Scion
connections
Issue Seven I March 2013

Government invests in Scion technology

A $4.7 million Government grant to build a world leading waste treatment plant in Rotorua, will help to pave the way for a cleaner, healthier living environment for New Zealanders.

The plant will be a commercial scale demonstration model of the TERAX™ technology, which converts sewage sludge into energy and useful products. It will be built at Rotorua District Council's (RDC) sewage treatment facility where a pilot plant has been operating since 2011.

Pilot plant trials have shown the technology is capable of reducing the volume of municipal waste going to landfill by over 90 percent, and greenhouse gas emissions by more than 70 percent. In line with this is the significant reduction in associated financial and environmental costs, with useful industrial chemicals generated as by-products, that can be used for such things as fertilisers or in the production of bioplastics and biofuels.

"The success of the pilot model has given the council and Government confidence to invest in a full scale demonstration plant that will put TERAX™ in the spotlight, nationally and internationally" says Scion Chief Executive Warren Parker.

"TERAX™ is likely to change the economics of municipal and industrial organic waste disposal and minimise its environmental impact. It will also demonstrate a new way of creating sustainable products and generating value from renewable resources."

Scion, in partnership with RDC, developed TERAX™ as a solution to the amount of municipal waste going to landfill. The hydrothermal deconstruction technology involves two processes: the first ferments the sludge to reduce its volume, the second uses high pressure, temperature and oxygen to break down biosolids and release energy and valuable chemicals.

If the technology is adopted by councils nationwide, it is estimated two million tonnes of biodegradable waste could be treated each year. In addition to the substantial reduction in costs associated with landfilling, the recovered chemicals can generate income. In this instance, RDC will utilise the process outputs to lower the chemical costs of running its own sewage treatment plant.

TERAX™ has already attracted the attention of many regional authorities, and will be made available through a technology licensing company formed by Scion and RDC. They are jointly working on several national and international opportunities, with further research being carried out on how the technology can be applied to other industrial organic waste streams.

Contact: trevor.stuthridge@scionresearch.com

> From pilot to production – bridging the gap

Commercialisation is a big part of what we do at Scion. In this issue of Scion Connections we highlight some of the technologies currently under development with our partners. While most of these innovations are for uptake by New Zealand firms, we always keep a close eye on international market developments, competing technologies and collaboration opportunities.

Anyone with 'hands on' experience in commercialisation knows it is both challenging and highly rewarding. As economies and firms globalise, this challenge (and the scale of opportunity) is increasing. The broad rule of thumb that an approximately tenfold increase in effort and resources is required to progress from a novel science idea to proof of concept, and a further hundredfold increase to achieve full market release is rarely wrong. Despite this 'truism', science projects are generally not funded beyond the proof of concept stage, meaning investment for the critical steps to get technologies into the market needs to be sourced elsewhere.

At Scion we address this 'step-up' challenge by accessing funding, such as through the MBIE Preseed Accelerator Fund (PSAF) and (now) Callaghan Innovation for TechNZ programmes, to supplement firm and Scion investment. These funding options play a critical role in bridging the gap – the so-called 'valley of death' – to where projects can be fully funded by the client.

Getting funding right is only one dimension of success. We aim to involve firms as early as possible to gain both their expertise and co-investment. Proven disciplines such as stage-gating are applied to ensure a systematic pathway of development. Access to pilot facilities is essential to 'iron-out' the challenges of scaling up to market volumes and generating sufficient product for robust in-market testing to be conducted.

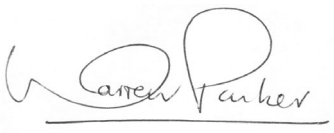
The composition of the development team should also evolve to ensure it has skills appropriate for each stage of development. It is invaluable to have members of the firm acquiring the technology, such as LignoTech (page 4), intimately involved within the project team. We are getting better at documenting and sharing our experiences in commercialisation so that successes are repeated and mistakes are made only once. Indeed, contrary to the views held by many commentators in the popular media, we have a surprising array of experience in commercialisation within Scion (and other New Zealand research providers and the private sector).

