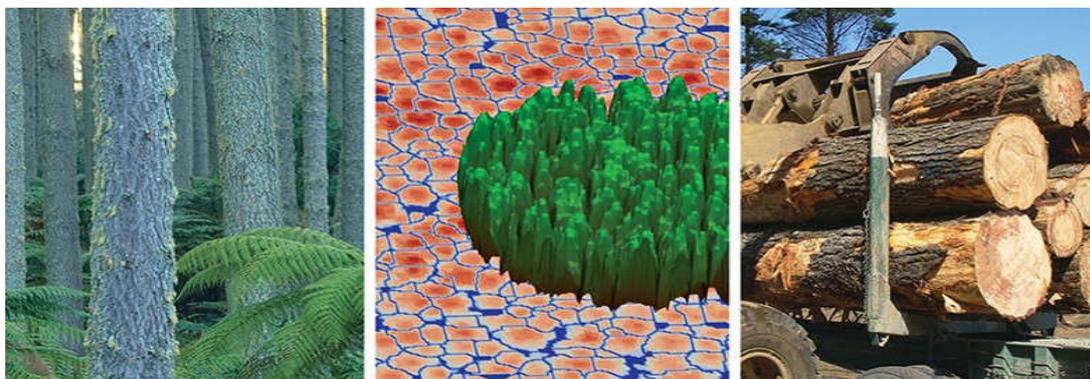


Biostimulants and Foliar Sprays

Simeon Smail, Steve Gatenby and Graham Coker



Low intensity, high impact

The productivity of plantation forests is driven by numerous processes occurring in the tree, in the soil under the tree and in the wider environment

How can we get the processes we want to occur more rapidly, or to a greater extent?

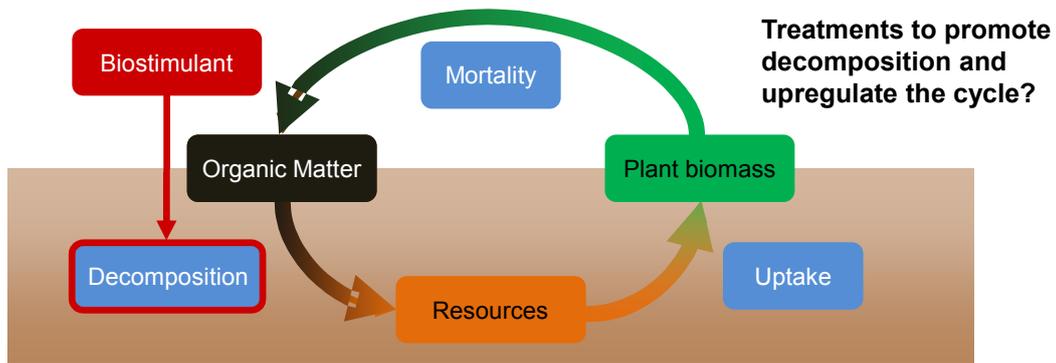
Directly adding nutrients to trees enables greater precision and efficiency – not having to go through other parts of the ecosystem

What are the opportunities to more effectively deliver nutrients and other useful substances to trees?

To achieve this, we have been investigating **biostimulation** and **foliar spray treatments** – developing systems with reduced inputs that produce growth responses that are more efficient, and less intense, than conventional treatments

A simple biostimulation target

The rates at which soil microbes and soil animals release mineral nutrients from organic matter is a key limitation



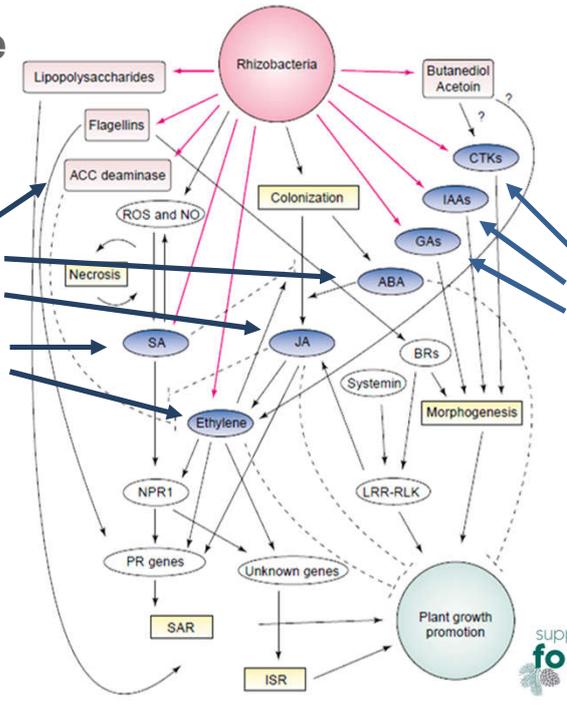
Treatments to promote decomposition and upregulate the cycle?

