FOREST GROWERS RESEARCH

2017 Annual Research Report

ISSN 2537-9305

Forest Growers Research Ltd
99 Sala Street
Rotorua 3010

+64 7 921 1883
forestgrowersresearch@fgr.nz
www.fgr.nz

supported by forestgrowers commodity levy

Geoff Thompson, Chair, Forest Growers Levy Trust

The levy on harvested timber was introduced in 2014. It is administered by the Forest Growers Levy Trust (FGLT) for the benefit of all New Zealand forest growers.

Now into its fourth year, levy revenue invested by the FGLT has increased annually from $4.2m in 2014 to a budgeted $8.6m in 2017.

THE LEVY

Levy monies are allocated to a wide range of activities. All proposed work programmes are screened by the relevant joint Forest Owners Association/NZ Farm Forestry Association committee and then presented to the FGLT who assess whether the recommended programmes meet their investment criteria. The breakdown of levy expenditure in 2017 by broad category is as follows:

Research 60.4%	Biosecurity 12.7%
Health and Safety, Training 11.7%	Promotions 8.6%
Environment 3.6%	Fire 1.5%
Transport 1.0%	Small and Medium Enterprises 0.5%

The levy has provided flexibility, continuity of funding for longer-term projects, and the ability to respond at shorter notice to new priorities. This is a vast improvement over the voluntary funding mechanisms that the industry previously relied upon. The levy also enables substantial leveraging of government research funding.

Research comprises the largest proportion of expenditure, with over 60% of available levy funding allocated to research programmes. The FGLT, on behalf of forest growers, considers that well-targeted and credible research is fundamental to the success of the forest industry. We are committed to the ongoing support of research programmes that improve the profitability, sustainability and safety of forest investments.

The FGLT acknowledges the significant effort put in by the industry via the Forest Research Committee, the Forest Owners Association and the NZ Farm Forestry Association to ensure research funding proposals are relevant, high-quality, and will deliver value to all forest growers. The efforts of the very capable research teams working across our research providers should also be acknowledged. It is their innovative and forward-looking thinking and expertise, coupled with industry involvement and guidance, which are laying the foundations for the future success of our industry.

With a large proportion of the levy invested in research, execution of the research becomes extremely important. The FGLT is therefore very pleased that forest owners have taken steps to create a single research management entity, Forest Growers Research Limited (FGR). FGR now ultimately manages almost all the research activities of forest growers irrespective of funding sources. This ensures that research investments across all of our forestry research programmes will be well-coordinated and well-managed.

The outcomes from the research programmes supported by the FGLT to date are significant and far-reaching. This annual report provides some examples of the very tangible contribution that the levy is making to the promising future ahead for all New Zealand forest growers.

As chair of the Forest Growers Levy Trust I offer my congratulations to all those involved in the planning and delivery of this exciting programme of work.

Regards

Geoff Thompson

Chair, Forest Growers Levy Trust

Introduction

Welcome to this first edition of Forest Growers Research Annual Research Report. Forest Growers Research took over management of the majority of industry-funded collaborative forest-growing research on July 1st 2017, so this report marks our one-year milestone.

Forest growers in New Zealand have a long history of working together on matters of common interest. These include fire, biosecurity, health and safety, social and environmental aspects, promotion of forests and wood products, transport, and research and innovation.

Russell Dale, Research and Development Manager, Forest Growers Research.

THE RESEARCH

In research, this cooperation began with the research cooperatives in the late 1980s. These continued until the Radiata Pine Breeding Cooperative was transformed into the Radiata Pine Breeding Company in 2003. A new company, Wood Quality Initiative, (later the Solid Wood Initiative), was also formed to focus on wood quality research around the same time. In 2007 the remaining research cooperatives merged into a new industry-controlled company, Future Forests Research, and new research activity in forest systems, environmental and social aspects, steepland harvesting and specialty species began.

In mid-2016, forest growers decided to rename Future Forests Research as Forest Growers Research. This was to align it more closely with the Forest Growers Levy Trust, the principle funder of forest-growing research, and to bring all the research under a single organisation's umbrella.

Forest Growers Research (FGR) took over the management of most forest-growing research on July 1st 2017. In doing so, FGR inherited the already well-functioning collaborative industry/research structure built up over six years of Future Forests Research activities.

Research direction is set and guided by industry via the Forest Growers Science and Innovation Plan. This is a key guiding strategy, developed by a joint Forest Owners Association/NZ Farm Forestry Association Forest Research Committee. It identifies priority areas for research investment, and ensures that research programmes are targeted to support industry priorities.

The overall objective of the strategy is to improve the profitability of growing forests on a sustainable basis by:

- protecting forest assets and markets from adverse factors
- improving productivity and uniformity of forest stands
- sustaining and enhancing forestry's licence to operate
- improving efficiency and safety in operations and supply chain logistics
- ensuring multiple species options for diversity of sites and markets.

The Forest Research Committee has a crucial role in maintaining the research strategy, evaluating research priorities, and making recommendations to the Forest Growers Levy Trust. It also ensures that forest-growing research needs and priorities are well-communicated to government and other policy agencies.

FGR's role is to ensure that research programmes funded by forest growers, government and other investors are well managed. FGR also ensures high standards of financial, environmental, and health and safety compliance, reflecting the value of the collective investment in research. In 2017, the total research investment managed by FGR was $5.05 million, spread across six main programmes.

Bringing the management of research funded by forest growers under one entity improves coordination, industry engagement and provides synergies in communication with stakeholders along with governance and management. The overall research programme is an exciting mix of projects spanning the forest value chain from genetics right through to harvesting, all contributing to the vision of improving the profitability, safety and sustainability of forest growing in New Zealand. It is an exciting time for forest growing research.

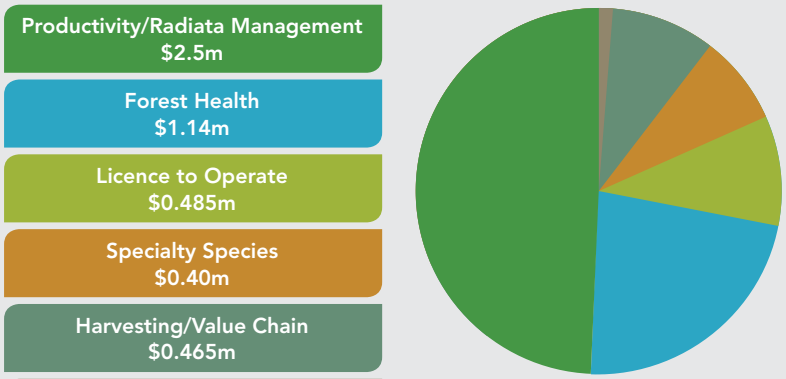
Research outcomes such as those we describe in this annual report can only be achieved through the dedication and vision of a very talented group of researchers at our key research providers, namely Scion, the University of Canterbury, Lincoln University, Landcare Research and the Marlborough Research Centre. Our research providers work alongside an equally dedicated and visionary group of industry practitioners.

The commitment of these people, and the support of the Forest Growers Levy Trust and forest owners, large and small, throughout New Zealand, makes this impressive package of world-class research possible.

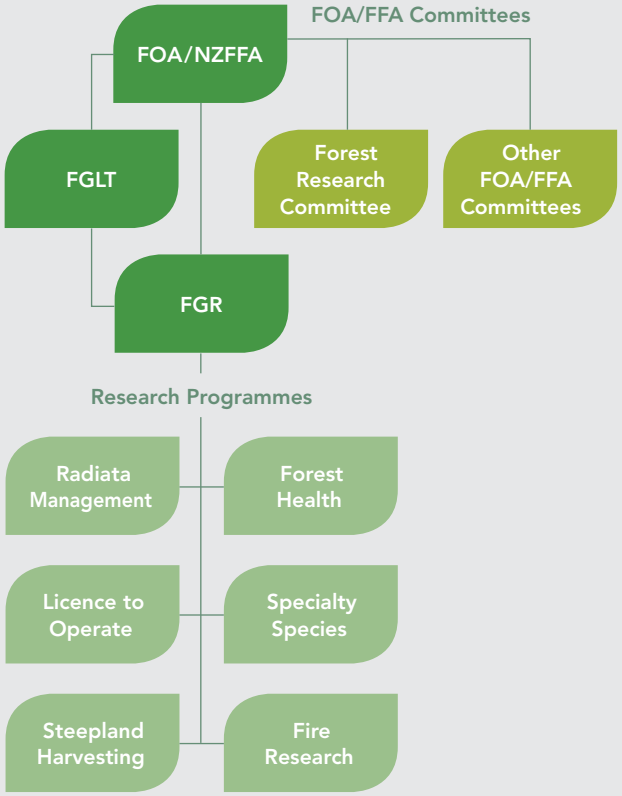
I trust that you enjoy reading the report and are reassured the research programme is in good hands and the support of the Forest Growers Levy Trust and other funders is enabling forest-growing research to go from strength to strength.

Russell Dale

Research and Development Manager, Forest Growers Research



Spread of research investment across research programmes



Relationships between the Forest Growers Levy Trust (FGLT), Forest Owners Association (FOA), NZ Farm Forestry Association (NZFFA), the Forest Research Committee (FRC), Forest Growers Research Ltd (FGR) and other FOA/FFA Committees.

