2013 Annual Science Report

FUTURE
FORESTS
RESEARCH

www.ffr.co.nz

Phil Taylor – Chairman

Today's forest industry has been shaped by past research endeavours in all aspects of forestry – from tree breeding and forest growing, to harvesting, transportation and processing into final products. The protection of our forest estate from fire, pests and disease is heavily dependent on a well-resourced research infrastructure. This world class research capability is one of the reasons why our forest industry has attracted international capital investment to New Zealand's shores.

Great research has built this industry to where it is today. We have a responsibility to ensure that this effort continues. This means we must continue to invest in the pursuit of new knowledge to answer the hard questions that will enable this industry to prosper and contribute to New Zealand's economic and social wellbeing.

FFR has taken this responsibility seriously over the last six years. Our research programmes have been developed to help answer some of the hardest questions facing the industry today, so value can continue to be delivered to forest owners and the nation in the future.

FFR was established by the forest industry and Scion as a collaborative venture in 2007. At that time, FFR set six challenging objectives. Foremost amongst these objectives was the need to improve industry leadership of forest growing research and to strengthen the level of engagement between researchers and end users to ensure more focused research and better uptake of outcomes. It was recognised as being critically important that R&D should be defined by and developed for the broadest range of end users across the forestry sector. We have made an increased effort over the past year to engage with a wide range of stakeholders.

One of the key driving forces behind setting up FFR was to improve technology transfer. Research in itself will not deliver outcomes that improve the profitability and sustainability of our forests and forest lands. It is the application of this research that generates gain. To this end FFR has focused a great deal of time and attention to delivering the outputs and organising research and technology transfer activities on a more commercial and professional basis.

From the start, a key objective for FFR was the need to set high standards of governance, which is absolutely critical given the significant investment of industry and government funds. The sixth and final objective set when FFR started back in 2007 was that of advocacy. To be the body that advocated for forests and forest research across both the private and public sectors.

In his overview on page 4, Russell Dale reports on how have we done against the broad objectives set when FFR was formed.

Future Outlook

FFR's role as the key R&D manager for the forest growing sector is coming to an end. While this will not be the final communication from FFR to members, it is important to provide all our stakeholders with an update on significant changes that will be occurring in the R&D sector over the next 12 months.

Proposed changes to industry structures for organising research will result in a new entity to manage R&D under the new Forest Growing Levy Trust Board. The introduction of a compulsory levy to support industry good activities is a positive step by the forest industry. It will provide greater certainty of funding for activities such as R&D. This will result in the transfer of many of the functions of FFR to this new entity and the likely winding up of FFR in early to mid 2014.

The Board of FFR has always supported the need for the efficient delivery of research. To this end we recognise that the R&D prioritisation, funding and delivery is likely to change under the levy environment and that FFR, in its current form, may not be the best vehicle to take the industry forward. As R&D development and delivery heads in a new direction, FFR will actively support the transition to a new entity while applying attention to ensure the interests of all its members are protected and enhanced where possible.

Russell Dale, CEO (left) and Phil Taylor, Chair

Acknowledgements

FFR has been exceptionally well served by dedicated, skilled and committed people. Special mention must go to our theme leaders; Mike Riordan, Kit Richards, Patrick Milne and Keith Raymond and to Veronica Bennett, our extremely capable administrative assistant, all ably led by CEO Russell Dale. Without the hard work of these people, FFR would not have been able to deliver the R&D programmes to our investors that it has.

My thanks also go to the Board members (pictured on page 24). They have contributed their time voluntarily to make sure the industry's collective interests are protected and enhanced. They have all acted with a high degree of integrity and professionalism, acknowledging without question that they have a role to serve the interest of all members.

Also, we should not forget the critically important role that all our research providers have played, especially Scion and their equally committed staff. Scion's scientists have worked closely with our theme leaders. A large degree of the success we have built within FRR has been as a direct result of the partnerships that have been built up between our researchers and industry.

Our vision has been to ensure a prosperous future for New Zealand's plantation forest industry through innovative, well focused research of a world class standard. Through the lessons learned and bridges built over the past six years, we are confident that this vision will be continued. We wish to thank everyone who has worked so hard to ensure the success of our collective efforts and to uphold the value of research as an integral part of the industry's prosperity.

In conclusion, I challenge those who will manage the organisation that succeeds FFR to ensure that all the good features of FFR and people who have committed and served so well are not lost to the industry.

Russell Dale – CEO

Over the past six years, FFR has succeeded in promoting improved efficiency in research management to the forest industry. It has not always been plain sailing. Research results cannot be produced one day and adopted the next. Forest managers and scientists operate in different worlds that present vastly different challenges. FFR has facilitated better communication and mutual understanding so we can all work together for the good of the industry. The resulting outcomes, summarised in this report, offer benefits that are significant, long lasting and far reaching.

The research results from the last six years will go a long way towards replenishing the research capital that has served our industry so importantly for the last century. Without reinvestment in research we run the risk of depleting this capital and slowly eroding the competitiveness and sustainability of our industry.

Industry leadership of research programmes has grown considerably through the efforts of the FFR Board of Directors, FFR management and, in particular, our Technical Steering Teams. Industry people with knowledge and skills in the particular research fields have provided the direction and guidance needed to ensure the success of the programmes. The collective contribution of time by industry people on these steering teams over the course of the programmes (estimated to be over 400 man days) is a very significant in-kind investment by the sector.

Enhancing engagement between researchers and industry has been a focus and strength of FFR. This has occurred at all levels: strategic, tactical and technical. FFR has been successful in achieving this through: twice yearly member meetings where research results have been presented, often in a field setting; regular workshops and member updates. These meetings have become a highlight for many participants, enabling meaningful two-way communication between industry members and researchers.

