass for biofuels quickly to meet interim emissions targets by 2035. Scion scientist Dr Alan Jones realistically points out that this outcome depends on dedicated bioenergy forests grown on a 16-year rotation at high stocking density, given available land.

Any new plantations must grow successfully and deliver biomass of sufficient quantity and quality to meet expected energy demands. They will need to be grown on hill country where they can be deployed economically without displacing current food production.

Planting an additional 240,000 hectares of dedicated bioenergy forest would be the equivalent of one percent of New Zealand's land area, or three percent of the land currently under sheep and beef. This area would meet the Climate Change Commission's net zero target by 2050.

A forest of this size would yield a biomass equivalent to 35 PJ annually, or just over a third of that used by fossil sources in process heat. It would potentially displace three million tonnes of CO_2 per year from fossil fuels, the same as taking a third of New Zealand's 4.4 million cars off the road.

The preferred forestry species for short rotation crops are already well-known to New Zealand forestry. Radiata pine, as well as *Eucalyptus fastigata* and *Eucalyptus regnans* have rapid initial growth traits favourable for short rotation bioenergy forestry. Of the three, radiata pine is the best understood silviculturally and has the greatest potential environmental adaptability. The other species may have greater suitability within narrower environmental ranges and may be more suitable for select locations. Priority areas for afforestation were identified as: Hawke's Bay, Gisborne, Central North Island, Northland, Canterbury, Otago-Southland and the Southern North Island.

Jones points out that the devil is in the details.

"No-one has planted short rotation forests at any great scale on New Zealand's hill country so we will need to make sure that we use the most appropriate tree species with the highest possible yields under the most sustainable intensively grown forestry regime.

"But this will also come with potential risks around disease susceptibility, erosion risk or growth limitations on certain soil types or microclimates. To understand this, we need to get bioenergy forest trials underway yesterday," says Jones.

For more information on this project, contact alan.jones@scionresearch.com

A glowing collaboration

A David Trubridge Navicula pendant light made from a biomaterial formulation developed by Scion, was on display in the Tiaki restaurant at the New Zealand pavilion at the World Expo in Dubai.

The Tiaki restaurant in the New Zealand pavilion at the World Expo in Dubai was adorned with David Trubridge pendant lights earlier this year – one of those being made from a shimmering biomaterial formulation developed by Scion.

Showcasing New Zealand's innovative and sustainable spirit, the Navicula pendant light featured a composite of sustainable bio-based plastics and native pāua shells developed by Scion scientists, with a beautiful iridescent sparkle.

The Navicula design was inspired by microscopic diatoms which live in water and produce 50 percent of the oxygen in the air we breathe. Designer David Trubridge is a recognised leader in sustainable design for his high-end lighting that is produced with minimal environmental impact.

Trubridge was asked by New Zealand Trade & Enterprise (NZTE) to develop an installation for the World Expo, which ran from October 2021 to March 2022. He created custom colour Navicula pendant lights, with a Scion biomaterial light at the entrance of the Tiaki restaurant reception. Over the course of the World Expo, the restaurant welcomed more than 700,000 visitors.

Trubridge says the main objective of working with Scion was to show what's possible, and hopefully as the commercial environment changes, to make it more attractive for companies to take up the baton to move away from oil-based plastics.

"Scion has been experimenting with New Zealand materials to make biomaterial colour. They've used kiwifruit to make green, harakeke (flax) to make brown, the pāua added more of a glitter effect.

"I love the pāua Navicula pendant light they developed because it's different – the light shines through, the colour works well. The whole way along we said it's important to get a texture, as we didn't want it to have a glossy shine that made it look like plastic. Scion achieved a rough texture which is important – it works really well, it's quite different to our plywood lights and I like that."

Scion materials, engineering and manufacturing research group leader Marie Joo Le Guen says it is a fantastic showcase of the utilisation of biomaterials in an everyday product.

"Scion's mission and vision is transitioning New Zealand from a linear to a circular bioeconomy. To achieve this, working with artists, designers, teachers or educators, is one of the most important parts of our job. It allows us to bring our innovative biomaterials to life, while taking people on the journey."