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A bit more complex

Indirect effects on plant growth by moderating responses to pathogens and other stressors



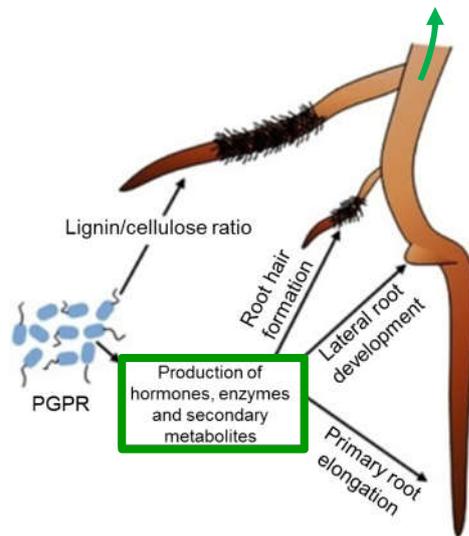
Stimulation by plant growth promoting rhizobacteria

Direct effects on plant growth by manipulating plant behavior

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But really not that complex



Effects on growth behaviour both below and above ground

Treatments that copy how soil microbes manipulate plant growth?

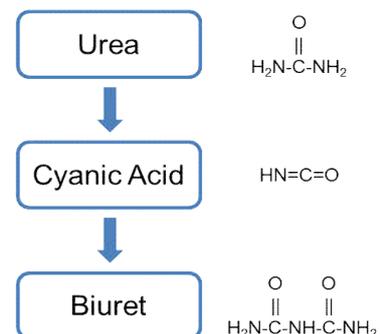
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Biostimulation trials

Biuret – a byproduct of urea production, develops above 132 °C, about 40% nitrogen by mass

- Capable of stimulating forest soil microbial activity – increased rates of mineralisation
- About 50 times less soluble than urea
- Known to have phytotoxic effects on plants – significant negative effects have been observed in some plant species at application rates as low as 3 – 4 kg per ha
- Initial work focussed on trying to find a sweet spot – more microbial activity, no harmful effect for pine



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Biuret trials – toxicity

Carried out numerous trials to find a toxic effect since 2015... and so far, haven't seen anything...



Doses of biuret to recently germinated seedlings...

... produced very happily growing seedlings



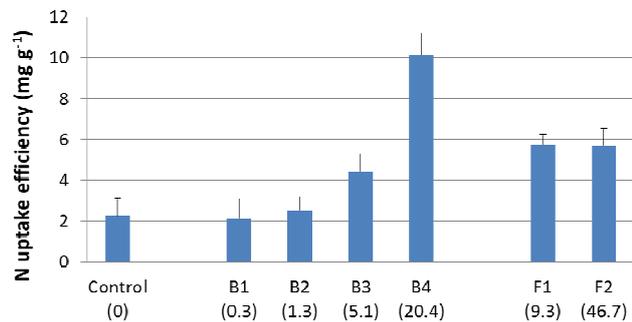
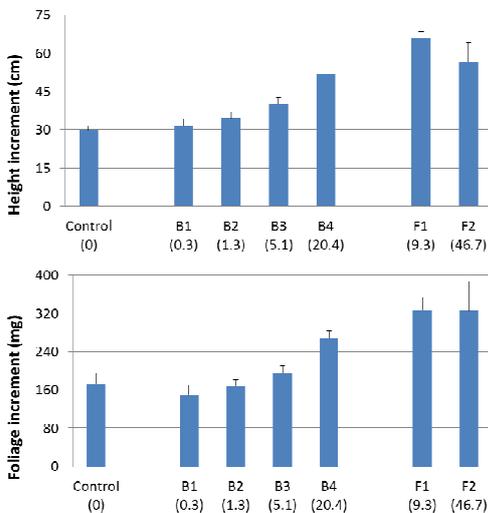
Ramped up to 20.4 g N per seedling (~20 T N per ha), needle burn only

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Biuret trials – what was it doing?

