ScionConnections

SCION NEWSLETTER ■ ISSUE 27 ■ MARCH 2018

Considering the options: Mike Bennetts Z Energy CEO, Hon. Dr Megan Woods Minister for Research, Science and Innovation and Scion's Dr Paul Bennett.

Growing a biofuelled New Zealand

New Zealand could build a renewable low carbon transport fuels industry - but only if we as a nation get our act together.

A new report by bioenergy specialists at Scion looks at how New Zealand could grow and process feedstock crops into liquid biofuels targeted towards the heavy transport, shipping and aviation industries.

Complexities and complications

There is no broad consensus on biofuels in New Zealand. This only compounds the difficulties of establishing a new, large, and complex biofuel value chain that involves considerable technical risk, over several decades.

How we might do this and what it could mean for New Zealand in environmental, social and economic terms are some of the questions the Scion scientists behind the New Zealand Biofuels Roadmap study set out to explore.

Dr Ian Suckling, technical lead, says the team wanted a way to explore different futures. "We wanted to consider the effects of a wide range of different feedstocks, technologies and fuel mixes. Overall, we set out to come up with alternative futures that would inform and stimulate debate around biofuels, not make recommendations," said Ian.

The sheer number of options available to the team meant they had to carefully consider the scope of the study. After discussion with stakeholders ranging from forest growers to fuel distributors and

(Continued on page 8)

CONTENTS

Unleashing the power of forestry

Right now is an interesting time for New Zealand and Scion with two forces propelling new thinking. The global trend to a bioeconomy and circular economy approach is increasingly being led by consumer pull, which we are seeing in New Zealand also with actions such as the recent 'Ban Plastic Bags' petition. Such consumer demand coincides with our new government's strong focus on forestry.

In my previous editorial "A billion trees" (*Scion Connections*, December 2017) I talked about the huge and transformational opportunities from trees as a renewable resource in rejuvenating and invigorating our sector and our regional communities.

For decades we at Scion have known that trees are remarkable, renewable resources. Planted as forests they can be at the heart of a low-carbon, bio-based future New Zealand. Now is the time for such a step change.

Scion can and will embrace this momentum to deliver on our core purpose to "drive innovation and growth for the benefit of New Zealand".

We have very recently adopted the mission statement:

Enhancing New Zealand's prosperity, well-being and environment though trees

Kia piki te ora, te taiao me te whai rawa o Aotearoa mā te ngāherehere

We see truly legacy-creating opportunities through planting the right trees in the right places for the right purposes.

The future we envisage has Scion operating in a low-carbon bioeconomy that we have helped develop and shape. We will bring a fundamental underlying strength to the entire forest industry, and the value chain we help create is more critical now than ever before.

So why does forestry make such a compelling proposition?

- Forestry has a critical role to play in mitigating New Zealand's climate change obligations. Carbon capture is one of the many benefits well-managed forests bring to growers (who can trade carbon credits) and society in general. Increased use of forest products also contributes to our carbon sinks.
- Forestry and forest-based industries are taking a significant and growing global position in the move from linear economies to circular economies where renewable bio-sources, such as trees, replace petrochemicals to provide a renewable and sustainable way of living.

> "We see truly legacy-creating opportunities through planting the right trees in the right places for the right purposes."

- Forestry offers social and economic regional renewal through new business models, integrated and optimal land use, value chain optimisation and the opportunities for new enterprises stemming from a bioeconomy approach.
- Growing the right one billion trees in the right place for the right purposes offers a true legacy opportunity for New Zealand. (Simply put, this means planting the right cultivar to meet downstream market demand products.)
- Forest, wood and bioproducts science (including gene editing) is developing around the world at a high pace, and New Zealand needs to be abreast of that to both protect its future and to take advantage of emerging opportunities.

So, how is Scion placed to respond to global trends (such as consumer demand for sustainable outcomes) and challenges (such as heightened biosecurity exposure through increased border traffic and climate change)?

As a New Zealand Crown Research Institute with a proven legacy of science impact, we will continue to provide the key science and research capability to grow this nation's future as well as respond to threats.

Scion is already highly aligned with the Government's priorities, including:

- Planting a billion trees in 10 years – the right tree in the right place for the right purpose.
- Regional economic development though planting, growing, harvesting, local processing of exotic and indigenous species, recreation, tourism, increasing people's well-being and creating vibrant communities.
- Commitment to the COP 21 Paris Climate Agreement, where forestry is a key mitigant to greenhouse gas emissions.
- Environment, especially water quality and land erosion concerns.
- Housing, where house building can be changed to house manufacturing.
- Heritage, with a strong focus on biodiversity and bio-protection.
- A strong economy (for all New Zealanders), realising the very large potential that forestry and related manufacturing brings.

