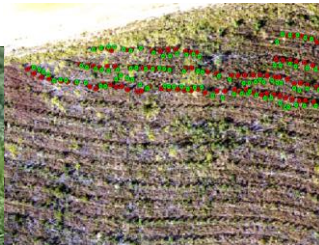


Precision Planting

Presenter: Carol Rolando/Brian Richardson

Meeting Date: 7/10/2022



Topics

- Overview of precision planting theme
- Update on key activities
- Results from precision spraying trial



Workstream overview

Aim: reduce establishment costs and increase forest value by taking advantage of the opportunities offered by a multitude of new technologies.

- Mechanisation of planting operation
 - Reducing the dependency on labour
 - Improve health and safety for planting
- Capturing data on individual trees
 - Improving planting density/implementing variable stocking rates
- Increasing the efficiency and precision of early silviculture
 - Automated weeding
 - Site specific nutrition



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Workstream overview

■ Total budget \$6.31M

- Support phased validation of new technologies
- Ensure new data collected and delivery protocols optimise value provided by new technologies
- Solutions are intuitive and designed with end-users in mind.



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What will be delivered?

Examples of outputs/technologies

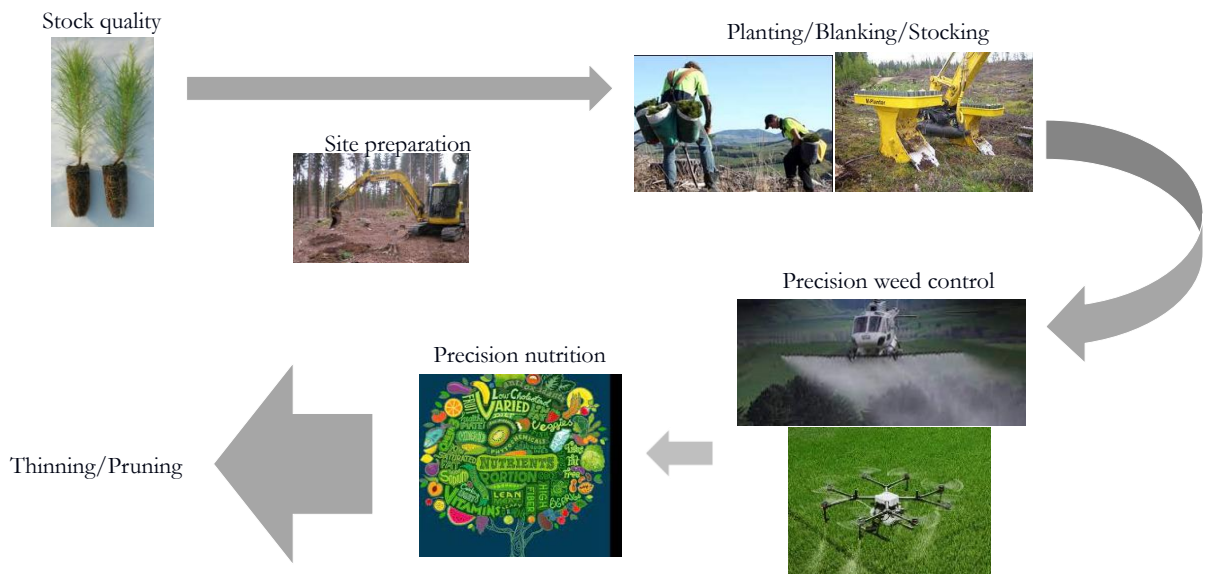
- Benchmarked and validated mechanised planting platforms
- Additives to extend the planting season (for mechanised systems)
- Specs on stock type and performance (link to Nursery Theme) and suitability for planting systems
- GPS enabled planting tools
- Automated precision spraying tools
- Customised/optimised approach to nutrition at planting/during establishment
- Optimal planting configurations (links with 4.5 Forest System Design)

Outcomes

- Confidence in mechanised planting platforms
- Solutions to optimise the economics of mechanised planting systems
- Enhanced productivity with reduced reliance on labour
- Reduced chemical and fertilizer use
- Spin-off benefits for native tree establishment

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Suite of tools to support establishment



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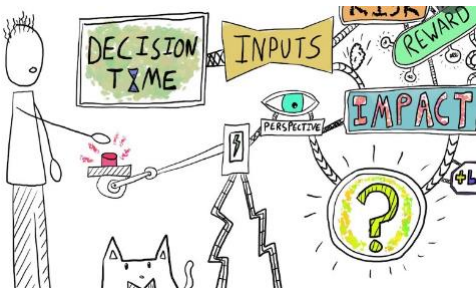
Workstream activities and timeline

No	Activity	Yr 1	Yr2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7
2.1	Validation and efficiency of mechanisation							
2.2	Data and digital							
2.3	Steep land planting							
2.4	Extended planting seasons							
2.5	Improved nutrition and vegetation management							
2.6	Next generation systems							
2.7	Manual planting							

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Critical stop/go decision points

- 2.1 Validation of (available) mechanised planting platforms
 - A critical first step is to benchmark the planting economics of internationally developed technology in the New Zealand setting.
- 2.3 Steep land planting
 - Site suitability studies will provide critical insight on the potential for the development of steep land planting solutions.
- 2.4 Extended planting
 - The performance of water retention systems in small scale trials will be a critical determinant for ongoing field validation and engineering design for mechanised planting systems.
- 2.7 Improved nutrition
 - Expert knowledge identifies no benefit from nutrition at planting AND/OR nursery studies fail to show significant benefits from nutrient addition



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Precision Silviculture Partnership



Where are we at?