We have seen participation by forest owners from the largest companies to the smallest, regional councils, education providers, industry consultants, advisers and service providers to the industry. All have increased awareness of the very important role that R&D plays in industry success. FFR has also engaged with Ministers and officials to ensure the importance of industry R&D is recognised at Government level.

A professional approach to research management has resulted in a focus on programme planning, identification of programme deliverables, and good contract management. The commercial approach adopted by FFR from its inception has been a real strength in terms of improving research delivery to end users.

As a company responsible for wisely managing government and industry funds, the FFR Board has adopted a high standard of governance practice. This, in turn, has given investors in FFR research programmes, the Government, and industry members a high level of confidence in the management of the research programmes and the integrity of our financial management.

Through strong advocacy for the forest sector, both central and regional governments are far more engaged and aware of the challenges our industry faces and at the same time the opportunities that our industry provides the country. Integrated land use planning tools have allowed us to demonstrate to local authorities the real value that forests provide in the landscape. Our flagship steepland PGP harvesting programme is widely recognised by the Government as a success story. It has been identified by our industry as one of the key R&D developments that will help answer some of the very real challenges facing our industry in the health and safety area.

We are very proud of what has been achieved during the six years that FFR has operated. We hope that many of the features of FFR that have, without question, added significant value to its members will be incorporated into the new industry organisation that emerges.

Radiata Management

New Zealand's commercial forestry success has been achieved through continuous refinement and intensification of radiata pine management. In recent decades, improved genetics and silvicultural practices have driven measurable gains in radiata pine productivity, up to 30% on some sites. Building on this tradition of improvement through refocused research efforts, FFR has opened the door to more breakthroughs in the way trees are grown for commercial production.

New tools and technologies have been delivered to help forest managers improve tree growth, wood quality and end product performance. Beyond these immediate results, achievements within the Radiata Management theme offer potential to transform the way planted forests are managed in New Zealand.

Over the past six years FFR has made a major contribution to building the bridge between science and industry that is needed to see this potential realised.

# Modelling growth and quality

Tree growth modelling

FFR has put more information in the hands of forest managers by delivering the following improvements through the FORECASTER modelling system:

- A reliable national model for radiata pine growth projection and yield estimation (300 Index) completed by Scion.

- An improved national wood density model and wood stiffness model (MOE) developed by Scion. This FORECASTER upgrade includes growth and wood property algorithms that describe spiral grain, microfibril angle, biological metrics such as Stand Density Index, juvenile core extent and carbon allocation.

- Addition of *Eucalyptus fastigata*, redwood, Douglas-fir and cypress growth models to enable silvicultural planning, reporting and economic analysis of alternative species.

- The stability of FORECASTER and its functionality from a user's perspective has been greatly enhanced over the past two years making it a more effective framework for deploying science in a usable form.
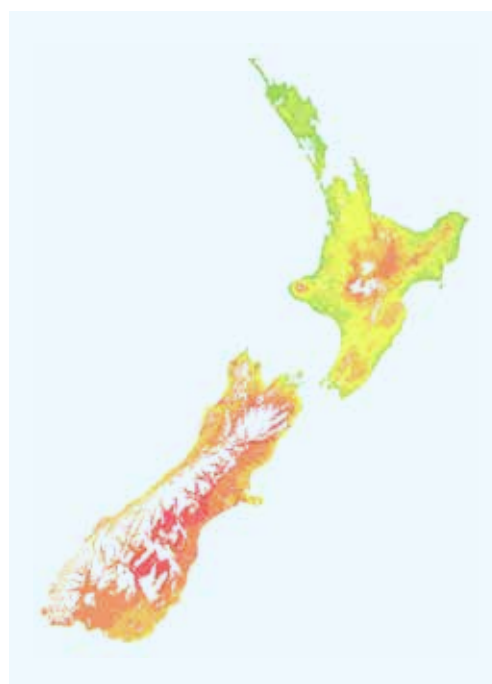
Easier access to forest information

Spatial "surfaces" enable a wealth of forest information to be delivered in a usable form. Scion has produced national "surfaces" of radiata pine productivity in terms of both site index and the 300 Index. These surfaces can be downloaded by forest managers into their GIS system to assist with analysis and planning.
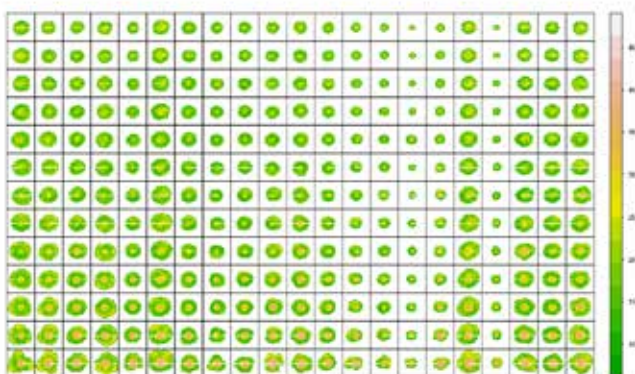
Understanding wood formation

Scion has developed a mechanistic model to study the processes involved in tree growth and wood formation. Because of the long growing cycles involved in forestry, it is important that forest managers have tools that enable them to understand what the intended and unintended consequences of their actions are in terms of wood quality. Such knowledge will help them make better decisions about the management of future crops.

Predicting end-product performance

Scion has developed novel ways of measuring and characterising wood properties. This industrialised process for sampling wood properties has radically decreased the cost of data collection, while at the same time providing data with improved resolution. This technology provides an objective way of accurately mapping the wood properties within any given stem which can then be used to predict end-product performance. The fundamental knowledge gained through this research enables forest managers to quantify the impacts of their decisions, not only in terms of volume and log grade outturn, but also in terms of the quantity and performance of end products.

