Pine propagation in New Zealand and the drive towards Ellepots.

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Kaingaroa Timberlands

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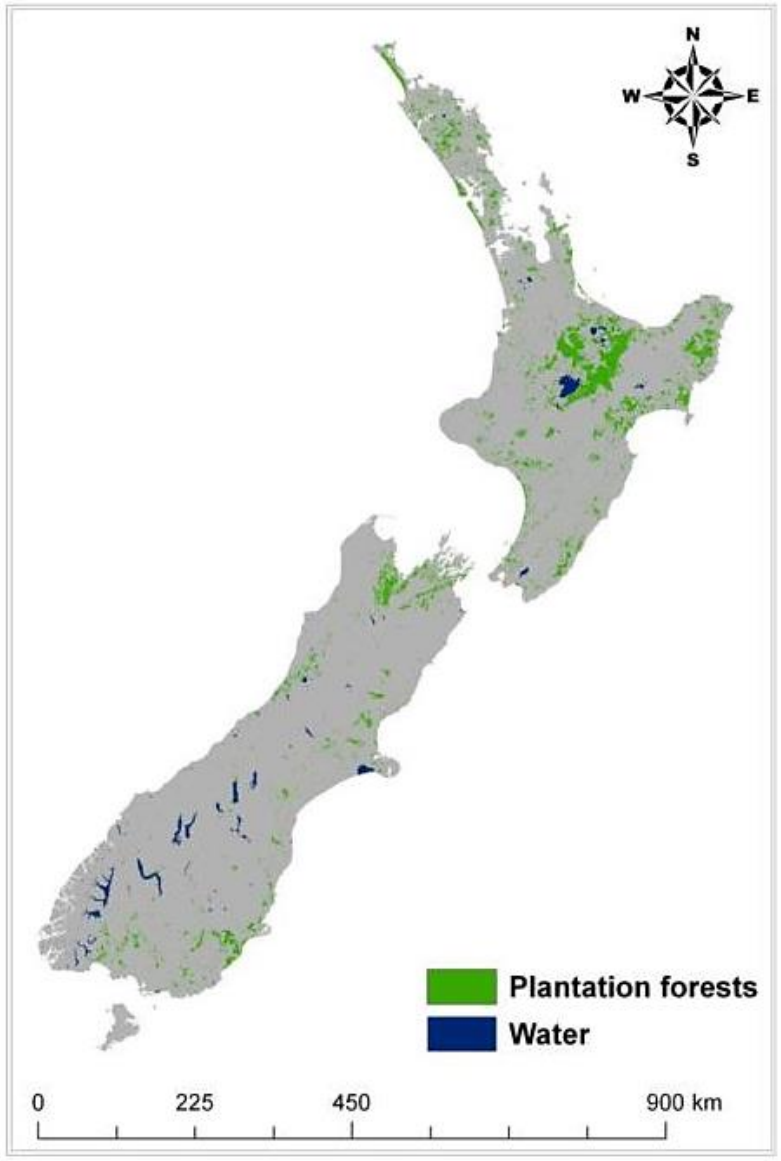
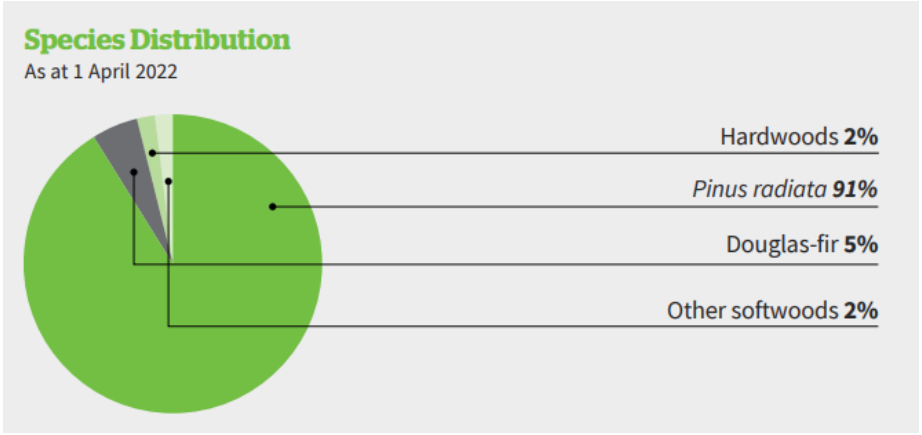
New Zealand Forests Overview



- 1.76 million ha (7% of total land area)
- 96% in private ownership
- 67% FSC certified
- 40% on land owned by Māori
- 91% *Pinus radiata (28yr rotation)*
- Average MAI ~ 25 $m^3ha^{-1}yr^{-1}$



85,424 ha OF PLANTATION FOREST WAS PLANTED IN 2021, COMPRISING 40,424HA OF REPLANTING AND 45,000HA OF NEW PLANTING. 1

* Forest Owners Association: Facts & Figures 2021/22. New Zealand Plantation Forest Industry. link

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New Zealand Forests Overview

In 2022 34.4 million m^3 was harvested from New Zealand forests

- 20.2M tons logs exported annually. Value of approx. $6.69 billion (FY2022/2023).
- 14.2M tons logs processed in New Zealand annually (9.6T sawlogs, 2.9M pulp, 0.9M reconstructed panels, 0.4M poles and 0.3M chip for export).

* Forest Owners Association: Facts & Figures 2021/22. New Zealand Plantation Forest Industry. link

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New Zealand Nursery Industry Overview

Tree Stock Sales from 2014 to 2022 (millions)

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Pinus radiata	64.6	48.5	47.2	45.8	49.3	48	56.6	84	88.4	91.8	114
Other	7.9	5.7	3.6	3.8	3.4	3.4	3.3	4.8	3.5	4.7	6
Total	**72.5**	**54.2**	**50.8**	**49.6**	**52.7**	**51.4**	**59.9**	**88.8**	**91.9**	**96.5**	**120**

* Forest Owners Association: Facts & Figures 2021/22. New Zealand Plantation Forest Industry. link

- There are 24 commercial forestry nurseries in New Zealand.
- Approximately 90% of *P. radiata* in New Zealand is grown in open ground as a bareroot crop.
- Tree prices vary from about $450/1000 for OP seedlings, to $1200+/1000 for clonal cuttings.