Radiata Management

The Growing Confidence in Forestry's Future (GCFF) research programme is FRG's major government and industry funded six-year programme (2013-2019). Its goal is to shift New Zealand's forest management to 'precision forestry': highly site-specific management, utilising the latest science and technology. In doing this, the GCFF aims to build the foundations to double the productivity of New Zealand's radiata pine forests by 2025, whilst maintaining the quality of the environment and upholding important wood quality traits.

THE VALUE OF LONG-TERM TRIALS

An outstanding attribute of the GCFF is the high level of collaboration between researchers and industry, and in particular the recognition of the value of long-term research.

A nationwide series of silvicultural trials established about thirty years ago by the NZ Forest Service were in danger of being lost – many of these trials are now in privately owned forests, and are at harvestable age.

"The forest industry has made a huge commitment in recognising the value of these trials, and getting the most scientific return from the investment in trial design, establishment and measurement over all those years," says Dr Peter Clinton, GCFF Programme Leader. "The information we are extracting from the trials forms a fundamental foundation of the GCFF programme. We are beginning to answer many questions about the interactions between silviculture, environment and genetics on wood quality, and impacts of intensive regimes on long-term site productivity."

The next generation of trials, a series of 'Accelerator' trials, is being established as part of the GCFF on sites across New Zealand. Ultimately the trials will demonstrate how fast radiata pine can grow in different conditions without compromising wood quality.

"The GCFF is a world-class programme; it is really pushing the boundaries of international science. What impresses me most is how cohesive it is – it is multi-pronged, but all the energy is harnessed towards a common goal. There are explicit links and feedback loops between researchers, forest owners, and the wider forest community." Associate Prof Brian Strahm, VirginiaTech, USA (visiting researcher 2017).

PHENOTYPING AND REMOTE SENSING BRING TRANSFORMATIONAL CHANGES

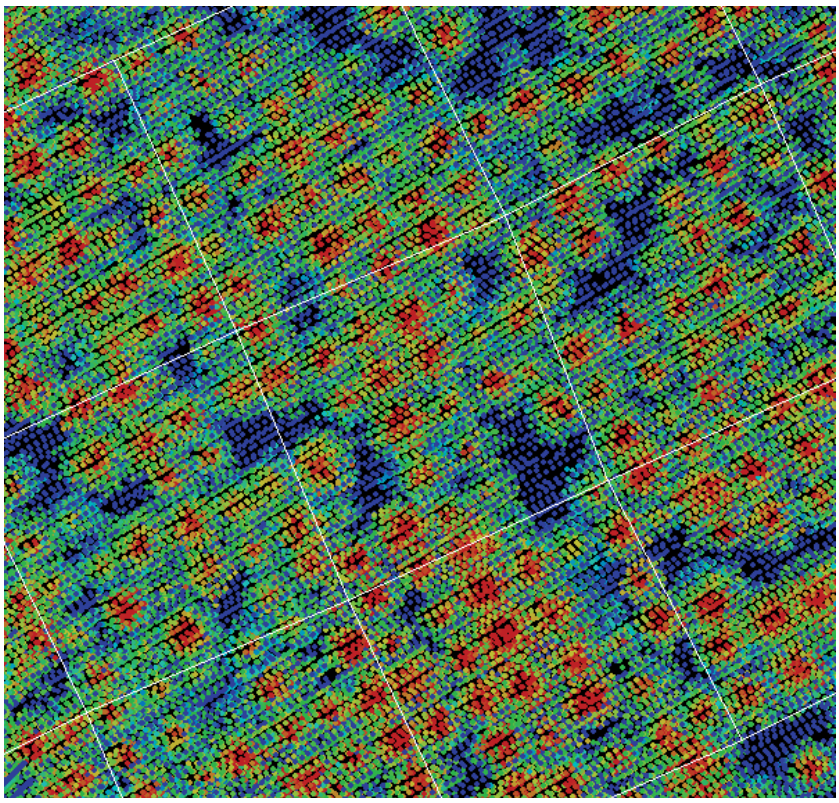
The suite of new remote sensing applications being developed and applied by Scion's informatics scientists provides evidence of how technology is transforming forestry research across multiple research areas.

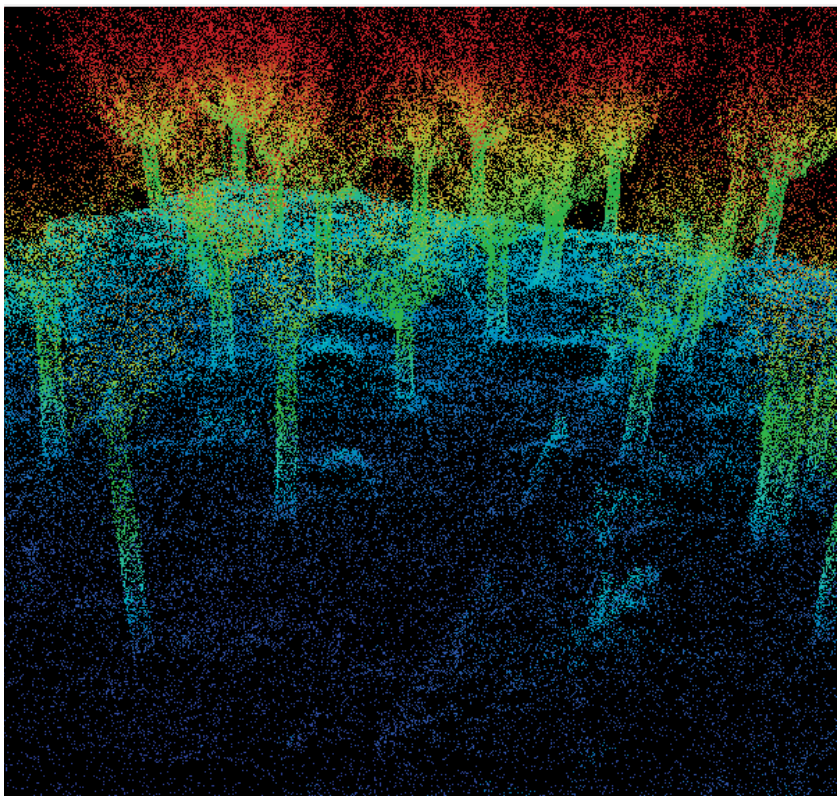
"LiDAR is one example of technological changes which have revolutionised remote sensing and forest research," says Dr David Pont. "It is now possible to tackle bigger research questions, and ultimately integrate them in breeding and managing better trees."

David has developed techniques using LiDAR and other remote sensors to identify and characterise, or 'phenotype' individual trees. The ability to describe the phenotype is a key component driving genetic improvement, because it reveals more about the response of trees to interactions between genetics, environment and silviculture than was ever known before.

David has worked on both aerial and terrestrial laser scanning to develop ways to describe trees' crown size, height, form, DBH and volume, now as accurately as by using manual techniques.

Other remote sensing techniques are being investigated to describe disease incidence and wood quality. All of the information being captured is of great value for tree breeders, who have been making huge strides in advancing molecular genetics techniques, but have been held up in making breeding advances by the need to phenotype large numbers of trees accurately and cost effectively. The research is also building a better understanding of the drivers of tree growth, needed by foresters to select and manage improved breeds for their sites.





▶ DBH, height, and volume have been estimated for individual trees using conventional aerial LiDAR at 20 points per m² (above). Methods are being developed to obtain more detailed tree descriptions using high density LiDAR, from a UAV at 300 points per m², and from a hand-held unit at 24,000 points per m² (below).

John Lee, Scion wood quality scientist, uses the Resistograph on a mature pine.

TESTING WOOD QUALITY

Research to understand the processes behind wood formation, which in turn determine wood quality, is one area of research benefitting from having access to long-term trial resources. Researchers have the opportunity to quantify the relative impacts of genetics, site and silviculture on growth, yield, and wood properties in the 1980s NZ Forest Service trials resource.

A range of new tools and techniques are being used to investigate wood properties in the mature trees. These include the IML Resistograph, which drills a hole in the tree, and by measuring torque every 0.1 mm, generates data on ring structure; this can be directly related to density and stiffness properties. Also the DiscBot, a robot which scans discs of wood from cut trees using X-ray, near infra-red and ultrasound technology to obtain a raft of data on wood composition and quality.

"We believe the market will become more discerning," says Dr John Moore, "and forest profitability is directly linked to processors' demands. If we can understand the drivers behind wood properties, ultimately it will give tree breeders and growers more options in matching genetics and silviculture to the site and desired wood properties."

MAKING THE MOST OF TREES IN MID-ROTATION

"Rather than fertilising to correct deficiency and bring up the tail-end of the forest, we are looking to boost the average. Hosting a trial adds to our knowledge about nutrient ratios and opportunities to improve them. We get a lot of value out of Graham [Coker]."

Craig Brown, Estate Manager, Nelson Management Ltd, host of a GCFF mid-rotation trial.

Traditionally, mid-rotation fertiliser applications have been based on testing levels of nutrients in foliage; convention states that nitrogen (N) levels below 1.2% indicate deficiency, and the recommendation has been to top-dress the forest with granular urea. However, tree nutrition and response to nutrients is complicated.

"Our new paradigm states that, if we know the N levels in foliage, we can determine what the level of phosphorus (P) and many other nutrients should be, and design fertiliser applications to remove nutritional growth limits. This is a big shift in our thinking," says Scion's Graham Coker.