Image: Debbi Thyne

Remote sensing
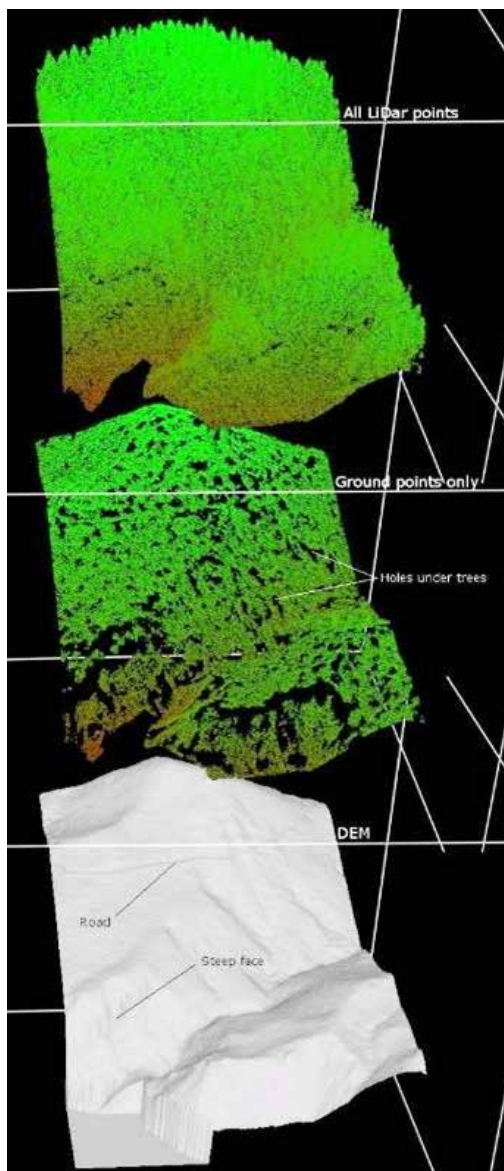
LiDAR takes hold

FFR has taken remote sensing technologies from an academic possibility to a practical reality. A workshop held by FFR in 2010 introduced the concept of using airborne LiDAR to create digital terrain models for harvest planning and forest inventory. Since then, the technology has been evaluated, technical specifications have been developed and uptake by the industry has been rapid. Timberlands Ltd is planning to acquire LiDAR coverage for the entire 180,000 ha estate that they manage and to update their yield tables using methodologies developed by Scion through research funded by FFR.

RapidEye adopted

FFR-funded research shows that satellite images produced by RapidEye offer another cost effective option for forest inventory and disease assessment. Scion and Indufor have evaluated the technology and developed a toolkit so forest managers can immediately put this technology to use.

Sharing knowledge

The speed at which industry has adopted new remote sensing technologies is a major achievement. The formation of working groups that include scientists and forest managers has been an important contributor to this success. FFR, working with Scion, has run industry workshops to demonstrate new options of using aerial photography, LiDAR, and satellite imagery. These workshops bring together users, researchers and technology suppliers to conduct practical training and explore new possibilities. These developments represent a step-change in forest information management.

Modelling productivity

New tools and knowledge enable site-specific management of radiata pine to improve productivity and environmental outcomes.
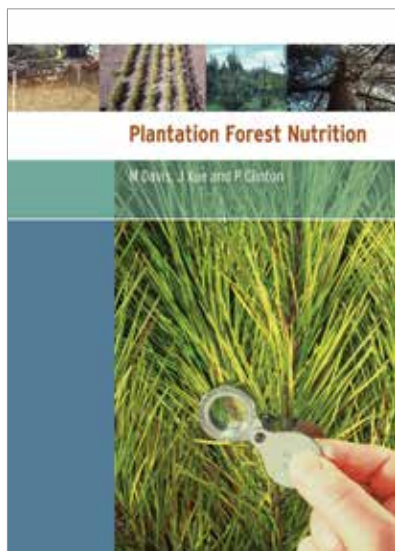

Forest nutrition manual published

FFR made Scion's latest knowledge of forest nutrition available to forest managers by publishing a comprehensive manual.