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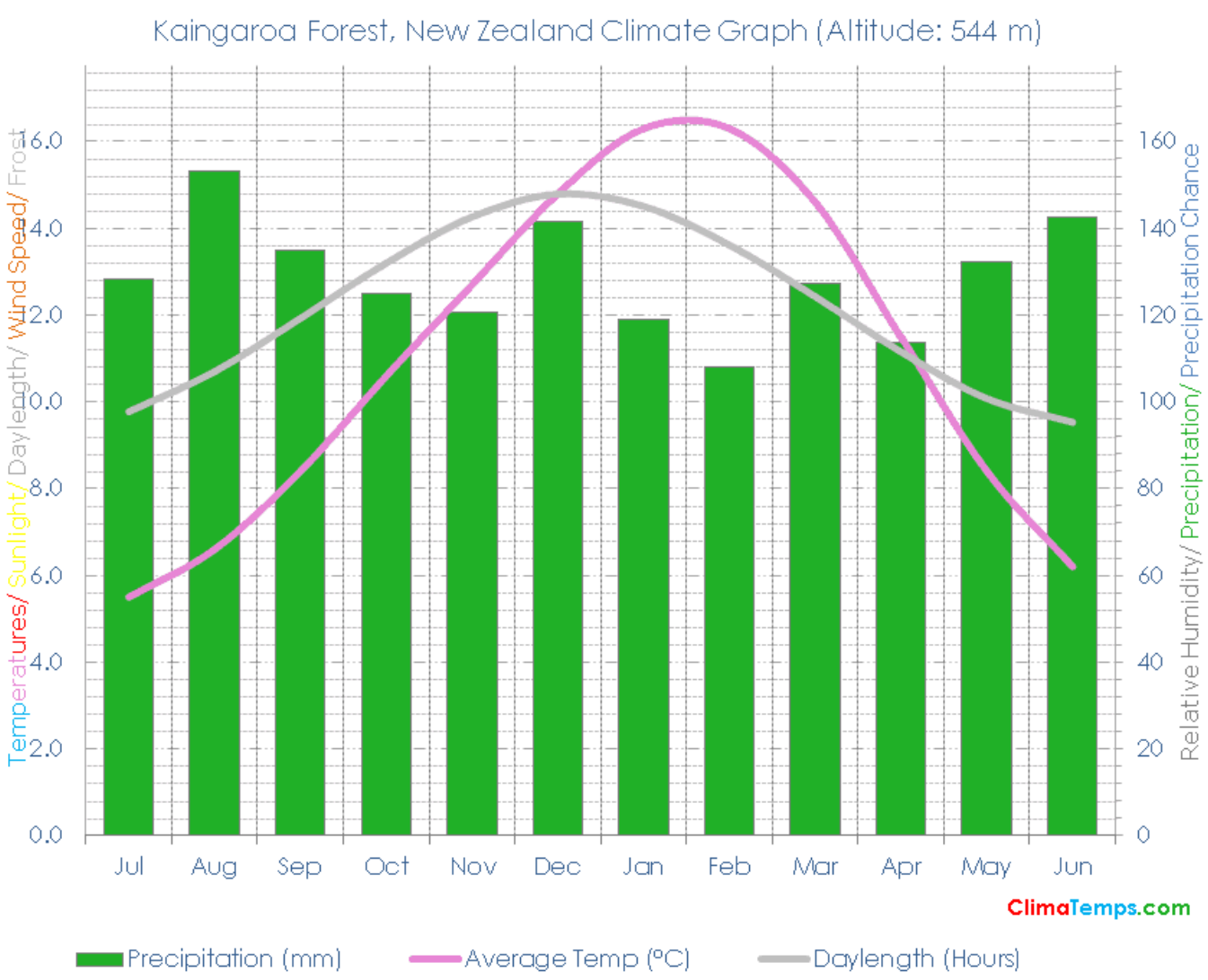
NZ Climate – A perfect fit for bareroot crops



- Mean annual temperature 11-12ºC. Mean annual rainfall 1285 - 1546mm.
- Consistent rainfall, peaking over winter.
- Partial dormancy in *P. radiata* over winter (June, July and August).
- Low vapour pressure deficits at lifting and planting.

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New Zealand Nursery Industry Overview

https://nz.pfolsen.com/market-info-news/wood-matters/2016/february/pf-olsen-container-grown-seedlings-out-performed-bare-root-seedlings-in-field-trials/

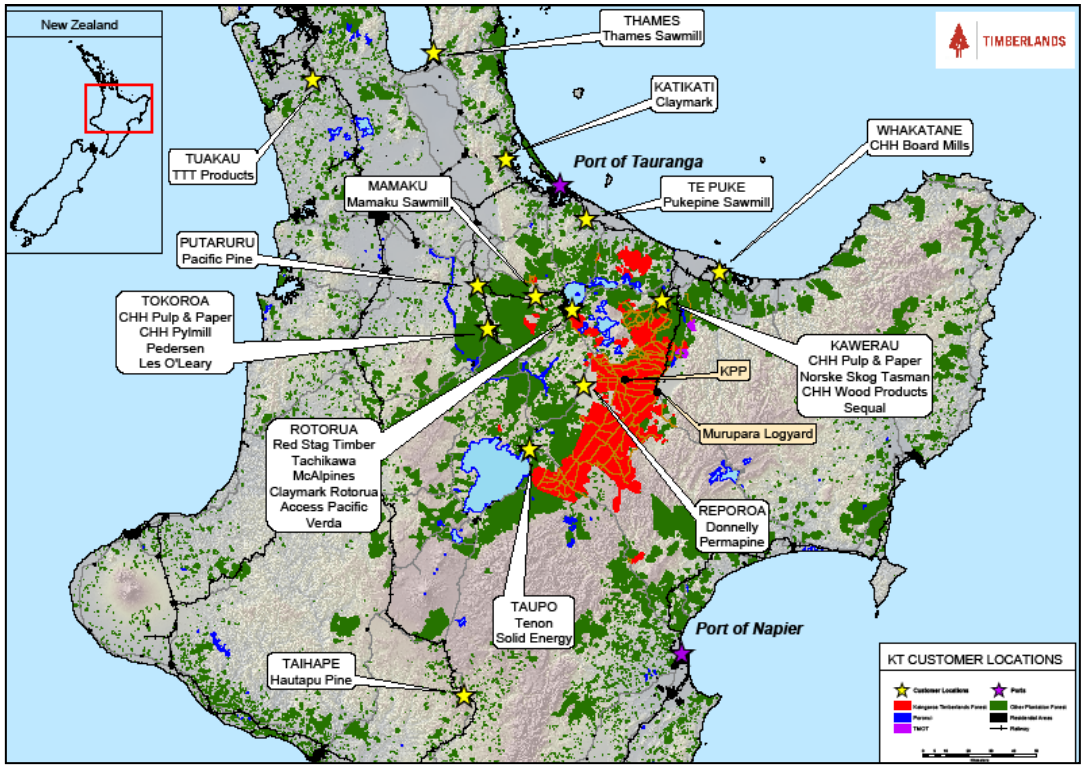
Bareroot production vs Containerised production