Scion's biomaterials technology platform takes natural fillers, such as sander dust, kiwifruit hair and skin, seashells, grape marc, harakeke, bark or casein and combines them with biobased polymers. Compounding the filler with the polymer creates a biocomposite which is then shaped into a new form that can be used.

"This Navicula pendant project's success is the result of a 12-year partnership with David Trubridge based on a shared vision towards sustainability and kaitiakitanga," Le Guen says.

Trubridge adds "it was wonderful to be part of New Zealand's creative community on exhibit in Dubai – to be there telling the story of our land and our people".

The Navicula pendant was formulated by Scion's Marie Joo Le Guen, Jamie Agnew, Maxime Barbier, Regis Risani and Rob Whitton.

For more information on this project contact mariejoo.leguen@scionresearch.com
See a behind the scenes video and more images at www.scionresearch.com

Forest Research Institute pulp and paper laboratory, date unknown.

Celebrating 75 years of impact

This year, Scion turns 75. Since its inception in 1947, expertise has grown from research to support the development of sustainably managed exotic plantation forests and forest product industries, to a broader view of the role of forests in supporting a circular bioeconomy. This evolution represents the increasing importance of forests, and Scion's commitment to enhancing New Zealand's prosperity, wellbeing and environment through trees.

With 332 full-time-equivalent staff in Rotorua, Christchurch and Wellington, our talented people are tackling some of the biggest challenges facing our planet and helping Aotearoa transition to a low-carbon circular bioeconomy.

Scion chief executive Dr Julian Elder says the 75th anniversary is a chance to not only reflect on where we've come and where we're headed, but to make a commitment to acknowledging the place that Scion sits right now – quite literally, the land on which the institute was built.

"When we opened our award-winning innovation hub, Te Whare Nui o Tuteata, in March 2021, we were on a journey of inviting visitors into Te Papa Tipu campus, where Scion is headquartered in Rotorua, and sharing our work with the community.

"A significant and very special part of that journey has been the relationships we have developed with Ngā Hapū e Toru; Ngāti Hurungaterangi; Ngāti Taeōtū and Ngāti Te Kahu o Ngāti Whakaue."

Ngā Hapū e Toru are the mana whenua of the 114 hectare site where Scion is situated in the Te Papa Tipu campus.

Ngā Hapū e Toru trustee Veronica Butterworth explains that when the land was used by the Crown as a forest nursery from 1898 and then for forestry research from 1947 onwards, physical connection of the hapū to this land was severed but the spiritual connection was never lost.

"Land is the basis of identity and wellbeing for our people," Butterworth says. "We are genealogically connected through our whakapapa to the land itself, as we trace our ancestry from Papatūānuku (the earth mother) and Ranginui (the sky father).

"Our whakapapa ties to the land and the various parts of the natural environment are fundamental aspects of our culture and our lives. Whakapapa and whanaungatanga give rise to obligations to look after the land, the waters and the environment on behalf of our ancestors and ourselves for future generations."

It is this kaitiakitanga (guardianship) of the land, and the long-term perspective of Māori, that Dr Elder says will guide Scion as we head towards a circular bioeconomy future.

"Right now, we are on the cusp of huge opportunities with the circular bioeconomy. Scion, and New Zealand, are incredibly well-placed to contribute to this – we grow things well, we're great at the science and, vitally, mātauranga Māori and the worldview of Māori has much to teach us about interconnectedness with our environment."

In July this year, Ngā Hapū e Toru and Scion will sign a Memorandum of Understanding that will recognise the value of working together in the spirit of cooperation and partnership.

Butterworth says,"Looking to the future, our hapū are building a relationship with Scion to reconnect our people and traditions to this land. The name of this campus, Te Papa Tipu – land on which to grow – is appropriate."

For principal scientist Brian Richardson,

celebrating 75 years of Scion is a chance to acknowledge the high-calibre breadth of work that has been achieved over that time.

