

Welcome to the latest update of the six-year 'Growing Confidence in Forestry's Future' (GCFE) research programme (Oct 2013 - Sep 2019), which involves a multi-disciplinary team of scientists at Scion, along with collaborators from other Crown Research Institutes and Universities. The research aims to raise the profitability of current and future commercial forests and is jointly funded by the Ministry of Business, Innovation and Employment (MBIE) and the Forest Growers Levy Trust, with the support of the NZ Forest Owner Association (FOA) and the NZ Farm Forestry Association (FFA). In addition to this newsletter, the programme website (<http://gcfz.nz/>) also provides information on upcoming events (workshops, field days, annual conference, and innovation cluster meetings) and contains links to technical reports and peer reviewed science publications (<http://gcfz.nz/publications/>). Further information is also available on the FOA website (<http://research.nzfoa.org.nz>).

The programme team have been busy establishing several new trials over the winter that will support key areas within the GCFE programme. These trials focus on improving seedling quality, closing the window of vulnerability and accelerating forest growth to improve productivity. In addition to these new trials, the programme is currently benefiting from several trial

series that were established under previous programmes. We expect that these new trial series will not only yield results for the GCFE programme, but will also provide a legacy for the future.

This newsletter also contains an update on wood quality research within the programme. This research is focussed on understanding wood quality in the current resource, and also on predicting what wood quality may be in the future. A highlight for the programme is the impending commissioning of a robot that will automatically collect data on wood properties from disc samples (see page 3). At the other end of the spectrum, new micro-coring techniques have been developed for sampling the growing cambium and this is being used to aid the development of stem form simulation models that will enable the prediction of wood properties in future forests.

There has also been a lot of engagement between researchers and industry through workshops, cluster group meetings and, most recently, at the Forest Growing Conference in Nelson. We profile some of these events as well as a previous research collaboration that was renewed at a recent meeting in Beijing.

Peter Clinton
(Programme Leader) and the research team

Research update

Quantifying the size of the productivity gap

One of the major goals of the GCFE project is to double forest productivity without compromising wood quality. A key step towards this goal is to identify areas throughout New Zealand where actual radiata pine productivity is below potential productivity. The development of process-based models, which are built on the physiological processes of tree

growth, provides the means to explore what factors limit growth at any particular site. Productivity drivers vary from site to site with various complex direct and indirect interactions. Unlike empirical models, process-based models are able to identify and explain what is stopping site productivity from reaching its potential.

Over the past 12 months we have been parameterising and validating the process-based model CABALA (Carbon Balance) for radiata pine in New Zealand.

CABALA is an integrated model that simulates the mechanisms required for forest growth above and below ground at a variety of scales. Once current productivity was determined, a series of productivity lever scenarios were tested with CABALA. Lever scenarios included increasing soil depth, removing stones, nitrogen fertilisation, increasing organic matter, and changing the soil carbon to nitrogen ratio (C:N). These scenarios were selected to identify which

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Quantifying the size of the productivity gap

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site factors were limiting productivity and what could be done to increase growth. While some levers are unrealistic (e.g., removing stones), they are important to identify site limitations.

The preliminary results from the lever scenarios clearly showed that there is no one size fits all approach for increasing productivity. The drivers of productivity vary throughout the country. Some regions, like the Hawke's Bay, have a large percentage of forests substantially below their potential productivity while other regions, such

as mid to high elevation sites in Southland are close to their productivity potential. The productivity gap spatial maps were presented at the FOA Conference in October and will be made more widely available in 2016.

Improving seedling quality and establishment performance

Nearly 10,000 seedlings have been planted out across five sites over the last two months as part of a new trial series to test the extent to which altered nursery practice can improve the initial performance of a plantation. This work expands on research carried out previously in the Future Forests Research programme, which found that seedlings grown with reduced chemical use in the Te Ngae nursery performed significantly better in the field for several years after planting. However, the applicability of this earlier research is limited as seedling performance was only tested at a single forest. The use of multiple sites in this study will enable the results to be generalised across a much wider area.

