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Scion creates new bioadhesives

Scion has created a new recipe for adhesives made 100 percent from bio-based ingredients. This breakthrough will help manufacturers of wood panel products to overcome regulatory and customer concerns about formaldehyde emissions.

New Zealand manufacturers of medium density fibreboard (MDF) have been working for many years to reduce formaldehyde in response to regulatory pressure from Japan. Similar concerns have more recently emerged in the US and Europe, resulting in higher demand for "green" panel products.

Suitable alternatives to standard adhesives do not grow on trees. Or so everyone thought. Three years ago, chemistry scientists at Scion initiated an entirely new research programme to create bioadhesives.

Project leader Dr Warren Grigsby says their aim was to make adhesives that do not require any formaldehyde or petrochemicals, using a green chemistry approach. He likens the process to creating a new kind of healthy cake without a recipe or any ingredients. They started with assorted forestry and agricultural residues such as pulp mill waste and arable crop processing leftovers.

"We extracted various chemicals from plant residues and then brought these ingredients together in new ways to create building blocks for adhesives," Warren explains.

Like every good experimental process, Warren admits they had a few flops along the way. When the research team eventually hit on a recipe capable of holding an MDF panel together, things really started cooking.

"Our next step was to scale up the process and work out the feasibility of using our new recipe in an MDF manufacturing plant."

Using the fibre processing plant located at Scion, scientists ran a pilot study and achieved their goals. By overcoming the stickiest of challenges, Scion has laid the groundwork for creating green panels using ingredients that are grown or sourced in New Zealand.

"We now have proof of concept at pilot scale and are focused on providing underpinning science that will lead to commercialisation," Warren says. "As with any new product development, there is more work to be done to achieve a commercially viable solution. We find this stage of research is best done in partnership with industrial manufacturers."

With architects, designers and furniture makers all seeking this kind of product, Warren believes the technology is poised for global uptake.

"The green approach could offer local manufacturers a competitive advantage over wood panel processing plants located overseas. Scion is keen to speak with manufacturers who may be interested in exploring this opportunity."

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> Vandals revive GM debate

The destruction of 375 pine seedlings in Scion's genetic modification (GM) field trial under containment at the end of the Easter break generated national interest. Little sympathy or support was expressed for those who put themselves above the law. The police are continuing their investigations, and Scion will be continuing the research.

Forest industry leaders unanimously condemned the vandalism and strongly reiterated their support for the research.

The anti-GM claim that the trial poses a risk to New Zealand's biosecurity status is groundless. The trial was approved by the Environmental Protection Agency (formerly ERMA) following rigorous review of all aspects of the science (including submissions from opponents of GM) and an assessment of the benefits and risks. The trial is regularly monitored by MAF (now Ministry for Primary Industries). As one national newspaper commented, "*The greatest environmental threat posed by the field trial of genetically modified pine trees at Rotorua was not the test itself, but the actions of those who risked the spread of GM material by breaking in and destroying the crop.*" (The Dominion Post - 17 April 2012)

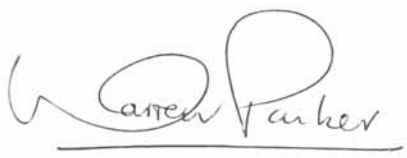
New Zealand has potential to gain more from GM technology than most countries because of its bio-based economy and environmental challenges with water, invasive pests and exotic diseases. For the same reason rigorous assessment of all risks is required before releasing GM livestock, crops and trees commercially. As Sir Peter Gluckman, the Prime Minister's Chief Science Advisor, observed in his February 2010 report on "Climate Change and the scientific process; "*Science is a process based on questions leading to partial answers, in turn leading to more questions and more partial answers, and so forth. In complex systems, this rarely leads to absolute certainty, but much more often to a balance of probabilities. Science-based decisions that society has to make will always rely on weighing up the risks of acting versus those of not acting.*" And, so it is with genetic modification of radiata pine – building on our previous research on the environmental impacts of this technology, local research is needed now to increase our understanding of potential GM benefits for forest productivity.

It is important to be aware of the timeframes for this research. It may be up to a decade before any commercial release and we can anticipate that knowledge about GM technology will more than double over this period. At that stage, industry and regulators armed with new knowledge and the extensive results from Scion's field trials will be very well equipped to make an informed decision on whether to commence plantings of GM trees in our plantation forests. With New Zealand's major future markets – China, India, the ASEAN economies, Australia and the Americas – already growing GM crops, and the time needed to harvest these trees, barriers to wood and fibre products made from GM trees in 2040+ would seem highly unlikely.