Workstream activities and timeline

No	Activity	Yr 1	Yr2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7
2.1	Validation and efficiency of mechanisation							
2.2	Data and digital							
2.3	Steep land planting							
2.4	Extended planting							
2.5	Improved nutrition and vegetation management							
2.6	Next generation systems							
2.7	Manual planting							

2.1 Validation and efficiency of mechanised planting systems

Aim: Benchmark the performance of currently available mechanised tree planting systems in the NZ environment and implement solutions to optimise their efficiency.

If currently available systems not suitable for NZ then possibility the programme could fund development of bespoke solution

Milestone	Stop/Go (tick)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Mechanised planting economics are benchmarked in a scaled setting	x							
System design improvements are developed and prototype testing is complete								
Early tree stock performance is characterised								
Human factors assessment is complete								
Planting configurations are optimised								
Production prototype unit is built and optimised planting designs are available								

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2.1 Progress

- Technology scan of precision planting technologies completed Q4: 21-22
- Aim: to identify opportunities to adopt technologies for NZ forestry.
- Key recommendations:
 - International move to mechanisation (adoption in SA and South America of Scandinavian technologies) – reduce dependence on labour
 - Real opportunity in the capture of location data at planting
 - Shift to mechanisation will require industry to review whole system impacts:
 - Pros and cons of bare-root vs container planting stock
 - Maximising no. operations machine can complete and period over which planting occurs
 - Upskilling workforce

Novelquip – Proplant 1 – South Africa



Risutec



Pottiputki planting tube



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2.1 Progress

- Forest companies are already driving the innovation and testing of planting machines
- 2 mechanized planting systems (soon to be) in NZ: M-Planter and Plantma-X
 - Pan-Pac trialling Plantma-X March-September 2023.
 - Manulife and Timberlands trialling M-Planter, with others interested in trialling.



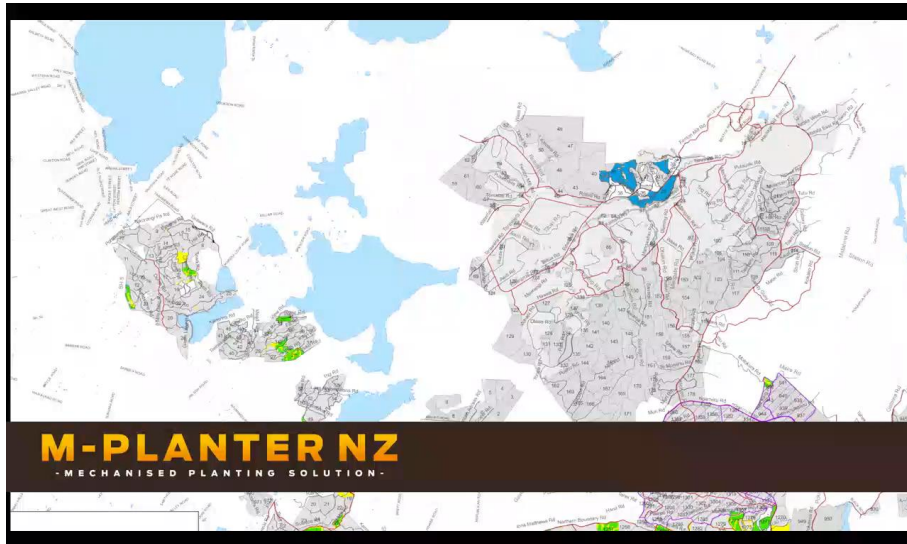
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Plantma-X



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M-Planter



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2.1 Progress

- Role for Precision Silviculture Programme
 - Benchmarking performance (**productivity and planting success**) using consistent approach to trials across industry and supporting quality data collection.
 - Supporting system upgrades/analysis of work-flows and interventions to increase efficiency
 - Providing platform across industry to share data/outcomes
 - Identifying the fundamental science to underpin whole of system success.
 - Evaluate worker performance/optmise for human factors
- Approach (22/23)
 - Agree with industry how to benchmark economics of current systems using consist approach (Oct)
 - Implement trials with interested stakeholders (November >)
 - Link with nursery theme on evaluating stock quality specs and out-planting performance as well as 2.4 Extended Planting.

