

Scion connections

Issue Two | December 2011

Canada's Bio-Pathways



Pictured from right to left: Andrew Goodison with Warren Parker, Michael Jack and Trevor Stuthridge from Scion. Andrew's visit was sponsored by New Zealand Trade and Enterprise.

Canada might be a hemisphere away from New Zealand, but their forest products industry is not that far removed. It is an export-focused sector dominated by traditional manufacturers of pulp, paper and board products struggling to return a profit. Like us, Canadian foresters are under pressure to innovate and compete on the global market. For them, the pathway forward is clear.

A project undertaken by the Canadian forestry sector, known as Bio-Pathways, could give New Zealand manufacturers some clues about future options. A key figure in the project, Andrew Goodison of FPInnovations in Canada, recently visited New Zealand to address the Advanced Biofuels Research Network symposium hosted in Wellington by Scion.

Andrew says the Bio-Pathways project took a hard look at future options for Canadian manufacturers to produce a wide range of bio-products from wood fibre. The results showed that strong markets will continue to exist for traditional forest products such as wood and pulp. Meanwhile, new technologies with smaller niche markets will generate a much higher price.

"It's all about getting the highest dollar value out of every cubic metre we cut," he says. "Numerous viable options exist to convert forest biomass to bio-energy, bio-chemicals and bio-materials. These options are best achieved by integrating their production with the traditional forest industry."

By combining the old and the new, projections show that companies will experience growth rates far above those being generated by the traditional forest product sector. According to the Bio-Pathways report, rapidly growing markets for new bio-products based on wood fibre could reach an estimated \$200 billion by 2015.

"The potential market sizes are staggering. Countries and companies with the right policy framework, the desire to foster innovation and the ability to deploy the resulting technology will be poised to grab market share in these areas."

While the Bio-Pathways project identified a clear opportunity for the Canadian forest industry, how will they bring their vision to reality?

It is already happening. Sawmills are expanding into bioenergy and pulp mills are converting into bio-refineries for production of pulp, bio-energy and bio-chemicals. But what does it take to initiate change on this scale?

"The Government has a huge role to play in helping to de-risk investments in new technology and foster innovation across the value chain. The industry has united to present a single voice to government and results from this study provide quality information that is being used to inform policymakers," Andrew explains. "The other crucial factors are to embrace new technologies and partner with the right companies to accelerate commercial success."

Following Andrew's visit, Scion is now assisting with the application of the Bio-Pathways methodology to the New Zealand forest industry.

For more information and to access the Bio-Pathways report see www.fpinnovations.ca or www.fpac.ca.

> Planning for rapid change: the new norm

Uncertain times call for more, not less planning. Daily media reports leave us in little doubt that we are living in times of unprecedented change and market volatility. There are no signs that this level of tumultuousness will lessen over the next decade.

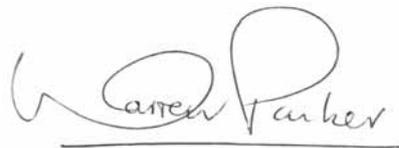
The scale and speed of economic transformation in China, India and Brazil, even before the effects of the huge public debt of the US and some EU economies, has precipitated a fundamental structural shift in the relativities between economies (in geopolitical influence). Game changing technology, such as the iPad and "big data" computing, and the consolidation of companies to form globally integrated supply chains, are adding impetus to changes in how economies and societies function.

Scion has a big role in helping industry with the challenge of succeeding in this rapidly evolving future. Even though we completely refreshed our strategy earlier this year after drawing on extensive input from forest industry and other key stakeholders, we have just initiated a critical reassessment of this to identify where fine-tuning and refocus is needed. For example, we need to think more about how we enable growth opportunities in Asia and India, regain share in Australia and support a rebound in domestic demand for solid wood in particular.

For the first time we will be aided in this process by our Strategic Advisory Panels. An outcome of the CRI Taskforce reforms, the Panels - one representing science, the other the users of the new knowledge and technology arising from this - will respectively bring an international science and industry perspective to bear on where our science should be headed.