Together with our iwi and industry partners we aspire to truly unleash the power of forestry to enhance New Zealand's economic, environmental and social well-being well into the future.

Dr Julian Elder
Chief Executive

FOR FURTHER INFORMATION
contact Dr Julian Elder at
julian.elder@scionresearch.com

Rotomā No 1 Inc Whānau Day – whānau gather at Tapuaeharuru Marae, Rotoiti.

Intergenerational land management solutions

"Kia mau ki te whenua, hei oranga mo te iwi" – "Hold onto the land as sustenance for our people", is the vision statement of Rotomā No.1 Incorporation (Rotomā). The incorporation manages over 1,200 hectares of forest surrounding Lake Rotomā on behalf of more than 2,000 shareholders that whakapapa (have family connections) to it.

Rotomā is working with Scion to design a land use system that fulfils its unique requirements – fostering a connection between land and shareholders and providing long-term sustainability in social, cultural, environmental and economic goals. Agroforestry might be the answer the incorporation's Committee of Management is looking for.

Changing the landscape with agroforestry

Right now the whenua (land) located at Lake Rotomā is in the final stages of a five-year radiata pine harvest – but in 10 years' time it could be hosting a functioning multi-use agroforest system. Agroforestry includes trees or shrubs grown amidst crops and pasture. It brings together agricultural and forestry technologies to create land use systems that are diverse, productive, healthy, ecologically sound, and sustainable.

Rotomā is working with Forest Scientist Lania Holt to explore a mix of options for the whenua. Starting with two main themes – horticultural crops (i.e. Chilean "hazel" trees) and eco-tourism.

Rotomā Chief Executive Neville King says, "Ordinarily, the land would've been replanted in pine and then we'd wait for things to happen and go through the same cycle. But our motivation is more than just the financial side. It's social, and we're considering environmental impacts as well. It's about creating opportunities that we wouldn't have had previously and doing things that align with our long-term strategy."

The project is six months through a two-year timeframe. The next steps are to design options with the pine forest for tourism including mountain biking and a lodge, make connections with groups around Aotearoa who are doing similar projects, and secure access to seed of Chilean "hazel" crop trees.

The end of the project will see the Rotomā Committee of Management (Committee) presented with a business case weighing up the land use options. Lania explains, "The business case is where it all stacks up. It'll identify the cost of investment (opportunity cost) and the value potential beyond return on investment. It will include cash flow timings, variety of employment, sustainability, scalability and identify other land use opportunities. The committee can then make decisions with that information."

Leaders in land use

Neville says it has to be about more than kaitiakitanga. "We want to be known for more than just pine forests, that's part of it, but we want to be innovators in our own right, in how we use our whenua."

As one of the first Māori entities to harvest a forest it also owns, Rotomā is poised to lead other land managers looking to diversify their land uses – Māori and non-Māori alike. But for the committee, it's about connecting people back to their land, back to their community and ultimately, back home.

FOR FURTHER INFORMATION on the Rotomā Agroforestry Project contact Lania Holt at lania.holt@scionresearch.com

Liam Wright and Dr Christina Dunker install a sonic anemometer.

New weapons in the battle for urban biosecurity

Biosecurity officials receive over 10,000 reports of suspected new pests and diseases in New Zealand every year[1]. Pest plants, insects and pathogens can arrive with goods and people travelling through air and sea ports near cities around the country. Managing these invaders in densely populated urban environments presents an array of challenges that will grow as urban migration continues and international movement of cargo and passengers increases.

Dr Tara Strand leads a research project to reimagine the way we manage urban biosecurity incursion responses. Project researchers are developing tools and concepts that could result in faster detection of new organisms, reduced pesticide use, improved incursion responses and engagement with communities, creating a stronger biosecurity defense network for New Zealand.

> Their research trials have proven the concept that a UAV wired with a pheromone sensor-antennae can detect specific pheromones from a target insect.

Active surveillance

When any new pest is discovered, important questions biosecurity officials need answered is 'where is it and how far has it spread?' Gauging the distribution quickly can influence the response to the pest and early detection enables eradication treatments that prevent further spread. Dr Steve Pawson and the team, including aerial robotic company Aeronavics, are using UAVs (unmanned aerial vehicles) to detect pests earlier.