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2.1 Planting Stock Performance

- Increase in mechanisation could see shift from bare-root to container stock.
- Stock quality specifications and out-planting performance (NZ) based on research conducted pre-2000 with little to no information on what constitutes quality container stock (seedling or cutting).
- Availability of new container systems (e.g. Ellepot/paper pot) shift the goal posts again!
- Is there a requirement to evaluate:
 - the current status of knowledge re- quality plant specs for NZ
 - trials on performance of container vs bareroot systems in NZ?
 - whole of system (biological and economic) impacts through industry shift to container plants?



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2.4 Extended Planting

Aim: investigate solutions to widen the planting window to improve utilisation of planting machines

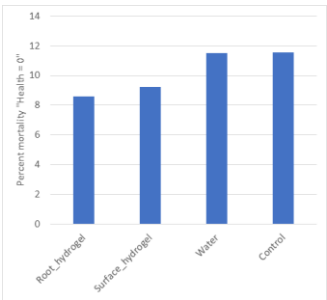
Milestones	Stop/Go (tick)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
A review of water retention systems is complete								
Matrix systems are tested and optimised at nursery scale	X							
Engineering designs for matrix delivery systems are developed								
Prototype delivery systems are built and tested								
Prototype systems (delivery and matrix) are tested in a variety of geospatial settings								
Tree performance across sites is validated								

- “Go Early” High level review and early trial funded in March 2022
 - Trial with M-Planter at a site in Tarawera Forest planted in April 2022
 - 4 treatments: no water, 500 mL water, 500 mL hydrogel applied to root zone, 500 mL hydrogen applied to surface of mound.
 - Used a nanocellulose hydrogel produced by Scion

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2.4 Progress

- Early results
- Approach 22/23
 - Implement additional trials with interested companies 22/23.
 - Investigate:
 - Rates and placement of hydrogel
 - Opportunity to include other growth stimulants/hydrogels
 - Performance across a range of soil types
 - Integration with mechanised systems



2.6 Improved nutrition and vegetation management

- Aim – evaluate opportunities offered by new technologies to optimise early growth
- Initial focus was on nutrition only but GG approved inclusion of precision vegetation management
- Trial for precision weed control already on the go

Milestone	Stop/Go (tick)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
A review of controlled release fertilisers and growth stimulants is complete								
Nursery studies assessing tree growth and nutrient retention for a selection of fertilisers and stimulants are complete	x							
Trials assessing in-field delivery of additives vs pre-inoculation of containerised stock are performed								
Engineering designs for automated additive delivery are developed (in-field or in-nursery as appropriate)								
Prototyping is completed and a production-ready prototype produced								

2.6 Fertilization at planting

- Is there any evidence of a benefit from application of fertiliser at planting?
- Do we need to review?
- Linked to seedling quality work – better to fertilize seedlings in the nursery?
- Evaluate other opportunities to optimize early nutrition with new technologies.



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2.7 Manual Planting

Aim – improve efficiency of manual planting – focus on GPS enabled spade

Milestones	Stop/Go (tick)	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Key in-field performance criteria will be established and a GPS technology review is undertaken								
Selection of suitable systems for further validation will be made								
System precision is assessed using a variety of static and mobile configurations, across geospatial settings	X							
Human factors assessment is complete								
Mobile device applications are designed and developed								
Micro-processing designs are created and 3D printed prototypes are produced								
Data delivery protocols are developed and systems integration is complete								
Prototype systems are field-trialled and optimised								

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2.7 Description of GPS enabled spade

- HAF Ltd has developed a GPS enabled planting spade handle and associated smart phone app.
- Handle can be fitted to spades already in use.
- Each time tree planted, button on handle pushed to record tree location (uses GNSS satellite system).
- Location data sent via Bluetooth to smart phone app to be downloaded at end of day.
- App includes barcode/QR scanner to track details of stock from nursery to field.
- Launch of SouthPan (Southern Position Augmentation Network) will likely increase accuracy to within 30 cm.



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2.7 Benefits from use of spade

- Unique location for each tree
- Assist machine learning/post-planting mapping of tree location
- Early stocking data
- **Next steps** – Programme will be trialling spades in NZ (Jan>)
- Interest in trials welcome!
- Accurate recording of seedling batch and location (nursery to field tracking)
- Ability to analyse survival (time, location) with environmental conditions and planter
- Initial trials conducted by HQP plantations have received favourable review

GPS Enabled Spade Handle Field Test Data



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Focus for 22-23

- Quantify the effectiveness of mechanised planting through implementation of field trials (2.1)
- Initiate review on planting stock performance and specifications for quality planting stock (containerised vs bareroot, cutting vs seedling) (2.1)
- Progress the extended planting season project with additional small-scale field trials (2.4).
- Progress evaluation and testing of automated release spraying (with SPS) (2.5)
- Identify next steps for progress of improved nutrition studies (2.5)
- Initiate testing and improvements of a new high-spec planting spade (2.7).

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For discussion/consideration

- Review on planting stock quality and performance
- Review evidence for benefits of fertilization at planting
- Expressions of interest in:
 - Mechanised planting trials
 - Extended planting season trials
 - GPS enabled spade trials

Precision Silviculture Partnership

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