Mechanised Planting Industry Scan

Final report

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Forest & Wood Products Australia

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Prepared for

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by

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Executive Summary

Mechanised tree planting is rapidly gaining strategic importance for forest growers and contractors across Australia and New Zealand as the sector faces tightening labour supply, increasing safety expectations and the demand for more consistent establishment outcomes. Although interest is high, adoption remains in an early phase: most operations currently consist of trials, single-machine deployments and short-term contracts that has limited the rate of investment and industry-wide learning.

This industry scan consolidates current knowledge, operational experience and stakeholder perspectives gathered from growers, contractors, manufacturers and research organisations. It provides a comprehensive summary of machine capabilities, the conditions under which they perform well, the constraints limiting adoption and the opportunities for coordinated industry development.

Information gathered is presented under the following scope themes:

- Current use
- Machine capabilities
- Decision-making
- Performance in conditions
- Seedling survival and health
- Modifications
- Extent of adoption
- Problems encountered
- Future plans.

The key messages are:

1. Productivity and cost parity with manual planting are insufficient metrics on their own - mechanised planting should be evaluated on whole-of-operation and whole-of-rotation value.
2. Multi-year contracting and co-investment will improve opportunities for adoption and scaling.
3. Nursery specifications and seedling handling are important considerations for overall logistics and operational implementation.
4. Systematic, replicated trials with standardised reporting and commitments to long-term monitoring will assist with building durable evidence and confidence.

Adoption drivers

The strongest motivations for considering mechanised planting relate to safety and labour. Manual planting on steep or slash-heavy second-rotation (2R) sites is physically strenuous and brings associated risks of slips, trips and falls. Seasonal labour is expected to become increasingly difficult to source and retain. Both growers and contractors see potential for improved survival, early vigour and greater efficiency when irrigation, fertiliser and precise microsite preparation are integrated at planting. Single-pass capability - replacing multiple site-preparation and pre-and post-planting treatments - offers further economic and environmental advantages.

Operational performance
Machine performance is highly dependent on-site conditions, machine type and seedling stock characteristics. Forwarder-based systems deliver the highest throughput on gentle, uniform terrain, particularly first-rotation (1R) sites with low or no levels of slash. Excavator-mounted systems provide superior manoeuvrability and planting quality on 2R sites, variable sites and steep terrain. Early evidence suggests improved seedling stability, survival and early growth when planting stock is well matched to machine requirements. Additional gains are possible when integrated irrigation and fertiliser systems are used. However, the current evidence base remains limited and relies largely on short-term or anecdotal observations.

Key constraints
Barriers to adoption at scale are significant. Many factors, including high capital cost, uncertain seasonal utilisation, terrain limitations, variable performance of different sites, short contract periods and seasonal demand are influencing contractor investment decisions. As machines are sourced from Europe, support and parts availability can be challenging. Operations are constrained by the need for significant modifications to deal with local conditions and to work effectively on 2R sites with heavy slash and root loads. Logistics issues, particularly seedling handling and stock compatibility, frequently reduce machine productivity. Skilled operators are also in short supply, with limited structured training pathways.

Industry readiness
The majority of growers surveyed remain cautious. While many are open to further trials, only a small proportion use mechanised planting operationally at present. Contractor responses tended to be more optimistic, but they would like to see multi-year certainty to scale fleets and refine equipment. Balancing financial risk with operational concerns is a fundamental issue.

Strategic opportunities
Clear opportunities exist to accelerate adoption and build an evidence base that supports long-term investment. A coordinated 3–5 year mechanised planting program could combine multi-year contracting, cost-sharing, machine leasing/shared fleets and structured trials across multiple sites and conditions. Establishing a trans-Tasman mechanised planting network would strengthen knowledge exchange, standardise performance reporting and improve nursery–grower–contractor collaboration. The integration of GNSS-based tree-level data into broader forest management systems offers further gains for whole-of-rotation planning, auditability and harvest efficiency.

With targeted support, partnerships between contractors, growers and manufacturers and a shift toward whole-of-rotation evaluation, mechanised planting has the potential to reduce establishment risk, improve safety and deliver more uniform and higher-quality forest establishment across Australia and New Zealand.

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Introduction

Over the last five to ten years, Australian and New Zealand forestry companies, contractors and research entities have been investigating a range of mechanised planting systems. The main stated drivers for considering a move to mechanised planting have been to improve safety performance and to mitigate potential labour constraints.