I think that much more should be made of this wealth of local expertise before rushing off to find the latest international 'guru' to host workshops on innovation ecosystems that bear little resemblance to circumstances in New Zealand.

As noted above, scale-up facilities are pivotal in de-risking new technology. Two recent new investments in this area, the BioPolymer Network (BPN) Pilot Plant and our Nursery Container Facility, are featured in this newsletter.

We are planning to make further capital investment into pilot plants over the next few years to support the commercialisation of technologies in our pipeline. Typically these plants cost several million to design, construct and commission so it is important that we confirm market demand and ensure we are not duplicating facilities readily available elsewhere. Our pilot mechanical pulp mill is a great example of the value they add. Opened in 1986, this has had extensive use by all of New Zealand's pulp mills and is now central to our bioenergy-chemicals research programme.

Your comments on any of the articles in the following pages would be most welcome – please feel free to contact me.



Warren Parker
Chief Executive

Want to know more?

CONTACT: Dr Warren Parker
EMAIL: warren.parker@scionresearch.com

> Maestro of numbers tackles wicked problems

Big data scientist, Oliver (Ollie) Chikumbo is applying powerful optimisation techniques to problems as diverse as eucalyptus management, land-use in a rural catchment and smart city planning in Portugal.

Big data and analytics are becoming crucial tools for corporations and industries such as forestry, to find answers to extremely complex questions. Big data scientists, armed with massive computing power, sophisticated algorithms and (importantly) a penchant for problem solving, stand at the forefront of efforts to create meaning from chaos.

Ollie sits in an office surrounded by an array of continuously-running desktops, laptops and iPads. He's the conductor of an orchestra; his computers are the musicians, his algorithms are sheets for numbers instead of notes.

At times, a single computer might be operating for three or four days continuously before spitting out an answer to a really 'hard' problem.

Hard problems are the curse of mathematicians. For example, trying to optimise land use for multiple and often conflicting objectives frequently defy traditional mathematics.

Ollie's weapon of choice, evolutionary algorithms (EA), provides the only possible solution to these sorts of problems. As their name suggests, EA borrow concepts from evolutionary genetics.

Applying the approach to forestry, Ollie derived optimal thinning regimes for a eucalyptus forest. The problem he set out to solve was how to optimise thinning activities that maximise both sawlog value and pulpwood production volume at the same time. Typically, thinning regimes are designed to maximise either value or volume production, but not both.

Ollie's solution would enable a forester to supply all markets and with the flexibility to provide the product most in demand at the right time. The result was a mosaic of thinning regimes across the forest estate to meet sawlog and pulpwood demands from frequently uncertain markets. These sorts of skills will be in high demand as large amounts of forestry, GIS, genotype, product, transportation and wood processing data become routinely available.

These skills have made Ollie valuable to designers of future city ecosystems such as British-based LivingPlanIT. Ollie's techniques to handle big data can be used to optimise thousands of complex variables (for example, balancing aesthetics with efficient use of capital), to design, build and operate cities.

Ollie envisages massive amounts of data from the future forest industry will be handled using these techniques to provide practical day-to-day decision support for forest managers.

Sparked by a discussion with Professor Sir Peter Gluckman, and by cleverly adapting recent concepts from evolutionary biology, researchers from the Liggins Institute and Ollie have also recently teamed up to tackle 'wicked' problems. We thought hard problems were a challenge says Ollie – but wicked problems make them look like child's play!

Want to know more?

CONTACT: Dr Oliver Chikumbo
EMAIL: oliver.chikumbo@scionresearch.com

> LignoTech - leading the green way forward

Strong, lightweight and economical are highly desirable properties when it comes to buying a car. But one made using corn residue?

This may be the case in the not so distant future. A revolutionary technology developed by Ashburton-based company LignoTech Developments Ltd, transforms bio-waste into a replacement for petrochemical and mineral fillers used in the manufacture of plastics and composites. This biomass transformation technology is capable of adding significant value to what would otherwise be livestock feed or go to landfill.