- Low nursery setup costs.
- Labour intensive with low mechanization and automation.
- Large land requirement.
- Highly seasonal production and planting times.
- Planting stock generally considered ‘tough’ by industry.
- Industry example: *Murray’s nursery, Woodville. Approx 50ha and 9 million bareroot P. radiata pa.*

- High nursery setup costs.
- Good mechanization and automation.
- Lower land requirement.
- More flexible production times and wider planting windows.
- Planting stock (erroneously) sometimes considered ‘softer’ by industry.
- Industry example: *PF Olsen Nursery, Waiuku. Approx 6ha and 5 million P. radiata pa.*

Overview of Timberlands Forestry

- KT is a partnership of investors who own the forest plantation (trees only and some assets): 55.5% PSP (Canada), 42% NZ Super Fund, 2.5% Kakano (iwi)
- 200,000 ha plantation.
- Significant infrastructure: Kaingaroa Processing Plant, Murupara Rail Yard, Forest Genetics and Te Ngae & Rerewhakaaitu nurseries.
- Iwi (Māori) owned land.



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Overview of Timberlands Forestry

- **Species:**
  - 95% Radiata pine, 4% Douglas-fir, 1% Other species
- **Re-establishment programme**: 6,500-7,500 ha/year
- **Thinning programme:** 10,000 ha/year
- **Harvest volume:** (4.8M tonnes)
  - 4.3M radiata pine in F24
  - 230K Douglas-fir (sunset)
  - 10K other species
  - 250K production (commercial) thinning
- 60-70% by volume is domestic and balance exported.
- FSC & PEFC certified.
- High biological productivity
  - MAI ~ 28 m^3/ha/yr
  - 28-year rotation

Timberlands Nurseries

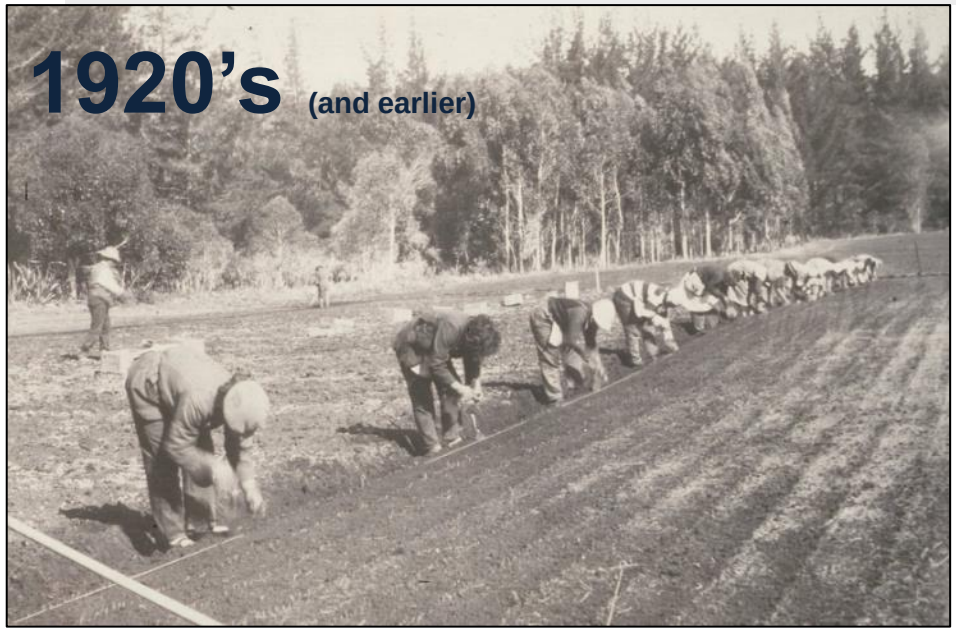
Te Ngae Nursery

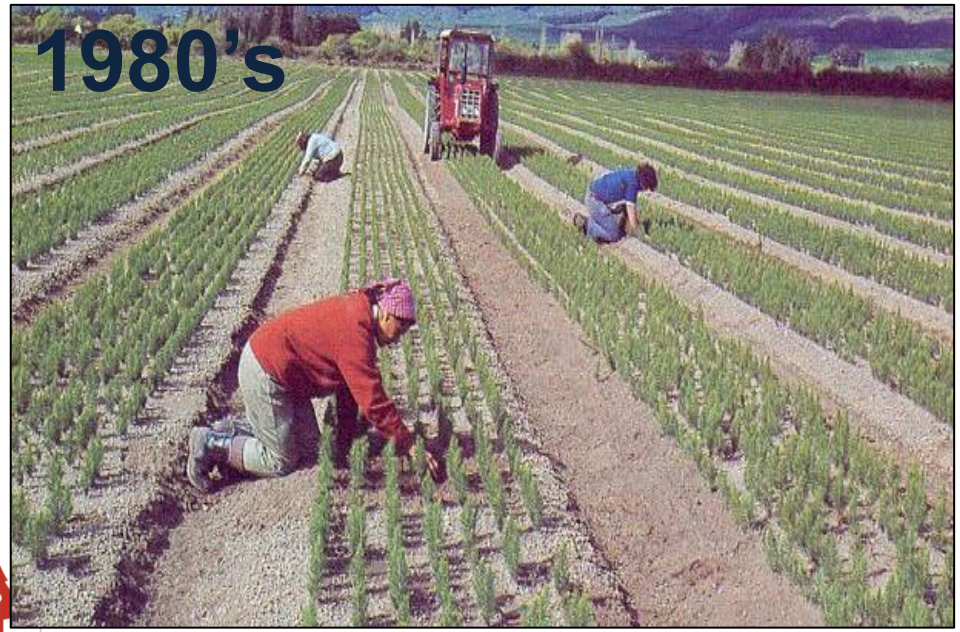
- 82 ha Nursery
  - 48ha Bareroot growing beds
  - 25ha motherstock
  - 2.7ha containerised nursery
  - 6ha other
- 12 permanent staff.
- 60-90 seasonal staff (April to October)
  – Guarantee living wage of $27.80 / hr.