Dr Richardson has worked at Scion for 39 years across many areas of forest science. In that time, he has seen a lot of changes – and a lot of things come back around. The highlights across the organisation have been many – genetic improvement of radiata pine, overcoming many forest health challenges and biosecurity incursions, supporting development of sustainable forest management practices to ensure maintenance of productivity and license to operate, and creation of management models using data from the permanent sample plot (PSP) database.

"There are certainly too many work programmes for me to name but the impact that Scion's research has had on New Zealand, across all our teams, has been significant.

"Scion has certainly been a leader across a range of areas. Our work in areas such as ecosystem services – quantifying the benefits of forests beyond the timber – were happening long before the topics were accepted as mainstream activities."

Looking to what Scion's future might hold, Dr Richardson looks back at the biomaterials strategy that was developed in 2003.

"That strategy was a brilliant work of foresight and if you look at our strategy today, it's similar in terms of what we are wanting to achieve. The biomaterial work was formed from really looking at the global trends and issues around sustainability and the need to move to a more circular economy. While it may not have used those exact words, that was the crux of it. But it was really hard to get any traction, as the strategy was ahead of its time.

"Today of course, everyone's talking about alternative fuels, bioenergy and so on. New Zealand's future may even include forests grown for biomass and conversations are starting to happen about where these could be.

"Looking to the next 75 years, those issues are not going away. Greenhouse gases driving climate change, fuel costs skyrocketing - all these things are coming to pass so the notion that we need to think more about sustainability and circularity in terms of the economy and plant-based economic growth I think plays beautifully into the hands of an organisation like ours. We've been working on these things for many years and we need to just keep pushing ahead."

Doug Gaunt is a principal researcher in the materials analysis, characterisation and testing team. He joined Scion in 1979 and says the organisation's contribution to the structural timber sector has been transformational.

Gaunt and his team focus on commercial testing for the timber building sector, supplying customers with the information they need to develop their own products and to meet export standards.

"Scion has been doing this work extensively for 40 or 50 years and I'd like to think that our research and expertise has impacted most building products in New Zealand. That is a huge testament to the work that has been conducted in our timber engineering labs.

"We've changed the entire grading system for the structural timber sector by shifting from visual grading to a system that is now fully machine-graded and third-party audited."

For Gaunt, it's the impact that Scion has made for New Zealand, and for individuals, that is really special to him.

"Changing the grading system has been a highlight for me. But I also really love working with all our clients and I get a highlight almost every week from working with them. They come in wanting ideas and, thanks to our knowledge, they can leave with a better product."

Entomology quarantine laboratory in 1979.

Gaunt sees the future for Scion focusing on impact, people and continuing to tell the strong Scion story.

"It would be wonderful to see us connect more – with industry, with our community and with trainees. That's how I got my start at the then Forest Service. I was a trainee technician and we spent time across different labs getting training. That's where I fell in love with timber processing and my career grew from there.

"I think we'll see a lot more timber buildings. Te Whare Nui o Tuteata is a stunning example of what can be done with wood.

"And of course, climate change is coming. We know there's a changing disease risk, there's a changing fire risk, there's a changing wind risk, there's all those sorts of things factored into our forest estates, because if we don't have an estate, we haven't got a forest sector, a processing sector. So keeping the existing forests viable and healthy has got to be a key thing for us to do.

"The New Zealand government is also committed to planting trees as a way to help mitigate the effects of climate change so let's plant as many trees as we can and if in 30, 40, 50 years our biggest problem in the world is working out what to do with all these trees then I think we've had a success."

Forest Research Institute Nursery weedicide screening trial, date unknown.

Roanne Sutherland inspecting midges growing on ramarama.

"In New Zealand, midges are largely understudied, therefore a lack of knowledge exists about these tiny native flies. It is important to explore the relationship between the larvae and the plant host. Myrtle rust is having detrimental impacts on ecosystems and economies worldwide, including here in New Zealand on our Myrtaceae species."

Dr Toni Withers, Scion entomologist

Friend or foe?

The scientific discovery of a midge that feeds on myrtle rust spores has Scion scientists researching whether it is a friend or foe in the fight against myrtle rust.