The new trial involves the use of *Pinus radiata* and *P. attenuata* x *P. radiata*



Recently planted seedlings at the Ngaumu Forest site, Wairarapa.

hybrid seedlings that have been grown in the Scion nursery under one of twelve different nursery management regimes. Prior to leaving the nursery gate, reductions in fertiliser and

fungicide use had not significantly affected either the health or size of the seedlings. By tracking the performance of these seedlings in plantations with different conditions, Scion will capture valuable new data exploring the possibility of raising seedlings to better suit the site they will be planted at, and the extent to which the efficiency of chemical use in seedlings nurseries can be improved.

Establishing these trials has been a significant undertaking. Substantial effort went into the design and implementation of the nursery treatments, the selection and establishment of the field sites, followed by the planting of the seedlings. Health and growth assessments of the trials will be conducted over the next few years, with results made available as they come to hand.

What is the maximum level of radiata pine productivity?

The first Accelerator Trial was established in southern Kaingaroa Forest during the winter. This trial series will provide the

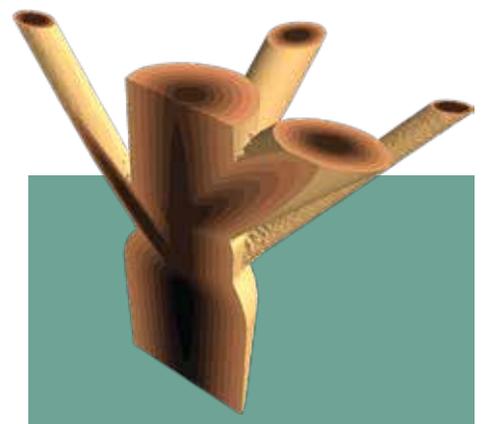
basis for future detailed studies of tree growth and wood formation across a range of genotypes, sites, site modifications and treatments intended to make trees grow faster. Information from these trials will help us to understand how to achieve the goal of doubling the productivity of future forests and what the implications for

wood quality and sustainability might be. Future treatment options for enhancing productivity at the Kaingaroa Forest trial will be selected shortly based on the results of site characterisation and modelling work (using NuBalm). In the coming months, the search will also be on for another two accelerator trial sites to be established next winter.

Development of a tree growth and wood formation simulator - SFsim

In a tree stem, wood properties and their variation determine the performance of the products that are extracted from logs. As part of the GCFF programme, we are further developing SFsim (a Stem Formation Simulator) which is a piece of scientific software designed to simulate the internal structure of tree stems for a given growth environment (climate, soils, management). The objective of SFsim is two-fold: (1) to create a

comprehensive picture of how trees function by integrating the underlying biophysical processes; and (2) to anticipate the impact of high productivity regimes and climatic change on wood quality and log value. The software is now being validated using new datasets.



Development of internal wood layout in a branch cluster.

Can we close the window of vulnerability quicker to reduce the risk of erosion?

To enable the continuity of harvesting on steep slopes in New Zealand, sustainable methods for preserving soil quality and preventing debris flows post-harvest must be explored. Post-harvest sites in steep country are vulnerable to intense weather events where the risk of erosion and debris flows are increased. There is a period of 6-8 years post planting (window of vulnerability) until canopy closure where the land remains more vulnerable. A new trial has just been established to investigate if it is possible to shorten this window of vulnerability while still maintaining an economically viable radiata pine crop. The trial is in the Waikura Valley in the East Coast of New Zealand.



Newly planted radiata seedlings at the trial site in Waikura Valley.

The aim of the trial is to determine to what extent the willow species Tangoio (*Salix matsudana x alba*) will reduce the growth of radiata pine when grown in varying arrangements or mixtures. Tangoio was selected for its known soil stabilisation properties, and because it is recommended by Gisborne District

Council for this purpose. However, it is not known if its rapid growth characteristics will result in undesirable growth reductions for radiata pine, or what the best arrangement of the two species is for reducing the window of vulnerability.