Their research trials have proven the concept that a UAV wired with a pheromone sensor-antennae can detect specific pheromones from a target insect. The team is working with experts from France to miniaturise the concept and refine it.

Tara explains, "This tool is undergoing development to pinpoint a pest's location much faster than a human surveillance team. The time saved could reduce the opportunity for the organism to spread, minimising the treatment area and disturbance to urban residents."

This will increase the chance of eradication; or arrive at a decision point sooner than would otherwise be the case.

Targeted application

Once the distribution of a pest has been established the next step is to eradicate it. When it comes to insect pests, the current practice is often to treat the host plant, either by pesticide application or host removal, leaving the pest population to decline from loss of useable habitat, or by direct action of the toxicant.

Dr Ecki Brockerhoff and his team have created a model that links the pattern and amount of host plants across a landscape with the population dynamics of pest species. He explains, "The model considers the distribution of host plants across the landscape and the effects on the target pest's population, identifying how many and which host plants will need to be made unavailable to the pest species to drive it towards eradication.

"This new knowledge will help to develop new early incursion response strategies and more efficient use of controls like pesticides."

To put these targeted strategies into action, researchers are developing tools that deliver pesticides to a single tree at a time. Working with the company HeliResources, Dr Brian Richardson and the team have evaluated a ring-shaped spray boom that is tethered below a helicopter and delivers pesticide to one tree at a time. A working protocol for this new tool has already been delivered to

[1] https://www.mpi.govt.nz/protection-and-response/finding-and-reporting-pests-and-diseases/keeping-watch/

MPI and is ready for deployment.

UAVs are also undergoing testing for targeted spraying. Machines tested to date are capable of delivering 10-20 litres of spray in a single load. Research efforts have focused on both the swath patterns and wake strength produced in a variety of scenarios. The work is the result of collaborations with HeliResources, Aeronavics and the US Forest Service.

Brian says, "Broadcast spraying techniques are generally a last resort in urban environments, but the methods we're developing will focus the control spraying where it's needed, minimising unneeded disturbance."

Dr Brian Richardson inspects spray droplet dispersion on Eucalyptus leaves.

Evaluating engagement

Tools to improve community engagement in urban biosecurity issues are also being investigated by the research team. Together with MPI and Will Allen and Associates, researchers have developed a 'rubric' or framework to help biosecurity managers to visualise and measure the performance of their community engagement strategies.

The rubric creates a mechanism for teams to evaluate components of their engagement strategies by assessing quality of performance against a scale. As a tool, the rubric can help users to learn and share from differing perspectives, measure social and technical details, quickly identify needed improvements and is adaptable across programmes. A detailed rubric has been developed with MPI's general surveillance team.

Tools for tomorrow

This short (3 year) research programme has contributed new tools that are ready for deployment (vegetation fragmentation modelling, ring boom spraying procedures, general surveillance rubric) and their success has earned the programme a gold rating from funding provider, MBIE. The research team credits the shared perspectives from industry bodies, Māori, regional councils and government departments for making this programme robust and relevant to the challenges of urban biosecurity, as well as the strength of national and international research collaborations helping to realise these concepts.

It's not over yet says Brian, "This programme has helped us to test concepts and identify areas that we can improve on. We want to hone in on these next and continue developing and refining these tools."

FOR FURTHER INFORMATION on urban biosecurity research contact Dr Tara Strand at tara.strand@scionresearch.com

HeliResources' ring-shaped spray boom in action.

Mapping the options - Mike Lambert, Manager Customer and Business Development, at Port of Tauranga.

Kawerau container terminal - demand nearly triples!

The town of Kawerau in the Eastern Bay of Plenty (EBoP) is unique. It boasts the world's largest application of geothermal energy for industrial use, and provides the ideal environment and support for companies pursuing a sustainable way of operating. Couple that with a growing export manufacturing sector and strong primary industries and you have a region producing a wide variety of value-added products at the forefront of New Zealand's growing export bioeconomy. Scion is working with EBoP businesses to find a new and more efficient way of transporting their products to the world.

Efficient transport

Industrial Symbiosis Kawerau (ISK) is a group of Kawerau-based organisations working together to find efficiencies and minimise waste between their diverse industries. They have been looking for an efficient way to transport the 30,000 20-foot equivalent containers of goods produced in the EBoP each year. At present, most of the cargo makes its way on trucks to the Port of Tauranga via State Highway 2 and containers are often packed at different locations along the way. The trucks travel alongside KiwiRail's East Coast Trunk railway line, an efficient line with spare capacity.