The other big shift is that, instead of granular top-dressing, aerial liquid fertiliser application is being trialled. Liquid N applications to seedlings have resulted in a ten-fold reduction in cost of products for the same growth response as conventional granular urea.

Results to date suggest foliar applications of N and P in mid-rotation are more cost-effective than granules. Foliar applications also have significant environmental advantages, because most of the fertiliser reaches the target crop and little is lost to the soil or leached. Work is continuing on improving the cost-efficacy of site-specific foliar applications. Combining liquid fertiliser or plant stimulants with routine copper fungicide applications is one potential option.

"The time is coming when forest managers will be routinely testing soils pre-harvest, and testing foliage in the early years post-establishment and again in mid-rotation prior to fertilising," says Graham. "Site-specific fertiliser regimes will become the norm so growers can get the most from their land."

ENHANCING SEEDLING GROWTH WITH LESS RELIANCE ON CHEMICALS

Scion's Dr Simeon Smaill has been pioneering nursery treatments with reduced levels of fungicides and fertilisers for some years. Simeon's work has proved conclusively that lower chemical inputs in the nursery can increase the activity of the most beneficial mycorrhizal fungi, producing healthier seedlings with above average survival and growth rates.

The first 2,500 'low fungicide' seedlings grown in a trial at Timberlands Ltd Te Ngae nursery, Rotorua, were planted in Kaingaroa Forest six years ago; continued monitoring reveals an 8.2% basal area growth gain compared with standard planting stock. A subsequent trial at Scion's research nursery produced 10,000 low-input seedlings using only 50% of standard fungicides. These seedlings are now growing in five different forests and are following the same growth trajectory as the high-performing stock from the first trial. Simeon is working with ArborGen at their Tokoroa nursery to test this research at operational scales, which also includes the successful use of a novel nitrogen source and bio-stimulant to replace urea.

"I am confident that the simple adaptations to standard practices we have developed can be dropped into any plant nursery, reducing costs and producing better quality seedlings while using fewer chemicals," says Simeon.

In the next iteration of trials, small clusters of low-input seedlings have been planted into 46 sites around the country. Simeon is looking at interactions between seedlings and site. "The long-term game is to enable nurseries to produce designer seedlings which meet different site requirements."

'Low fungicide' seedlings n Kaingaroa Forest, at age 2. At age 6, these seedlings are showing an 8.2% gain in basal area compared with untreated stock.

THE ROLE OF UAVS IN FOREST MANAGEMENT

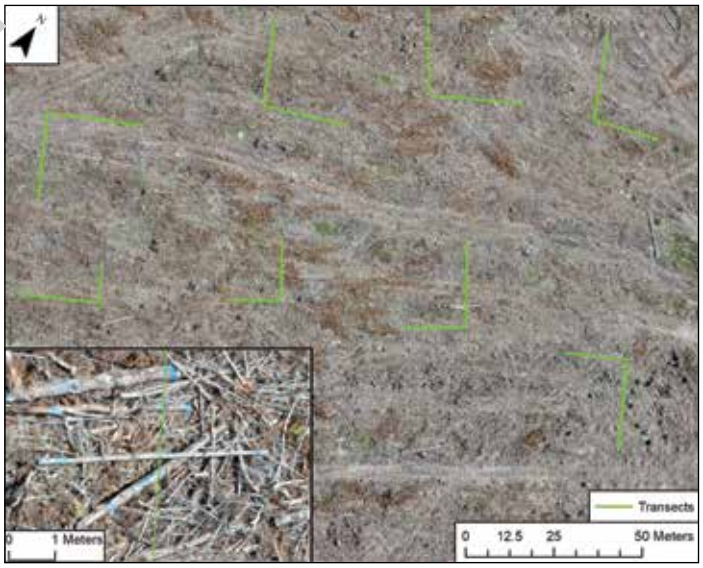
New UAV technologies and their applications in the forest are of interest to many forest owners. Scion's Dr Grant Pearse reviewed four potential UAV applications, using commercially available UAVs and sensors. He concludes that niches definitely exist for UAVs, especially for small-scale assessments unsuited to aerial or satellite techniques; however, the technologies are young and rapidly developing.

IMPROVING SMALL-SCALE FOREST INVENTORY USING REMOTE SENSING

Scion researchers are also investigating how to adapt LiDAR techniques, combine LiDAR and data from UAV mounted sensors, or use UAV mounted sensors alone, to produce accurate, cost-effective inventory data appropriate to small forests. The rapid development of UAVs and associated miniaturised sensors, including laser scanners, is exciting: however, challenges remain, including integrating the data into forest inventory programmes.

SUMMARY: UAVs in forest management

UAV application	UAV performance	Areas for improvement	Applicable in practice?
Cut-over detection and mapping	UAVs can repeatedly survey and monitor forest harvest operations by detecting and mapping the cutover edge.	Automated detection and tracking needs refinements to avoid tracking e.g. roads.	Yes, using manual flights
Post-planting survival	UAV imagery could be used to locate and count live, dead, and missing trees at 8 months post-planting. Also can provide information e.g. on weed cover, which managers may value.	Weeds can cause false detection and the method needs to be modified for site conditions e.g. mounded / un-mounded.	Proof of concept stage
Post-harvest waste assessment	Compared with traditional line transects on a ground-based harvesting site, the UAV-based assessment proved very accurate, both in terms of locating waste and making volumetric assessments.	UAV could not identify rot in individual stems left on site (but can assess sweep).	Proof of concept stage
Windthrow detection and mapping	High altitude flight was capable of accurately classifying windthrow areas and produced an output that can go straight into mapping software.	Counting individual stems requires further refinement.	Proof of concept stage



Waste assessment mapping. ▲
Windthrow mapping. ▶

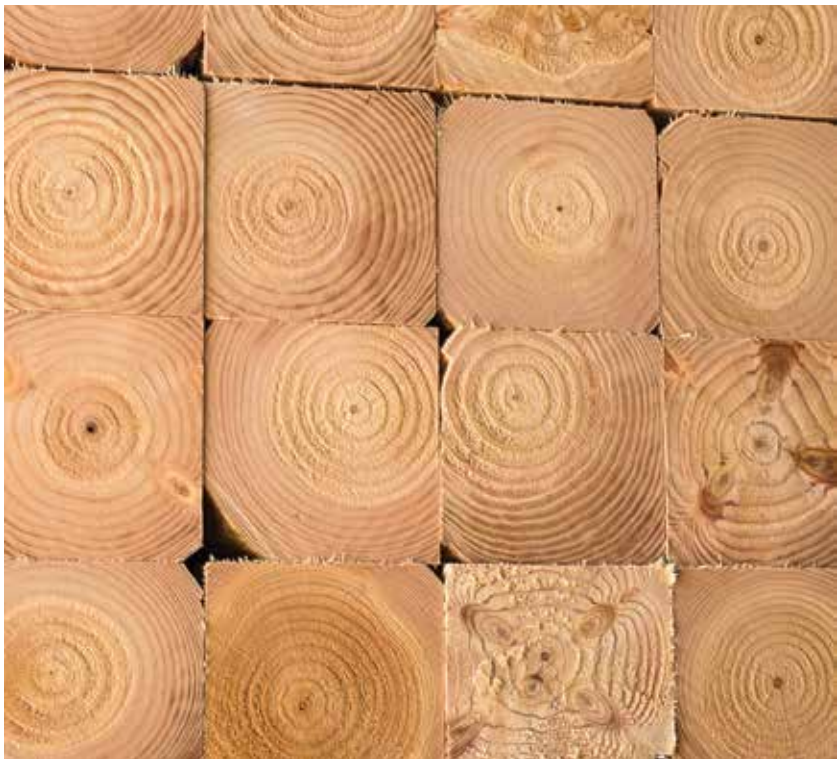
SCIENTISTS ON SECONDMENT

Much greater interaction between scientists and industry partners under the GCFF has led to several Scion researchers being seconded to forest management companies over the past couple of years.

"It benefits both parties," says Ian Hinton, Timberlands Ltd. "It helps scientists understand the industry's needs and how we use research, and it gives forest managers a way to bring research into their business. It's a win-win."

Some of the secondments are short, for information sharing or collaboration on a particular project. In contrast, Dr John Moore's has a two-year part-time role at Timberlands to meet a specific research need.

Dr John Moore.



RADIATA PINE AND DOUGLAS-FIR CALCULATORS REDESIGNED

Web-based calculators for radiata pine and Douglas-fir projections have been updated and simplified. The new versions have been designed with small-scale growers in mind and will be freely available on the FGR website.

The new calculators use the standard 300 and 500 indices for radiata pine and Douglas-fir respectively. The grower enters the forest location on a geographic interface, and can then explore the impact of different establishment and silvicultural treatments on responses such as growth and log yields.

Overall the project has greatly improved the usability of the calculators, and aligned their outputs with those of Forecaster, Scion's well-known forest management system for large forest owners.

"The NZFFA supports FGR research in areas such as harvesting innovations, and radiata pine growth modelling and site productivity, because it increases potential profitability for small-scale growers.

Updates to the radiata pine and Douglas fir calculators, and calculators for Eucalyptus fastigata, cypress, and redwoods, also are valuable for our members."