There has been limited published reporting on mechanised planting topics: Anon (2021), Ghaffariyan (2021), Petro (2022), Bayne *et al* (2023) and Dickson *et al* (2025). Additional information and updates about trials in Australian and New Zealand have been provided at ForestTech conference presentations in Australia and New Zealand: Sutton (2020), Svyanen (2022), Fear (2022), Baker (2022), Valencia (2022), Sutton (2022), Walpole and Wood (2023), Airey (2023), Andreis (2024), White (2024) and Hooper (2025).

Early investigations into the feasibility of mechanised planting tended to focus on the capacity of machines to plant at similar rates to manual planters. Using this metric alone as the basis of comparison makes it difficult to make the business case for the high capital cost of mechanised planting machines.

This narrow comparison can obscure the broader operational case: modern mechanised planters can combine many functions - spot cultivation, ripping/mounding, fertiliser and herbicide application, irrigation and precise tree location - potentially reducing passes, emissions and total establishment cost while improving quality and auditability. Anecdotal evidence also indicates better survival and improved early growth compared to manually planted sites. Consideration of these factors and the capacity for a single-pass operation that removes the requirement for additional site preparation work may improve the economics of mechanised planting operations.

Individual growers and contractors have been conducting operational trials over this time, but little information about them or contemporary attitudes to mechanised planting is available. Forest and Wood Products Australia (FWPA) requested an industry scan to better inform future research, collaboration and information sharing between growers, contractors and researchers.

This report synthesises current knowledge and stakeholder feedback and is structured around the following scope areas agreed with FWPA:

- Current use
- Machine capabilities
- Decision-making
- Performance in conditions
- Seedling survival and health
- Modifications
- Extent of adoption
- Problems encountered
- Future plans.

Unless noted otherwise, content is derived from survey responses received from growers, contractors, research entities and manufacturers at the end of 2025 and notes collated from follow-up interviews and internet searches conducted in early 2026. Figures and examples are indicative and should be interpreted in the context of local site conditions, species, machine configuration and operator experience.

The main focus of the survey was growers and contractors, with 52 surveys emailed to growers and contractors in Australia and New Zealand. A link to the grower/contractor survey was also shared on LinkedIn, so the full extent of the target audience is not known.

A separate survey was emailed directly to nine research organisations and nine manufacturers/distributors.

A summary of the responses received to the online surveys is shown below:

Survey target	Responses received
Growers	26
Contractors	9
Research entities	7
Manufacturers and distributors	4

Appendix 2 summarises the survey theme areas and a high-level response summary. Spreadsheets of the survey responses are available but have not been included in this report due to their size.

Follow-up discussions were also held with a subset of contractors, growers and manufacturers.

Survey summary and discussion

Current Mechanised Planting Use

Industry surveys indicate low, but growing, adoption in Australia and New Zealand. Interestingly, despite the fact that most mechanised planting hardware originates from Scandinavia, very little mechanised planting is undertaken in that area. Manner and Ursson (2021) identify that <1% of tree planting in Nordic countries is mechanised. The global mechanised planting market is still developing, with fewer than 500 units produced to date by all manufacturers worldwide[1].

Among Australian and New Zealand growers, two organisations reported current mechanised planting use, with a further seventeen signalling intent to adopt; others remain undecided or do not plan to proceed in the short term. Among contractors, five were undertaking mechanised planting operations at the time of survey. Contractors highlighted that the current reliance on trials and short-term contracts limits long-term investment certainty.

The survey results report that four contractors in Australia and New Zealand are using or have trialled excavator-mounted planting machines (Risutec, Bracke and M-Planter). One contractor is using a forwarder-towed PlantmaX operationally. A second contractor in New Zealand has been working with Forest Growers Research (FGR) to trial a leased PlantmaX, recently adapted from a forwarder-based configuration to a Morooka platform to improve manoeuvrability.

Notably, with many growers managing estates with planting rates exceeding 1,000 ha/year, there is potential to support mechanisation if operational and appropriate costing models mature. However, most current activity remains trial-oriented rather than fully commercial.

Mobile Plant / Machine Capabilities

a) Machine families and configurations

Radcliffe (2026)[2] describes how mechanised planting technology has evolved through three distinct generations. Each generation provides specific advantages for different operational contexts and terrain challenges. The three generations can be summarised as follows:

Generation 1: Tractor-Towed Planters

Continuous operation ideal for first rotation conversion of pasture to plantation. Requires manual seedling loading plus tractor operator. Best suited for large, flat, cleared land with minimal obstacles. Basic technology with significant safety considerations.

