Scion
connections
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Matching science with Māori aspirations

The conclusion of the Waitangi Treaty settlements will see approximately 40 per cent of New Zealand's planted forests owned by Māori. This provides the opportunity for Māori to contribute significantly to the national economy through forestry.

It may also herald an evolution from current plantation forestry practice into one that aligns to the social and cultural needs of Māori, providing them the ability to determine their future through a long-term inter-generational approach to land and forest management. What is needed in the interim is a period of relationship building between industry and Māori that will allow for the exchange of science and technology with that of understanding Māori's aspiration for their land.

Scion has a strategy in place to help Māori grow their cultural, social and economic wealth through forestry and the sustainable use of their land.

"Our relationship with Māori land owners begins before any research or investment proposal is put forward," says Russell Burton, who overseas Scion's Māori research and investment strategy. "This allows each party to gain an appreciation of each other's aspirations and objectives. These dialogues will open the door for business opportunities. Māori are preparing to become active participants rather than just landlords, and we can help with that."

Much of Māori-owned land is presently leased to forest growers. Once harvested, Māori will decide what to do with their land that will provide a return on investment, employment and the opportunity to reinvest in their land while retaining environmental and cultural values.

An example of this is Scion's work with Te Tai Tokerau Forestry Innovation in Northland, to enhance the value of their land and generate employment through a forestry-based infrastructure. The inclusion of iconic native species, such as kauri and totara, will be an important element of the project.

It's a bigger picture than just trees, Greg Steward, Scion's technical officer and manager for alternative species explains. "For Māori, forestry is not just about pine trees; it's about other tree species, water, the land, jobs. Whatever is done with the land needs to fit with their cultural and spiritual values, to re-establish roles for indigenous species, and to make good use of the land through multi-use forests, such as mixed plantings with under-cropping for early cashflow. There is also the opportunity in parts of the central North Island to utilise the geothermal energy to power wood processing industries."

Māori are key stakeholders in the future of forestry; the decisions they make will help shape the future of the country's bio-economy. The bigger picture here includes such things as bio-refineries and the processing of woody biomass into bio-plastics and bio-fuels. In the central North Island, these can be powered by the untapped geothermal activity that abounds. Underscored by Scion's forestry science and technology, this has considerable potential for re-investment in the region, the land and importantly, the people.

Want to know more?

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> Today's decisions shape our future in forestry

At Scion we work hard at understanding and interpreting how global trends and the drivers of change in business and society will impact on the New Zealand forest industry and the biomaterials sector. This helps us to build future scenarios and determine what new knowledge, technology and public policy will be required by our stakeholders to succeed in different future operating environments. And, this in turn directs our science, collaborations and investment priorities.

Wherever possible we like to think about future possibilities with our customers so that we can utilise their knowledge of how markets are changing and understand the supply chains through which they are reached. We try hard to imagine a range of different future scenarios rather than to simply extrapolate from today's circumstances - history tells us disruptive technologies and other 'wildcards', while difficult to foresee, should not be overlooked!

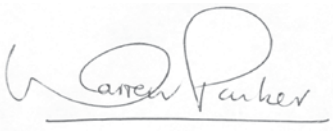
As originally illustrated by Shell, with its 40 year global scenarios; well-crafted scenarios help to ensure decisions made today are consistent with the future vision we want to achieve. In the near term for the forest industry this is to achieve $12 billion of exports by 2022. Looking beyond this to the 2030s we expect to have forests that are more than twice as productive as today. Some of these will include genetically modified trees that contribute more to the environment and have traits better suited to consumer needs than at present. Land owners will be paid for the environmental services their forests provide. Earnings per log will be significantly lifted through the sale of high value products from harvesting and processing residues, and technologies that improve processing efficiency such as engineered and modified wood products. And, Māori will have much greater investment and involvement in the forest industry than today.

A larger national plantation of highly productive forests will help New Zealand in many ways. They will increase export earnings, reduce greenhouse gas emissions, and increase both water quality and biodiversity. Importantly too, jobs will be generated in regions, which will contribute to the vibrancy of rural towns and communities.