The project is a collaboration between LignoTech, research partner Scion and US-based Fisher Composite Technologies. LignoTech has developed a patented steam explosion technology which 'pressure cooks' lignocellulosic (woody) residue material, such as dried distillers grains, corn fibre and sugar beet pulp, making it more degradable and amenable to further processing. This creates a product that is suitable for use in plastic bio-composites.

Sustainability, renewability, eco-efficiency and green chemistry are guiding principles of the next generation of materials

With the corn-ethanol industry in the United States alone responsible for over 40 million tonnes of bio-waste a year, this technology is garnering serious interest internationally.

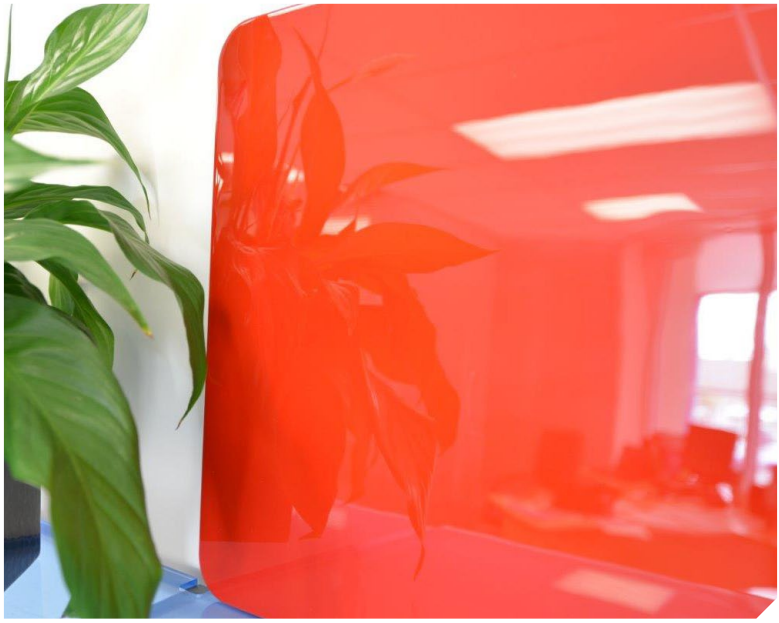
As Garry Haskett, Chief Executive of LignoTech says, sustainability, renewability, eco-efficiency and green chemistry are guiding principles of the next generation of materials and processes. "We transform agricultural waste into something useful and give them a second life."

The powder produced from the LignoTech process can be used as filler in the manufacture of plastic bio-composites such as thermosets and thermoplastics, with the added advantage of being more versatile than other organic fillers. Thermoplastics are materials that melt and flow when heated, and can therefore be re-moulded, whereas thermosets cure, or set, and do not melt or flow when re-heated.

Adding value to bio-waste

Bio-composites containing LignoTech treated fillers are lighter and stronger than their counterparts made with dense, heavy calcium carbonate. The process also makes smaller and more evenly sized particles allowing for tighter distribution, which makes for a superior, more paintable surface on the moulded product.

With thermosets used in the manufacture of sheet moulding compounds (SMC) and bulk moulding compounds (BMC) for such things as car bodies and farm equipment panels, these



Sheet moulded compound (SMC) made with LignoTech treated material creates a smooth, paintable surface, highly desirable to the automotive industry.

properties make it highly desirable to the automotive industry in particular.

Millions of tonnes of dried distillers grains are derived from the production of ethanol from corn each year in the United States, and this ground-breaking technology is generating considerable interest from North American manufacturers.

Russell Fisher, president of the chemical engineering consultancy, Fisher Composite Technologies in South Carolina, is working alongside LignoTech and Scion to trial the technology with potential North American customers, ready for when LignoTech's US plant comes on-stream later this year.

