Scion
connections
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A new kind of wood adds value

Substituting just 1% of tropical timbers with sustainably grown radiata pine would be a significant opportunity for New Zealand. Scion's wood processing scientists are developing and preparing to commercialise a technology platform with New Zealand based companies that can deliver new applications for wood. The technology is protected by international patents.

The Scion team has successfully developed "dewatered" wood from radiata pine. The dewatered wood is not an end product. It is a superior material that relies on downstream modifications to achieve a high-value, wood-based material that meets a range of market needs not currently met by radiata pine.

An early application of this platform technology demonstrates that the resulting modified wood product has similar physical and appearance properties to tropical hardwoods such as teak.

The research is developing a transformative technology using supercritical carbon dioxide. Supercritical fluids behave like both a gas and a liquid and have been used in commercial applications to remove chemicals from a substance without distorting the original structure of the material.

Dewatered wood looks and feels like any other piece of timber, but is slightly heavier as it contains 40% moisture content, compared with about 10% in kiln-dried timber.

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

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

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

To date, research in New Zealand has been limited by the availability of a dewatering supercritical fluids facility that can process larger amounts of wood. In addition to continuing to work closely with companies interested in licensing the technology, Scion has commissioned Transfield Worley to design a Supercritical Pilot Plant. This would be located at Scion's Rotorua campus to produce sufficient volumes of dewatered material to further the research programme on the process and assist potential licensee firms complete market and economic evaluation of prototype products.

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> Increasing our onshore manufacturing is critical

Scion welcomes the establishment of the Advanced Technology Institute (ATI) and is pleased that 'wood and fibre products' are identified as one of the focus areas. A lot of water has yet to go under the bridge in defining ATI's business model and *modus operandi* but that will not slow our work in strengthening the competitiveness of existing manufacturing firms and fostering new sectors in the forest industry.

The Government's aim is to increase export earnings from 30% (low by OECD standards) to 40% by 2025. Increased onshore manufacturing is critical to achieving this. It aligns directly with the forest industry's aspiration to grow export earnings from the current $4.8 billion to $12 billion by 2022.

A vibrant manufacturing sector generates higher paying jobs (on average) and local economy multiplier effects (for example, often four to six additional jobs for every job in wood fibre processing). These benefits can be very significant when firms, like many in the forest industry, are located in regional cities and towns.

Increasing onshore manufacturing of logs and other forest materials such as post-harvest residues and stumps is going to be a tough, but 'doable' challenge. It will require gains across the value chain from design to the application of lean principles, logistics and critically new science discoveries. The latter generates uniqueness and barriers to competitors through intellectual property.

Scion, through its 'Biomaterial Futures' strategy, initiated in the early 2000s, is very well placed to contribute strongly to this initiative. Our work in wood plastics, wood derived 'green' chemicals, polymers and adhesives from stump resins, carbon fibres and renewable energy from cellulose are all examples of a global transformation that is well underway in the forest industry.

With shortages of energy, water and other natural resources coming into sharp focus in many Asian countries, our customers are telling us that interest in these technologies is building and changes to address these issues is rapid. Our customers are also experiencing a sharp increase in demand for verified environmental and chain of custody performance from the forest to the final consumer. These can all add to New Zealand's competitive advantage and brand in forest products and services.

The macroeconomic settings for New Zealand exporters, as in most countries at present, are difficult. A high and volatile exchange rate, relatively high cost of capital, low direct foreign investment; diminution of the Emission Trading Scheme for forest owners and difficulties in attracting and keeping top talent are some of the factors that have to be overcome in building a stronger manufacturing base. Therefore we have to do things differently to countries that have scale, market proximity, greater R&D spend and brand advantages. That is why Scion's science and innovation strategy has a strong emphasis on three dimensions: how to build new products and value into brownfield manufacturing sites; the establishment of new sectors and firms (such as in biomaterials and composites); and technology translation. The latter is critical because it is the dynamic interplay, sharing of ideas and experiences and co-creation of products and processes that will help to speed up the establishment of a larger and more competitive manufacturing base in New Zealand.

Your feedback and comments on the any of the articles in this edition of ***Scion Connections*** are most welcome.