This is why achieving Scion's vision of "Prosperity from trees – Mai i te ngahere oranga" is so important to us and our stakeholders.

As you will read in this edition of *Scion Connections* our scientists are already hard at work creating this better future by partnering with Māori to grow their economy through forestry, addressing the impacts of climate change, and using the WoodScape model to direct investment into the most promising technologies for wood and wood fibre processing.

I hope you enjoy reading about these examples of the research we are doing and, as always, I welcome any comments you might have on how we can increase the value of this work to you.



Warren Parker
Chief Executive

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> Building community resilience to climate change

The Waiapu River has the highest sediment loading of any river in New Zealand and the flow on effect for the community is huge.

Erosion, low incomes, poor infrastructure and population migration leave many rural communities in New Zealand vulnerable to climate related impacts, and unable to take advantage of opportunities for a better future.

Scion scientists Tim Barnard, Duncan Harrison, Luke Barry and Loretta Garrett, are working with Ngāti Porou researchers and Gerard Fitzgerald (Fitzgerald Applied Sociology) to explore ways to build community resilience to the impacts of climate change through effective forest strategies. Their research is focused on the Waiapu Catchment on the East Coast, one of the most vulnerable rural communities in the country.

"Forests have a key role to play in the restoration of cultural values and community wellbeing as well as the degraded landscapes in the region," says Tim Barnard, Forest Environment and Economics Team Manager and project leader.

"Communities in the Waiapu catchment and Ngāti Porou in particular, have been dealing with the effects of environmental, social and economic shock for over a century. Heavy deforestation has led to years of erosion. The Waiapu River has the highest level of sediment loading of any river in the country and the flow on effect for the community is huge."

Previous strategies to re-forest vulnerable land in the catchment have not been as successful as hoped. Lack of resourcing has been a key issue, along with wider challenges facing the community such as the availability of seasonal food and fresh clean water, and the on-going loss of human and social capital. These have all led to reduced community functioning, wellbeing, loss of services and marginalisation.

Wholesale deforestation of the land for farming began in the late 1880s with the arrival of Europeans, causing rapid erosion and landslides. This created gullies that have been expanding for decades. Natural weather extremes such as Cyclone Bola and other large storms have also taken their toll.

The Waiapu catchment is of considerable spiritual, cultural and economic significance to Ngāti Porou. Scion is now working alongside the community to develop an integrated afforestation programme that will provide employment for local people, opportunities for innovation, entrepreneurship and regional economic development, and that embraces Ngāti Porou's aspirations for economic independence.

Research to date has provided insight into the extent of erosion and degradation of the river. Through interviews, hui and workshops held with the community, the research team has also developed a bi-cultural framework of climate change indicators and a socio-economic profile of the community that provide a measure of community well-being.

"So far we've determined indicators that affect the community in some way," says Tina Porou, former director and acting chief executive of Ngāti Porou Whanui Forests. "For example, changing natural indicators derived from matauranga Māori, understanding the values underpinning exotic and native forestry, and sustainable development options for Ngāti Porou to consider for the future.

"We now need to determine what scope there is for change, and practical solutions that will turn aspirations into reality. We have to figure out how to get institutions and private investors on board with understanding the needs of Ngāti Porou in dealing with the effects of climate change.

"Tim and the team have a passion that makes me more appreciative of my environment and the potential there is on the East Coast. It's a positive move by Scion being so proactive about meaningful research for Māori communities."

Want to know more?

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> WoodScape model presents options for investors

Investment decisions can be complex, often requiring detailed analyses of a multitude of options.

This is particularly the case in the wood processing industry. The challenge scientists at Scion tackled was designing a practical way to analyse and compare a range of diverse processing options for the industry with a view to potential investment.

The solution was developed in the form of WoodScape, a techno-economic model built by a team of scientists across a range of disciplines.