The DiscBot - a versatile wood scanning technology

Scion has developed and built the 'DiscBot'; a novel scanning technology designed to assess a range of wood properties that affect the quality of sawn timber and other end products. The automated disc scanner uses a robot to move wood discs past several different sensors, which capture

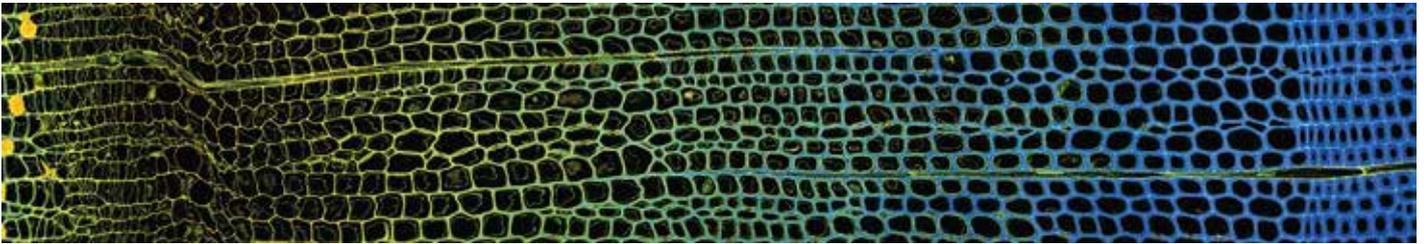
information on wood density, microfibril angle and spiral grain angle.

A near infrared camera is also used to detect the different light absorbing qualities of lignin, cellulose and other chemicals in the wood. Wood density is measured using X-rays, and stiffness by the speed at which an ultrasound wave travels through the wood. Masked light transmission is used to detect the presence of spiral grain by measuring how light is distorted as it travels through the wood.

As recently reported in the *Scion Connections* newsletter, the DiscBot will enable us to better understand the quality of wood that has been laid down throughout the whole tree, and how this is affected by genetics, silviculture and site, and what the implications for end product quality are. This knowledge will help us to better characterise the forest resource that is out there, so that we can plan how to best add value to it.

One of the main advantages of the DiscBot is that it can test multiple discs quickly and efficiently and the volume and speed of data generated will be invaluable for the current GCFF research projects. For questions about the DiscBot contact John Lee at john.lee@scionresearch.com





Microscope image of a microcore. It extends from the phloem on the left, through the cambium (small cells) and cell expansion (yellow/orange) and shows lignification (blue) of the cell wall. There is an earlywood/latewood boundary on the far right.

Microcores - a new technique for getting wood quality information

A novel microcore method based on confocal fluorescence imaging has been developed to examine how wood is produced as trees grow. This method will help scientists to better understand how wood is formed in the cambium and how this process is controlled by exogenous (temperature and day light) and endogenous (phytohormones) factors. Fundamental knowledge gained from these microcore studies can then

be used to manipulate cambial processes to improve both wood properties and growth performance. One of the main advantages of this method is that it can be used to measure tree responses soon after a treatment is applied instead of having to wait to observe changes after many years.

This microcore method will be used to study the cambium response in mid-rotation intervention trials aiming

to increase productivity, and also in the Forest Accelerator Trials. In addition, cambium data obtained will also be used to validate the Stem Formation Simulator (SFsim). Initial results show promising correlations between radial growth and cambium cell production for fast and slow growing trees.