If a 'bigger picture' is viewed, by 2050 the world will need 70% more food production per year than it does now to feed a projected 9 billion people and with less land and likely less water than today. And, it will also need more fibre from renewable sources such as trees, smarter ways to deal with waste, weeds and pests; and non-oil, low carbon sources of energy. Without action, it is abundantly clear that pressure on natural ecosystems and biodiversity will intensify enormously compared to today. GM technology offers one means to achieve some of the resource efficiency and quality gains that will be necessary. For the anti-GM protestors to deny credible alternative solutions to these global challenges to humankind is both morally and scientifically irresponsible.

As I noted to the media at the time of the vandalism, Scion will not be deterred by those who put themselves above the law, lack the decency to respect years of careful work by dedicated scientists, or protest by non-democratic means.

Hei kona ra



Warren Parker
Chief Executive

> GM research to continue

At left: A minor setback to important research. Scion's field trials in containment investigate how genes affect particular traits when grown under simulated production conditions. Radiata pine within the trial has been genetically modified to influence growth rate, reproductive development, herbicide tolerance, biomass utilisation, wood density and wood stability.

The attack on Scion's field trial of genetically modified trees in April has revived debate about genetic modification (GM). Is it worth continuing to pursue this research given the enormous costs relating to compliance and security?

The New Zealand Forest Owners Association (FOA) says yes.

Forest growers believe that GM could provide environmental and economic benefits, and they support research to investigate this technology in the New Zealand context.

"GM has potential to reduce the need to use persistent herbicides in forest establishment and to eliminate the spread of wilding trees from plantations through the development of sterile clones," says FOA senior policy analyst Glen Mackie.

"To have an informed debate on whether commercialisation would be a good idea, we need to investigate the risks and benefits."

By trialling genetically modified trees, Scion is enabling the industry to do just that, says Scion General Manager, Dr Elspeth MacRae.

"The impetus from the industry and Government is to develop trees that grow faster, have higher value products, require lower inputs (such as herbicides and insecticides) and can mitigate climate change. Genetic modification is fast emerging in forestry as a safe and effective way of increasing the gains made through traditional breeding," she explains.

Genetic modification is distinct from traditional breeding techniques because it allows plant breeders to introduce a single, clearly identified trait into a breeding population. The insertion of genes takes place in the laboratory.

"In some countries, New Zealand included, there has been reticence about GM while other parts of the world accept the technology and use it widely," Elspeth says.

"In 2011, 16.7 million farmers in 29 countries grew genetically modified crops commercially, and over 90 percent of them were small farmers in developing countries. Numerous studies confirm that these crops provide significant economic and environmental benefit."

Despite this evidence, some people are still unsure about the value and risks of GM plants in New Zealand's environment.

"Decisions on whether or not to use genetically modified (or conventionally bred) plants should be made by governments based on scientific evidence," Elspeth explains.

"Scion is at the forefront internationally in applying genetic modification techniques to radiata pine and other conifers. The opportunity exists for New Zealand to benefit from this knowledge as our research continues."

Scion CEO Dr Warren Parker says the research will continue and new plantings will be established this year.

For more information
www.scionresearch.com/genetic-modification

> Taking carbon into account

Scion is a major player in developing robust carbon modelling methods and inventory procedures for assessing carbon stocks in planted and indigenous forests.

Over the past decade, Scion has worked closely with the Ministry for the Environment (MfE) and Ministry for Primary Industries (MPI) to develop methods for measuring and forecasting forest carbon stocks. These methods are an integral part of New Zealand's Land Use and Carbon Analysis System (LUCAS), run by MfE. The information is used at a national level to satisfy international reporting requirements under the Kyoto Protocol.

Scion CEO Dr Warren Parker says that New Zealand is in the fortunate position of being able to use carbon stored by forests to offset a large portion of our national greenhouse gas emissions, avoiding significant cost under Kyoto commitments.

"Scion's expertise and long-term research programmes have played a major role in making this possible," he says.

To meet the challenge of calculating carbon in planted forests, Scion has combined its carbon prediction model - known as C_Change - with complex growth models. At the heart of the carbon forecasting system is the 300 Index growth model for radiata pine and the 500 Index for Douglas-fir. Both of these models are routinely used by the forest industry to forecast growth and yield of wood products.

Scion's leader of carbon research Dr Peter Beets says the advantage of this system is that it can accurately account for the impacts of silviculture when predicting carbon sequestration.

"Pruning, thinning and harvesting operations have a large impact on carbon stocks. So does wood density. The growth models used to forecast carbon take all of these complex factors into account," Peter explains.

The trading of carbon domestically and internationally is creating an important new revenue stream for individual forest owners. Scion is now working with MPI to provide key components of the carbon calculation and forecasting system for planted forests registered in the Emissions Trading Scheme (ETS). Forest owners with at least 100 hectares of radiata pine and/or Douglas-fir forest in the ETS will have their carbon calculated by the system.