Scion value chain researcher and logistics specialist, Ginny Christians explains, "Industrial Symbiosis Kawerau asked us to undertake a feasibility study to see if rail would be a viable option to transport the goods.

"We found that no single exporter is large enough to commission a freight train service but, collectively, exporters operating across the EBoP dispatch enough cargo to the port to justify at least one daily freight train."

Without a facility to package the products, exporters in the Eastern Bay of Plenty have limited options for transporting products that require containerisation. The status quo - trucking product and packing closer to the port - is time consuming and comes at a significant cost. The ideal solution is a container transport hub closer to the producers. This could save transport costs, reduce vehicle emissions and improve congestion on roads.

What followed

In the year after the feasibility study was released, ISK has received an influx of interest in the proposed container terminal. The addition of proposed new export manufacturing companies has potentially tripled the amount of freight to be transported. With this significant increase in demand, Ginny was contracted to carry out a new study to assess if the rail line could handle the increased capacity.

Her results showed sufficient capacity on the railway line to meet the surging demand of 95,000 containers per year and that rail resources can be acquired to coincide with the time when the terminal becomes operational.

The analysis shows that, while Ports of Auckland can be a valuable addition, the Port of Tauranga remains the best choice of destination for the majority of the containers coming from this region, both economically and environmentally. Under the most likely scenario in Ginny's report, she also found that the container terminal and train from Kawerau could save on average $103 per container for 18 out of 21 exporters who transport their goods to Tauranga.

The economic impact would equate to an approximate saving of $3.6 million per year plus environmental and social benefits of removing approximately 70,000 heavy vehicle return-trips per annum from SH2 (approximately 200 trucks a day), and reducing CO_2 emissions by as much as 25,000 tonnes per annum.

Meanwhile, ISK has appointed its preferred container terminal operator, ISO and located a suitable site with supportive land owners; Putauaki Trust.

David Turner, Chair of ISK says, "A vital point regarding the container terminal is that, principally, it is about eliminating supply chain waste for value-add businesses in the EBoP - so those businesses can access global markets more efficiently. This way our communities have more opportunities to add value. The terminal is regarded as being a significant asset that will benefit the entire region."

For what happens next – you'll have to watch this space.

FOR FURTHER INFORMATION on the Kawerau feasibility studies contact Ginny Christians at ginny.christians@scionresearch.com

The economic impact of optimising radiata pine stand density

Optimising radiata pine stand density could increase the net value of New Zealand's plantation estate by $1.7 billion.

The Scion research team including Dr Mike Watt, Mark Kimberley, Jonathan Dash, Duncan Harrison, Dr Juan Monge and Les Dowling, used the productivity indices Site Index (SI) and 300 Index (I300) to develop a model that predicts the optimum final crop stand density (S_{opt}) for a standard structural grade regime. Using this model the team was able to develop productivity maps, or surfaces of S_{opt} covering the whole country.

The average predicted S_{opt} for growing structural grade logs across New Zealand was found to be 614 stems per hectare. As the current final stand density for structural grade regimes averages around 500 stems per hectare there is definite scope for increasing the volume of high-value log products.

Most recently, the researchers have run a series of simulations to check the accuracy of the model's S_{opt} predictions, and to look at the potential economic gains

of optimising stand density.

Net value per hectare, internal rate of return (IRR) and net present value (NPV) were all found to increase linearly as stand density approached S_{opt}; beyond S_{opt} values increased very slowly or plateaued.

Increasing stand density to S_{opt} will result in gains in gross and net value of around $5,200 and $2,320 per hectare and a 0.44% increase in IRR. The potential gains for the entire plantation estate are $3.8 billion (gross) and $1.7 billion (net), which, when discounted, are equal to $349 million and $156 million in 2017.

Forest owners and managers can use the developed model with input parameters that reflect their specific situation to plan targeted operations to optimise stand density and maximise the value of their crop.

FOR FURTHER INFORMATION
on this paper contact
Dr Mike Watt at
mike.watt@scionresearch.com

Watt, M.S., Kimberley, M.O., Dash, J.P., Harrison, D., Monge, J.J., & Dowling, L. (2017). The economic impact of optimising final stand density for structural saw log production on the value of the New Zealand plantation estate. Forest Ecology and Management, 406, 361-369. https://doi.org/10.1016/j.foreco.2017.07.044

Campus upgrade underway

The first stage of Scion's Rotorua campus upgrade is now complete.