Nitrogen leaching in production forests

The science to describe and quantify the role of forests in nitrogen leaching has been delivered by Scion. With increased focus by regional councils on nitrogen leaching and water quality, this science will make a valuable contribution to decisions and policy.
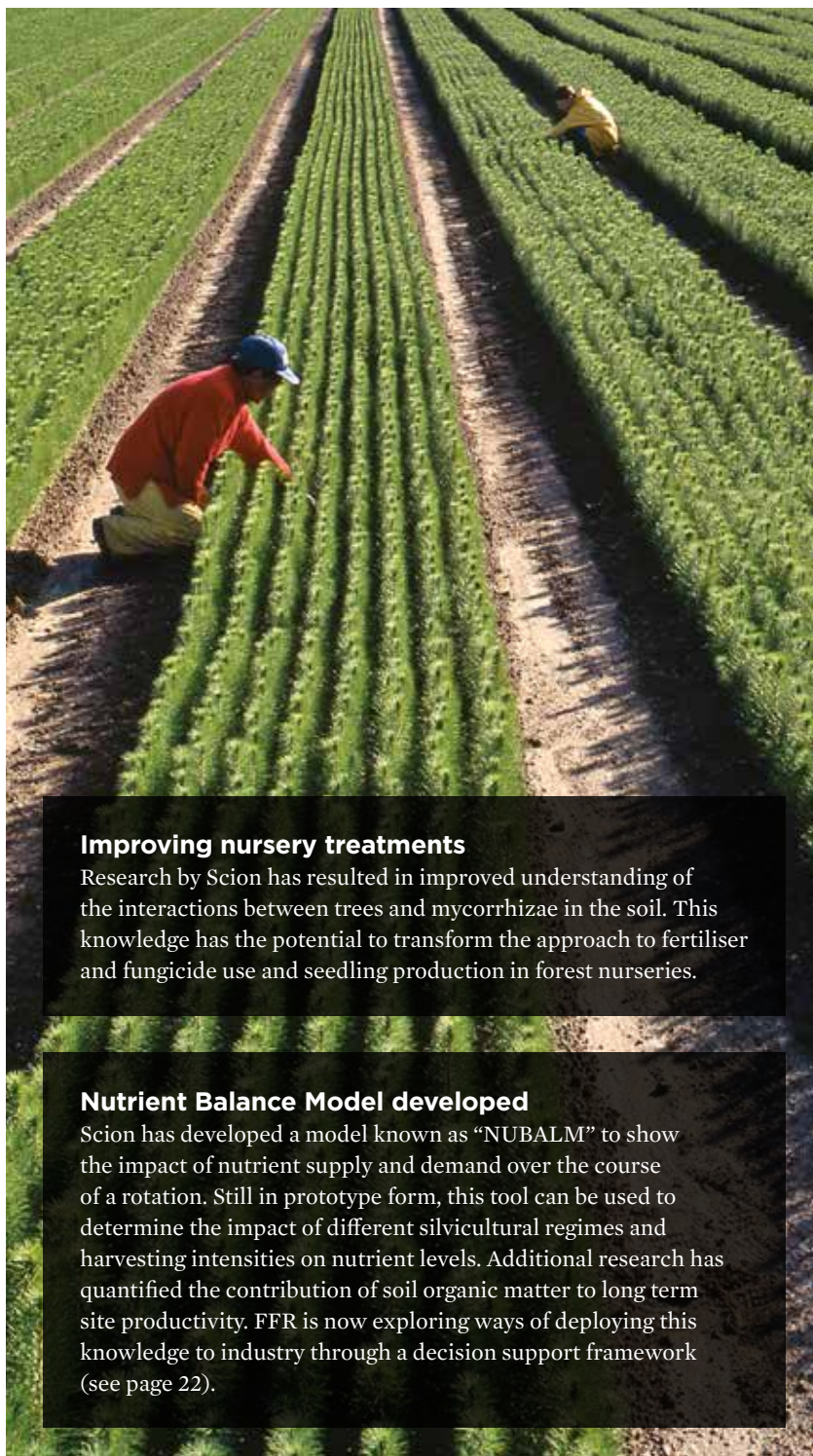
Improving nursery treatments

Research by Scion has resulted in improved understanding of the interactions between trees and mycorrhizae in the soil. This knowledge has the potential to transform the approach to fertiliser and fungicide use and seedling production in forest nurseries.

Nutrient Balance Model developed

Scion has developed a model known as "NUBALM" to show the impact of nutrient supply and demand over the course of a rotation. Still in prototype form, this tool can be used to determine the impact of different silvicultural regimes and harvesting intensities on nutrient levels. Additional research has quantified the contribution of soil organic matter to long term site productivity. FFR is now exploring ways of deploying this knowledge to industry through a decision support framework (see page 22).

Enhancing communication

One of the greatest challenges faced by FFR has been the issue of putting useful knowledge in the hands of forest managers, and getting them to apply it. Experience in almost every sector shows the difficulty of technology transfer, particularly in a world where information is increasingly complex and often overwhelming.

FFR has addressed this challenge by getting back to the basics of two-way communication. Workshops have been delivered by FFR to provide practical training in three key areas: quantitative silviculture; forest productivity and resource assessment. Participation in these workshops has been high

and feedback has been enthusiastic. Although the concept of these industry workshops is nothing new, FFR has succeeded in reviving and invigorating this mechanism of communication between researchers and practitioners to provide an excellent model of tech transfer in action.

Following on from the workshops, FFR is using new communication technologies to build communities of interest. This network enables practitioners to share and discuss information arising from research as part of their continuing professional development.

Diverse Species

When FFR was established six years ago, there was a strong appetite for alternatives to radiata pine. Although many other tree species offer commercial potential in New Zealand, the lack of information available to investors undermined their confidence in growing other options. Research supported by FFR provides better and more accessible information about what can be planted, and where to plant it for maximum return.

The Diverse Species theme has succeeded in building knowledge, developing tools and improving treestocks for a range of promising species. In areas where afforestation is encouraged and incentivised, particularly in lake catchments and highly erodible areas, growers can now make the choice to grow different species for commercial gain.

Although planting rates in New Zealand forestry are currently low, the results of this research put the industry in a much stronger position for when the next wave of afforestation occurs. Whatever direction the forest industry may take in the future, the drivers towards greater diversification are likely to continue. A solid foundation is now in place to enable new developments to unfold.

Douglas-fir

Reliable tools developed

Models and calculators for Douglas-fir enable growers to forecast likely returns from different silvicultural regimes. Both the Douglas-fir calculator and Forecaster have been developed to supply consistent and reliable information to underpin forest management and investment decisions. New functionality to include genetic and site analysis will bring these Douglas-fir tools to a similar level of sophistication as those used for radiata pine management.

Knowledge delivered to forest managers

A key result from this programme was new information regarding the impact of latitude and altitude on Douglas-fir stiffness. This valuable insight has altered management decisions about where to grow Douglas-fir, and which treestocks to plant on certain sites to gain maximum return. Results of wood quality research are now available to forest managers through stiffness and density surfaces that can be downloaded and used in GIS analysis.

Improved treestocks available

Enormous strides have been taken towards advanced breeding of Douglas-fir. Improved traits are now available through new genetic selections and expanded seed orchards. Options for breeding Douglas-fir with resistance to Swiss needle cast have also been identified to enable better disease management. Breakthroughs made in tissue culture techniques open up future options for mass propagation of improved genetic material from Douglas-fir.