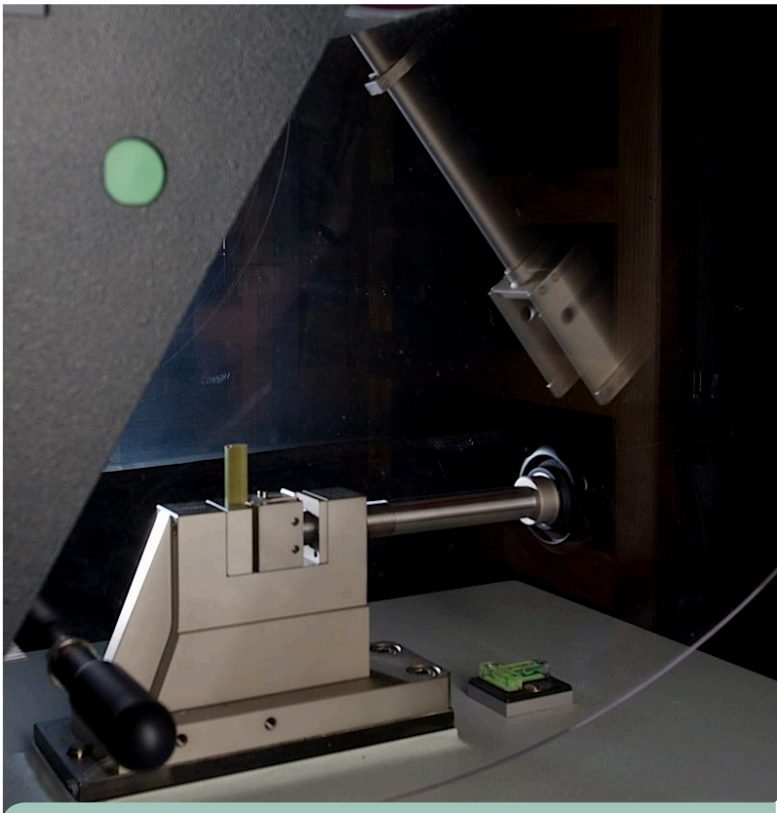
Millions of tonnes of dried distillers grains are derived from the production of ethanol from corn each year in the United States

"This technology adds value to what would otherwise just be a mountain of bio-waste. Over and above its other benefits, SMC that's made up of 15-25 percent LignoTech treated material has less than half the specific gravity than that made with calcium carbonate – meaning it weighs considerably less. This is huge for the automotive industry when it comes to gas mileage," says Russell.

"This technology has even been embraced by Reichhold Corporation, one of the leading petrochemical companies involved in the manufacture of thermosets. They are working with us on this technology – that's a huge endorsement."

Scion is currently working on further enhancements to the LignoTech product by modifying the surface chemistry.

> Behind the scenes



The CEAST Resil Impactor tests the toughness of materials by measuring the energy required to fracture test pieces.

Scion has been working with LignoTech Developments Ltd since 2007, initially undertaking service contracts to test the mechanical properties of LignoTech material, such as impact resistance, stiffness and strength.

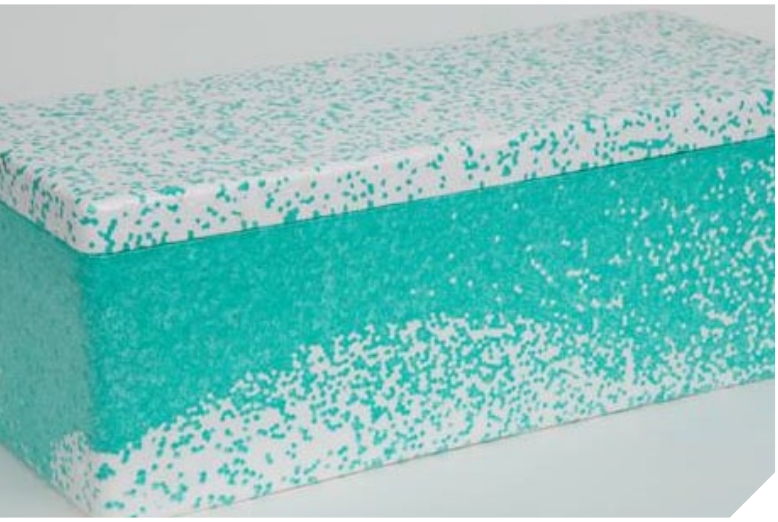
In 2010 a strategic collaborative agreement was established between the two companies.