Dr Craig Trotter, who is leading the ETS design for MPI says the well-proven, national applicability and accuracy of Scion's models were the key reasons for using them in carbon calculations under the forestry ETS.

"Scion's expertise in forest inventory and carbon assessment is embedded in New Zealand's international and domestic efforts to reduce emissions and contribute to controlling climate change."

"New Zealand is well advanced in forest carbon measurement and Scion is at the forefront of this technology."

New Zealand is able to use carbon stored by forests to offset a large portion of our national greenhouse gas emissions. This offsetting has been made possible though robust carbon modelling and inventory methods for assessing carbon stocks in planted and indigenous forests.

> Carbon monitoring in New Zealand attracts international interest

Planted forests play a vital role in helping New Zealand to meet our national obligations under the Kyoto Protocol. This position sets us apart from many other developed countries that do not include forests in their emission trading schemes (ETS).

The largest ETS in the world, run by the European Union (EU) does not include carbon credits from forests, because of concerns about the difficulty and cost of quantifying carbon accurately enough. A group of visitors representing major forestry interests in Europe recently visited Scion to learn how New Zealand has met this challenge.

Leading the group was Jason Funk, Land Use and Climate Scientist from the United States Environmental Defense Fund. He said the purpose of the tour was to explore the work that New Zealand has done in bringing legitimate forest credits into the ETS – something that is not yet allowed in the EU ETS.

"One of the key questions for the group was: what kind of measurement system is necessary to ensure high levels of accuracy and confidence in forest carbon measurements?" Jason explained. "New Zealand is well advanced in this area and Scion is at the forefront of this technology."

Dr Jason Funk of the US Environmental Defense Fund pictured at far left with EU delegates representing forestry interests. From left to right: Dr Georg Erlacher (European State Forest Association Chair), Dominic Marcellino (US), Mariana Deheza (France), Susan Braatz (Forest & Agriculture Organisation of United Nations - FAO), Constantin von Waldthausen (Germany), Dr Peter Beets (Scion), Jan Haino (Finnish Ministry of Agriculture and Forestry).

Want to know more about carbon models?

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> Managing wind risk in forests

Intense storms have damaged large areas of forest in some parts of the country. While the actual percentage of the forest estate damaged in recent years is less than it was in the 1970s and 1980s, research suggests that this risk is not going away.

Scion science leader Dr John Moore specialises in understanding wind effects on trees. He says that extreme storms and their damage patterns are difficult to predict. NIWA's climate change projections show that the frequency of extreme winds is likely to increase in almost all regions, with cyclone activity expected over the Tasman in summer.

"Whether or not you take climate change predictions seriously, forest growers always need to manage wind risk. We know that significant losses from wind occur on average every 4-5 years in New Zealand," he says.

The good news is that forest growers can take steps to reduce windthrow risk through changes in silvicultural regimes and harvesting operations.

John says it is also important to have plans in place for dealing with an event once it has happened.

"You don't want to be making it up as you go along if you don't have to!"

Want to know more about wind risk?

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> Reducing wind risks

- **Site** – Certain landforms and soil types make trees vulnerable to wind damage. Gullies are at risk because they tend to funnel the wind, and gully bottoms have higher soil moisture content that can reduce root anchorage strength. Soil types or features that encourage shallow rooting can reduce tree stability.
- **Species** – Radiata pine is considered more susceptible to wind damage than many other species, particularly in saturated soils. Douglas-fir tends to be more stable due to its plate-like root structure and more flexible crown.
- **Silviculture** – Any action that opens up the stand can increase wind risk. For example, late thinning (over 18 m mean top height) significantly increases the risk of damage.
- **Rotation age** – As trees get larger they become more vulnerable. Damaged areas are often concentrated in older age classes, especially radiata pine stands over 30 years old.

> Salvaging logs

Wood is affected by sapstain as it dries out so every salvage operation is a race against time. Research by Scion shows that the rate of log deterioration is influenced by the following factors:

- **Bark protection** - Trees uprooted by wind tend to deteriorate at a slower rate than processed stems. This is because storm damaged stems typically remain protected by intact bark.
- **Air temperature** - Less time is available for log recovery during spring and summer, and in warmer regions such as the northern North Island.
- **Moisture levels** – Unlike snapped stems, uprooted trees remain alive longer and can obtain moisture through roots still present in the ground, keeping the wood green for longer. Trees that remain rooted after windthrow during winter can potentially stay in good condition for up to a year.