Eucalypts

Calculator available online

A model for predicting growth of *Eucalyptus fastigata* has been made available to growers through an online calculator. This tool, along with productivity surfaces available for GIS analysis, enable growers to identify promising sites and predict expected volumes.

Improved genetic stock

Seed with traits of Improved tree growth and wood quality for *E. fastigata*, *E. nitens* and *E. regnans* is available through Proseed. The identification of superior parents has opened the way to further breeding gains for *E. nitens*.

Proven value recovery

Results of sawing studies demonstrate that eucalypts as young as 18 years old offer good value recovery if markets open up for the timber. This research confirms the potential of *E. regnans* as a viable short rotation crop.

Options for managing forest health

Research into integrated pest management identified good options for chemical and biological control of pests on *E. nitens*. A promising parasitoid that attacks larvae of Eucalyptus tortoise beetle is under investigation.
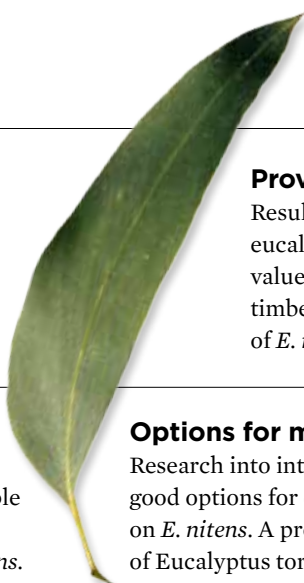
Redwood

Feeding the redwood revolution

A major success story within this programme can be seen in the redwood growing community. Sawmilling studies carried out by Scion demonstrated that high value, durable redwood timber can be produced in New Zealand. Working closely with an enthusiastic group of redwood investors, scientists have provided better information on silviculture, siting and genetics. Improved growth models and productivity surfaces are now available to assist planning and investment. New plantings and a strong development plan enable a path forward for this promising species.

Cypresses
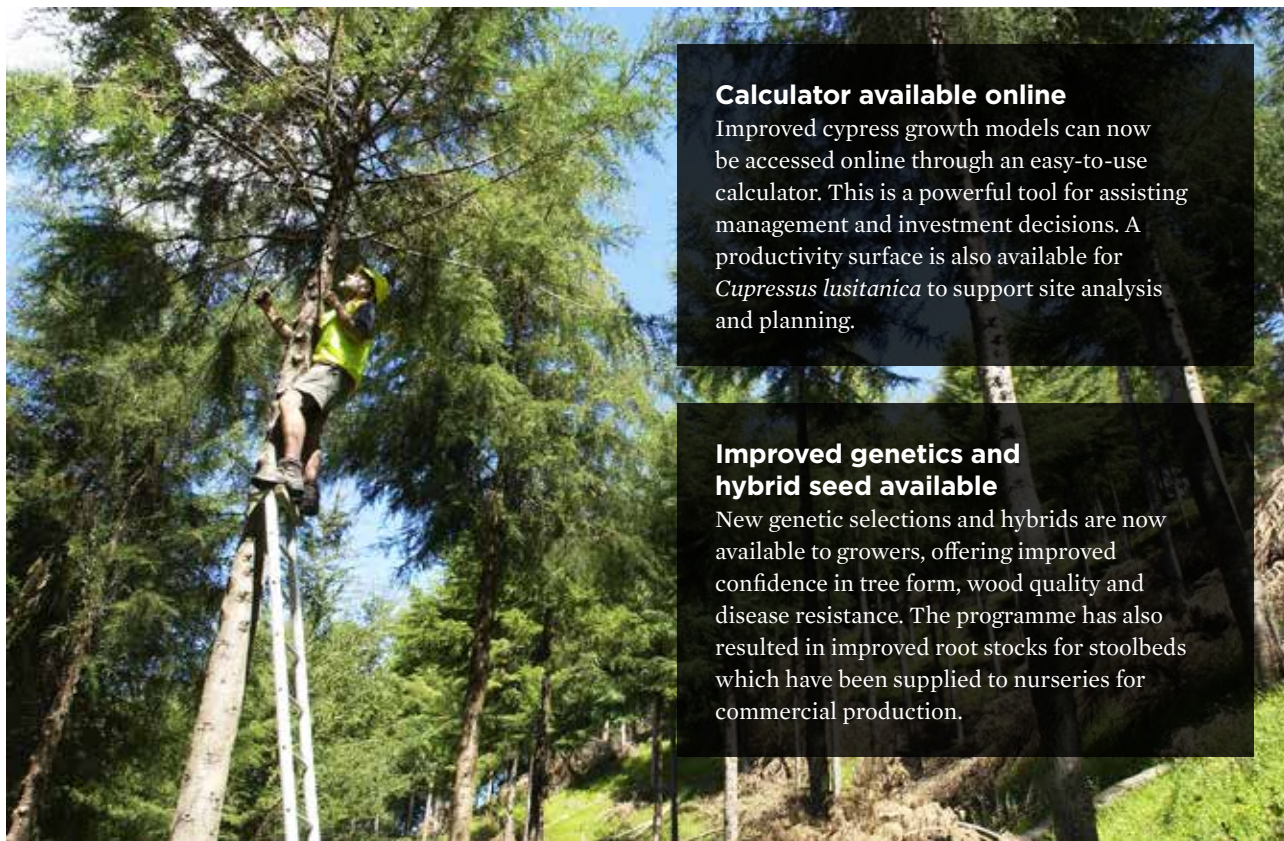
Calculator available online

Improved cypress growth models can now be accessed online through an easy-to-use calculator. This is a powerful tool for assisting management and investment decisions. A productivity surface is also available for *Cupressus lusitanica* to support site analysis and planning.