The team, led by scientist (biofuels and bioenergy) and Technical Leader for the WoodScape project, Peter Hall, and Dr Michael Jack, science leader for Clean Technologies, worked alongside FPInnovations in Canada to adapt their model to one that was robust, versatile and consistent with the New Zealand operating environment. The model can also be expanded to a range of applications and industries outside of wood processing.

WoodScape was developed as a result of the Wood Council of New Zealand's (Woodco) drive to increase export earnings from the country's wood processing industry.

About half of the country's 24 million cubic metre annual harvest of logs is exported unprocessed; a figure set to increase along with the national wood supply.

About half of the country's 24 million cubic metre annual harvest of logs is exported unprocessed; a figure set to increase along with the national wood supply. Greater onshore processing will provide a significant boost to the regional and national economy, and is the key driver behind Woodco's strategy to more than double forest and wood product exports to $12 billion by 2022.

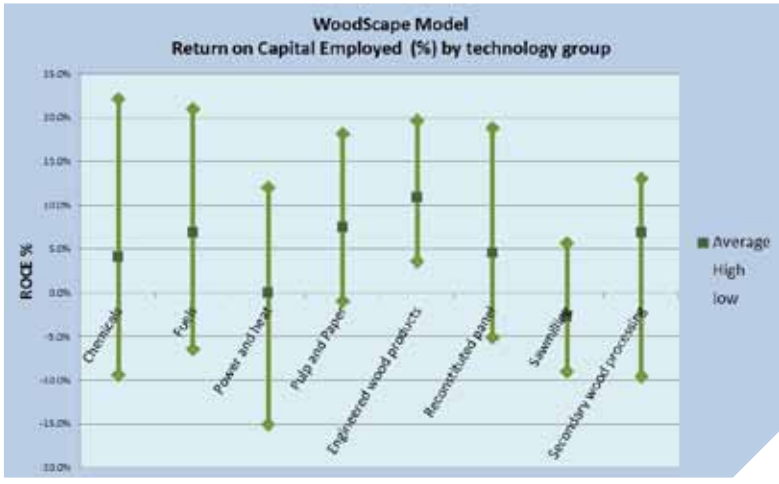
"Due to the global financial crisis and associated low housing starts, the wood processing industry in New Zealand has been struggling," says Peter Hall. "On the other hand there seem to be a number of new processing technologies and products that look promising. What we needed to determine was how an investor could go about comparing all possible options and figure out where to focus resources for the future.

"To achieve this, we needed a model that could analyse a broad range of issues and variables. This includes such things as location, feedstock supply, log grade and volume, plant scale, operating costs, regional and national benefit and, of course, market."

The WoodScape study brings together a matrix of performance metrics and presents a range of options for the investor, and the industry, to consider. It draws on data from 39 existing and emerging wood processing technologies to provide an economic and sensitivity analysis that spans the entire forestry and wood processing value chain.

Central to the model outputs are the return on capital employed, or ROCE, and earnings before interest, tax, depreciation and amortisation (EBITDA). In addition, they incorporate socio-economic measures (employment and GDP) and the sensitivity of these measures to fluctuations in key variables, such as foreign exchange rate, product price, energy or feedstock supply costs. This helps to identify areas of risk and highlights where the largest gains for future research are likely to be achieved.

Factoring in region-specific information about wood quality and volume, the result is a value chain analysis where variables along the supply chain can be explored and potential opportunities identified.



WoodScape model showing an example of Return on Capital Employed (%), or ROCE, by technology group.

A-grading logs at Red Stag Timber, Rotorua

"The model and its outputs have undergone rigorous review by industry," says Dr Michael Jack. "It's been used to analyse a broad range of technologies from traditional to emerging, and as diverse as sawmills, panel products, pulp and paper, engineered wood products and biofuel plants."

The emerging technologies analysed with the model have been developed to at least pilot scale to ensure certainty around the variables.

"WoodScape is a valuable tool for investors. They can use it to investigate a particular technology or an investment opportunity, as well as identify those that are region or site specific.