- Set and sow 11.5 - 12.5M cuttings / seed pa (May to September)
  - Require 100 – 120 kg of control pollinated seed pa (~ 2-2.5M seedlings)
- Dispatch 7.0 – 7.5M *P. radiata* pa (May to September) ~ 65% OTG
- 66% Bareroot : 34% Containerised
- 30% clonal cuttings : 40% Family cuttings : 30% Seedlings (CP)

- New bareroot nursery (125ha) under construction

Threats to the bareroot crop





- Bareroot propagation has been highly successful for the past 100 years, so why change?

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Threats to the bare root crop – Labour supply

New Zealand faces labour shortages in nurseries and planting crews.

- Highly seasonal work.
- Rely heavily on a low skilled migrant labour force.
- Labour costs are high : Minimum wage = $23.15 per hour (R246.46), Living wage = $27.80 per hour (R295.96).

$400 a day to plant trees but no-one wants the job

Heather Chalmers · 14:26, Jan 16 2019

What do we need:

- Job security through year-round production.
- Longer planting season.
- Attractive to a skilled workforce.
- Automation of menial tasks through mechanization and robotics.
- Improved working conditions and ergonomics.

https://risutec.fi/pm-tree-planting-machine/

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Threats to the bare root crop – Climate change

New Zealand faces increasing temperatures, less rainfall in the north and less predictable rainfall.

- Very few bareroot seedling nurseries currently irrigate their crops.
- Bareroot cutting crops rely heavily on current environmental conditions, in winter, for success.
- Deployment of bareroot crops rely on partial dormancy of trees as well as cold, wet lifting and establishment conditions.

What do we need:

- Improved environmental control during production (as with containerised growing).
- Tree stock types able to survive highly variable planting conditions (as currently experienced over autumn and spring, where containerised trees are deployed).

Threats to the bare root crop – Legislation

New Zealand faces increasing social and governmental pressures around chemical and water use.

- Fewer of the chemicals needed for bareroot crops are permitted.
- Decreasing social license to operate with high water and fertilizer use.
- High intensity cropping, without soil sterilisation leads to high pathogen build up.

What do we need:

- Improved disease management through environmentally friendly systems like UV-light sterilisation.
- Stopping re-using growing media.
- Better water management, including capture, sterilization and re-use.
- Non-chemical or well targeted weed management

Weiland, Jerry & Littke, Will & Haase, Diane. (2013). Forest nurseries face critical choices with the loss of methyl bromide fumigation. California Agriculture. 67. 153-161. 10.3733/ca.v067n03p153.

Nonfumigated plot shows disease and weed pressure, right foreground. Fumigated plot is in Background. (USA)

Opportunity for containerised stock

- Job security through year-round production.
- Increased planting season.
- Quick adoption of existing technologies for automation of menial tasks through mechanization and robotics.
- Smaller, more skilled workforce required.
- Improved working conditions and ergonomics.
- Controlled environments for production.
- Tree stock types that improve establishment, with reduced transplant shock.
- Improved disease management through environmentally friendly systems like UV- light.
- Better water management, including capture, sterilization and re-use.
- Reduced reliance on chemicals for disease and weed management.

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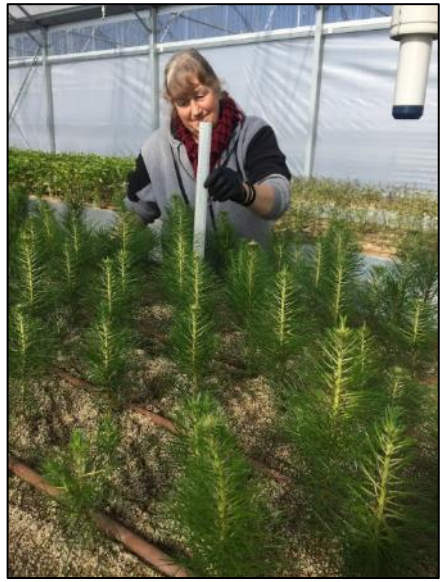
Recent containerised stock research

Aiming at year-round *P. radiata* nursery production and longer planting windows, recognizing the need to mechanise operations.



- Extending the planting season and preparing for field mechanization with containerised cuttings.
- A mini-hedge cutting system for year-round *P. radiata cutting* propagation.
- Use of paper pots to improve nursery efficiencies and dispatch, and field establishment.

A nursery production system to help meet our changing forestry needs. Ford, C, Lloyd, A. October 2021. Forest Growers Research Conference, 2021.

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FOREST GROWERS RESEARCH

Recent containerised stock research

Extending the planting season and preparing for field mechanization with containerised cuttings.

Stock types tested were:

- Transplant systems TS48 trays (125cm^3).
- Paper pots from Ellepot (x3), BCC and PlantPaper (held in Hiko V150's) (125cm^3).
- Two bareroot treatments – July and November settings.

Rooted cutting in a paper pot in June 2019.

Containerised paper pot trial plants on the tables in September 2019.

Transplant systems TS48 tray with radiata cuttings

(Image from: https://www.transplantsystems.co.nz/media/commerce_products/92/features/48_cell_tray-slide_965xa.jpg)

Recent containerised stock research

Extending the planting season and preparing for field mechanization with containerised cuttings.

- Cuttings set in November 2019, were planted monthly from March 2019 to October 2019. Winter (June) bareroot were included as a control.

Donald Epapara planting out the first month's treatments on 5 March 2019.

- Cuttings planted in March were 4 months old (from setting date). Crop cycle is normally 12-14 months.
- Conditions in March were very dry. No water was applied at planting.