Improved genetics and hybrid seed available

New genetic selections and hybrids are now available to growers, offering improved confidence in tree form, wood quality and disease resistance. The programme has also resulted in improved root stocks for stoolbeds which have been supplied to nurseries for commercial production.

Indigenous species

Kauri growth model and calculator developed

A significant research project to develop a growth model for native kauri demonstrated the commercial potential of this high-value species for planted forests. An on-line calculator developed by Scion, is available to support investment decisions in this exciting new area.

Treestock production costs reduced

To date, results from early field trials indicate a 50% reduction in establishment costs with bare-rooted seedlings without loss in early growth and survival. Increased scale will allow further increases in efficiencies.

DNA tool developed for totara

A new methodology has been developed for identifying subspecies of totara that will better enable hybridisation within and between various totara species. This approach will provide opportunities to improve the production potential of the genus. As these species hydridise naturally, cultural links are not affected.

Contingency species

Future options safeguarded

A major achievement of the programme was the documentation and protection of genetic resources in exotic stands and trials throughout New Zealand. This valuable resource could hold the key to future forestry options, particularly in high country and difficult sites. If this resource is ever lost, it would be difficult or impossible to reintroduce the species.

Harvesting and Logistics

If fully implemented, some of FFR's most tangible contributions toward achieving the goals of improving productivity, reducing cost and improving worker safety in the forest industry have been delivered through the Harvesting and Logistics theme. Three years into this research programme, there are already new machines and technologies available for harvesting contractors, and many more in the pipeline. Mechanisation of harvesting steep forest slopes is seen as the key to achieving the goals outlined above.

Prior to the establishment of FFR, harvesting research was inactive for many years, with minimal funding and few resources aimed at this vital step in the forest value chain. In 2010 an industry/government collaboration enabled through the Primary Growth Partnership (PGP) brought renewed vigour and much needed focus to the area.

The value of potential benefits from harvesting and logistics research could reach $100 million by 2018 through cost savings, fewer accidents, energy savings and machinery sales. While this may sound like a long shot, impressive results achieved over the past year in the Harvesting and Logistics theme suggest the ambitious target is achievable.

Mechanisation on steep terrain

ClimbMAX works the hills

The first commercial model of a harvesting machine designed specifically to work on steep country has been implemented in the past year. The ClimbMAX machine, designed and developed by Kelly Logging Ltd and Trinder Engineers Ltd in Nelson, is now being used in steep forest harvesting operations. Subsequent orders have been received from other harvesting contractors and machine manufacturing is under way. This milestone, enabled by the PGP funding, is seen as a real breakthrough in the mechanisation of forest harvesting on New Zealand hill country. The ClimbMAX machine provides the stability and power needed to work on steep slopes, while enabling stems to be picked up and bunched for greater hauler efficiency.

HarvestNav puts computer in the cab

Machine operators now have access to a new software application that brings harvest plans and digital terrain models directly into the operator cab of harvesting machines. Operators can upload the application onto a tablet and use it to display relevant information as they work. This technology works in a similar way to vehicle navigation systems in cars, but it works in 3D. The system forecasts the next 100m of where the machine is heading and provides information on terrain, profile and slope, and warns if critical machine slope is exceeded. The operator uses this information to guide the stability of the machine on terrain where their view of the ground can be limited by felled trees, slash and undergrowth. The system, which can be used in any harvesting machine, was developed by Interpine Forestry Ltd in Rotorua.

Teleoperation for the future

Teleoperation offers major safety advantages over manual operations and is heavily used in many dangerous industries. FFR supports a research programme to make these technologies available to the forest industry. Over the past year, researchers have succeeded in developing a lab-based hydraulic circuit at the University of Canterbury to test the design of a new teleoperation system. Two graduate engineering students have been recruited to work on this project so progress is accelerating fast. A highlight this year has been the filing of a patent by Scion for a novel tree felling technology using robotic systems.

Higher productivity extraction

New grapple control systems available

A lightweight hydraulic grapple control system implemented by FFR is now in use by a local harvesting company. FFR facilitated the introduction of the Alpine Grapple from an overseas manufacturer and tested it in New Zealand conditions. Researchers worked with the manufacturer to modify the system, producing a "Beta Prototype" that improves the hydraulic control of the grapple while maintaining the low overall weight of the unit. Full assessment of the modified unit has been completed and it is now commercially available.

Advanced hauler vision system commercialised

One of the biggest impediments to hauler operators is the inability to see what is happening on the slopes below them. The FFR research programme has catalysed a whole new area of development using modern camera technologies to assist logging operations. A new camera system for the hauler cutover developed by Scion now enables hauler operators to see the whole operation, instead of relying on verbal instructions from ground spotters. The technology uses a robust, pole-mounted camera located within the cutover. Operators can see exactly where the stems are lying (and in manual operations where breaker outs are located) enabling them to extract loads more efficiently and safely. Hauler operators who have used the vision system as part of the development project see it as a major breakthrough that will reduce costs, improve safety and eliminate frustration.

Improving operational efficiency

Benchmarking system proving its worth

A benchmarking system developed by the University of Canterbury enables harvesting managers to compare their productivity against the average of other operations. The large database, which is owned by FFR, now contains four years of data from harvesting operations throughout New Zealand. This year FFR ran industry workshops to explain how the benchmarking system can be used to assist management and measure improvements. In the past, foresters could only gauge productivity by comparing notes with other operators. The Harvesting Cost and Productivity Benchmarking database enables a higher degree of professionalism while protecting the confidentiality of individual datasets.