"It will help investors answer the question – are we doing the right thing? And it will also help us, the scientists and the industry, gain better understanding of the industry as a whole and where Scion can generate the greatest impact from research investment."

Scion is currently applying the model across several wood processing businesses and councils in the central North Island to help identify investment and employment opportunities, and in one instance, a better utilisation of a processing residue.

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> Can the WoodScape model help you?

Scion is able to use the WoodScape model on behalf of clients, wood processors, investors or other agencies to assess and compare wood processing opportunities, including clusters of complementary technologies, at a site-specific or regional level.

Peter Hall (left) and Dr Michael Jack are project leaders for the WoodScape model, a techno-economic model for analysing wood processing technologies.

> Ground-breaking research through global connections

Research Leader Dr Warren Grigsby is a synthetic and polymer chemist investigating the production of bio-adhesives using renewable resources.

Working together with leading research organisations around the globe helps Scion's research teams gain access to advanced scientific tools and helps foster innovative thinking. It also helps cement Scion as a world-leader in areas such as forestry management and genetics, biosecurity, bioenergy and bioproducts.

"It's vital for our scientists to network with overseas connections to keep them challenged and to drive debate with others in similar fields," says Scion's General Manager for Sustainable Design, Dr Trevor Stuthridge. "That is why Scion is participating in numerous multi-party collaborations in, for example, Europe and North America, including working strategically with sister organisations, such as FPInnovations in Canada and VTT in Finland.

"As a result, we are also gaining worldwide respect for our niche expertise. Our work in biofuels, for example, is now attracting investment from Korea.

"Most of this success is achieved by pooling shared expertise and specialist resources to produce ground-breaking research that could not be completed at any one institute, or even within a single country."

One such collaboration with a commercial focus has been with global wood processing giant Sonae Industria Group. Business Development Manager Jeremy Warnes and materials scientist Damien Even have been working with Sonae at their plant in France and with companies in Italy, Hungary and the US to trial Scion's innovative technology for the production of wood fibre 'dice' at a commercial level. The dice are used in the production of reinforced plastics and bioplastics. Sonae has recently extended their Woodforce licence from Scion to develop this technology for North America.

According to Dr Elspeth MacRae, General Manager for Manufacturing and Bioproducts, Scion's participation in the European Framework Programme (FP) and the European Cooperation in Science and Technology (COST) also extends our linkages with European research partners. "COST helps cooperation in common research projects, or Actions. It provides scientists with access to research grants and collaborations that span international borders through shared scientific goals, and the transfer of technology and expertise."

COST Actions fund scientific exchange by way of Short Term Scientific Missions (STSMs). This enables some of Scion's key scientists to visit, or work for a period of time at renowned research institutions such as Salzburg University (Austria) and the Royal Institute of Technology (KTH) in Sweden, providing opportunities to forge vital scientific relationships. These often lead to the publication of volumes of work co-written by scientists living in different hemispheres. Our work with bio-adhesives, biofuels, bio-energy, bio-plastics, wood fibre modification and in the development of lignin nano-fibres are just some of these collaborative COST Actions.

Dr Stefan Hill, Research Leader in Biopolymers and Chemicals, has been researching the molecular behaviour of dewatered wood. Together with colleague Dr David Sandquist, Dr Hill has the opportunity to further explore the movement of water molecules through various wood species using NMR technology at Wurzburg University, as well the dynamics of cellulose crystals using leading-edge synchrotron technology at the German DESY facility in Hamburg.

Dr Hill sums it up when he says, "Scion has a good range of people, expertise, scientific management structure and is open to opportunity - it's blue sky. We punch above our weight and are well respected for our enthusiasm. We also work collaboratively and are not precious about our work, which is important when forging relationships."

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> Cardboard boxes given aerospace treatment

New Zealand's export industry is heavily reliant on cardboard boxes, and understanding how boxes fail under heavy loads is crucial. Until now, scientists have only been able to observe how boxes look before and after failure.