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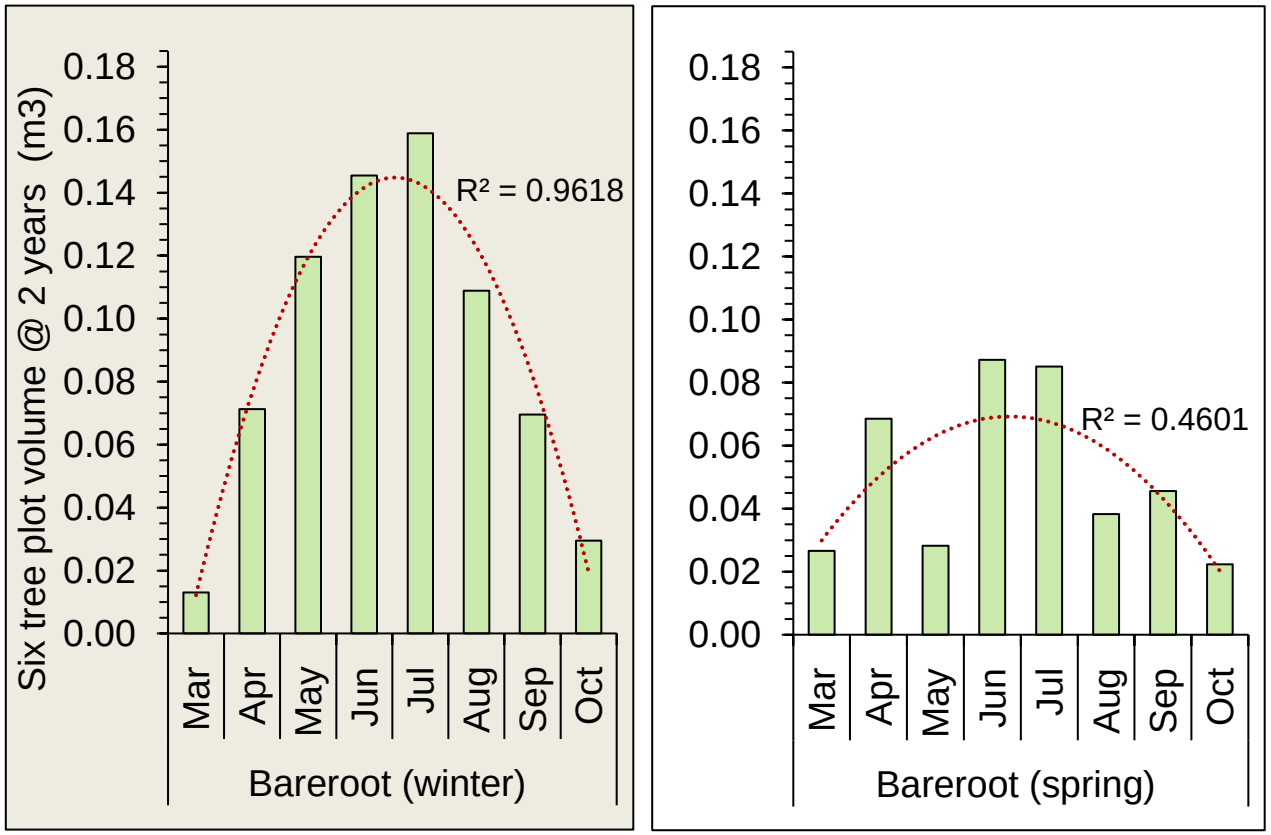
Recent containerised stock research

Extending the planting season and preparing for field mechanization with containerised cuttings.

- Winter set bare root did favourably over winter planting but poorly outside that window, as we would have expected from experience.



$p_{month} < 0.001$
$p_{method} < 0.001$
$p_{month.method} = 0.056$

- Bareroot cuttings set in November did poorly across all planting months, despite increasing age at planting.

FOREST GROWERS RESEARCH

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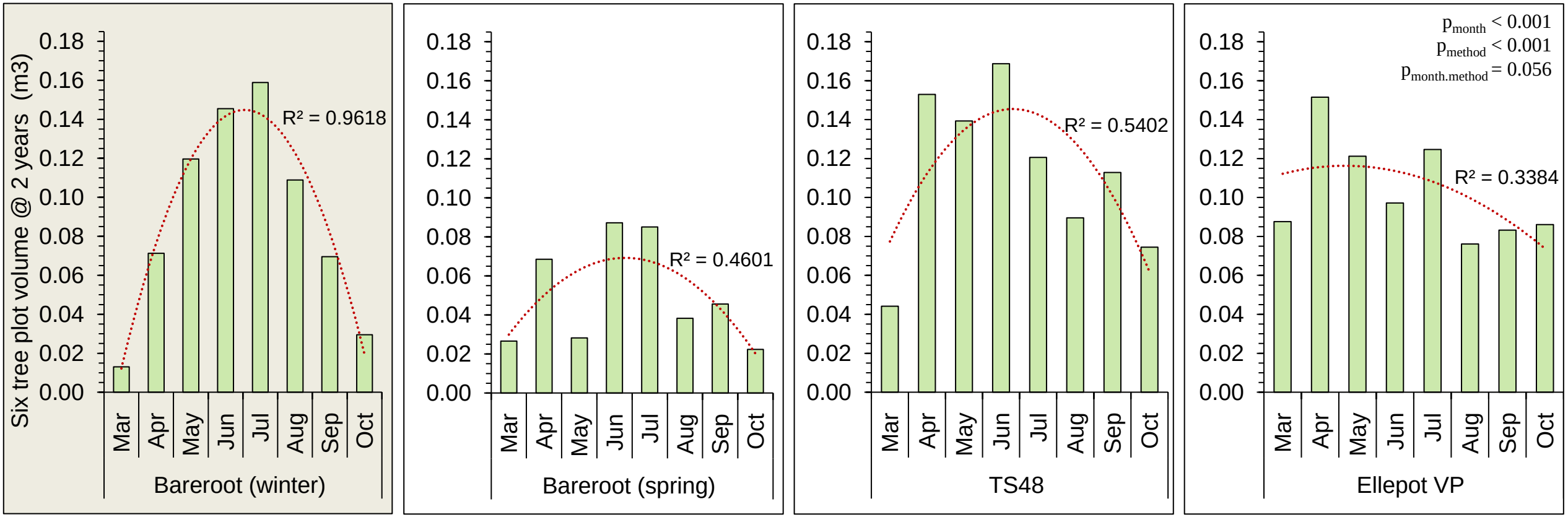
Recent containerised stock research

Extending the planting season and preparing for field mechanization with containerised cuttings.

- The TS48 plugs did as well, or better, than the winter set bareroot control in most months and did significantly better than bareroot cuttings of the same age, but did poorly in March.
- The paper pots showed good overall survival and growth and outperformed both bareroot and the TS48 treatments in March (at 4 months of age).



Recent containerised stock research

Extending the planting season and preparing for field mechanization with containerised cuttings.

- This trial has reinforced that containerised *P. radiata* can be used to extend the planting window.
- Radiata cuttings can be harvested and set outside of winter and still be ready to plant by the next planting season and successfully establish in field. Our nursery growing season can therefore be reduced.
- In addition to nursery handling benefits, paper pots may provide some early establishment security, where plugs may not yet be full consolidated or planting sites are harsh.