Midge larvae feeding on myrtle rust spores were first observed during disease assessments near Rotorua in 2018 by Scion researcher Roanne Sutherland. The tiny larvae proved to belong to an undescribed species of a rust-and mildew-feeding genus of fly and has only been formally described in partnership with Australian insect taxonomist Dr Peter Kolesik, in 2022.

Scion entomologist Dr Toni Withers says the midge is new to science and is a very exciting and important discovery for the team undertaking myrtle rust research.

"In New Zealand, midges are largely understudied, therefore a lack of knowledge exists about these tiny native flies. It is important to explore the relationship between the larvae and the plant host. Myrtle rust is having detrimental impacts on ecosystems and economies worldwide, including here in New Zealand on our Myrtaceae species."

The next stage of the research turns to determining how many rust species this larva eats and whether the midge could become a natural enemy of myrtle rust, or a vector spreading the spores.

Myrtle rust (*Austropuccinia psidii*) is a serious threat to New Zealand Myrtaceae including ramarama, rōhutu, maire tawake and pōhutukawa. The fungal disease was first reported in May 2017 and is now widespread, established and causing significant damage.

Both chemical and biological control options are relevant to help manage myrtle rust now that it is considered an established pathogen in New Zealand. Scion's work in this area has included testing chemicals in containment facilities, as well as investigating biological control options.

For more information on this project, contact toni.withers@scionresearch.com

Larval stage of the fly on a Lophomyrtus bullata *(ramarama) leaf being prepared for the microscope.*

Making zero the hero

Eliminating plastic waste is "doable, but difficult," a report, released by Scion in March, has explained.

"Reaching the objective of zero plastic waste will require aligned efforts by science, industry, government and the public," says Marc Gaugler, report author and Scion's lead for the Distributed and Circular Manufacturing portfolio.

"Our research shows there is already extremely high commitment from industry, but they need support from central and local government in the form of clear and coordinated policy, regulation, incentives, and much better nationwide recycling systems. Consumers will have to do their bit – without their demand and participation, it cannot succeed.

"We must also make sure that the strategy fits with other initiatives to reduce carbon emissions and pollution," he says.

The report, titled *Making zero the hero*, focuses on re-using and recycling the plastics we mostly use now and stopping them from escaping into the environment. It comes as the Ministry for the Environment (MfE) seeks views on proposals to significantly transform recycling in New Zealand.

The report's authors worked with industry partners to identify the challenges, barriers and opportunities to understand how global plastic supply chains are part of New Zealand's transition to a New Plastics Economy.

Making zero the hero follows the 2019 report on the New Zealand plastics problem by the Prime Minister's chief science advisor, professor Dame Juliet Gerrard, which lamented the lack of data on which to base a strategy.

"It's great to see this report aiming to fill some of the information gaps we identified in *Rethinking Plastics*, using a very practical, evidence-based approach," says Gerrard.

Packaging New Zealand president Harry Burkhardt says Scion's *Making zero the hero* report is noteworthy because it puts the onus on both the packaging producer and the consumer.

He says successive governments have dealt with the packaging industry as primarily a waste producer.

"We're pleased to see a report that provides a much more balanced perspective of the role consumers, government and business will have to play if we want to reduce plastic waste."

In March, the United Nations passed a landmark agreement to stop plastic pollution, and the New Zealand government announced a consultation process on separating household and commercial food waste, standardising recycling collection across the country, and a drink container return scheme.

Scion portfolio leader for Distributed and Circular Manufacturing Marc Gaugler, is the lead author of Making zero the hero.

"When it comes to plastic, New Zealand is different to many countries. We currently have no raw plastics production domestically so we buy materials in a global market. Implementing New Plastics Economy systems will boost the resilience of our businesses in the face of global supply chain changes and overseas sustainability trends." Marc Gaugler, Scion

Gaugler explains that the perception of plastics is very negative, however we also need to acknowledge that plastic is an incredibly important material that, though carbon emission-intensive to produce, allows all sorts of efficiency gains.

"For example, plastics mean lighter planes and cars, requiring less fuel to run, and affordable, vital healthcare products. Recycling a metric tonne of plastic packaging into new products conserves almost 1.4 tonnes of CO_2-equivalent emissions.