Engagement

Forest Growers Research Conference, Nelson, October 2015

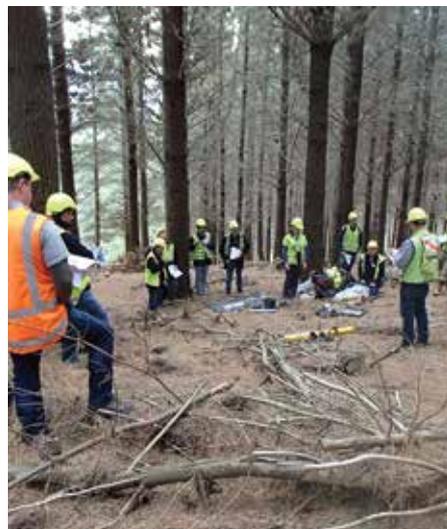
A number of researchers from the GCF programme presented results at this conference, which was attended by over 100 people. Presentations covered the productivity gap, silvicultural strategies for closing this gap and maximising the production of certain target log grades,

and forestry economics. Some of our wood quality work was presented in the poster session. The conference provided an excellent opportunity for researchers and industry to engage and discuss the research that is being undertaken in the programme. Presentations from this meeting are available on the FOA website (<http://www.research.nzfoa.org.nz/documents/5612>). Two awards were presented to GCF team members at

the conference. John Moore received the Communication and Sector Engagement Award for his work in identifying opportunities to improve productivity and the value of forests and engaging with large and small forest owners to communicate the key findings of his research. Annette Brockerhoff received the Contribution to a Science Team Award for her project management of the GCF research programme.

Increasing soil sampling capacity in the industry

Two soil sampling workshops have been held, in Christchurch in May and Rotorua in September. These practical workshops provided a hands-on approach to introduce the tools and fundamentals of consistent soil sampling in a planted forest. These were held in response to forest managers' requests to better understand the soil and the link with stand productivity. Both workshops were well attended with a lot positive feedback received. Practical soil sampling information sheets can be found at <http://gcff.nz/publications/>.



Sampling soils for chemistry and bulk density at the South Island workshop.



Describing the soil profile at the North Island workshop.

What does the forestry sector need in the way of nutrient management tools?

The Forest Growers Levy Trust recently funded two projects to examine the sector's need for nutrient management tools. This builds on the existing Nutrient Balance Model (NuBaIM) developed by

Scion. An external oversight group has been formed, providing expertise in industry and regulatory issues during the development of the tool. This group will also assess the validity

of a development plan for the tool that will be produced from a series of stakeholder workshops. Information on the dates and locations of the NuBaIM workshops can be found at the GCFF website or contact Simeon Small directly (simeon.small@scionresearch.com or phone 03 364 2987 extn. 7833)

Productivity Enhancement Innovation Cluster

The Productivity Enhancement Innovation Cluster met on 22 September in Rotorua and discussed a diverse range of topics around assessing nutritional status of sites and trees, and methods of enhancing site productivity. Presentations were given on: site, soil and productivity; how to determine nutritional limits of productivity; a nutrient decision support system; example of a mid-rotation fertiliser

trial; towards precision forestry - planning an aerial application for best outcomes; nutrient management using cover crops; and the risk of altering current production.

conducted under the GCFF programme. These include changing nursery practise to better prepare seedlings for plantation conditions, establishment of riparian plantations, and likely impacts of climate change on the soil services that underpin primary sector productivity. Also attending the meetings were members from the FFA Middle Districts Branch, nursery manager and foresters. These discussions help to foster engagement and sharing knowledge. If there is more interest in having more of this sort of interaction, please let us know and we can investigate ways to make it happen.

Engaging with Horizons Regional Council

Simeon Small recently met with members of the Horizons Regional Council and discussed a wide range of issues arising from the research

International links

Co-development of research on ecosystem services in Europe. Richard Yao gave a presentation on the spatial economic modelling of forest ecosystem services at the New Frontiers in Forest Economics Conference in Beijing, China in August. There, Gregory Valatin of Forest Research (UK) and Richard renewed previous collaborative ties and are now exploring opportunities related to the forest ecosystem services in Europe with a focus on water. Gregory had previously hosted Richard in 2010 for a visit to the Forest Research headquarters in Edinburgh.



Richard Yao (left) and Gregory Valatin.