Neil Cullen, President, NZ Farm Forestry Association

"The GCFF is going from strength to strength. At Timberlands we made a conscious decision to take an active part – to put more in, and to get more out. Now we're starting to see some real benefits – for example, with LiDAR and nutrition, as well as genetics through the Radiata Pine Breeding Company."

Ian Hinton, Technical Manager at Timberlands Ltd, and chair of the GCFF Technical Steering Committee.

SUMMARY: KEY GCFF ACHIEVEMENTS TO DATE

Productivity gap characterised	Potential gains in productivity along with key limiting site resources identified and mapped. About 18%, 317,000 ha, of the existing radiata pine estate is significantly below its productivity potential. Site limitations can be mitigated and productivity increased by targeted management interventions.
Improving site utilisation by increasing stocking levels	Spatial models show conclusively that increasing the stocking rate in structural regimes will significantly increase productivity and profitability, with a forecast 25% increase in returns. Growers are adjusting regimes as a result.
Improving site nutrient use with mid-rotation fertiliser applications	Mid-rotation fertiliser applications will be more cost-effective thanks to new understanding of how nutrient balances in the soil affect tree growth; also through development of foliar nutrient application techniques. Workshops and videos on soil sampling delivered to industry.
Reducing chemical use and improving plant quality in forest nurseries	Costs and chemical use in the nursery can be significantly reduced while seedling growth and resilience improve. Adapting fertiliser inputs has also shown positive results. Several major forest nurseries trialling new regimes.
Using remote sensing to describe individual trees	Using LiDAR and other sensor technologies we can now describe individual tree characteristics: this is a key advance in our ability to phenotype forest trees and describe genetic expression.
Micro-coring to assess wood quality in young trees	New micro-coring technology has been designed to study the development of cells in the cambium of trees, and how this can vary according to a variety of experimental treatments and climate.
'Accelerator' trials: next generation trials established	Trials will show how fast radiata pine can be grown in different environments without compromising wood quality. This represents a highly valuable resource for addressing both the short and long term research questions. Six trials in total planned, three already established.
Innovation clusters – Product Quality, Productivity Enhancement, Sustainability, and Phenotyping	Unique 'co-innovation' approach involving researchers and industry partners to ensure shared understanding of issues and clear pathway to implementation of new knowledge. Regular meetings including workshops and site visits for information sharing.

https://gcff.nz Scion, Arborgen, Rayonier, Wenita, Timberlands Ltd, Nelson Forests Ltd, University of Canterbury.

GCFF is a six-year (2013-2019 inclusive) joint initiative between Scion, the forest growing industry and the Ministry of Business Innovation and Employment (MBIE). It has an average budget of $5.1 million per annum.

Social Licence to Operate

The forest industry needs a social licence to operate – that is, acceptance and approval by stakeholders and the wider public of the business activities of forestry along the whole value chain. Social and environmental research supported by FGR both through the Growing Confidence in Forestry's Future (GCFF) programme and a number of independent projects is essential to give the public confidence in our industry.

VALUING ENVIRONMENTAL AND SOCIAL BENEFITS OF PLANTED FORESTS

Valuing all the goods and services from forests over time – economic, environmental and social – is complex. The Forest Investment Framework model (FIF) is a spatial economic tool capable of doing just this.

In a recent project commissioned by Wenita Forest Products, Scion's Dr Richard Yao quantified the major ecosystem services of the Wenita forest estate, assessing four key elements: timber, carbon, avoided soil erosion, and recreational hunting. The FIF revealed that environmental and social values of the estate account for a greater share of overall values than timber sales. James McEwan, Wenita Technical Manager, says this was the first time Wenita had tried to value the non-timber benefits of its estate, and the process helped Wenita meet its FSC certification requirements.

"Ecosystem services are gaining a higher profile all the time, as forest owners, and regional and national authorities, look to include non-timber values in policy and planning," says Richard. "We are continuing to expand FIF, adding new functions to evaluate other important forest services such as nitrogen avoidance in waterways, recreation and biodiversity."

Wenita Forest Products (Ecosytems Services report), GCFF.

REDUCING THE RISK OF SEDIMENT IN WATERWAYS

Harvesting operations, if not carefully managed, can compromise water quality and biodiversity in forest streams and rivers. Research by Dr Kris Brown, University of Canterbury School of Forestry, has resulted in some specific guidelines to reduce risks of water and sediment run-off from harvest sites.

Kris visited 23 recently harvested forest blocks, looking for 'breakthrough channels' via which water and sediment were reaching waterways. On average, there were 3.4 breakthroughs per kilometre of stream, or one for every 6.5 hectares of harvest area. These frequencies compare closely with harvesting activities studied in the USA. Ground-based logging resulted in nearly twice as many breakthroughs as cable logging, and 73% of breakthroughs were associated with concentrated runoff from roads, trails, stream crossings, and machine tracks on hills.

Kris concluded that, for most operations, minor adjustments will result in significant gains. Careful planning of road location and gradient is the biggest factor, while other guidelines include:

- harvest planning to minimise tracking and stream crossings
- installing road drainage structures to control small amounts of water and reduce surface run-off velocity
- positioning road drainage structures to avoid direct and indirect discharges to streams.

The guidelines are already being communicated to harvesting crews by at least one forest company, with Kris contributing to a series of PF Olsen Ltd's environmental training workshops.

EXAMPLE: poor stream-crossing design

The road running to this stream-crossing approaches via a through-cut (i.e. cut slopes on both sides of the road), and road surface runoff is confined to the ditches until just before the crossing. Here runoff travelled for 144 metres in the ditches from the landing to the stream. Ideally, road-stream crossings should be designed to avoid through-cut approaches. Options for disrupting the ditch flow could include a series of rock check-dams in the ditches or sediment traps (e.g. a soak hole and/or slash bund) located at the ditch outlets.

University of Canterbury; forestry companies who facilitated the field work at the 23 different locations.

Forest Owners Association, FGLT.

RECOVERY OF FOREST WATERWAYS AFTER SEVERE STORM DAMAGE

Scion's Dr Brenda Baillie was in a unique position to assess the recovery of three streams in recently harvested catchments following a massive 2011 rainstorm. The streams are in Houpoto Forest, Bay of Plenty, managed by Hancock Forest Management NZ Ltd, and Brenda had completed her PhD studying the same streams. The 1-in-a-100 year storm initiated debris flows that scoured out the streams, devastating their aquatic life and riparian vegetation.

Brenda tracked the recovery of aquatic invertebrates and fish, and riparian vegetation. Overall, a reassuring picture of ecosystem resilience came through, although different components of the stream are on different recovery trajectories. Some fish and invertebrate species were back to at least pre-flood numbers after five years, but streamside vegetation was much slower to recover.

Recommended interventions to encourage stream biodiversity following severe storms, or if harvesting near waterways, include (i) retaining riparian vegetation, (ii) pro-active riparian re-establishment (e.g. seeding) and, (iii) if accessible, strategically adding woody debris to streams to create habitat and a food source for aquatic life.

Houpoto Forest stream (i) before harvesting (ii) after harvesting and debris flow (iii) five years later.

Scion, University of Waikato, Hancock Forest Management NZ Ltd, Nga Whenua Rahui, Pohe Environmental.

Scion, Hancock Forest Management NZ Ltd, Matariki Forests, PF Olsen Ltd, Forest Owners Association, Forest Growers Levy Trust, Bay of Plenty Regional Council.

WINNING AGAINST WILDINGS: NEW APPROACHES TO CONTROLLING WILDINGS SPREAD

A new 5-year MBIE-funded research programme to halt the spread of wildings is underway, led by Dr Duane Pelzer of Landcare Research.

"This is the first time we have had a truly integrated approach to wilding control. It wouldn't have been possible without funding from the forest industry," says Duane.

The total area of wildings in New Zealand now exceeds that of plantation forests, and is growing by at least 4% each year, so the work is urgent. Landcare Research will focus on invasion dynamics, wilding ecology and impacts, and catchment-scale effects of wildings. Scion will work on early wilding detection, wilding and plantation management, and developing sterile trees. The research team will work closely with the existing NZ Wilding Conifer Management Group.

Early gains have been made in wilding detection using remote sensing – in this case LiDAR combined with other aerial data. Scion researchers are now confident that they can detect wildings and distinguish small wilding trees from tussock and other scrub species. Detecting wildings early provides the best chance to control them before they start producing cones, exacerbating the spread.

Landcare Research, Scion, Lincoln University, University of Canterbury, Nanyang Technological University (Singapore), Department of Conservation, Ministry for Primary Industries, Land Information NZ, NZ Wilding Conifer Management Group.

MBIE Endeavour Fund, FGLT.

PUBLIC TRUST AND THE PRIMARY INDUSTRIES

One of the core elements of a social licence to operate is that people trust the industry and its spokespeople. In a new project, Scion researcher Dr Peter Edwards is aiming to develop an understanding of how people gain trust. This includes investigating what sources of information people use to form opinions about an industry, and, in doing so, whether and how people differentiate between different players – for example, different forest companies – and different sectors – for example, logging trucks and sawmilling.

Peter is collaborating with other researchers in New Zealand and Australia across all primary industries. The first element of the project will be an information-gathering survey, due to be reported on by the end of 2017.

Lincoln University, Plant and Food, Otago University, CSIRO, University of Tasmania.

Our Land and Water National Science Challenge.