"Furthermore, plastics are deeply embedded in so many industrial processes, we simply could not do without them.

"We have to turn the public away from the overly simplistic idea of elimination, and channel their goodwill into sensible reduction and re-use, conscientious recycling, and replacement where that is possible, without compromising food safety and protection, for example.

"There's a lot of education that has to happen, but we have a New Zealand public willing to learn and keen to do the right thing," Gaugler explains.

Scion's work on New Zealand's New Plastic Economy was funded by the Ministry for the Environment's Waste Minimisation Fund. Scion is working on a number of projects to replace fossil fuel-based plastics, chemicals and other products with wood, bark and other plant materials.

For more information contact
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Full report at
www.scionresearch.com/?a=80606

Scion's Te Whare Nui o Tuteata puts NZ on the architecture world map

Scion's innovation hub, Te Whare Nui o Tuteata, has won 15 domestic and international awards since opening in March 2021, making it an international timber architecture icon.

The Rotorua building is believed to be a world-first diagonal-grid (diagrid) timber structure for a three-storey building, while also being embodied-carbon neutral. Its name and design feature stories of tangata whenua, Ngā Hapū e Toru. The building was designed by RTA Studio in collaboration with Irving Smith Architects.

In December 2021, Te Whare Nui o Tuteata won two World Architecture Festival awards (World Best use of Certified Timber Prize; World Higher Education and Research), and a New Zealand Institute of Architects (NZIA) National Award (Commercial).

Overall, Te Whare Nui o Tuteata won 15 significant national and international awards, and Scion sustainability architect and portfolio leader Andrea Stocchero believes there are many compelling reasons why.

"Tackling climate change requires working together and this building provides an invitation to 'come walk in our forest' and see how we can all better participate with the environment."

Rich Naish, RTA Studio executive director

"From the outside, you see a simple building with fascinating colours that match the forest and at the entrance, Māori kōwhaiwhai patterns from the tangata whenua. But inside you see a striking timber structure, architectural lines and natural materials in harmony with each other – that is what is so impactful.

"The world is on a quest to decarbonise across many different sectors. Trees sequester carbon from the atmosphere while they're growing, as long as the wood is in use that carbon is stored so it's not going back into the atmosphere. If the timber is sustainably certified it means that the forests are re-growing after each harvest, and the carbon sequestration cycle continues."

Te Whare Nui o Tuteata stores 418 tonnes of CO_2-equivalent for the life of the building, which is the equivalent of one person flying 160 times return from Auckland to London.

"We calculated that the timber we see in Te Whare Nui o Tuteata has been regrown in 35 minutes by New Zealand planted forests," illustrates Stocchero.

"This is a compelling story about the

capacity for New Zealand forests to provide the timber we need for future developments.

"I believe Te Whare Nui o Tuteata won these awards because it showcases the opportunities architects have with timber to design exciting, beautiful buildings while using a locally-grown and manufactured material that is also helping to reduce our carbon footprint."

RTA Studio executive director Rich Naish says the team is honoured to have been recognised at the World Architecture Festival Awards.

"The recognition of this building and the innovation it proposes for sustainability and carbon neutrality in the building sector, particularly in the weeks after COP26 (the 2021 United Nations Climate Change conference), could not be more relevant. We are proud to be able to make a global contribution to the climate emergency," he says.

Irving Smith Architects design director Jeremy Smith says it's wonderful to be recognised on the global stage for Te Whare Nui o Tuteata which sets new conventions.

"Tackling climate change requires working together and this building provides an invitation to 'come walk in our forest' and see how we can all better participate with the environment."

Other awards included Property Council NZ Awards of Excellence, Best of Best Masterprize Award for Green Buildings at the USA Architecture Masterprize Awards, The Building Award at the Indo-Pacific INDE Awards in Sydney and the Designers' Institute of New Zealand Best Design Awards Purple Pin.

Top right: *Dr Lloyd Donaldson.* Middle right: *Dr Qiliang Fu.* Bottom right: *Dr Rebecca McDougal.* Above back row L-R: *Maxime Barbier, Karl Molving, Rob Whitton, Dr Marie-Joo Le Guen and Sean Taylor.* Above front row L-R: *Dr Yi Chen and Dr Stefan Hill.*

Awards celebrate Scion talent

Wood nanotechnology, seaweed nanocellulose products and an internationally recognised microscopist were among top successes celebrated by Scion at the 2021 Science New Zealand Awards.