[1] Janer (*pers. comm.)* 2026

[2] Radcliffe (*pers. comm.*) 2026

Generation 2: Crane- (or Excavator-) Mounted Systems
Optimised for second rotation replanting with site preparation capabilities (ripping, mounding or scarifying), GNSS tracking and optional integrated fertiliser and herbicide application and irrigation systems. Superior terrain versatility.
These machines have been proven globally, operate with lower speed but have significantly higher adaptability than Generation 1 machines.

Generation 3: Continuous Planters
Cutting-edge (generally) forwarder-based technology that plants while moving. Includes some or all Generation 2 capabilities plus continuous motion operation for highest productivity rates. These platforms require significant capital investment and large-scale work packages to justify deployment.

Proof of Concept systems
Early autonomous/proof-of-concept systems (notably Risutec Forest Maker, Södra BraSatt, John Deere Mechanised Planter and the electric AutoAgroMachines Forest Bot) can be added to the three generation types identified by Radcliffe. These high-capacity machines are predominantly being developed for the Brazilian market and combine GNSS-led site design with autonomous or semi-autonomous operation and data capture.

Appendix 3 provides a summary of the currently available and developmental mechanised planting platforms.

In Australia and New Zealand, current use is largely based on the following systems:

Excavator-mounted planters (Bracke, Risutec, M-Planter). These planters operate with single or multiple heads, have different cultivation options, strong manoeuvrability and are adaptable to steep and variable terrain.

These units are best suited for challenging terrain on Australia's east coast and in New Zealand. With a productivity of around 200 stems per hour, these excavator-based systems sacrifice raw speed for superior seedling placement quality and terrain versatility. They are able to navigate steep slopes, rocky ground and obstacles that would stop forwarder-based machines entirely[3].

The Rapid Planter from the Canadian GN Corporation is expected to commence trials in Queensland in Q2 2026[4]. Although this is an excavator-mounted machine, it is expected to deliver high-capacity planting with three planting heads and large capacity seedling storage.

Forwarder-based high-throughput systems (PlantmaX). There is currently one PlantmaX operating commercially in Western Australia, with a second unit undergoing testing and evaluation of an alternative transport mechanism in New Zealand. With production rates of 1,400 – 1,600 stems per hour (and potentially up to 3,000 per hour), these systems excel on relatively flat ground, delivering industry-leading productivity rates. Their continuous operation capability makes them ideal for large-scale plantation establishment with flat, consistent terrain profiles, especially greenfield/first rotation

[3] Radcliffe (*pers. comm.*) 2026
[4] Brown (*pers. comm.*) 2026

sites. However, excavator-based alternatives tend to perform better where topography is varied.

While this type of machine has the highest productivity potential, the claimed planting rates of 3,000 stems per hour are only achievable under perfect conditions with flat, uniform terrain, free of debris and with long, straight runs. Any changes, such as those relating to obstacles, slash load, shorter row length and slope will reduce the actual planting rate[5].

b) Slope, terrain and access

Excavator-based systems generally outperform forwarder platforms in broken terrain, around stumps and on steeper slopes (>15–25°), leveraging boom reach and slewing to place seedlings precisely. Planting with excavator-based systems on steeper slopes is feasible but would require a self-levelling cab and tilt-levelling function on the planting head to ensure trees are planted vertically[6].

Forwarder-based systems deliver unmatched throughput where rows are long and turning is minimised, but suffer from a large turning radius, getting stuck on stumps and in slash and reduced coverage on complex blocks.

Figures 1a and 1b summarise planting currently undertaken by terrain class in Australia and New Zealand respectively as reported by growers who completed the survey.