Forest Health

FGR's Forest Health research has three main initiatives to protect New Zealand's trees from pests and diseases, and enhance national biosecurity:

1. reducing the impact of needle diseases in radiata pine and other tree species
2. developing low-impact techniques for the rapid detection and control of new pests in urban areas
3. bioprotection – using natural organisms to increase tree productivity and resilience.

KEY AREAS OF NEEDLE DISEASES RESEARCH

- **control:** identifying chemical control measures or other management techniques to control diseases in the short term
- **prediction:** understanding what factors, from stand management to the environment, influence infection and spread, and how to detect diseases as early as possible
- **host resilience:** longer term programmes, such as improving tree genetics, which will create resilient trees for the future.

Typical red needle cast expression.

COPPER PROVES EFFECTIVE AGAINST RED NEEDLE CAST

Red needle cast (RNC) is the most significant needle disease currently affecting some of New Zealand's radiata pine plantations. Red needle cast is a *Phytophthora* disease, so is part of a large group of pathogens that cause diseases such as kauri dieback and crown rot in apples.

An early success in the fight against RNC has been the discovery that copper is an effective treatment. This is good news for forest managers, many of whom already use copper in dothistroma spray programmes.

Small-scale trials have shown that RNC is controlled by copper. Dr Carol Rolando, Scion pest management specialist, is now working with Hancock Forest Management NZ Ltd on operational-scale trials to fine-tune some aspects of copper treatment regimes. The aim is to clarify optimal timing of copper applications: RNC generally strikes in winter, suggesting late summer/early autumn spraying. Unfortunately this doesn't coincide with the main spring dothistroma spraying.

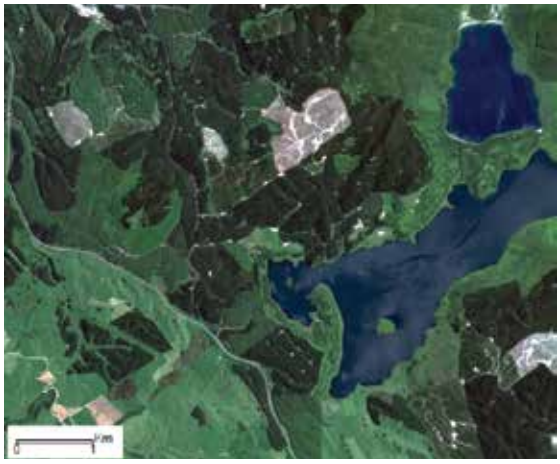
Copper is an environmentally benign chemical, with no harmful build-up in soil, litter or water. A cost-benefit analysis reviewing the known impacts of RNC on radiata pine growth versus the costs of applying copper will be completed in 2017.

NEW SATELLITE IMAGES IMPROVE DISEASE DETECTION AND MONITORING

Scion researchers are making rapid advances in using remote sensing to detect and monitor forest diseases. Satellite imagery in particular has the potential to cover very large areas, and hence be used as a tool for early detection of disease.

Scion's Dr Grant Pearse is working on surveillance of red needle cast, and is developing techniques for interpreting imagery from the European Space Agency's Sentinel-2 satellites. Sentinel-2 data is free, will have a 5-day return cycle, and is delivered at 10-metre resolution, providing spatial, spectral and temporal information. The downside is that large volumes of data must be processed.

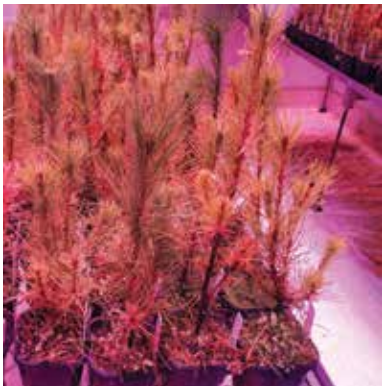
"We have been able to detect severe outbreaks of red needle cast," says Grant," and we are working on ways to map and monitor the disease. This will help us to bring a spatial dimension to our understanding of the disease in New Zealand."



Example of Sentinel-2 imagery, Whakarewarewa Forest, Rotorua.

Grant is also exploring the use of UAV data and conventional LiDAR to characterise disease impacts and expression at much finer resolutions. This will support future work exploring the effects of terrain and micro-climate on disease severity and expression.

In future, armed with both better monitoring tools and understanding of disease behaviour, forest managers will be able to target resources more effectively on disease management.



Seedlings inoculated with RNC in Scion's new fog lab.

Dr Nari Wiilliam checks for RNC symptoms, Kinleith Forest.

HEALTHY TREES, HEALTHY FUTURE

Healthy trees, healthy future
Enabling technologies to combat *Phytophthora* diseases

The Healthy Trees, Healthy Future research programme (HTHF) is a $10 million cross-sector programme studying *Phytophthora* diseases. HTHF leader, Scion's Dr Nari Williams, says research into red needle cast under the HTHF programme is already yielding results relevant to the forest industry.

"In the past year, we took about 500 grafted radiata pine out into Hancock Forest Management NZ Ltd's Kinleith Forest and screened them for disease. We had 44 different genotypes from selected lines, with parents that are highly represented in current seedlots. Having access to the Radiata Pine Breeding Company's controlled breeding populations is a real benefit for us.

"Luckily for us, RNC levels were high at the time. The trees were out there for about eight weeks, by which time they had high disease expression. We now have some useful early data to feed back to the industry about lines that look like they will be the best ones to grow."

HTHF researchers are delving into the fundamental science of *Phytophthora* host-pathogen interactions and disease resistance. Transferring this information into research on spray programmes could yield significant benefits. Next steps include taking infected tissues and investigating how the pathogens operate and interact with their hosts, and more research at gene level to increase knowledge about which genes make for a resistant host.

https://healthytrees.co.nz

Scion, Hancock Forestry Management NZ Ltd, Plant and Food Research, Massey University, University of Auckland, Landcare Research, Kia Toitu He Kauri, Radiata Pine Breeding Company.

Ministry of Business, Innovation and Employment, Ministry for Primary Industries, Pipfruit NZ, Forest Owners Association, Forest Growers Levy Trust , Radiata Pine Breeding Company, Kauri Dieback Programme.

THE URBAN BATTLEFIELD: PEST CONTROL IN URBAN AREAS

New insect pests are most likely to arrive in New Zealand via our seaports and airports, and initially establish in the urban areas close to these entry points. A multi-sector team is developing new methods of detecting and controlling pests in these sensitive areas. Their aim: that new insect pests are detected and controlled rapidly, cost-effectively, and with minimal disruption to local communities.

New biosecurity surveillance system introduced

The forest industry has made a significant financial contribution to the complete redesign of the forest biosecurity surveillance system. The new-look system is underpinned by a Government Industry Agreement (GIA). That agreement improves the forest industry's involvement in decision-making during an incursion, and its influence over the biosecurity system as a whole.

Some broad-scale surveillance of the national forest estate will continue under the new system, and importantly, the proportion of resources targeted at high-risk areas will increase.

Forest Biosecurity Committee member, Scion's Lindsay Bulman, considers the new system is a huge improvement. "The changes will mean earlier detection of pests and pathogens, and more emphasis on 'readiness' activities," says Lindsay. "More effort is going into looking for new pests of radiata pine and Douglas-fir in high-risk areas such as near ports, so the forest industry gets a much better bang for its buck."

TETHERED RING BOOM A PROMISING TECHNIQUE

A novel tethered ring boom, capable of target-spraying individual trees, has been tested by a team led by Scion's Dr Brian Richardson. The ring boom, developed by HeliResources, hangs well below the helicopter, and spray can be directed right into the target tree's canopy. Trials in the forest have included looking at effects on spray deposition of different tether lengths and spray droplet sizes.

Brian considers the tethered boom technique is viable for biosecurity operations, and overcomes a number of the practical problems associated with targeted spraying in urban areas.

"Current techniques either involve a second person in the helicopter using a lance, or a helicopter boom that has been adapted to spray from just a few nozzles. Neither technique is ideal; problems include getting the helicopter very close to the trees in urban areas, where there may well be access issues, and excessive downwash velocities from the helicopter."

The Scion team have some further ideas for stabilising the boom and providing the pilot with a better view of the target. Stefan Gous of HeliResources confirms that there is a lot of interest in the technology. "It is already being used in wilding control; we are now working on developing a new version of the ring boom which can be operated by any helicopter," says Stefan.

The tethered ring boom in action.

UAVS FOR PEST CONTROL AND DETECTION

Scion is working with UAV manufacturer Aeronavics as well as HeliResources to evaluate the performance of spray UAVs. These aircraft are capable of lifting 10-20 litres of spray; current research includes characterising the swath patterns produced under a range of operating conditions and, through Scion's collaboration with the US Forest Service, development of a UAV wake model.

While the current research is focused on urban pest eradication programmes, the technology will likely have broader applicability. Examples include pesticide application near sensitive areas including forest boundaries, and in small woodlots or smaller horticultural areas.

One of the most exciting and innovative aspects of the Urban Pest Control programme is developing UAV-based technology to actually detect pests. This entails a UAV fitted with a pheromone sensor – antennae which can pick up signals in the form of odours from the target insect.

Scion researchers have been working with French counterparts to develop the technology suitable for mounting in a small UAV. Similar sensors have been trialled in ground-based pest surveillance but this is the first time they have been tested as part of an aerial system. And although not yet operational, the work is evidence of the highly innovated approaches being investigated in this project.