All seven Crown Research Institutes and Callaghan Innovation were recognised at the awards. Scion's awardee for Lifetime Achievement was Doctor of Science, Lloyd Donaldson for his microscopist work, Scion's awardee for Early Career Researcher was Dr Qiliang Fu – leading scientist in wood nanotechnology and functionalisation, and our awardee for the Team Award was the AgriSea NZ and Scion collaboration.

Scion Forests and Biotechnology scientist Dr Lloyd Donaldson was named one of the eight Lifetime Achievement Award recipients for his influence as an internationally recognised microscopist specialising in plant anatomy and ultrastructure for the last 40 years at Scion. He has pioneered techniques in confocal fluorescence imaging of wood and biomaterials, with his methods forming part of researcher toolboxes globally.

An Early Career Researcher Award was made to scientist Dr Qiliang Fu who specialises in wood nanotechnologies, including various chemical treatment and functional approaches, applied to tailor and modify the nanostructure of bulk wood. Dr Fu has contributed strongly to developing this field globally.

Scion's awardee for the Team Award was the Scion and AgriSea NZ collaboration team which together are accelerating new nanocellulose-based business opportunities.

Scion's wood pulping expertise and AgriSea's 25 years in seaweed processing has resulted in a novel seaweed gel product.

The team developed a method to produce nanocellulose from AgriSea's seaweed waste without disrupting current products and processing. Their innovative approach enables the extraction, isolation and manufacture of high-value nanocellulose hydrogel and nanocellulose. Applications for these materials include performance biocomposites, biomedical engineering applications, wound care, cosmetics and drug delivery.

The Scion team members are Dr Stefan Hill, Sean Taylor, Dr Yi Chen, Rob Whitton, Dr Marie-Joo Le Guen, working with AgriSea team members: Clare and Tane Bradley and Dr Melodie Lindsay.

A commitment to forest pathology and an ability to communicate complex science in a compelling manner saw Dr Rebecca McDougal named a finalist in the Bioprotection Aotearoa Science category at the NZ Biosecurity Awards.

The awards, run by Biosecurity New Zealand, acknowledge individuals and organisations who work to safeguard the biosecurity of Aotearoa.

Rebecca was one of 24 finalists selected from a record 90 entries. She was nominated by the Forest Owners Association and the Forest Industry's Biosecurity Committee for her outstanding contribution to the protection of the plantation forest estate as well as her ability to communicate complex science matters to forest owners.

Scion's history

1898 — **Whakarewarewa Nursery established:** Shortly after the Crown aquired land from Ngāti Hurungaterangi, Ngāti Taeotu and Ngāti Te Kahu, the Whakarewarewa Nursery was established, essentially the land upon which Scion its today. More than 60 exotic species were planted to determine which species grew best in New Zealand conditions.

1947 — **A government-owned forest experiment station:** Scientific research commenced on the present campus under the auspices of the New Zealand Forest Service.

1949 — **The research station was officially named the Forest Research Institute (FRI).** The institute became an internationally recognised leader in plantation forestry science. The Sirex wasp wiped out a third of all pine trees in the Central North Island in the late 1940s. Researchers worked to tackle the wasp problem, focusing on plant health, climate, soils, tree spacing in the forest and forestry management.

1984 — **1984 -1992:** An era of intensive science reform (and overall economic reform) with a reduction in government funding of research and the introduction of a 'user-pays' system. A new, contestable funding mechanism which impacted all research institutes.

1987 — **The Forest Service ceased to exist.** The FRI became part of the new Ministry of Forestry.

1992 — **Ten Crown Research Institutes created.** The major government research providers (DSIR, MAF technology, FRI and the Meteorological Service) were reorganised into 10 stand-alone Crown Research Institutes. FRI did not survive this reorganisation process intact. The bulk of the Forest and Wildlands Ecosystem staff were separated off and became part of what was eventually named Landcare Research New Zealand, while the rest became New Zealand Forest Research Institute.