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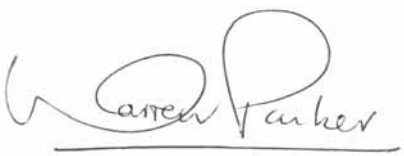
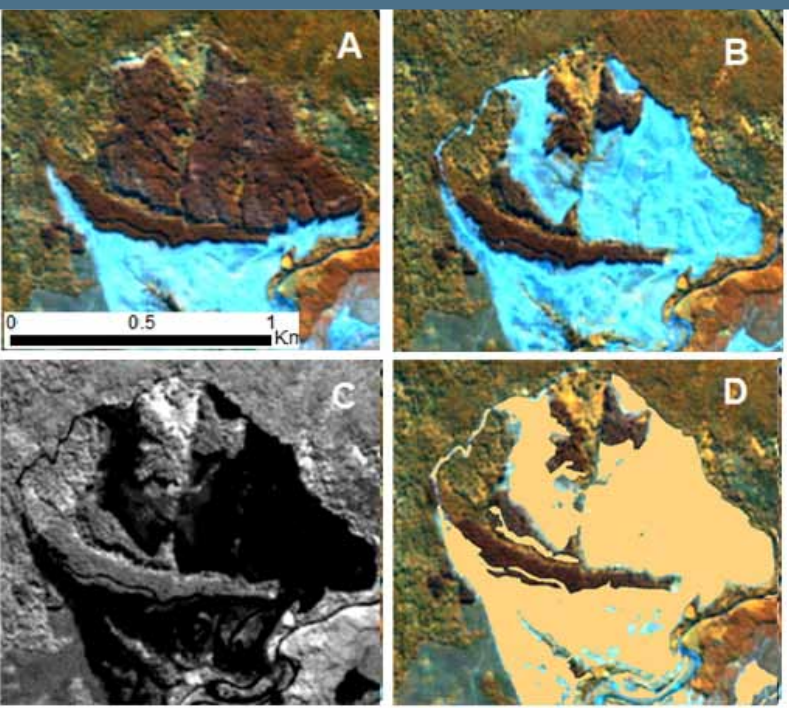


Warren Parker
Chief Executive

> Satellite imagery aids forest management



Time series showing detection of harvesting using RapidEye imagery. Shown are the (A) stocked area, (B) the same area following harvesting, (C) Enhanced Vegetation Index imagery of the harvested area and (D) the GIS representation of the harvested area.

Satellite imagery is proving an effective tool that meets forestry management and research needs for cost effective, up-to-date information on the status of forest resources.

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

"The project demonstrated that RapidEye satellite imagery can be used to identify new harvest areas, delineate stands, and gaps within stands, such as wind-throw areas and erosion," says Philip Elworthy, Forest Services Manager at Rayonier New Zealand Ltd.

Mr Elworthy adds that while RapidEye satellite imagery is becoming a valuable tool for forest management, its real power will be realised when data are incorporated in GIS-ready tools or used in combination with traditional aerial photography.

RapidEye is a German-based company that owns a constellation of five identical satellites circling the globe daily with each producing high resolution imagery. Given its near-continuous global coverage, forest managers have access to a vast archive of imagery via an online search tool. An area 70 by 70 km is able to be imaged in one satellite pass at a cost of about NZ $1.50 per km^2 (or 1.5 cents per ha). The image resolution at 5 metres is high enough to map resources at a 1: 25000 scale.

Targets on the ground, such as trees, bare earth and leaves reflect light in different well-known wavelengths. Light reflected by chlorophyll from healthy trees is in the 400 to 750 nanometre (nm) wavelength range. Changes in reflectance values in the 750 to 850 nm range indicate aged or stressed leaves and can be an indicator of disease or a sign of limiting environmental factors such as water shortage or nutrient deficiencies.

Overseas, satellite technology has been used for updating national forest inventories, monitoring deforestation and harvesting rates, fire risk, wind damage and plantation establishment.

With increased data available over large areas, satellite imagery may prove to be a boon for forest researchers. Already, Scion's resource assessment project leader Dr Michael Watt in collaboration with industry has completed a number of studies using satellite imagery to give insights into radiata pine forest growth in New Zealand. In one study, detecting the reflectance of trees until canopy closure (typically seven years) should be able to provide a reliable assessment of how successfully large stands have established.