INVOLVING URBAN COMMUNITIES

The Pest Control in Urban Areas project is developing new ways to involve urban communities, including Māori, in biosecurity.

"We are learning from the social scientists in our team just how much better we could be at talking to people, and addressing their concerns," says Dr Brian Richardson, Scion.

Melanie Mark-Shadbolt, Lincoln University and manager of the Māori Biosecurity Network, explains the problem. "Just because people are aware of something, doesn't mean they change their behaviour," says Melanie. "There are lots of examples of this – for example, kauri dieback and pest-free islands – where scientists and others have successfully raised public awareness, but no-one actually behaves differently to help solve the problem."

The solution lies in genuine community involvement, and ideally includes some co-design of pest surveillance and control activities. As a starter, the urban pest control team plan meetings with relevant urban communities where scientists will 'show and tell' some of the technology they use.

Scion , Will Allen and Associates , Auckland City Council, Eco Research Associates, LandCare Research, Lincoln University, Plant Protection Chemistry New Zealand, University of Canterbury, Centre National de la Recherche Scientifique, France, Institute of Ecology and Environmental Sciences, France, Forest Research, UK, US Forest Service, USA.

Programme Steering Committee and Partners: Ministry for Primary Industries, Department of Conservation, Greater Wellington Regional Council, Forest Owners Association, Māori representative (Ngāti Hine, Ngāti Whatua, Tainui), Pipfruit New Zealand, Kiwifruit Vine Health, HeliResources Ltd, Hammond Resource Management Ltd, Aeronavics.

BIOPROTECTION

Forest nurseries including PF Olsen Ltd and Timberlands Te Ngae Nursery are working with Dr Robert Hill, from the Bio-Protection Research Centre, Lincoln University, to produce inoculated radiata pine seedlings. The inoculant is *Trichoderma* – fungi that form natural endophytic associations with plant roots and enhance plant growth and resistance to disease. Robert's work has resulted in major productivity gains in tropical plantation forests, and is now being applied to radiata pine on a large scale.

Early trial results from applications of the *Trichoderma* endophytes in the nurseries show increases in seedling height and root biomass compared to untreated stock. The best endophyte treatments are being trialled at over 20 plantation sites, especially in areas with a history of serious losses from foliar diseases such as red needle cast and dothistroma. These trials are being monitored for establishment, mortality, growth and disease incidence and to date have shown 5 to 7% reduction in mortality, and up to 20% increase in tree height.

The most effective treatments will be made available to the forest industry, for example as a seed coating. They are predicted to add significant value to the industry both in terms of increased productivity and reduced chemical inputs.

PF Olsen Ltd, Timberlands Te Ngae Nursery, Juken NZ Ltd, Hancock Forest Management NZ Ltd, Nelson Forests Ltd, Rayonier

Forest Owners Association, Ministry of Business, Innovation and Employment, Bio-Protection Research Centre, FGLT.

Dr Robert Hill receives a NZ forest industry innovation award.

Specialty Species

FGR research on specialty species is managed by the Specialty Wood Products Research Partnership (SWP), and is currently focusing on Douglas-fir and both durable and non-durable eucalypts. Cypresses are also in the mix, but with less recent research activity. The SWP aims to create an industry generating $350 million of exports by 2030, providing regional opportunities for employment, Māori forestry and wood manufacturing.

DOUGLAS-FIR BREEDING: MEETING INDUSTRY OBJECTIVES

"I see this new breeding work as a game-changer. For the first time we are incorporating G x E [genetics x environment] responses into breeding, meaning we will have new genetics designed for regional deployment zones. There are huge gains to be made." Mark Dean, Forest Planner, Ernslaw One.

Douglas-fir breeding initiatives are being refocussed to meet industry objectives, with targets including a 35-year rotation, and yield of 600 cubic metres/hectare total recoverable volume without compromising form and stiffness. Two other sought-after traits identified are (i) needle retention, relating particularly to Swiss Needle Cast, and (ii) sterility – highly desirable because of the wildings problem.

Scion geneticist Dr Mari Suontama reports that a new generation of Douglas-fir seedlings has been established ready for field testing on three sites in 2018. The material includes non-tested genotypes from Ernslaw One and Proseed and provides potential selection material for the next generation. Genomic selection work is also underway, which will lead to more rapid deployment of improved tree material.

OEL made from Douglas-fir.

PROCESSING PROVIDES OPPORTUNITIES FOR LOW VALUE TIMBER

A new processing technique to produce Optimised Engineered Lumber (OEL TM) from both Douglas-fir and *Eucalyptus nitens* has been successfully trialled by Wood Engineering Timber (owners of the OEL technology) and Scion. OEL is a finger-jointed, laminated product for use in structural applications. It has the advantage of having known, uniform properties, and therefore can potentially be certified as structural grade. Logs as short as one metre can be processed, meaning OEL provides an opportunity to add value to highly tapered or swept logs that would otherwise go for export or pulp. The Prime sawmill site in Gisborne will become the home to the first commercial-sized modular OEL plant by late 2017, and will have the capacity to produce 50,000 cubic metres/year of OEL using radiata pine.

NEW EUCALYPTUS NITENS SEED ORCHARDS TO IMPROVE SOLID WOOD AND PULP PROPERTIES

Two new *Eucalyptus nitens* seed orchards have been established by Scion in collaboration with industry partner Southwood Export & Southland Plantation Forest Company (SWEL), after Scion geneticists identified the best genotypes to meet commercial improvement objectives. The germplasm originated from research funded by industry contributors and Scion.

One orchard will produce improved germplasm for solid wood, particularly focusing on reducing incidence of growth stress and shrinkage, while the other will provide germplasm for high-quality pulp.

> *"These orchards represent the next rung up the ladder – the fourth generation – of genetic improvement. We want to learn how to get more value out of our E. nitens crops, which we've traditionally grown just for pulp."*
>
> Graeme Manley,
> General Manager, SWEL.

DURABLE EUCALYPTS RESEARCH

The NZ Dryland Forests Initiative (NZDFI), part of the SWP, aims to establish a durable hardwood industry comprising 100,000 hectares of new plantations by 2050. The primary short-term goal is to produce large quantities of high-quality durable eucalypt planting stock. Research is focused on rapidly identifying superior trees on which to base a breeding programme.

Yanjie Li extracts a core from young *E.bosistoana.*

1. Measuring heartwood in young trees

Identifying trees with high heartwood and extractives content at a young age is a fundamental challenge for the NZDFI. Heartwood is the durable part of the stem, due to its extractives content, and so is essential in determining the value of future trees.

The University of Canterbury School of Forestry (UC) wood quality researchers worked with Callaghan Innovation to design a lightweight, battery-powered coring tool. The corer quickly extracts stemwood cores from eucalypt trees as young as six years old. PhD student Yanjie Li has extracted several thousand *E. bosistoana* cores from 99 families – trees of known genetic origin. *E. bosistoana* is highly durable, and one of NZDFI's selected species for breeding. Heartwood volume in the cores has been measured, and near-infrared spectroscopy (NIR) used to analyse the cores for extractives content.

Results show family differences in both heartwood and extractives content, indicating these traits are under genetic control – good news for NZDFI's tree breeders.

2. Family differences in insect pest tolerance

Huimin Li, UC PhD candidate, has assessed the susceptibility of *E.bosistoana* to insect pests, and also the impact of different levels of defoliation on tree growth. Huimin's results clearly show variation between *E.bosistoana* families in incidence and severity of pest damage, and could well provide a basis for breeding for pest tolerance.

In a related project, eleven durable eucalypt species were assessed for damage by a new insect pest, *Paropsisterna variicolis* – the eucalypt variegated beetle (EVB), which first appeared in New Zealand in 2016. Huimin found that, while all species were attacked to some extent, some individual trees from all species showed much greater tolerance than others. The least tolerant families had up to seven times the proportion of damage per shoot than the most tolerant ones. It is early days for this new pest, and a close eye will be kept on it over the next few growing seasons.

EVB larvae in NZDFI Hawke's Bay trial.

Adult eucalypt variegated beetle EVB *(Paropsisterna variicollis).*

EVB larvae and suspected parasitized eggs.

> *"The work on ground durables is so important in the context of what is happening in world timber markets. Science is the backbone of our forestry and vineyard industries and we must continue with it in the face of all the challenges. I just wish all this work had happened 50 years ago."*
>
> Clive Paton, Ata Rangi vineyard owner and farm forester.

The *Specialty Wood Products Research Partnership* (SWP) is a seven-year, $14 million industry/government partnership which began in 2015.

SWP members: Ministry for Business, Innovation and Employment, Forest Growers' Levy Trust, Southwood Export & Southland Plantation Forest Company, Juken NZ Ltd, Proseed Ltd, Ernslaw One, New Zealand Farm Forestry Association, Timberlands Ltd, Lake Taupo and Rotoaira Forest Trusts, Te Tumu Paeroa, Blakely Pacific Ltd, City Forests Ltd, Marlborough Lines, Vineyard Timbers Ltd.

SWP research organisations: Scion (who also bring aligned core funding), University of Canterbury, Marlborough Research Centre.