As a CRI, the revised New Zealand Forest Research Institute came into being on 1 July. The new CRI was strongly Rotorua-based and highly focused on plantation growing and processing, along with environmental and sustainability issues relating to commercial activity. As it was now a stand-alone company, the New Zealand Forest Research Institute needed to provide for its own corporate support and development, in an increasingly commercial environment.

2005 — **Forest Research Institute rebranded to become Scion.** The trading name Scion was adopted to reflect the growth of research programmes to include the development of new materials and energy from renewable resources and waste streams. A scion is a cutting from one plant, grafted onto another and is where new growth occurs. Similarly, by bringing ideas together here at Scion we are creating new opportunities for a circular biobased economy.

2021 — Scion officially opens Te Whare Nui o Tuteata, which means the great house of Tuteata. This name was gifted by Ngāti Hurungaterangi, Ngāti Taeotu and Ngāti Te Kahu. The hapū also gifted the kōwhaiwhai patterns used in this building, which come from the wharenui of Hurungaterangi in Ngāpuna.

2022 — A kawenata (Memorandum of Understanding) will be signed in July to formally establish and record the enduring partnership between Ngāti Hurungaterangi, Ngāti Taeotu, Ngāti Te Kahu and Scion.

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FORESTS ▪ PRODUCTS ▪ INNOVATION

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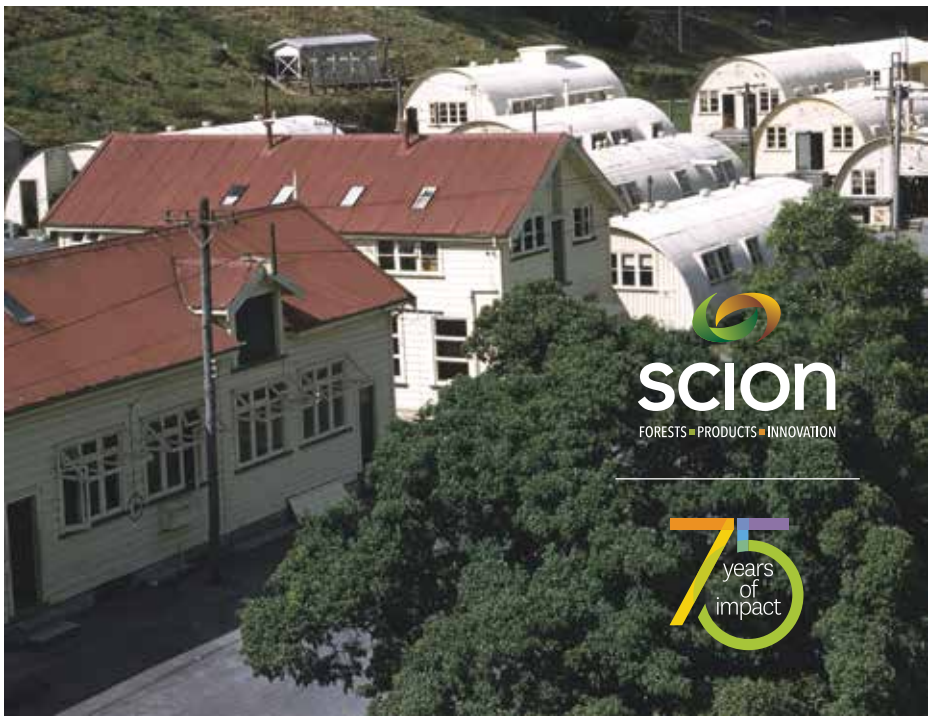
OUR JOB DOESN'T STOP HERE
WORLD FORESTRY
IS INFORMED OF OUR RESEARCH RESULTS
WHICH ARE SENT TO 103 COUNTRIES
IN ONE OF THESE WAYS
SCIENTIFIC PAPERS
ARTICLES IN OVERSEAS PUBLICATIONS
TOURING SCIENTISTS — LECTURES
CONFERENCES — NEWSLETTERS — FILMS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