Initial trial with recently germinated seedlings



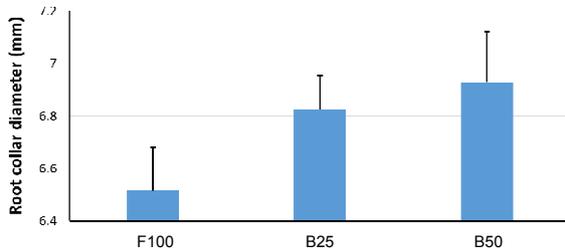
Massive increase in ability of plant to acquire nitrogen

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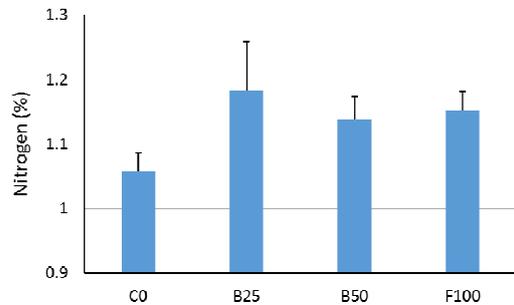
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Biuret trials – what was it doing?

Operational scale trial with Tokoroa ArborGen



- Gains in seedling growth rates with less N added
- Increased root collar diameters by 4.8% and 6.3% with only a quarter and a half the dose of N



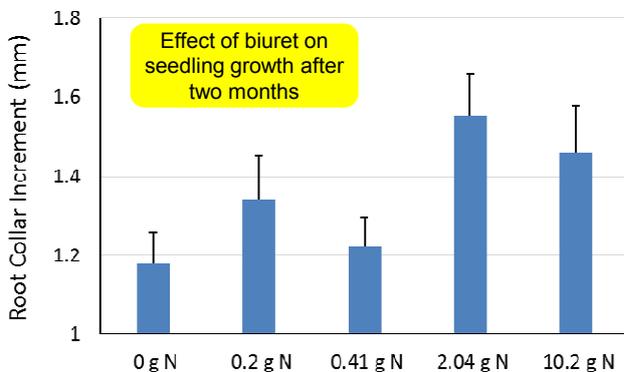
Increased growth and maintained N in plant despite adding less to the system - more efficient

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Biuret trials – what was it doing?

Most recent trials



Toxicity test – but found increases in growth, tapering off at the top level due to N toxicity

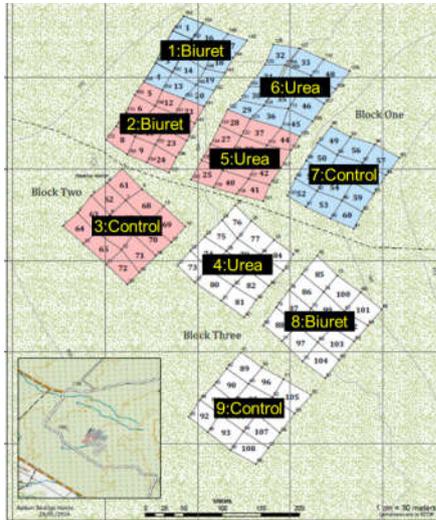
Second Tokoroa ArborGen trial, comparing 100% of N as urea to 40% of N as biuret over 6.3 ha

- Did not see growth enhancement with biuret this time, but no loss of growth – so again, more efficient use of added nitrogen
- Awaiting nutrient concentration analysis results, will allow uptake efficiency to be determined

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Time to see what happens in the forest



Biuret is in the process of being added to the first Accelerator Trial (Southern Kaingaro)



Can we get 125 kg of N per ha delivered as biuret to act like 500 kg of N per ha delivered as urea?