Want to know more?

CONTACT: Dr Elspeth MacRae

EMAIL: elspeth.macrae@scionresearch.com

> A natural alternative to a fishy problem



Scientists have long been researching eco-friendly packaging alternatives to one of the most widely used plastics, polystyrene. This is now a step closer with the construction, by Biopolymer Network Ltd, of a pilot plant capable of producing fish boxes made from a bio-foam that looks and behaves much like its less eco-friendly counterpart.

In a project spearheaded by Biopolymer Network, scientists at Scion have developed an environmentally sustainable and cost-effective alternative to polystyrene using polymers derived from renewable plant sources, such as corn or cassava.

"Polystyrene is used every day for a variety of thermal and protective packaging. However, it's made from non-renewable petrochemicals and is not easily disposed of, which is increasingly becoming a problem in the market place," says Sarah Heine, Chief Executive of Biopolymer Network. "Our aim is to make a product that has the same versatile moulding, strength and insulation properties as polystyrene, but that is compostable."

Naturally sourced polylactic acid (PLA) polymers are commercially available in the form of small pellets or beads. Biopolymer Network has developed the technology to impregnate these PLA beads with carbon dioxide, which then allows them to be expanded (to resemble bean-bag filling) prior to fusing and moulding. An added advantage is that existing polystyrene moulding equipment can still be used.

The resulting PLA foam looks and performs much like polystyrene with similar insulation and mechanical properties. Further research is currently being carried out by Scion to refine the foam and open the way for the production of a much wider range of products.

The pilot plant, which is based at Hope Moulded Polystyrene premises in Nelson, will produce fish boxes and lids in an effort to hone the production of PLA foams and place this biologically derived alternative to polystyrene into the cold chain packaging marketplace.

"A fish box needs to sustain heavy weights and rough handling, as well as being able to be disposed of safely at the end of its life. Our product offers a range of disposal options including industrial composting," says Sarah. "This pilot plant will enable us to evaluate and refine the PLA foam and the technology, and work towards commercial-scale production."

The New Zealand seafood industry is particularly interested to trial PLA fish boxes as a source of environmentally friendly packaging, increasingly sought-after in our export markets.

Biopolymer Network Ltd is a New Zealand research company dedicated to creating products using renewable, natural materials instead of petrochemicals. Biopolymer Network Ltd research base is built from three of New Zealand's largest and leading research organisations: AgResearch, Plant and Food Research, and Scion.
www.biopolymernetwork.com

Want to know more?

CONTACT: Sarah Heine
EMAIL: sarah.heine@biopolymernetwork.com

> Containerised technology for improved planting success

Scion's nursery undertakes specialised production for forest growers. Exotic and indigenous tree species can be supplied using containerised or bare-root technologies.

Our research shows that containerising seedlings can significantly prolong commercial planting seasons and reduce the stress typically suffered by bare-root seedlings, resulting in faster recovery and a higher survival rate for the young plants.

Capacity is now being scaled-up through the nursery's new purpose-built $300,000 containerisation facility, which has the resource to on-grow 370,000 seedlings a year. This has increased the nursery's total capacity to over 700,000 seedlings.

Contact: peter.harington@scionresearch.com

> Inside Scion's National Forest Herbarium

Scion's Forest Research Herbarium houses the country's largest collection of planted and indigenous forest tree species. Established in 1946, it is home to 30,000 catalogued, geo-referenced and securely quarantined specimens in a custom-designed vault.

Each sample in the collection holds a wealth of information about the tree species - leaf samples, flowers, bark and fruit, along with information about where the tree was (coupled with a GPS reading), who took the sample and when, and a brief description of the plant.