Field trial March 2019

Field trial January 2020

Field trial June 2021

Early container trials – Scion Nursery

A mini-hedge cutting system for year-round *P. radiata* cutting propagation.

Clonal macro-hedges at Rerewhakaaitu Nursery on 1 March 2024

Clonal mini-hedges in sandbeds at Scion in August 2021

Mini-hedge cutting system

- Clonal or CP seedlings established as containerised mother stock in an enclosed environment.
- Cuttings harvested every 2-3 weeks and rooted in a controlled rooting environment.

FOREST GROWERS RESEARCH

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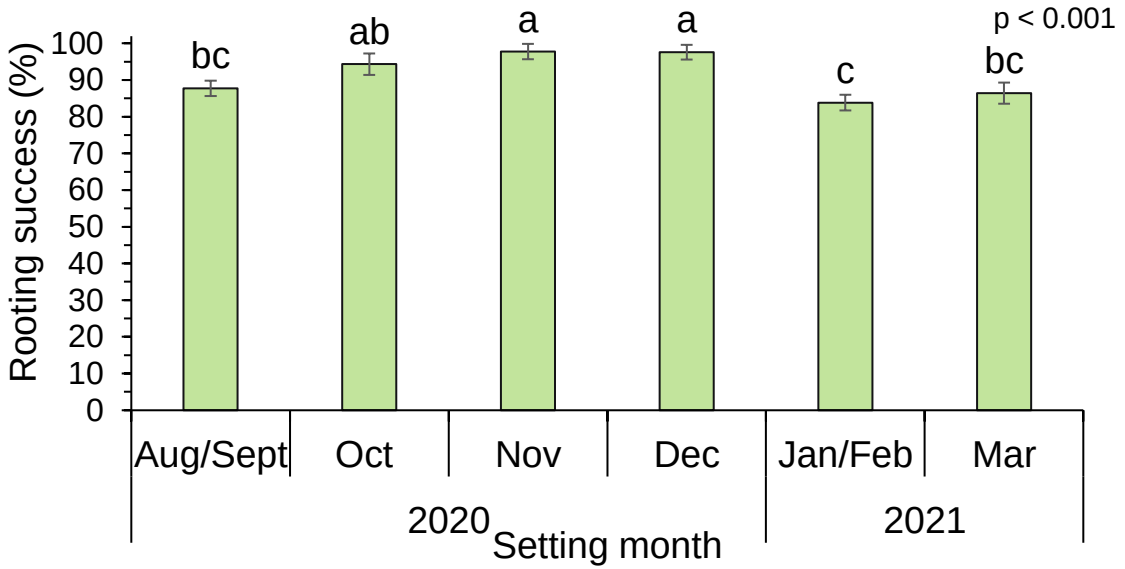
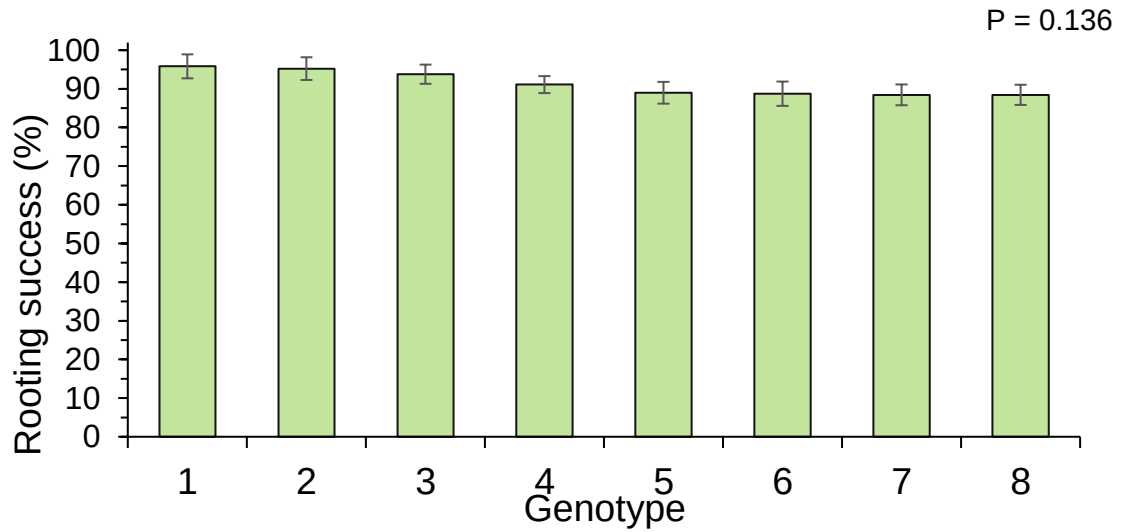
Early container trials – Scion Nursery

A mini-hedge cutting system for year-round *P. radiata* cutting propagation.