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Time to see what happens in the forest



0	Bt1	Bt2
0	0	0
0	Bt1	Bt2
Bo	Bo	Bo

Bt = biuret, Bo = Boron

Adding biuret and boron to the Site Modification trial series to measure impacts on soil microbial processes

Measuring changes in functional genes and enzyme activity in the soil microbial community

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Taking the plunge...

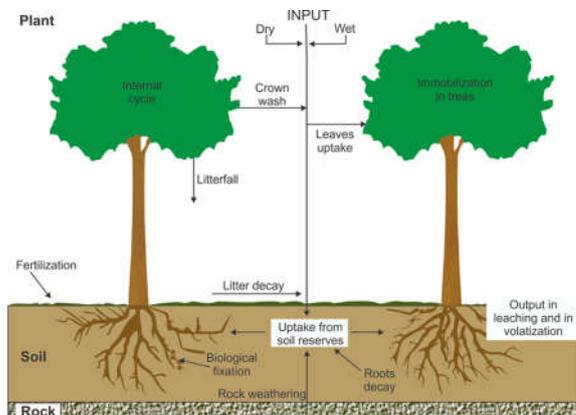
- Based on the results we have produced with biuret to date, there are now a couple of companies who have committed to applying this well known plant poison into trials within their estates
- Today we have Steve Gatenby to talk about some of the reasons why Kaingaroa Timberlands is interested in this product, and how it will be tested

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Why foliar fertilise?

- Roots gather nutrients from the soil and water
- But foliage is the driver of growth as it converts sunlight into crop volume
- Nutrient availability is limited by soil health and activity



But if nutrition is applied directly to foliage it avoids large pools and complex soil processes.

Foliar application results in better crop targeting

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Types of foliar applications – managers gaining control over crop growth and responses



- **Limits on crop growth**

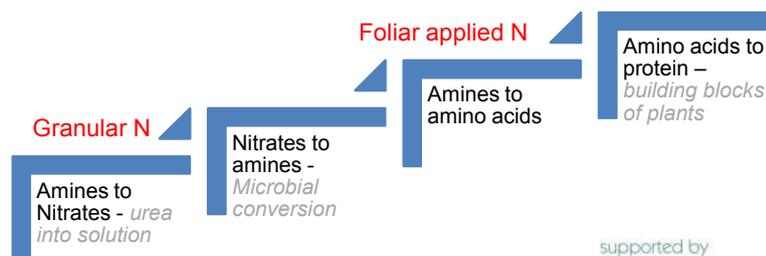
1. Nutrients (matching demand with supply)
2. Triggering activity (plant hormones, stimulants)
3. Crop stress (ACC deaminase)
4. Crop health (disease eg. Dothi, RNC)

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Why foliar applied N is more efficient than granular applied N

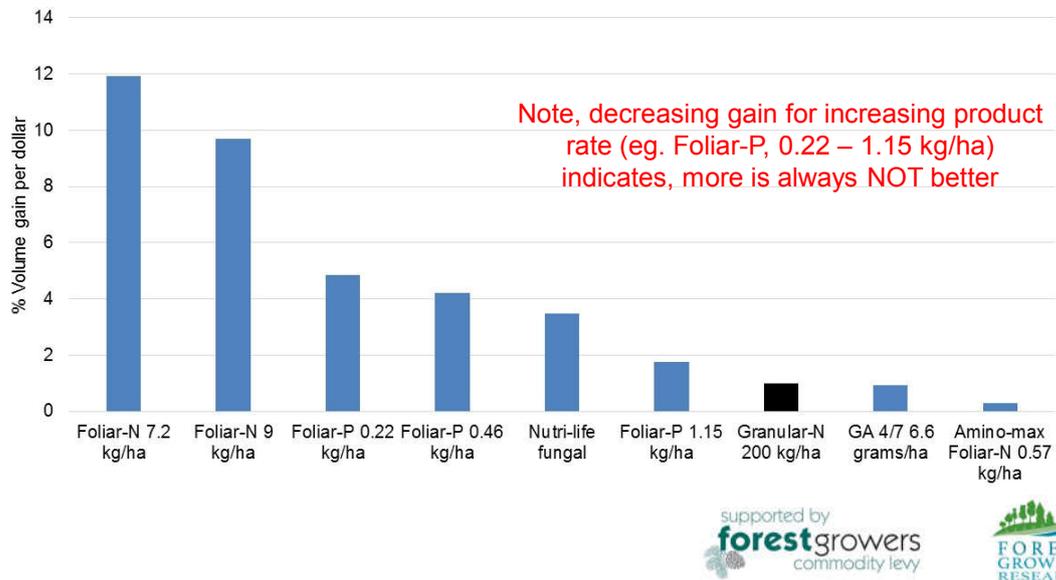
- Less energy required by the crop to utilise
- Applied at the site of use – faster uptake and less chance of leaching
- Operationally more efficient - doesn't need to be applied prior to rain
- Can potentially be applied with other operations