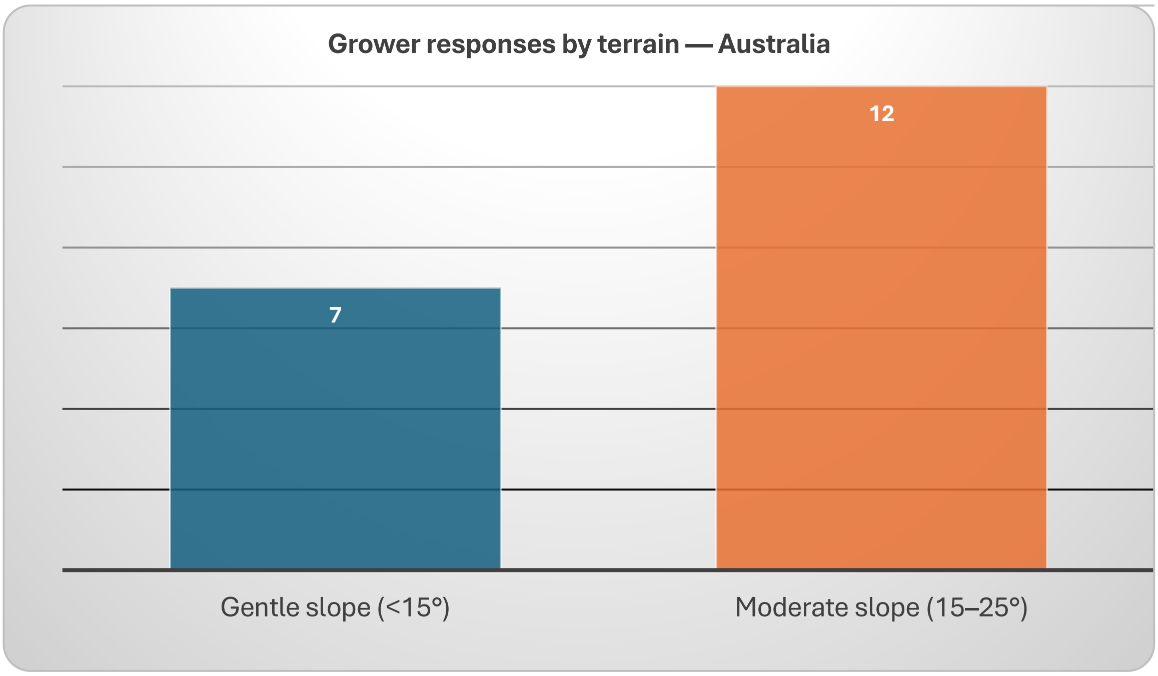

Figure 1a: Terrain classes currently planted as reported by growers – Australia
(Source: Mechanised Planting Survey)

[5] Outhwaite (*pers. comm.*) 2026
[6] Walpole (*pers. comm.*) 2026

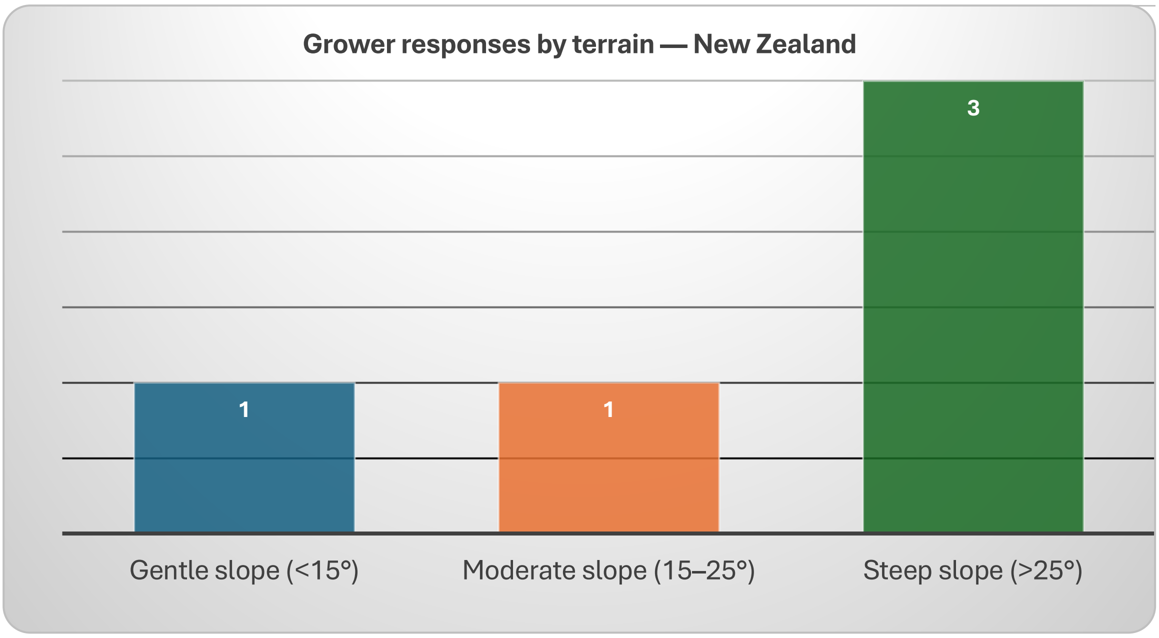

Figure 1b: Terrain classes currently planted as reported by growers – New Zealand
(Source: Mechanised Planting Survey)