He suggests that the variability of reflectance response across stands is able to highlight differences in growth and therefore areas that have either performed better or poorer than expected.

LiDAR (Light Detection and Ranging) is another active area of operational research. LiDAR, which is flown from a plane, can help create a three-dimensional representation of a forest. These data can be used to generate GIS-ready terrain models and forest metrics such as height, basal area and volume. The information derived from this can be used to improve harvesting planning, field inventory efficiency and plan wood supplies to customers.

On a national scale, future satellite and LiDAR-derived forest inventory maps will lead to improved estimates of wood supply and carbon stocks over time. (RapidEye satellite imagery has been available since 2010.) These tools also have high potential for monitoring the conservation forest estate.

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> Major boost for research areas

Scion's successes in the recent Ministry of Business, Innovation and Employment (MBIE) Science and Innovation Group investment rounds demonstrates confidence in the positive economic and environmental outcomes for New Zealand arising from Scion's industry partnerships and relationship with other research providers.

At $12.9 million, the six year Extrusion PLUS project attracted the greatest funding of any project in the 2012 MBIE Science Investment Round for high-value manufacturing and services research.

Led by Scion, the researchers will collaborate with three New Zealand universities, and a diverse mix of manufacturing companies, and will draw on links to other world-leading research institutes.

Project leader Dr Alan Fernyhough says the main drivers behind Extrusion PLUS were the global trends to "greener products" in our export markets and the reliance that New Zealand manufacturers have on imported raw (often petroleum-based) materials. Renewable biobased contents and low environmental impacts are increasingly desired or specified by consumers. Due to our isolation and small size, these materials limit opportunities to differentiate resulting manufactured products as being "New Zealand home-grown" or "green".

Extrusion PLUS will be an enabling technology platform – allowing New Zealand manufacturers with extrusion capabilities to create products with advanced functionalities from local-derived renewable sources. Extrusion is a very versatile process widely used in manufacturing with plastics, composites, fibres, adhesives, coatings, laminated structures, metals, as well as in food and pharmaceutical processing.

Garry Haskett, General Manager at Ashburton-based biomaterials company Lignotech, believes the prospect of new ways of processing biomaterials means he will be able to create new products for export markets. "Rather than relying on importing feedstocks from North America, we should be able to source these locally," he says.

A second research project to create 100 percent bio-based adhesives will receive $2.3 million of investment over four years. Scion scientist Warren Grigsby explains these bioadhesives can be used to create new engineered wood products that meet the sustainability requirements of export markets. Health concerns and end-of-life disposal issues surround formaldehyde-based adhesives currently used in products such as panelboards. (Bioadhesives research was featured in the June 2012 issue of ***Scion Connections***.)

MBIE has also invested some $5.2 million into a programme to protect and enhance New Zealand forest exports by mitigating market access risks. The programme will be led by Christchurch-based Scion entomologist, Steve Pawson.

"Our forest industry log exports are heavily reliant on the fumigant methyl bromide – a known ozone depleting agent and one that may raise market access issues in the future," Dr Pawson explains. "One component of our research will develop ways of applying either electrical energy or electron beams to logs, effectively sterilising the log before export. The same approach is being used in our hospitals to kill cancerous cells."

Further supporting the nation's rural fire research efforts, MBIE has invested $2.2 million into Scion's rural fire research work. The programme will extend over four years and will be led by rural fire researcher Grant Pearce and his Christchurch-based team. The four-year programme builds on a history of Scion and the rural fire sector successfully working together to mitigate the risks of rural fire in the New Zealand landscape.

Four research projects will be supported by the 2012 Sustainable Land Management and Climate Change (SLMACC) Research Fund. Lasting for either one or two years, they ranged in value from $172,000 to $575,000. The successful projects are: Forestry Strategies in the Waiapu Catchment; Harvesting and Management in Steep Hill Country; Impacts of Climate Change on Soil Carbon Stock; and Harvested Wood to Domestic and Export Markets.