Technology watch scans for opportunities

Scion maintains a close watch on what is happening overseas to identify technologies with local potential. This intelligence enables FFR to pick up new innovations which can be adapted to local conditions. Over the past year, researchers have investigated European yarding systems as an alternative to the large North American systems currently used. These systems may be better suited to complex terrain with multiple ridges, and could be implemented with lower capital costs. Researchers have also been investigating mechanised options for removing slash from streams to reduce environmental risks.

Environment and Social

Forestry is an important land use activity in New Zealand that makes a major contribution to the economy and provides strong environmental benefits. It is no exaggeration to say that the current viability of the forest industry is threatened by high land values, increasing compliance conditions and negative public perceptions.

FFR has driven a vital research effort to quantify the role of forestry in helping New Zealand to achieve sustainable primary sector performance. Science delivered through this theme provides the platform from which forestry proponents can address common misconceptions and regulatory pressures that form a real barrier to the long-term future of the industry.

While other FFR research themes address the immediate needs and future aspirations of forest growers, this theme recognises that not all issues confronted by the industry are physical or biological. This research may appear to have less direct application to forest managers, but its contribution to the industry could be even more imperative. The Environmental and Social theme tackles broad strategic issues to ensure that forestry remains a commercial and constructive land use option within the broader context of New Zealand Inc.

Supporting rational land use decisions

Forest Investment Finder evaluates viability of forestry on marginal sites

This modelling tool developed by Scion with FFR funding enables the analysis of class VI and VII land to determine expected returns from forestry. The Forest Investment Finder (FIF) is a valuable tool for planners, policymakers and forest investors because it can be used to spatially identify areas where forestry is profitable or unprofitable, including relativity to other land uses such as pastoral farming. The FIF framework is also capable of evaluating the benefits and drawbacks of ecosystem services arising from forest growing (see adjacent box) within a financial framework. This tool could help to challenge culturally-based assumptions and support economically rational decisions about land use change and landuse policy. It can be used to explore the economic values of timber and co-benefits derived from new areas and ultimately, new species forests as well as existing forests.

Methods developed for valuing ecosystem services

The value of forestry in providing recreation, aquatic habitat and avoided erosion has been quantified by FFR-funded research. Scion has succeeded in combining data from an erosion model produced by Landcare Research with economic analysis in FIF. This modelling exercise provides a first basis for identifying where forests could reduce costs to the public associated with erosion and flooding. These developments pave the way to evaluating appropriate land management into the future, and to support strategic decisions about forest use for either timber yield and/or public good. This same capability has been used to evaluate carbon sequestration and could be used to evaluate the public and private financial benefits of maintaining other ecosystem services associated with forestry, such as cleaner water or avoiding nitrogen contamination.

Multi objective decision making analysis methodology developed

FFR has supported a Scion research project with exciting potential for future land use decision making. This ingenious methodology, which balances multiple objectives to address complex scenarios, has received awards and gained international recognition for its unique capability. This approach offers potential for quantifying economic, environmental and social considerations of different land use options. Central and regional government are embarking upon a new era of "collaborative decision making" that requires enormous resources and extended time periods to solve catchment-scaled complex social and economic problems. This developing methodology represents a potential breakthrough to short circuit the processes required to achieve community-based solutions.

Dr Oliver Chikumbo of Scion and his US collaborators at Michigan State University received the prestigious Wiley Practice Prize, an international award for their work in multi-criteria.

Biodiversity assessment methodology developed

A new methodology for assessing biodiversity within the forest uses LiDAR metrics of forest structure. Developed by Scion to proof of concept stage, the technique offers potential for using remote sensing at a landscape scale to help with biodiversity monitoring.

Water quality

Water is likely to be central to environmental issues of the next decade. FFR commissioned research to find out how well the forestry land use was represented in the national water quality monitoring datasets; what needed to be monitored if forestry effects were to be properly monitored; what was the current state of knowledge of forestry effects on water quality, and what sort of monitoring network would be needed to represent forestry as a land use. This work demonstrated that forestry was underrepresented in the national monitoring framework. The parameters that need to be measured have been established and aligned firmly with those proposed under a current review of the national water monitoring system. Should it wish to implement a robust national monitoring network to feed into the forestry sustainability portal, the industry now has the information to know where and how many new sites are needed to ensure forestry is correctly represented as a nationally important landuse.

Portal concept to assist reporting requirement

A forestry sustainability indicator and visualisation portal prototype has been developed by Scion with support from FFR. This tool offers potential to assist forest – regional – national and international level reporting by providing central access to key indicators of sustainability as defined within the structure of the internationally recognised Montreal Process. It can also provide key operational indicators relevant to proving the forest industry's performance in relation to forest certification criteria. The portal, if adopted by industry, could provide long term environmental trend data critical to enabling an open and substantiated conversation with the New Zealand and international public on the sustainability of commercial forests. It could also provide a point of access for cohesive, reliable but simplified science-backed information about forestry in New Zealand and provide for easy creation of industry facts and figures, and national state-of-the-environment/sustainability) reporting.

Reducing herbicide risks

Research undertaken in the Environment and Social theme is focused on protecting the industry's licence to operate through generating science-based evidence and solutions. Nowhere has the benefit of this approach been more clearly evident than in the weed management research programme.

Improved environmental compliance and performance

The major challenge facing weed management in forestry is the need to reduce chemical use as required by Forest Stewardship Council (FSC) certification. Research into forest weed management has focused on two active ingredients identified by FSC as being highly hazardous, namely hexazinone and terbuthylazine. Before the adoption of FSC certification these active ingredients were almost exclusively used for first year post-plant weed control operations in New Zealand to control a wide range of weed species.

Research, undertaken by Scion with FFR funding, has delivered the following positive outcomes:

- Alternative formulations were developed for a range of weed species that exclude hexazinone.

- Studies conclusively showed that terbuthlyazine is strongly adsorbed by the soil and therefore unlikely to leach before it is broken down in situ. This research is consistent with a recent indication by FSC to remove this active ingredient from the highly hazardous list.