The refurbished top floor of the 1700m² multi-storey building was opened in early February. The design includes a feature wall of plywood panels made with Scion's Ligate, a environmentally friendly bioadhesive made with renewable resources.

The next phase of the upgrade will see the ground floor refurbished, creating new space for tenants and Scion staff. This is scheduled for completion in September. The new 'Innovation Hub' building is also expected to be started then.

Chief Executive Dr Julian Elder, says, "The centre of the redevelopment is an innovation hub for forestry, manufacturing and energy innovation, which is currently in the design phase.

The hub will support district and regional economic development, and spill over to national benefits.

"For Te Papa Tipu Innovation Park tenants, the campus redevelopment will provide shared spaces for growing businesses, government, opportunities for industry to collaborate and co-innovate, testing facilities, laboratories and modern, fit-for-purpose working spaces for staff. The three-year development is the largest at Scion for many years."

The Innovation Hub will also provide a space for the public to engage more closely with Scion's work, the forestry industry and the value that forests can bring to New Zealand.

FOR FURTHER INFORMATION
on the campus upgrade contact
Rob Trass at
rob.trass@scionresearch.com

Growing a biofuelled New Zealand

(Continued from page 1)

government organisations, the team focused on the production of liquid biofuels from sustainable feedstocks and not fuels that would require new or modified engines. A second focus was large-scale deployment and use of biofuels.

One possible future

The process of narrowing down options to find a range of the best solutions for New Zealand was done using the Bioenergy Value Chain Model (BVCM). Developed in the UK by the Energy Technologies Institute and modified for local conditions, the model balances multiple considerations to find the lowest cost solutions for potential biofuelled futures. Biofuel substitution at the relatively high level of 30% by 2050 is one possibility. In one future scenario, the BVCM model is given the latitude to use any combination of feedstocks, technologies and final fuel mix to calculate the lowest cost way to achieve 30% substitution.

If all land classes can be used to grow feedstock, the model favours existing and new forests, forest residues, canola seed and energy crops like miscanthus and willow, as the main feedstocks. Biodiesel and drop-in petrol and diesel would be the fuels produced. If the land available is restricted to non-arable land, growing and harvesting canola and energy crops is no longer possible and the feedstocks would come from existing and new forests and forest residues. The fuels produced would be drop-in petrol and diesel.

The energy crops and forests would be grown mostly in Northland, the East Coast, the central North Island and Marlborough/Nelson, areas where land is available, not too costly and the climate favours growth. Processing would take place in the same areas.

The team has run more than 50 scenarios, including looking at the effect of targeting specific fuels like jet fuel, one of the few ways to decarbonise the aviation sector. Specifying jet fuel increases cost as the system becomes less flexible and more expensive processing technologies are needed. However, it is unlikely just one type of biofuel would be produced. Most drop-in in biofuel technologies produce a mixture of petrol, diesel and jet fuel.

The benefits of 30% substitution

GHG emissions would be reduced by 5 million tonnes per year (compared with 2015 levels), which would be equivalent to removing half the cars on the road and we would be more energy independent and be able to cut our oil imports by 30%.

The regions where biofuel feedstocks are grown and processed would prosper. Considering the non-arable land option as an example, 50% more of the Gisborne area would need to be planted in forests and the area would be home to four pyrolysis and four upgrading plants requiring a nearly $1 billion in capital and creating 1000 jobs.

Assuming New Zealand does not wish to use arable land to grow energy feedstocks, new forests would need to be planted. With logs and forestry residue from existing forests and new plantings, a total forest area of around 613,000 ha would be needed. This is about the size of the Taranaki region.

What needs to happen next?

A biofuelled future is unlikely to happen by itself. Leadership at a national level is needed. The investment required is large and stakeholder industries will need a degree of certainty when committing to feedstock and processing options.

In the meantime, New Zealand should keep exploring short term, niche opportunities for biofuels. Early wins will start to build momentum, create a positive perception of biofuels and develop the country's regulatory environment.

With the right will, Scion's study and the Bioenergy Value Chain Model, New Zealand can now explore different options and plan the way forward to a sustainable future.

FOR FURTHER INFORMATION on the Biofuels Roadmap contact Dr Ian Suckling at ian.suckling@scionresearch.com

Subscribe to Scion Connections...

...and receive our latest news every three months in the post or direct to your inbox. Visit **www.scionresearch.com/subscribe** 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 online 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

70 years of science

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