Their advice and our assessment of the strategic landscape will inform where we should adjust the allocation of our core funding, seek new national and international research collaborations and either stop or initiate new research projects. It is therefore both an exciting and a very challenging time!

In preparing for this future we have also recently reshaped our science capability into nine teams. This new structure will build depth and leadership strength in science in areas that we believe are core to the future of the forest industry. This issue of Scion Connections gives a snapshot of the broad range of capabilities that reside within these teams.

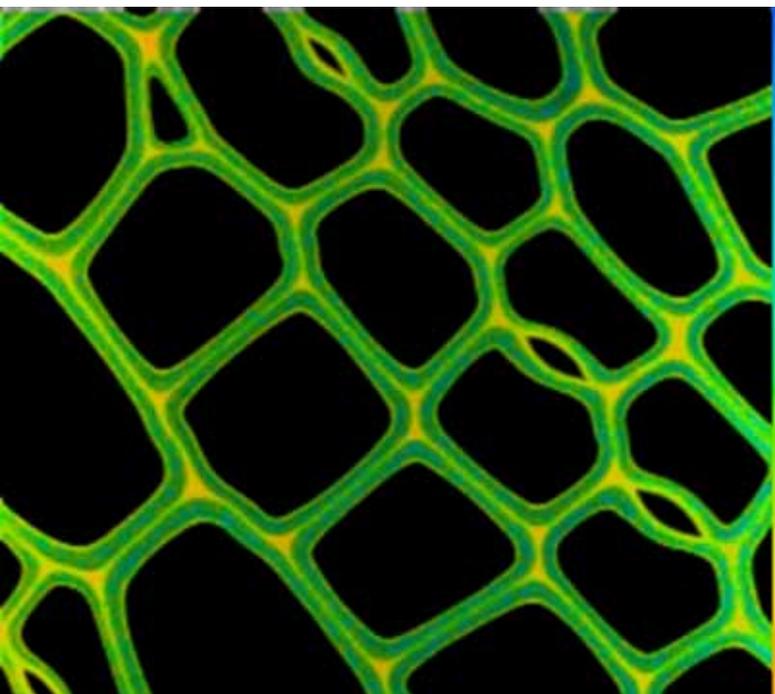


Warren Parker
Chief Executive



Scion's Dr Alan Fernyhough (at left) discusses bioplastic technologies with Scientific Strategic Advisory Panel members: Christine Hagström-Nasi (Finnish Forestcluster), Professor Ralph Cooney (University of Auckland), Dr Hugh Evans (Forest Research, UK).

> Lignin: the hidden forest product



Forest products collectively make up New Zealand's third largest export earner. The main forestry wares are wood pulp, raw logs or sawn timber, topped up with a range of paper, paperboard, panel and secondary manufacturing products. Chemicals hidden inside the wood are expected to form the basis of future forest products that could replace those derived from non-renewable resources. Scion scientists have their eye on lignin as a potentially valuable candidate.

Lignin is the second most abundant polymer on earth and plays a key role in wood structure. It is so hidden within the tree that a powerful microscope is needed to see it. Currently obtained as a by-product of the pulping process, lignin is mainly used in New Zealand to generate heat for industrial energy. Research programmes are focused on extracting and modifying lignin for other uses, including biofuels, bioplastics, rubber replacements and new materials.

Using specialised microscopy techniques, Scion scientist Dr Lloyd Donaldson is gaining greater insight into lignin's composition and properties. He has received an award from the prestigious Charles Fleming Fund to develop collaborative relationships with other global specialists at the forefront of plant science. He will use this award to conduct a research project in Adelaide using a technique called Fluorescence Lifetime Imaging (FLIM).

"This technique can be used to measure chemical properties of lignin and can also be used to measure interactions between lignin and other cell wall components," Lloyd explains. "Findings from these experiments will aid the development of novel wood-based materials including the production of biofuels from wood."

The experiment is part of a wider project that includes microscopy experts at the University of Leeds in England and the University of Belgrade in Serbia, who are equally interested in unlocking the hidden potential of plants.

Findings from these experiments will aid the development of novel wood-based materials including the production of biofuels from wood.

Want to know more?