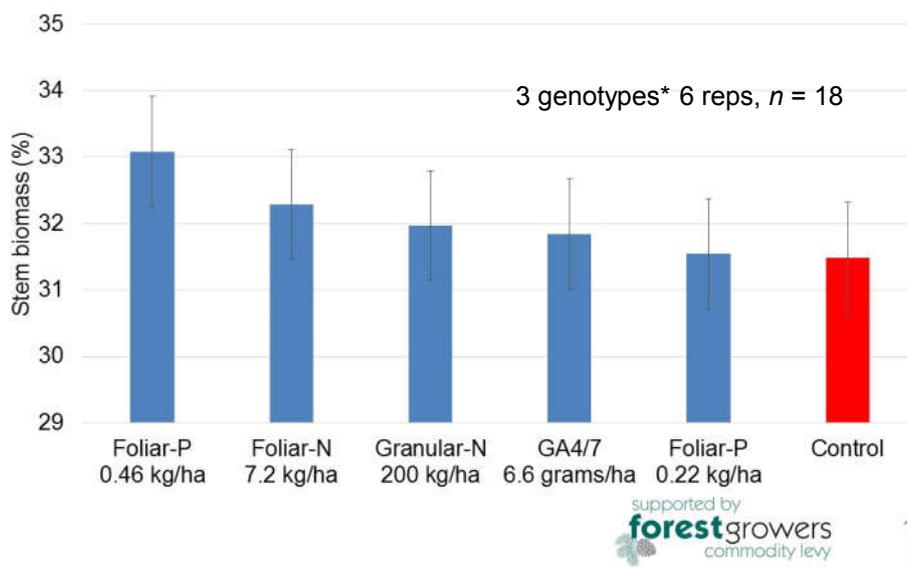
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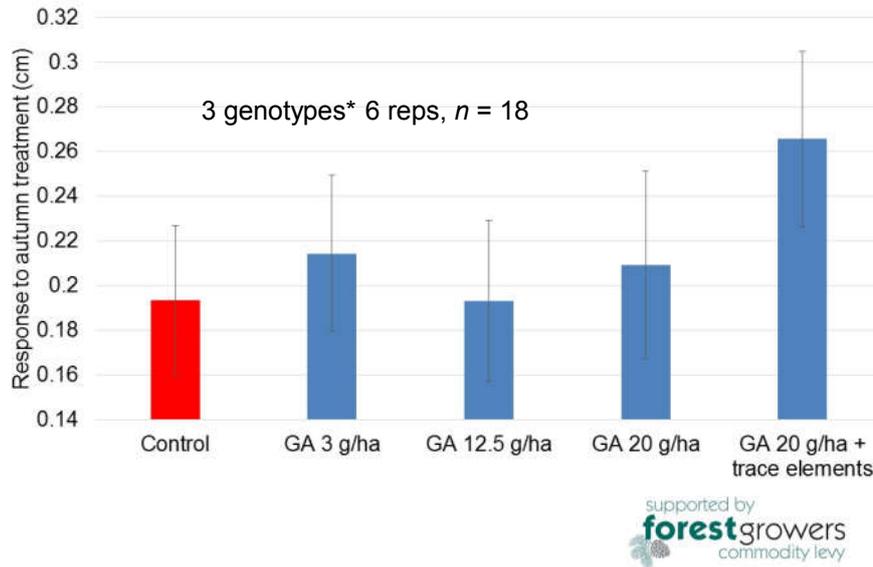
Example – foliar applied nutrients, growth gains based on cost (small radiata plants)