"Rather than relying on importing feedstocks from North America, we should be able to source these locally," says Garry Haskett of Lignotech on the future benefits of Scion's Extrustion PLUS project.

> Extreme make-over for Scion labs

The $5.5 million upgrade of one-third of Scion's ageing science labs is the largest improvement project undertaken on Scion's Rotorua campus.

The new laboratories, constructed inside the shell of a 1969 building, are now being populated by staff and laboratory equipment. The refurbished space provides 1500 sq m of 'state of the art' science laboratories creating a stimulating workplace. Within the new labs, the addition of specialist equipment will help expand research capabilities.

A fermentation laboratory, still under commission, will enable Scion to scale up its industrial biotechnology capability to generate larger amounts of microbially produced products including: enzymes; biopolymers and metabolites such as biofuels and biochemicals. This investment will showcase Scion's biorefinery research focus.

Scion CEO Warren Parker says the new labs were designed to be a world-class facility that New Zealand can be proud of.

Speciality areas are grouped together for better use of staff time and equipment. Open collaborative spaces allow new group working environments. Clever design has created a larger working area inside the old shell. Air conditioning and double glazing means the environmental footprint of the building has shrunk.

The labs have been designed with a glazed walkway along one entire side, allowing visitors to view science in action while remaining outside the labs itself. This feature helps to maintain high operating standards at all times, particularly in areas designed for physical containment of biological material.

> A hands-on approach to technology transfer

A new series of workshops for members of Future Forests Research (FFR) is putting the latest scientific knowledge straight into the hands of commercial foresters.

The first event was a two-day Quantitative Silviculture Workshop. Held in Rotorua, it attracted a full-house of foresters keen to update their skills. The course content, quality of presenters and promised learning outcomes hit the spot.

This was important for FFR, which was formed as a partnership of industry stakeholders and research provider Scion to maximise the benefit of technology transfer for New Zealand forestry. Creating outcomes, not just outputs is the basis on which Scion and FFR research is conducted.

Scion and FFR are constantly seeking more effective ways of embedding research findings into industry practices. Producing research reports for FFR members had only limited success as a technology transfer mechanism. A proposal to elucidate research findings via case studies was knocked backed following consultation. The way to do it, said industry, is through more face-to-face contact.

Before the workshop programme was decided, potential participants were surveyed to gauge their topics of interest.

"The survey results helped us tailor the workshop content so it would be directly applicable to attendees," said Dr John Moore, Scion's Forest Management Science Leader.

"We condensed about 70 research reports into three topic areas and designed a series of practical and highly interactive workshops relevant to the forest industry."

To ensure good learning outcomes, the workshops had presentations by industry experts and also applied forestry theory to real-life situations. Learning was achieved through frequent group exercises using empirical data and also field visits.

Another key benefit of the workshops is that they have been recognised by the New Zealand Institute of Forestry as counting towards participants' continuing professional development.

Following the success of the two silviculture workshops, held in Rotorua in June and in Christchurch in August, the Scion and FFR team are now designing the programme for a productivity workshop scheduled for delivery at both locations before the end of the year. A third workshop on resource assessment is planned for early 2013.

Feedback from the silviculture workshops was very positive, with participants greatly valuing the opportunity to interact with their peers and to ask questions of individual researchers.

FFR Theme Leader Mike Riordan confirmed this feedback and said, "Participants liked the combination of targeted presentations, followed by exercises to reinforce learning". One participant described the Christchurch workshop as "a fantastic event" and said "we need much more of this sort of stuff".

Another unexpectedly positive outcome has been the number of sets of forestry data that have been sent in to Scion for analysis. Many forestry companies collect a range of data on their trees but now they understand that they can obtain commercial value by having these data analysed and using the results to improve decision making. It has also been a great opportunity for Scion researchers to learn more about current industry practices and challenges.

Scion and FFR are planning to hold workshops annually to update foresters' knowledge. They also aim to create 'communities of practice' where foresters can share knowledge and examine issues. The goal is to transform practice by improving the connection between scientists and industry practitioners. Follow-up surveys will indicate the effectiveness of this new approach to technology transfer.