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> Lignification magic

Dr Armin Wagner and his team at Scion have created genetically-modified lines of radiata pine that differ in how they express a particular enzyme. In their research, they effectively switched the enzyme on or off and were able to modify both the type of lignin and the quantity laid down in the cell wall. This result demonstrates that the lignification process is able to be modified, providing fundamental knowledge for the development of feedstocks for biomaterials or biofuels. Their results have appeared in the leading plant science publication, *The Plant Journal*.

> Organic wastes disappear with TERAX™

Mounting piles of municipal biosolids cause headaches for local authorities and resource managers the world over. For those who wish it would all disappear, Scion has developed a technology that could help it do just that.

A hydrothermal deconstruction process being tested in Rotorua offers a new approach to waste management. The environmental technology, known as TERAX™, “cooks” sewage biosolids and breaks them down into smaller and simpler organic compounds. Strictly speaking the waste does not disappear, rather it is transformed. The process takes a pile of waste and turns it into useful industrial chemicals, energy or fertiliser products.

Scion and Rotorua District Council (RDC) have constructed a 200 litre/hour pilot plant at Rotorua’s Wastewater Treatment Plant to test the TERAX™ process as a potential solution to the district’s waste disposal problem. RDC Works Manager Peter Dine says early results from the pilot plant are exciting.

“There is a lot of interest in the process because we can now demonstrate that it actually works. The engineering challenges have been substantial as a whole lot of separate components need to work together, but we can see that it will do what was expected,” he explains.

Since the official opening of the hydrothermal oxidation plant in May 2011, the facility has been expanded to include an anaerobic fermentation plant to allow complete testing of the hydrothermal deconstruction process.

Scion’s General Manager Sustainable Design, Dr Trevor Stuthridge says the anaerobic fermentation plant uses bacterial cultures to pre-treat the organic waste and significantly decrease the volume of material that enters hydrothermal oxidation. The second step in the process uses high pressure and temperature with oxygen to break down the waste material and derive useful compounds from it.

“The greatest advancements have been in the recovery of valuable chemicals from the process, giving us the ability to change the economics of waste

disposal by generating value from these biological wastes,” he explains.

To put the nuts and bolts on these science ideas, Scion and RDC worked closely with Longveld Engineering in Hamilton, and Rotorua-based consulting engineers Allan Estcourt Ltd. Trevor says the technical hurdles have been both challenging and interesting as the pilot plant provides a good opportunity for troubleshooting issues that were not evident at laboratory scale.

Once the plant is fully operational and testing is complete, the next step is to design a commercial plant capable of handling all biosolids from Rotorua’s Wastewater Treatment Plant. That’s where it’s hoped the investment in research and development will pay off.

RDC Chief Executive Peter Guerin says a full-scale plant in Rotorua could initially remove thousands of tonnes of biosolid waste going to landfill per year, if successful.

“Applied to all of Rotorua’s organic wastes, it could ultimately achieve net benefits (cost reduction and value creation) of around \$4 million per year for the council and community,” he says.

Research shows the same technology could be used for managing organic wastes from food and industrial processors, such as pulp and paper, agriculture, dairy, meat and fruit processing. With 1.8 million tonnes of organic waste discarded each year in New Zealand, TERAX™ could transform it into a valuable resource - not magically, but scientifically.

There is a lot of interest in the process because we can now demonstrate that it actually works.

Want to know more?

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Scion pilot plant technicians George Estcourt (at left) and Anderson Aggrey provide engineering expertise to the project.

► Fast tracking innovation

The TERAX™ project shows how innovation can be achieved more quickly by adopting and adapting existing technologies, rather than starting from scratch.

When looking for a solution to the organic waste problem, Scion identified thermal oxidation as a good starting point. This is a proven method of breaking down organic compounds into carbon dioxide and water. Scion scientists saw the potential to adapt this technology so it would yield different kinds of chemicals.