Related publications:

McCarthy, J. K.; Hood, I. A.; Brockerhoff, E. G.; Carlson, C. A.; Pawson, S. M.; Forward, M.; Walbert, K.; Gardner, J. F. (2010). Predicting sapstain and degrade in fallen trees following storm damage in a *Pinus radiata* forest. *Forest Ecology and Management 260*: 1456-1466.

McCarthy, J. K.; Hood, I.A.; Kimberley, M.O.; Didham, R.K.; Bakys, R.; Fleet, K.R.; Brownlie, R.K.; Flint, H.J.; Brockerhoff, E. G. (2012). Effects of season and region on sapstain and wood degrade following simulated storm damage in *Pinus radiata* plantations. *Forest Ecology and Management 277*: 81-89.

> Putting the acid on wood

Acid produced from a chilli-dwelling bacteria may sound like nasty stuff but it could provide a natural alternative to synthetic preservatives used to treat wood. Scion wood durability team have screened almost 100 natural compounds sourced from medicinal and native plants, essential oils, agricultural/horticultural wastes, as well as secondary metabolites from bacteria and fungi.

Research shows that chilli waste (yes - the same chillis you use in hot food) has moderate antifungal properties. Using DNA sequencing, scientists have isolated acids from a bacterium growing in the chilli that halts the growth of brown rot on wood. This preservative only works if the wood remains dry. To overcome the leaching issue, scientists are now evaluating ways to impregnate natural preservatives into wood using agents that can cross-link these metabolites to wood fibres.

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> Biospife goes to Europe

Scion's collaboration with ZESPRI®, recognised as the world leader in premium quality kiwifruit, continues to grow. Scion scientists have been working with ZESPRI® to develop a bioplastic spife (spoon-knife) made, in part, from kiwifruit residue.

ZESPRI® in Europe had such a positive response to prototype biospifes displayed at a trade fair for sustainable agriculture in The Netherlands, that they requested 100,000 commercial sample spifes. These will be used in retail pre-packs of ZESPRI® ORGANIC supplied to several European retailers.

The Scion bioplastics team (Alan Fernyhough, Martin Markotsis, & Daniel Parker) optimised the formulation and organised scaled-up production of the necessary components. Thousands of biospifes are now coming off the production line at a New Zealand manufacturing plant.

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> A whole new racquet for flax

Scion has been stressing, stretching and pounding plant fibres to understand how they respond to repeated pressure. Flax fibres are of interest because overseas manufacturers are using them in combination with resins to make tennis racquets, high-performance bicycles and racing yachts. While carbon fibres have greater strength and stiffness, research undertaken by Scion for the Biopolymer Network shows that plant fibres have other redeeming qualities.

Actions like hitting a ball with a racquet, can place stresses and strains on the material, causing it to debond and eventually break. The result of Scion studies showed that flax and resin remain tightly bound together under repeated stresses of loading and unloading. The flax composite material had excellent dampening properties and retained its strength even after 20,000 load-unload cycles.

This research confirms that flax definitely has potential as a high-perfomance material for a wide range of sporting applications. Results of this study were published in the *Journal of Materials Science*.

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> Upcoming conferences

Scion is supporting the following events:

World Conference on Timber Engineering (WCTE)

The WCTE takes place in Auckland 15 – 19 July with a tour of the Scion campus on 20 July.

The objective of the WCTE is to provide a forum for the exchange of the latest technological advances, research results and design innovations.

This conference will be of interest to practicing engineers and architects, researchers, educators and manufacturers in the field of timber engineering.

www.conference.co.nz/wcte2012

Carbon Forestry Conference

The second annual Carbon Forestry Conference will be held in Auckland on 22 – 23 August.

The event will provide the financial and forestry industries with a much clearer understanding of how the market is operating; the major players in the marketplace; and will identify market and investment opportunities that exist through carbon forestry.

www.carbonforestryevents.com

Agricultural Biotechnology International Conference (ABIC)

ABIC 2012 will be held in Rotorua on 2 - 6 September. Hosted by NZBio, this is only the second time the conference has been held in Australasia. Scion is sponsoring a technical tour that will explore how agricultural biotechnology can meet some of the world's major challenges.

www.abic2012.com

> Scion celebrates 20 years of service to the rural fire sector

For every wildfire that breaks out in New Zealand, there is a fire manager reaching straight for field manuals or calculators produced by Scion.

Decades of data collection from experimental burns and wildfires have gone into building tools that enable managers to make informed decisions in firefighting operations.

Scion's contribution to the New Zealand rural fire sector will be highlighted at the 4th Fire Research Workshop in Rotorua when the fire team celebrate its 20th anniversary.

Scion is hosting the June workshop in conjunction with the Rural Fire Research Advisory Committee.

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