Example – N or P applied directly to foliage, influence on biomass allocation (small radiata plants)



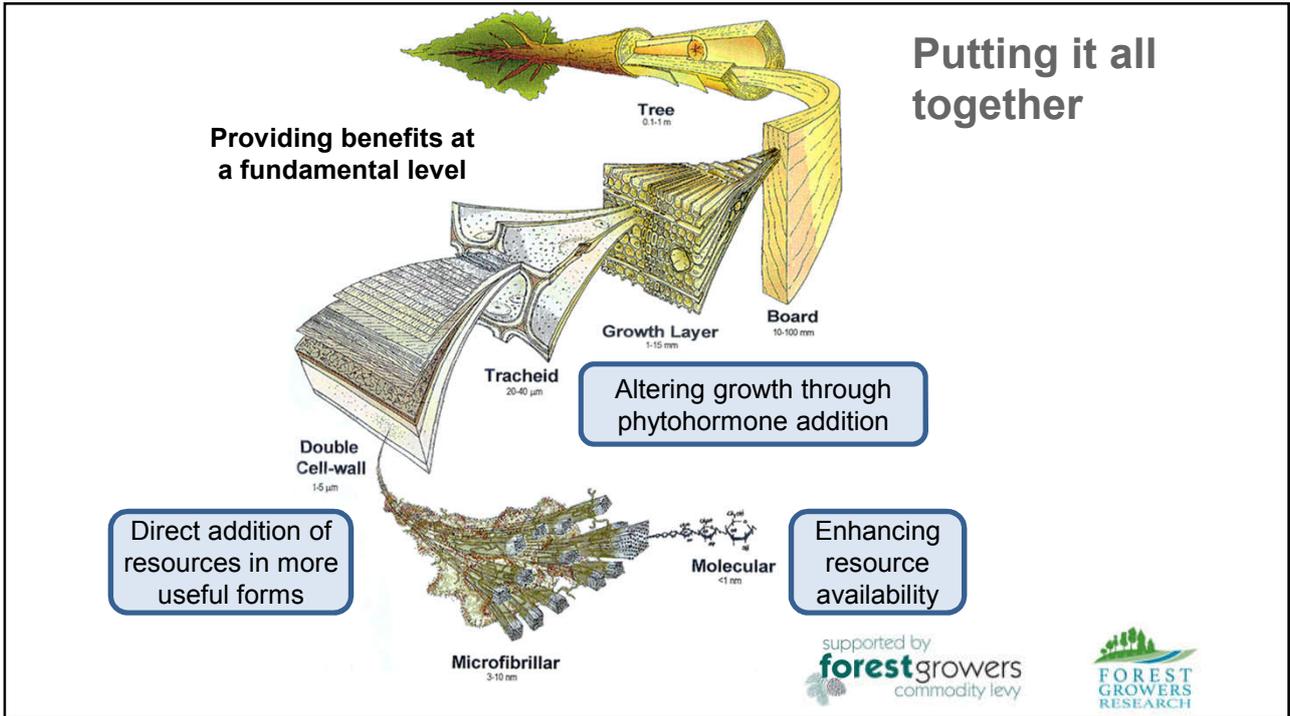
Example – Trace elements applied in autumn to mid-rotation trees (13.8 m tall radiata)



Summary – foliar applications

- Treatments of nitrogen and phosphorus to radiata provides strong evidence of increased cost efficiency compared with conventional operations.
 - A 10 fold or a \$100/ha cost advantage was obtained from foliar N application in trials carried out on small radiata in both 2015 & 2016.
 - We will apply it at a national operational scale next
 - We will continue to refine practices and maximise gains





However, still just a component of the overall package

Although we have good results to date, forest results are still interim at best

Likely that cost-effective benefits can be produced based on what has been seen to date, but still only part of the toolbox

Challenge is to make the outcomes of this work fit into other forest management practices

- What combination of treatments produces the best outcome for a given forest?

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**Growing
confidence
in forestry's
future** Research
Programme



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