The herbarium runs a loan system where national and international scientists can borrow specimens for scientific purposes, and staff are often called on to identify plants particularly by biosecurity officers who monitor the health of the country's flora. The collection is currently being photographed to expand the online database and make it more readily available. **Contact:** matt.buys@scionresearch.com

> Forest Protection Annual Science Report 2012

This recently released report marks a 20-year milestone for Scion's rural fire research group. The group was kick started in 1992 with the arrival of Dr Marty Alexander, Fire Research Officer from Forestry Canada, who commenced a 12 month secondment at the NZ Forest Research Institute in Rotorua. Twenty years of research effort culminated last year in the development of the SmartPhone application, *Fire Behaviour Toolkit*. This put fire behaviour software at the fingertips of fire managers.

"It was impressive to look back over the 20 years of fire research and see the tremendous gains that have been made."
Brian Richardson, General Manager Forest Science, Scion.

Other highlights include the establishment of a new programme for research into methyl bromide reduction; research focus on red needle cast, an emerging new disease affecting radiata pine; ongoing research into wilding conifer control; and applying forest aerial spraying expertise to the kiwifruit industry.

Available under What's New: www.scionresearch.com

> Fungi, fungicides and fertiliser

Research that may help nursery growers produce faster growing, more robust radiata pine seedlings has been recently published by Christchurch-based Scion microbiologist, Simeon Smaill and Katrin Walbert from the Rotorua office.

Mycorrhizae are critical to the establishment and growth of radiata pine seedlings. They are a class of fungi living in close association with the roots of most plant species and greatly increase root area, thereby improving water and nutrient uptake. Scientists guess there may be as many as 25,000 different species.

Simeon and Katrin set out to discover what effect variations in fertiliser and fungicide applications (common nursery practices) have on the mycorrhizal associations with radiata pine seedlings. They were particularly interested to know if fertiliser or fungicides had an effect on the composition of these mycorrhizal species in nine-month-old radiata pine seedlings.

Increased fertiliser and fungicide application rates substantially reduced the relative abundance of *Rhizopogon rubescens* mycorrhizae on the roots and increased the presence of a number of other species. *R. rubescens* is the species most closely linked with nutrient uptake in these seedlings, so it appeared that both fertiliser and fungicide use has a detrimental effect on seedling nutrient uptake.

The authors of the report were quick to caution that nursery managers should not abandon the use of fertiliser or fungicide, because there are valid growth target and disease mitigation

reasons not to. However, overuse of these products may leave seedlings with a reduced ability to uptake nutrients later in life.

Simeon and Katrin's research appears in *Applied Soil Ecology* 65 (2013) 60-64.

> Upcoming conferences

NZBIO. Auckland 18-20 March.
A well established showcase for the New Zealand bio-based industries. Visit nzbio2013.co.nz

13th International Symposium on Soil and Plant Analysis. Queenstown, 8-12 April.
New methodologies and emerging techniques.
Visit www.isspa2013.com

NZ Farm Forestry Conference, Orewa Arts and Events Centre. Auckland 20-23 April.
This year's theme is 'Back To Our Roots.'
Visit www.nzffa.org.nz/conference

> Subscribe to *Scion Connections* ...

... and receive our latest news every three months in the post or direct to your inbox.

Visit **www.scionresearch.com/scion-connections** to subscribe for the electronic version or email **publications@scionresearch.com** to order your hard copy – please put **"Scion Connections"** in the subject line.

We'd love to receive your feedback on *Scion Connections*. Tell us what you think by emailing **publications@scionresearch.com**

ISSN 2230 - 6137 (print)
ISSN 2230 - 6145 (online)

Scion Connections is published quarterly, and is also available on line at **www.scionresearch.com/scion-connections**

If you'd rather receive this newsletter via email, or wish to change your address details please **email: publications@scionresearch.com**

SCION
forests · products · innovation

49 Sala Street,
Private Bag 3020,
Rotorua 3046, New Zealand.
Telephone: +64 7 343 5899
Facsimile: +64 7 348 0952
www.scionresearch.com

Printed on 9lives Coated Paper, sourced from an Enviro-mark® NZ-Gold certified company.