3. Eucalypt propagation advances

Proseed Ltd is New Zealand's major tree seed supplier and a member of the NZDFI. Staff at Proseed have developed novel eucalypt propagation techniques in a new facility at their North Canterbury base, enabling them to root cuttings taken from selected *E. bosistoana* coppice. Two seed orchards of NZDFI species *(E. bosistoana* and *E. quadrangulata)* have also been established at Proseed, and are anticipated to begin flowering soon.

Thus, a critical link in the chain of rapidly generating large quantities of improved planting stock for growers is moving into place.

Steepland Harvesting

The seven-year Steepland Harvesting programme, managed by Forest Growers Research, has been extremely successful in developing new technologies for harvesting on steep terrain in New Zealand. A total of eight new technologies are at various stages of commercialisation; several are already in use in harvesting operations. When fully implemented, the programme will achieve savings of $8 per cubic metre of wood harvested, much safer working conditions, plus machinery sales from New Zealand companies.

TECHNOLOGIES DEVELOPED

The first machine that the programme supported was Trinder Engineering's ClimbMAX Steep Slope Harvester, which has led to a range of other winch-assisted machines replacing manual fellers on the slope. There are now about 65 winch-assisted machines operating in New Zealand, which has driven the increase in mechanised felling from 23% of operations in 2009 to over 50% in 2016.

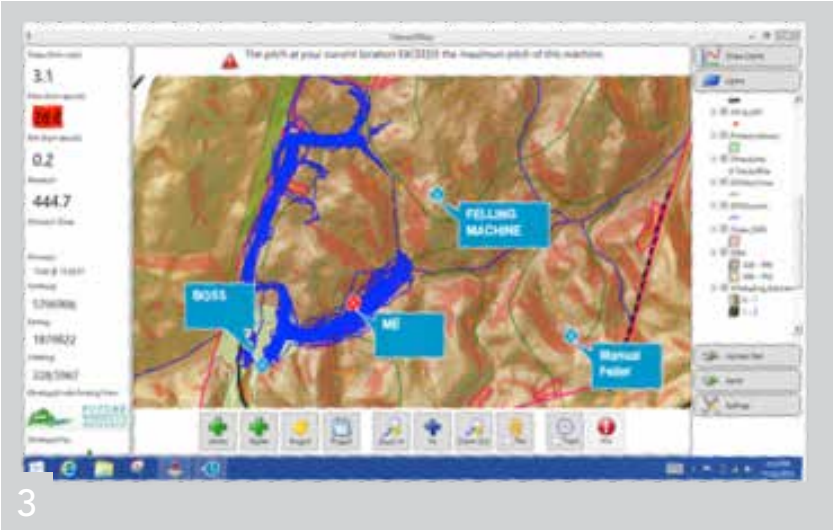
Subsequently a whole suite of new machinery and tools has emerged, all of which contribute to improving productivity and safety of steepland harvesting.

1. Alpine Grapple Carriage (Logpro Ltd) – eliminates manual breaking out, one of forestry's most dangerous jobs.
2. Teleoperated John Deere 909 feller buncher and mobile tail hold machine (Applied Teleoperation Ltd) – no worker on the slope, machines are operated remotely.
3. HarvestNav machine navigation system (Margules Groome Consulting Ltd) – teleoperated felling incorporating machine slope warning system.
4. CutoverCam hauler vision system (Applied Teleoperation Ltd) – gives the hauler operator full vision of breaking out zone.
5. Skyshifter tail hold carriage (Awdon Technologies Ltd, prototype) – reduces manual skyline shifting – a time-consuming and dangerous job.
6. Doherty Automatic Quick Coupler (Doherty Engineered Attachments Ltd, prototype) – rapid switching between processor head and loading grapple – enables efficient multipurpose use of a single machine on the skid.
7. Prototype robotic Tree-to-Tree felling machine (Scion and the University of Canterbury). Demonstrated as proof-of-concept in September 2016.


1

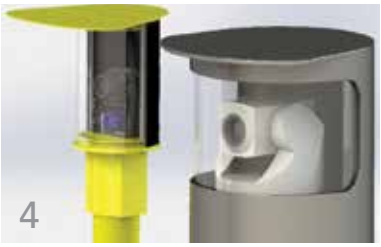

2


2



3


3


4


5


6


7

COMMERCIALISING THE NEW TECHNOLOGY

Over the last year FGR has engaged a commercialisation team, led by Geoff Todd, to help deliver the new products to market. "Engineers focus on designing and building things, whereas our role is all about people and delivery," says Geoff.

Each of the technologies is at a different stage of development and commercialisation. Both the ClimbMAX harvester and Alpine Grapple Carriage have already been adopted by the harvesting industry but several of the other technologies need business development support.

The new HarvestNav was ready to go to market: in this case the commercialisation team helped with aspects such as licensing and IP.

In contrast, the CutoverCam and the teleoperated tailhold and feller buncher are at manufacturing prototype stage. They have been bundled together into one start-up company, 'Applied Teleoperation Ltd', with the engineers becoming the shareholders.

The commercialisation team has helped set up the company, and raise capital. They will now work with them to raise more capital and launch all the products in New Zealand before taking them to overseas markets. Interest has already come from prospective investors in New Zealand and overseas, in Chile, Canada and the USA.

The Skyshifter and Automatic Quick Coupler are both at earlier stages of development and testing, and each will require different assistance again.

> *"Raising capital is a crucial part of the process. You need money to establish off-shore sales channels, and to attract investors. Capital investment means commercialisation can go a lot faster."* Geoff Todd, commercialisation specialist.

The ClimbMAX Steep Slope Harvester (Trinder Engineering).

TECHNOLOGY FOR SMALLER FOREST OPERATIONS: WANGANUI FIELD DEMONSTRATION

A field demonstration was held in Greenoch Forest near Wanganui, as part of the April 2017 NZ Farm Forestry Association annual conference. Around 60 delegates saw a full range of the new harvesting technology in action.

Farm forester Dougal McIntosh, who has already undertaken several harvests on his own steep land, was delighted with what he saw. He acknowledges the major effort needed by the FGR Steepland Harvesting team in setting up and running the demonstration.

"This is our levy in action. The speed at which this technology is developing is exciting, and the great thing is, it's all New Zealand-driven. I was particularly impressed with the Skyshifter and how this will speed up operations and take people off the slope. What we saw was only an early prototype – the potential is huge."

A second field demonstration was held at Gammons Forest in the Bay of Plenty in June as part of the HarvestTECH17 Conference. The third and final demonstration of the outputs of the Steepland Harvesting Programme was held in Moutere Forest, Nelson in August. FGR acknowledges the support of all the forestry companies and contractors involved in these field demonstrations.

"This work is hugely relevant to farm foresters, because the bulk of our forests are on steep country. Not all of the developments are suitable for smaller forests, but some definitely are. They will speed up harvesting operations, make smaller gangs more viable, make the work safer, and make us more competitive with lowland forests."

Dougal McIntosh, Wanganui farm forester.

The Steepland Harvesting Programme is a Primary Growth Partnership between the Ministry for Primary Industries and the forest industry. The programme is an alliance between the government, forest owners, engineering companies, research providers, and harvesting contractors. Total funding is $7.6 million ($3.9 m from the forest industry, $3.7 million from government).

The FGR demonstration at Greenoch Forest, Wanganui.

Paul Milliken of Applied Teleoperation Ltd demonstrates the new model CutoverCam at the field demonstration in Gammons Forest, Bay of Plenty.

THE AUTOMATIC QUICK COUPLER: INCREASING MACHINE EFFICIENCY IN SMALL FORESTS

One new tool of particular relevance in smaller-scale harvesting operations is the Doherty Automatic Quick Coupler. This device enables rapid change-over of attachments, without the operator leaving the cab – for example changing a processing head to a log loading grapple. Using the Quick Coupler means, in lower production operations, only one base machine is required to do the log processing and loading, resulting in lower capital machinery costs and much more efficient machine use.

The Quick Coupler is ideally suited to small-scale operations where production is often limited due to difficult conditions, where there is spare capacity of the processor, or where small skid sites make it difficult for a separate processor and loader to operate. Workshop testing has been completed and it will be deployed for forest testing later in 2017.

Fire Research

Government and forest industry-funded fire research in New Zealand is led by Scion's fire research scientists. The Scion team has 25 years' experience of collaborating with national and international scientists, fire authorities and land-owners. Cutting-edge research is being applied in fire-prevention tools for forest owners as well as the worst-case scenario of fighting forest fires.

FIRE ACTIVITY TRIGGERS UPDATED

In a pilot project in Nelson and Marlborough, the Scion fire research team have collaborated with Waimea and Marlborough-Kaikoura Rural Fire Authorities and the local forest industry to update the trigger levels used in fire guidelines for forestry operations.

The work was part of a Strategic and Tactical Fire Management Planning process led by the Rural Fire Authorities. The forestry operations fire guidelines were developed over 20 years ago and are based around the national fire danger rating system. As well as updating the trigger levels, the team improved the guidelines associated with these. They have also developed new activity triggers for other spark-hazardous operations such as roadside mowing, welding and metal cutting.

"The new guidelines will enable managers to better manage fire risk," says Andrew Karalus, Estate Value Manager with Nelson Management Ltd, and part of the project team. "They encourage a change in communication culture, with more good information to help decisions on fire risk management made available to each crew much earlier in the piece. They also allow for a more site-specific approach when fire risk increases."