Scion materials scientist Namasivayam Navaranjan recently worked alongside structural mechanics scientists at Monash University's Department of Mechanical and Aerospace Engineering in Melbourne to use lock-in infrared thermography to measure the tiny heat change in a box as it was placed under an increasingly heavy load. This proved extremely quick and reliable.

Future collaboration with partners such as Massey University and Carter Holt Harvey will further develop this technology for use in the engineering of boxes that are capable of withstanding stresses. This will reduce the cost of over designed boxes to both packaging manufacturers and exporters.

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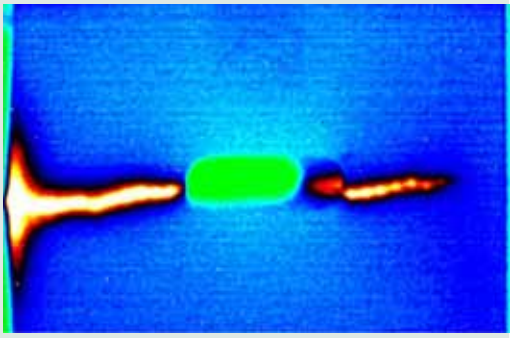

Dissipated energy in a box just prior to failure. The green area in the centre is a hand-hold in the box. Red, yellow and white colours indicate maximum stress. Stress is spreading left and right along a failure path away from the hand-hold and towards the sides of the box.

> Medical technologies used to assess moisture in dewatered wood

A team of scientists at Scion, led by Slobodan Bradic, have been using medical MRI and CT technologies at Lakes Radiology in Rotorua to assess moisture gradients in dewatered wood. These technologies have primarily been used for scanning humans.

Dewatering is the removal of moisture from the wood using carbon dioxide. This enables further modification to take place, such as adding colours and hardening agents. How much moisture remains and where it is distributed, has so far been unknown.

Green timber, dewatered wood and kiln dried wood were tested. The MRI scanner provided a clear picture of moisture in wet wood while the CT scanner, which measures density, was able to detect traces of water left behind in kiln dried wood. Three-dimensional images of moisture patterns inside wood have been created which will help our scientists work out more cost-effective methods to dry wood and lay the foundation for many high-value commercial applications.

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> One hundred years of state forestry and going strong

On 31 May 1913, the Royal Commission on Forestry published a report that established the foundation for exotic forestry in New Zealand. Commission members travelled some 7,000 miles throughout New Zealand, predominantly by horse and buggy, train and boat and visited native forests, exotic plantations and forest nurseries to provide an independent review of the state's role in plantation forestry.

The report followed others by professional foresters, timber experts, tree planters and officials from the Lands Department stretching back to 1877, and led to the eventual establishment of a forests department headed by professionally trained foresters.

The Commission recommended large scale planting of 'eucalypts for durability and pines for building timber' with particular reference to *Pinus radiata*. Forest land suitable for farming was to be given over to that use after harvest regardless of the quality of forest, and although areas of indigenous forests might be reserved for scenic purposes, afforestation was advocated over indigenous forest management.

› Growing NZ Indigenous Trees

New Zealand beeches are some of our best known and most important native trees, constituting two thirds of the country's remaining native forests.

Although beeches produce high quality functional and decorative wood for a variety of uses, they are not yet managed for wood production due to perceived difficulties in silviculture and processing. However, there is a growing interest in managing them particularly in sustainably-managed forests and in plantations.

Scion scientists Mark Smale, David Bergin and Greg Steward have recently published a comprehensive bulletin on the ecology, establishment and management of beeches for timber production, titled *The New Zealand Beeches*.

The bulletin is the sixth in a series about New Zealand Indigenous Trees published by Scion. Other titles are: *Native Trees; Pohutukawa; Farming with Native Trees; Totara*; and *Kauri*.

Bulletins are available for sale from the Scion Digital Print Centre.

$17.39 + GST each

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You can learn more about how forests contribute to the quality of water, or the role forests play in mitigating the effects of climate change. You can also find out about our wood fibre dice technology, or TERAX™, a technology that turns municipal waste biosolids into useful by-products.

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