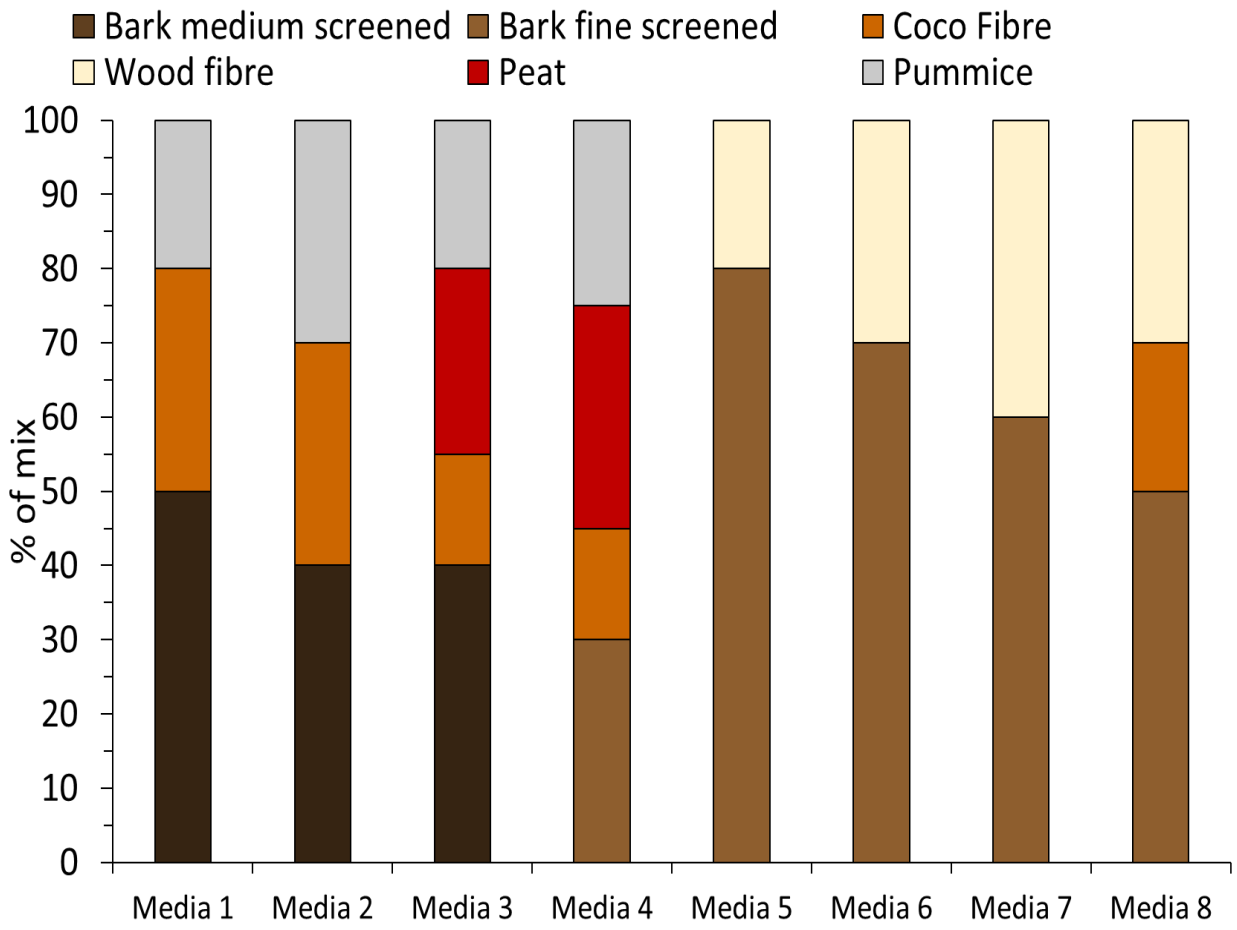
- *P. radiata* mini-cuttings set monthly, into Ellepots, at Scion from Aug 2020 to Mar 2021 (52 000 set in total). (*Bareroot cuttings from macro-hedges can only be set May – August*.)
- Rooting success between 84 – 98% across August to March (Average of 91%), with November and December doing best.
- Rooting success between genotypes ranged from 88 to 96%, but differences were not statistically significant.
- Typical rooting of clonal macro-cuttings is normally between 55-60%.





Ellepot propagation trials at Timberlands

Te Ngae Nursery Trials – matching media to container type



- 8 growing media options (some current, some new).
- 2 tray types (Transplant systems TS48 and Ellepot 4cm).
- Media volume = 125cc.
- Lifted early in the season.

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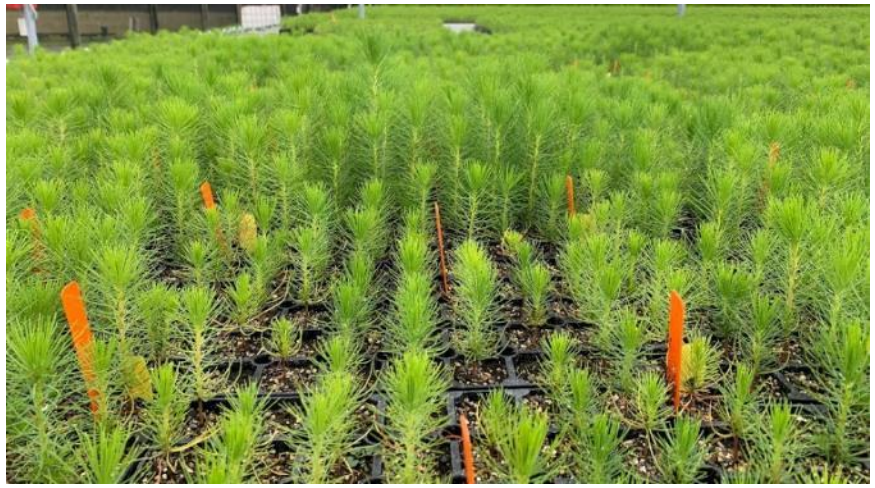
Ellepot propagation trials at Timberlands

Te Ngae Nursery Trials – matching media to container type

TS48 – Media 3

Ellepot – Media 4

- Historically, Te Ngae's container facility has lifted *P. radiata* seedlings at 70-80%.
- The 2022-2023 growing season (October- March) was the worst in 40 years with rarely more than 3 days of consecutive sunshine and 30mm of additional rainfall per week on average.
- This impacted growth directly and increased pathogen populations.