- Biological control project for South American pampas grass under way by Landcare Research. Researchers have made good progress with molecular identification of pampas species present in New Zealand. There are now known to be three separate species from different countries. The search for biological control agents can begin in earnest.

Managing hazardous landscapes
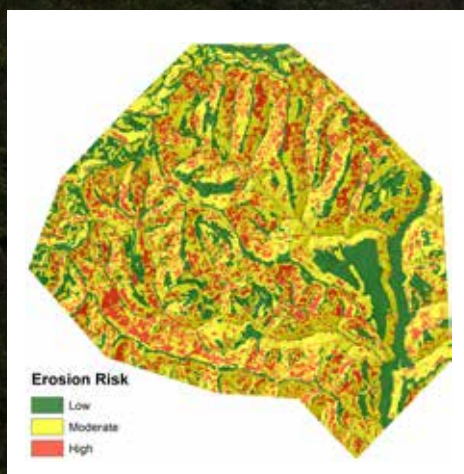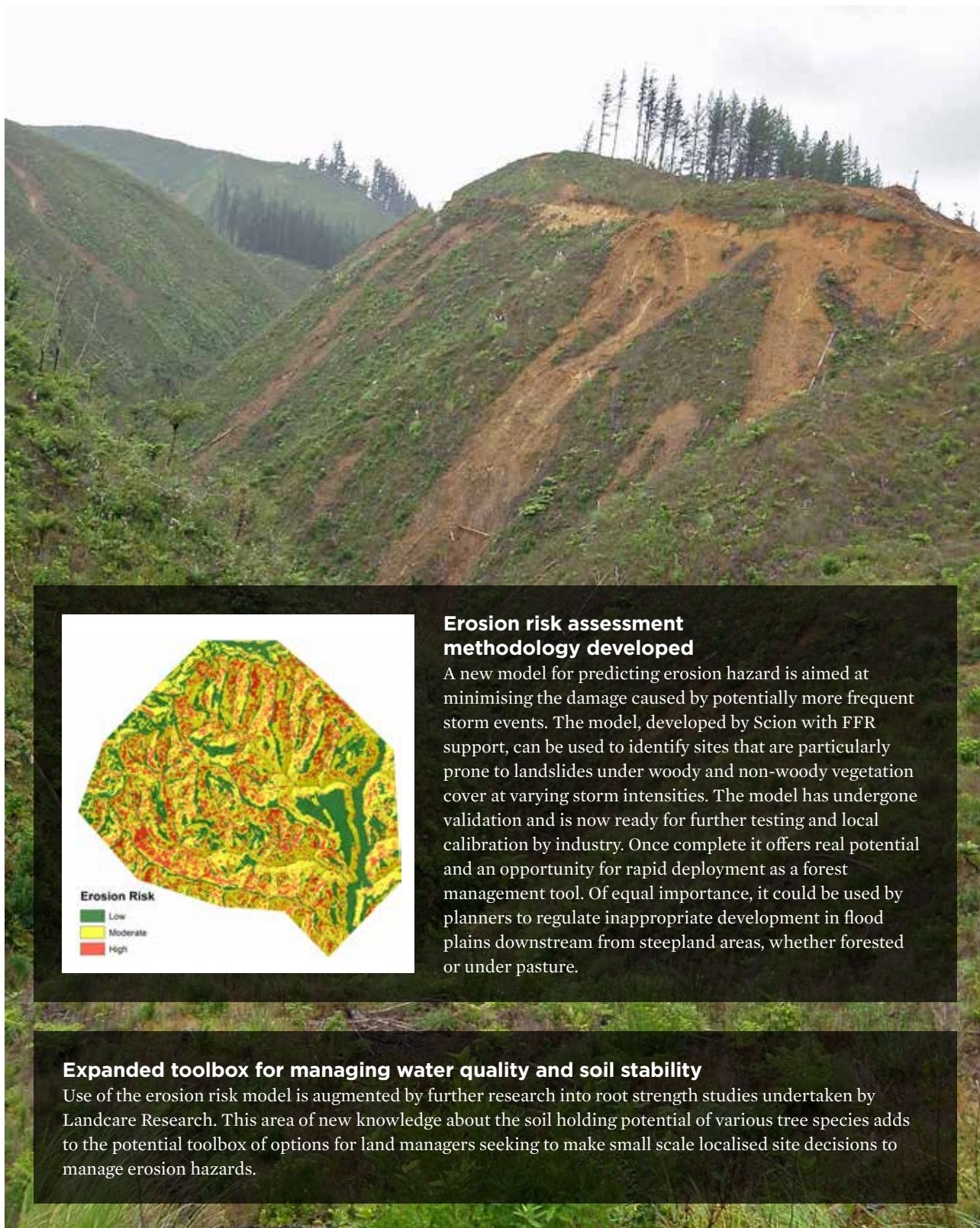
Erosion risk assessment methodology developed

A new model for predicting erosion hazard is aimed at minimising the damage caused by potentially more frequent storm events. The model, developed by Scion with FFR support, can be used to identify sites that are particularly prone to landslides under woody and non-woody vegetation cover at varying storm intensities. The model has undergone validation and is now ready for further testing and local calibration by industry. Once complete it offers real potential and an opportunity for rapid deployment as a forest management tool. Of equal importance, it could be used by planners to regulate inappropriate development in flood plains downstream from steepland areas, whether forested or under pasture.

Expanded toolbox for managing water quality and soil stability

Use of the erosion risk model is augmented by further research into root strength studies undertaken by Landcare Research. This area of new knowledge about the soil holding potential of various tree species adds to the potential toolbox of options for land managers seeking to make small scale localised site decisions to manage erosion hazards.

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