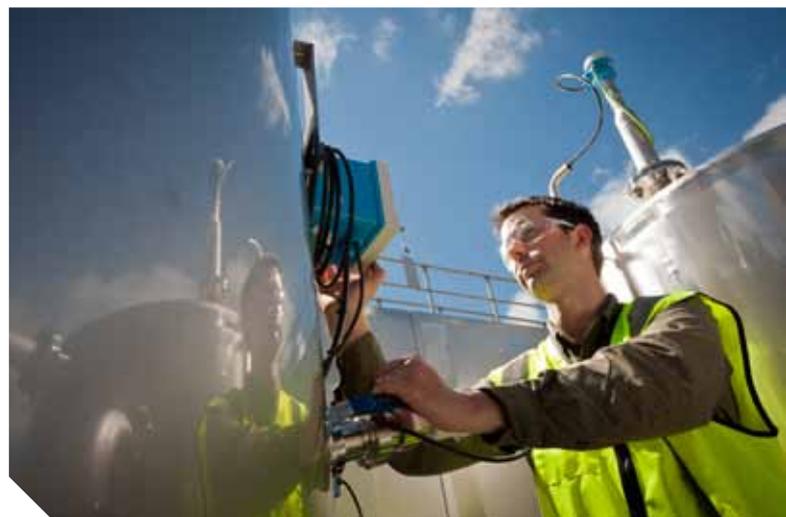
So TERAX™ was born - fostered by a dynamic partnership between user and research provider. At the opening of the pilot plant, Scion chairman Tony Nowell described the benefits of this approach.

"Each part of the technology in itself may not have been especially original, but the compilation and integration of the parts is where the novel solutions arose," he said.

"The message is clear - take a holistic systems view to foster diversity of thinking and make progress faster by building on, rather than duplicating or re-making, the work of others," Tony said.

The science team behind the technology is led by Dr Daniel Gapes and Dr Robert Lei (shown at the pilot plant).

A comparison between thermal hydrolysis and wet oxidative pre-treatment technologies written by Scion authors (Strong, P.J., Gapes, D.J., McDonald, B.M. 2011) has been published in the highly-ranked international journal Bioresource Technology.



> Kicking the weedy nuisance

If you want to plant a forest in New Zealand, you have to control the weeds. The challenge is that environmental certification standards are restricting weed control options for forest growers. This dilemma means that weed control must be treated not as a nuisance, but as a science.

Scion is part of a collaborative research programme known as "Undermining Weeds" that provides the science skills necessary to overcome common problems faced by primary producers in New Zealand.

For forest managers, weed control is necessary to ensure tree survival and improve growth throughout the life of the stand. The key is to achieve these benefits at minimum cost while avoiding negative impacts on the environment.

Scion's research programme aimed at forest weeds includes developing biological control options, identifying acceptable herbicides* and reducing spray volumes. Scion also provides training to forest managers on aerial spray operations, with emphasis on reducing risks from spray drift.

> What happens when trees become the weed?

Wilding conifers are a major weed in many areas of New Zealand. In collaboration with the Department of Conservation (DOC), Scion has developed a method for combating wilding conifers in steep terrain using aerial attack.

Trials across the South Island show that application of herbicide using a high pressure spray jet has achieved an excellent kill rate on trees up to six metres in height. This method enables a safer and faster option than manual control with chainsaws, saving over half the cost. For more information contact stefan.gous@scionresearch.com

The wilding conifer programme is a collaboration between DOC and Scion, subcontracted by Landcare Research.

Timberlands Forest Risk Manager, Colin Maunder says this kind of research has been vital for the industry to achieve cost effective weed management treatment options while retaining Forest Stewardship Council (FSC) certification.

"We are keen to support the weeds programme because it shows FSC that we are serious about reducing chemical use. The research is providing good scientific information on which to base policy debates and management decisions," he says.

The Undermining Weeds programme is a collaboration between AgResearch, Scion, Landcare Research and Plant Protection Chemistry NZ. This relatively small but highly effective programme has been identified by the Ministry of Science and Innovation as a good example of research that is delivering tangible benefits across the primary sector.

Partners within the forestry sector include Future Forests Research and the Forest Stewardship Council Cluster Group.

** A screening study of suitable herbicides for controlling five major weed species in FSC certified plantations has recently been published in the New Zealand Journal of Forestry Science (Rolando C.A., Gous, S.F., and Watt, M.S.) See www.scionresearch.com/nzjfs*

Want to know more about weed research?