Looking ahead

Innovation cluster meetings

- **Product Quality Innovation Cluster - Meeting**, 25 Nov 2015, 9.45 am - 4.15 pm, Rotorua. Agenda and online registration available at <http://gcff.nz/news-and-events/>. For general cluster enquiries contact John Moore at john.moore@scionresearch.com, phone (07) 343 5425.
- **Sustainability Innovation cluster - 'Developing good practice for steepland forestry'** field day and workshop, 11-12 Nov, Gisborne.

Information and online registration are available at <http://gcff.nz/news-and-events/>. For steepland forestry event enquiries contact Duncan Harrison at Duncan.harrison@scionresearch.com, phone (07) 343 5848.

- **Phenotyping Innovation Cluster - Meeting**, 8 December 2015, 9.30-11.30 am, Christchurch/ Rotorua video conference. Agenda and registration link will be at <http://gcff.nz/news-and-events/> later in the year. For general cluster enquiries contact Mike Watt

at Michael.watt@scionresearch.com, phone (03) 364 2987 ext 7823.

IUFRO Forest genetics for productivity conference, Rotorua, 14-18 March 2016. www.fgpc2016.nz

3rd Annual GCFF programme conference, Auckland, 10-12 May 2016.

5th Forest Ecosystem Services (FES) National Forum, Te Papa, Wellington, 24 May 2016 (TBC).

Phenotyping/Genetics workshop (date TBC, between April-June 2016).

Selected recent publications/ presentations related to the GCFF programme

A series of short papers on steepland forests:

Payn TW, Phillips CJ, Basher L, Baillie BR, Garrett LG, Harrison DR, Heaphy MJ, Marden M. (2015). Improving management of post-harvest risks in steepland plantations. *New Zealand Journal of Forestry*, **60**(2), 3-6.

Basher L, Harrison DR, Phillips CJ, Marden M. (2015). What do we need for a risk management approach to steepland plantation forests in erodible terrain. *New Zealand Journal of Forestry*, **60**(2), 7-10.

Phillips CJ, Marden M, Basher L. (2015). Forests and erosion protection - getting to the root of the matter. *New Zealand Journal of Forestry*, **60**(2), 11-15.

Garrett LG, Smaill SJ, Clinton PW. (2015). Nutrient supply one rotation to the next. *New Zealand Journal of Forestry*, **60**(2), 16-20.

Baillie BR, Rolando CA. (2015). Long-term management of streams in planted forest steeplands. *New Zealand Journal of Forestry*, **60**(2), 21-24.

Recent GCFF technical notes:

Davis M, Smaill S, Coker G. 2015. *Testing new soil enzyme assays for predicting forest fertiliser response - protease may have limited suitability*. GCFF TN-05, 4 pp.

Moore J, Osorio R, McKinley R, Lee J, Dash J. 2015. *Effects of silviculture and seedlot on radiata pine growth, wood properties and end-product quality*. GCFF TN-02, 7 pp.

Murphy G, Cown D, Moore J. 2015. *Economics of segregation based on wood properties*. GCFF TN-03, 6 pp.

Pearce G, Watt M. 2015. *Linking remove sensing techniques and leaf area index*. GCFF TN-08, 6 pp.

Pont D et al. 2015. *Locating individual trees within a forest using LiDAR*. GCFF TN-06, pp.

Watt MS, Dash JP, Watt P, Bhandari S. 2015. *Predicting productivity using combinations of LiDAR, satellite imagery and environmental data*. GCFF TN-07, 7 pp.

Note: Results of this programme and related work are often published in the *New Zealand Journal of Forestry Science* which has open access and publications are easily accessible through their website (<http://www.nzjforestryscience.com/>). Summary abstracts of other subscription only journal publications are typically available online through the individual journal's websites and full information can be obtained by getting in touch with the authors directly. The GCFF website <http://gcff/publications> provides the appropriate links to access the published information.

To learn more about the research projects in the programme:

Contact Dr Peter Clinton at peter.clinton@scionresearch.com

Visit the programme website at <http://gcff.nz/>

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