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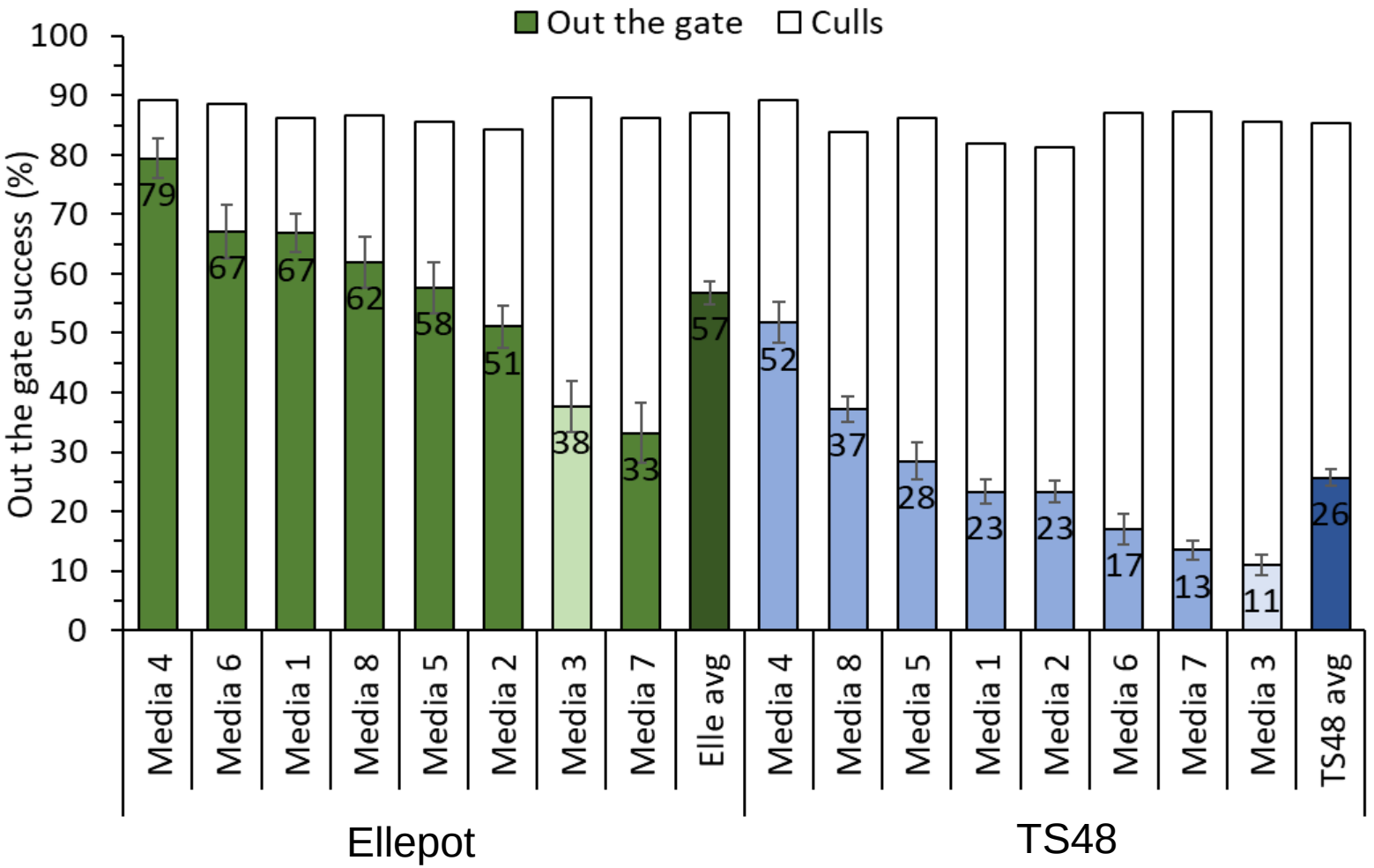
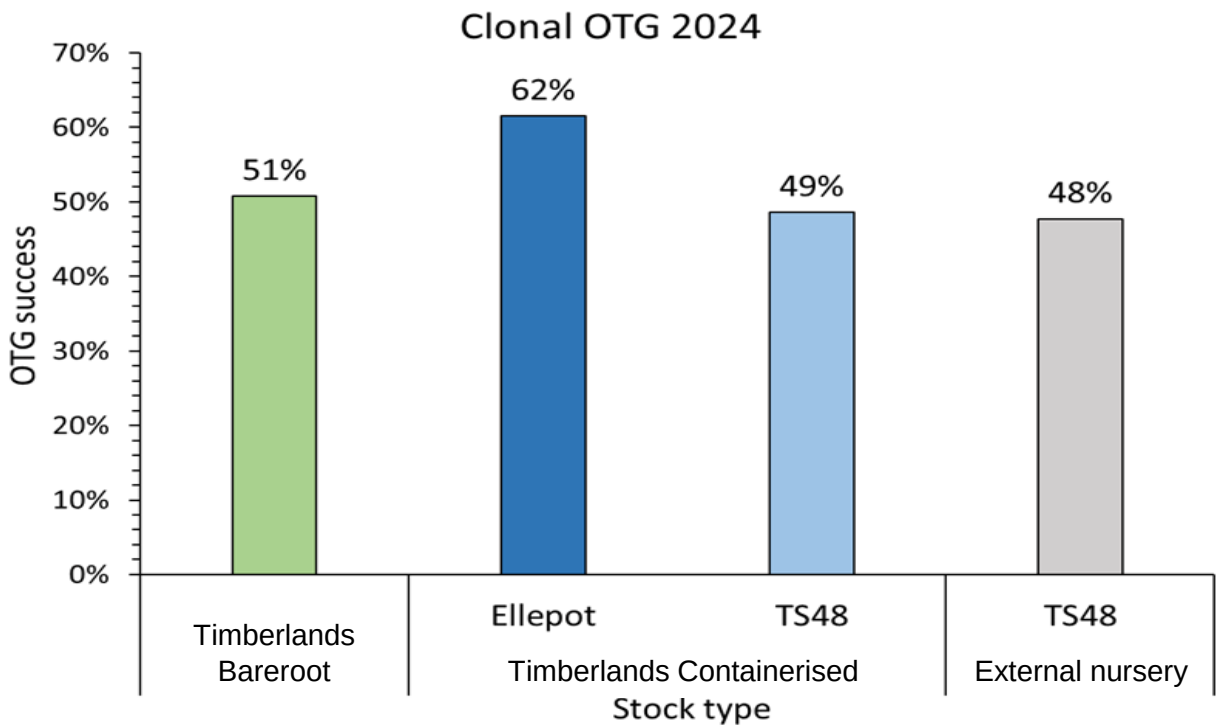
Ellepot propagation trials at Timberlands

Te Ngae Nursery Trials – matching media to container type



- Survival across all media and container types was good (85-90%).
- Out-the-gate success was greatly impacted by the poor growing conditions, with poor root growth.
- Media 4, specifically designed for use in Ellepots, proved the best media in both tray types.
- Some alternative, more environmentally friendly, mixes showed promise!
- Ellepots lifted with more than twice the success of the current industry standard tray.

2024 Clonal dispatch results at Timberlands



- Historically, Te Ngae's container facility has lifted *P. radiata* clonal cuttings at 50-60%. This season was a slightly more challenging one.
- Clones in Ellepots lifted 11% higher than the same clones in bareroot (62% vs 51%).
- Two clones in Ellepots were dispatched in May at 76% and 66%! They are normally only ready in September.

Concluding thoughts

- Bareroot production of *P. radiata*, in New Zealand, has been a highly successful deployment method, and is currently the foundation of forestry in the country.
- There are increasing pressures on the status quo in New Zealand forestry, for which containerised growing presents a very suitable alternative.
- Global and local experience have highlighted that the Ellepot system provides further advantages over other containerised systems.
- Timberlands are leading the way in testing and deploying new technologies, like Ellepot, in New Zealand and are well place to pivot entirely from bareroot if required.

Thank you

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