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> Unique facility to test biodegradation and composting

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

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

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

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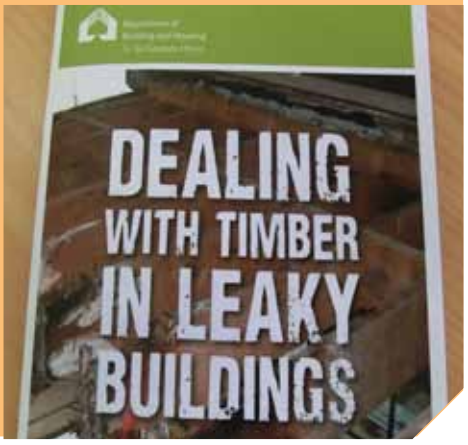
> Treating timber in leaky buildings

Novel research and technical advice from Scion's wood preservation team contributed to the Department of Building and Housing (DBH) publication, "Dealing with timber in leaky buildings". This guide was prepared for builders and building professionals.

The team, led by Dr Tripti Singh, evaluated treatments for partially degraded framing to alleviate the necessity of fully replacing wood when repairing leaky buildings. Research showed a double coating of boron-glycol was effective in limiting the spread of early stages of decay, provided the preservative was applied to at least three faces of the timber. Further research showed that for situations where three faces cannot be accessed, a combination of two coats combined with an injection of boron-glycol into holes between the studs was recommended.

The DBH guide, published in June 2012, provides practical advice on decayed timber, including on-site treatment. The latest version is available on the DBH website www.dbh.govt.nz



> WoodScape project follows Bio-Pathways study

New Zealand's wood processing opportunities are being evaluated by Scion in a Woodco commissioned project called 'WoodScape'. WoodScape aims to determine which wood processing and complementary technologies (pulp, paper, timber, panel products, energy and chemicals) will give the best return to wood processors.

The project will follow a similar methodology to the 2008 Canadian Bio-Pathways study, led by FPInnovations, which showed that integrating new technologies such as bioenergy and biofuels manufacturing with traditional wood processing pathways led to much higher returns. (Featured in the December 2011 issue of **Scion Connections**.)

WoodScape will also include a scenario analysis where the most promising wood processing technologies (either stand-alone or in clusters) will be evaluated for five regions within New Zealand.

To be completed by February 2013, the project is funded by Woodco (the overarching body for the New Zealand forest and wood sector) and the Ministry for Primary Industries, New Zealand Trade and Enterprise, and Scion. The project recommendations will guide Woodco's Strategic Action Plan, which has a target to grow wood-based products to $12 billion by 2022.

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> FFR Awards acknowledge Scion achievements

Three Scion staff were recognised in the second annual Future Forests Research Awards, presented in August. The awards were:

Communication and Sector Engagement
Won by Senior Scientist Graham West. The judges said that as programme manager of the FFR's radiata theme for the past 5 years, Graham had set high standards for communicating research results and was able to communicate complex and often difficult science areas in a simple way.

Science of International Quality
Won by Wood Quality Scientist Mark Riddell for the development of a new method of assessing spiral grain in trees. Spiral rather than straight grain can affect the strength and uniformity of wood products.

Contribution to a Science Team
Won by Charlie Low - Task Leader for Cypress Breeding and for Genetic Resources. The judges described his level of knowledge on a range of exotic forestry species on a range of sites as encyclopedic, and noted that he willingly shares his knowledge with anyone. He is also the specialist on other species that may be alternative commercial species, such as Abies and Mexican pines.

> Upcoming conferences

Scion is participating in a number of conferences over the next three months. For details please visit www.scionresearch.com/events.

> Scion and the University of Waikato cement relationship

Scion and the University of Waikato have signed a Memorandum of Understanding that will see the two organisations working together in research and teaching and to enhance their contribution to the Waikato and Bay of Plenty regions, iwi and New Zealand.

The agreement encompasses collaborative research programmes, commercialisation of research where possible, student projects and internships and the creation of executive education courses for the region and industry.

The agreement was signed at a function at Scion in Rotorua on 30 July. From left to right: Scion CEO Dr Warren Parker, Scion Chair Tony Nowell, University of Waikato Chancellor Rt Hon Jim Bolger, University of Waikato Vice-Chancellor Prof Roy Crawford.

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