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> Fanning the flames

As rural fire managers brace themselves for the upcoming fire season, spare a thought for fire fighters of the future. Scion rural fire scientist Grant Pearce was commissioned by the Ministry of Agriculture and Forestry to explore how climate change is likely to affect fire risk in New Zealand.

“Results indicate that fire climate severity is likely to rise significantly in certain regions,” Grant explains. “A doubling or even trebling of fire danger is possible in some areas as a result of temperature increases, higher wind speeds and lower humidity.”

The greatest relative (%) changes are likely in areas where current fire dangers are comparatively low, such as coastal Southland and Wanganui. Significant increases in fire danger are also predicted in the

country’s current hot spots, namely Gisborne and Christchurch. A summary of the report can be found on Scion’s website: www.scionresearch.com/fire.



> Multiplying success

The commercial radiata pine seedling industry in New Zealand relies largely on control-pollinated seed. But, tissue culture technologies for mass propagation have always worked better with open-pollinated seed.



In collaboration with other New Zealand and Danish scientists, Cathy Hargreaves and her colleagues at Scion have overcome this practical hurdle by developing new methods to initiate and proliferate tissue cultures from control-pollinated radiata pine seeds. This new approach has increased regeneration success from around 15% to over 50% of all sampled material.

As a result of this success, commercial testing of these new tissue culture methods is now underway.

For more information, take a look at Cathy’s paper on Scion’s website: www.scionresearch.com/nzjfs or contact her at cathy.hargreaves@scionresearch.com.

> Flight of the parasite

A parastoid wasp released last summer to control a eucalypt-munching caterpillar appears to be thriving. Scion introduced the *Cotesia urabae* wasp (pictured at right) as a biological control agent aimed at gumleaf skeletoniser (*Uraba lugens*). These caterpillars have become a costly pest in the Auckland region due to their voracious appetite for eucalypt foliage.

The wasp has survived its first winter in New Zealand and monitoring results show that it can pupate and emerge successfully. Scion plans to make a mass release of *Cotesia urabae* in Nelson this summer, in association with the Tasman District Council.

For more information contact toni.withers@scionresearch.com



> Science on Air

Scion scientists featured recently on Radio New Zealand's show "Our changing world". The topics covered show some of our diverse research areas:

- **Biofuel potential of waste pine** - developing ways to extract sugars from waste softwood to produce biofuels.
- **Termite gut microbes** - how enzymes produced by microorganisms could help break down wood to make biofuels.
- **Torrefaction** - a way to make waste pine more energy dense.
- **Buddleia biocontrol** - the buddleia leaf weevil is having a real impact in reducing a common weed in young pine plantations.
- **Modified zeolite** - a volcanic mineral may be a potent tool in efforts to reduce algal blooms in lakes.
- **Bioplastics** - plastics made from plant fibres including wood are the way of the future.
- **Waste 2 Gold** - testing new technologies to transform organic wastes to useful byproducts.
- **Forest health** - Scion's collections of fungi and insects are a fascinating look into the history of our forest health.

Podcasts of these interviews can be heard from the RNZ website (www.radionz.co.nz) or from Scion's website under "About us/Linking people with science".

> New Zealand Journal of Forestry Science – special supplement

The *New Zealand Journal of Forestry Science* has a biosecurity focus this year. Volume 41 includes a special supplement that contains papers from the fifth IUFRO Meeting on *Phytophthora* Diseases in Forests and Natural Ecosystems that was held in New Zealand last year.

Pristine ecosystems and managed forests around the world are at risk from damaging and often fatal diseases caused by *Phytophthora* species. This threat is increasing as these pathogens spread via the global movement of goods and people through trade and tourism.

The papers in this supplement capture all aspects of research on *Phytophthora* species from mapping new outbreaks to controlling existing infestations.

Individual papers are available at: www.scionresearch.com/nzjfs/volume-41S-Phytophthora-conference-proceedings. A printed copy of the entire volume including the supplement is also available as a one-off purchase.



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