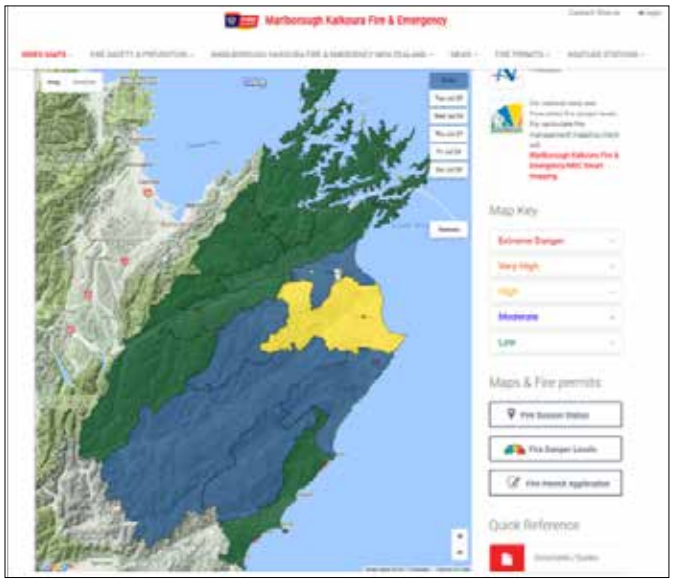
> *"The collaboration between forest managers, with their practical know-how, and the Scion team, with all their experience and scientific knowledge, was really beneficial. We fed off each other."*
>
> Andrew Karalus, Nelson Management Ltd.

The success of the pilot project has led to the new system being rolled out nationwide, incorporating regional adaptations based on differences in fire climate. Activity restriction triggers and how they are applied is of increasing interest to forest insurance companies, keen to ensure forest owners are not taking any undue risks.

NEW FIRE RISK WEBSITE LAUNCHED

A new fire risk website is available at https://fireweather.niwa.co.nz/. This new Fire & Emergency New Zealand (FENZ) national fire risk mapping system was based on the activity triggers pilot study for the Nelson/Marlborough region, and the website was developed by the Marlborough-Kaikoura Rural Fire Authority. The website clearly displays fire risk information, and is suitable for the public, forest managers and other users (e.g. roadside mowing contractors, power supply companies).

▶ Marlborough-Kaikoura RFA area website (now part of FENZ) fire risk index/fire danger levels page http://www.mkrfa.com/index-maps/fire-risk-index/



OPERATIONAL SUPPORT FOR THE PORT HILLS FIRES

Scion's fire research team have the skills and tools to play a vital part in fire-fighting operations. As a result, they have been embedded in the incident management teams in several recent major fires, including the February 2017 Port Hills fires on the outskirts of Christchurch.

"During the Port Hills fire, we provided fire behaviour support as part of the incident management team. We were involved in daily planning meetings and briefings, and our information was incorporated into operational fire-fighting decisions, including decisions about evacuations and lifting of cordons. Applying hard science helps take the emotion out of decisions like these," says senior fire scientist Grant Pearce.

At the heart of Scion's operational toolkit is 'Prometheus', a sophisticated fire modelling tool developed in Canada. Prometheus has been refined utilising data from research by the Scion team into fire behaviour in New Zealand conditions. Prometheus models critical aspects such as fire intensity and speed of spread under the prevailing fuel, terrain and weather conditions. The data is applied spatially to produce maps of where and how fast a fire is likely to travel across the landscape. Even once the Port Hills fire was contained, predictions for likely flare ups or 'break-outs' continued to be made for several more days. These were based on locations of remaining areas of active burning determined from drone-based thermal 'hotspotting' and up-to-the-minute localised weather forecasts.

The charred Port Hills landscape following the 2017 fires.

Active involvement in real wildfires allows the Scion team to see how well their tools and models work under operational conditions, and to collect more data to validate and improve them. The team can also reconstruct past fires – such as the three forest fires in Marlborough in 2015 that burned over 2000 hectares – to gain a detailed science-based understanding of what happened and why, and how well they were predicted by current models. This not only contributes to post-fire inquiries, but feeds into future fire prevention strategies as well.

NEW FIVE-YEAR EXTREME FIRE RESEARCH PROGRAMME UNDERWAY

A new five-year $8.75 million MBIE and industry-funded Extreme Fire research programme is underway, and will bring together an international team of fire experts including the Scion fire research team. New research under the programme aims to:

1. **Create a new fire spread model:** extending the science of extreme fire behaviour by testing a new theory around heat transfer at the fire front by turbulent convection processes. To include running highly instrumented experimental burns in a range of fuel types, from crop stubbles to wilding pines.
2. **Develop innovative decision support tools:** linking and automating several satellite and ground-based modelling tools into one real-time system. Will provide much improved fire detection, fire growth prediction, and smoke modelling, and hence greatly assist fire response.
3. **Investigate new fire-fighting tools and technologies:** developing new response technologies to prevent and suppress extreme fires, including UAVs, smart thermal sensor networks, and enhanced (potentially robotic) fire-fighting tools and equipment.
4. **Prepare communities for extreme fire:** developing strategies and methods for protecting important ecosystems, assets (e.g. forestry) and communities from extreme fire.

Scion, US Forest Service, San Jose State University, University of New South Wales, Canterbury University, Alberta Agriculture and Forestry (Prometheus), Tait Communications, The Nature Conservancy, Lincoln University, rural fire authorities.

Ministry for Business, Innovation and Employment, Scion core funding and fire stakeholder co-funding, including the Forest Growers Levy Trust, NZ Fire Service/National Rural Fire Authority (now FENZ), local government, Department of Conservation and NZ Defence Force.

www.scionresearch.com/science/managing-forestry-risk-and-climate-change/rural-fire-research, ruralfireresearch.wordpress.com/ (still under development).

FOREST GROWERS RESEARCH MANAGEMENT

Russell Dale
Research & Development Manager

Veronica Bennett
Office Manager

FOREST GROWERS RESEARCH BOARD

Steve Couper
FGR Chairman
Ernslaw One Ltd

Peter Berg
FGR Director

Barry Murphy
FGR Director
PF Olsen Ltd

FOREST RESEARCH COMMITTEE

Phil Taylor
Chairman
Port Blakely Ltd NZ

Mike Baker
Hancock Forest Management (NZ) Ltd

Grant Dodson
City Forests Ltd

Angus Gordon
NZ Farm Forestry Association

Ian Hinton
Timberlands Ltd

Glen Murphy
Independent

Jason Syme
Matariki Forests

SCIENCE LIAISON

Alison Stewart
Scion

PROGRAMME STEERING GROUPS

Steepland Harvesting

Russell Dale
Chairman
Forest Growers Research

Robert Miller
Ministry for Primary Industries (MPI)

Stuart Anderson
MPI

Steve Couper
Ernslaw One Ltd

Speciality Wood Products

Peter Berg
Chairman

Russell Dale
Forest Growers Research

Russell Burton
Scion

Phil de la Mare
Ernslaw One Ltd

Angus Gordon
NZ Farm Forestry Association

Dave Hilliard
Juken New Zealand Ltd

Bruce Manley
University of Canterbury School of Forestry

Graeme Manley
Southwood Export Ltd

Alison Stewart
Scion

Shaf van Ballekom
Proseed New Zealand Ltd

Jez Weston
Ministry of Business, Innovation & Employment

TECHNICAL STEERING TEAMS

Steepland Harvesting

Russell Dale
Chairman
Forest Growers Research

Dylan Foster
Juken New Zealand Ltd

Joseph Graham
City Forests Ltd

Sam Keenan
MPI

Hamish Macpherson
PF Olsen Ltd

Don McMurray
NZ Forest Managers Ltd

Tim Petro
Ernslaw One Ltd

Keith Raymond
Forest Growers Research

Mike Soper
Rayonier | Matariki Forests

Barry Wells
Port Blakely Ltd NZ

Ian Wilson
Interpine Forestry Group

Speciality Wood Products

Marco Lausberg
Chairman
Forest Growers Research

Mark Dean
Ernslaw One Ltd

Shaun Foster
Southwood Export Ltd

Marika Fritzsche
Timberlands Ltd

Sean McBride
Juken New Zealand Ltd

Dean Satchell
NZ Farm Forestry Association

Brendan Smith
Juken New Zealand Ltd

Growing Confidence in Forestry's Future

Ian Hinton
Chairman
Timberlands Ltd

Peter Oliver
City Forests Ltd

Simon Papps
Hancock Forest Management (NZ) Ltd

Aaron Gunn
Port Blakely Ltd NZ

Paul Adams
Rayonier | Matariki Forests

Biosecurity/Forest Health

Ian Hinton
Chairman
Timberlands Ltd

Bill Dyck
Bill Dyck Ltd

Mike Baker
Hancock Forest Management (NZ) Ltd

Paul Stevens
Ministry for Primary Industries (MPI)

Mark Forward
Nelson Forests Ltd

Wei-Young Wang
PF Olsen Ltd

Nigel Heron
Timberlands Ltd

ACKNOWLEDGEMENTS

FGR acknowledges the input of all research providers, industry supporters, and others who contribute to our world-class programme of forest research.

FGR also thanks researchers and others for use of photos and images in this report. Special thanks to Phil Taylor, Forest Research Committee Chairman, for additional photos, including cover and inside cover photos.

FGR Forest Research Report 2017
Production by Harriet Palmer

Graphic design by Sue Turvey,
One by One Design

Printing by
Greenlees Print