Survey responses identified the need for platforms with high-and-wide frames, strong final drive power for navigating slopes and good ground clearance. Winch-assist capability may be needed on steep slopes in New Zealand.

c) Slash density and soil type

Slash density on second rotation (2R) sites is a first-order constraint across all platforms. Heavy slash increases the time taken to clear an area to plant and can also reduce effective stocking (stems per hectare). Some contractors[7,8] have suggested that roots on 2R sites are more of an issue than slash and have focused on improving ripper technology on their excavator-based machines. This response was also reflected in the survey, which identified capability gaps on 2R/3R sites and that issues with penetrating soils containing sub-surface roots reduced productivity and planting quality.

Stumps are a problem for both manoeuvrability and for providing access to a clear planting position. This is particularly an issue for multiple-head excavator-based and forwarder-based high-volume planters, especially where first rotation row alignment is variable. Stumps have such an impact on planting rates for forwarder-based machines that Forest Growers Research is considering stump grinding and slash removal as part of its PlantmaX trials in New Zealand (FGR, 2026). It remains to be seen whether the financial benefits of increased planting rates will be sufficient to offset the additional site clearing costs.

Soil type and soil moisture can also impact on the reliability of machine planting tubes, with wet, plastic soils increasing mud ingress and causing blockages, especially when

[7] Mahnken (*pers comm.*) 2026
[8] Walpole (*pers comm.*) 2026

irrigation is applied. However, irrigation water can also be used to flush the planting tube and to improve seedling movement through the tube[9].

d) Seedling specifications and handling

Machine performance depends critically on nursery stock specifications. Consideration of issues such as plug integrity, container geometry, consistent seedling properties (diameter, seedling height and "bushiness") at the nursery, together with good moisture management practices from nursery to machine will improve productivity, consistency and planting quality in the field.

Mismatches between planting stock and tube/carousel design can lead to jams, media loss and poor quality planting results. Survey responses identified the need for improved plant delivery systems and stronger planting tubes that are compatible with a range of species and seedling sizes.

Machine productivity could be improved with larger on-board seedling capacity and improved reloading processes. Seedling reloading was identified as a major limiting factor in a Croatian study of the performance of a Bracke P11.a planter in Brazil (Soler *et al*, 2024). Automated tray-based seedling loading systems such as MagMat (Ersson *et al*, 2014) could reduce reloading time and increase productivity on excavator-mounted systems such as Bracke, Risutec and M-Planter.

The prototype GN Rapid Planter uses a larger capacity seedling storage and handling system than conventional carousel or tray-based systems. Performance of this alternative approach is yet to be demonstrated in the field.

Standardised "mechanisation-ready" stock specifications and compatibility for a range of seedling age/size and species are not yet universal and remain a priority for working with nurseries.

[9] Kavanagh (*pers comm.*) 2026

Decision-Making for Adoption and Machine Selection

a) Drivers

Survey responses from growers and contractors showed that the single strongest driver of interest was the increasing difficulty in securing and retaining planting labour. Together, growers and contractors repeatedly selected “Current or anticipated labour shortage” as a key driver in the survey and also highlighted that seasonal labour availability is inconsistent. Growers perceive mechanisation as a risk-reduction measure.

Safety concerns associated with manual planting (particularly on 2R sites) was the most frequently selected reason identified by growers in the survey. Some growers also considered that a lower supervision requirement compared to manual planting operations was a significant benefit. Growers also highlighted potential productivity improvements through single-pass efficiencies, reducing the requirement for pre-plant treatments, and improvements in planting efficiency, survival rates and the potential to extend the planting season with irrigation. Figure 2 summarises the top drivers identified by growers. Contractor responses in the survey were limited and have not been summarised in chart form.

Anecdotal evidence provided in follow-up discussions suggests improved survival and early vigour compared to equivalent sites planted manually[10]. While it is difficult for machines to compete on cost per seedling and/or productivity alone, the economic case becomes more compelling where single-pass operations replace separate site-preparation passes and where irrigation extends planting windows, survival and improves ‘get-away’. The economic case could be further strengthened by longer-term measurement of robustly designed trials and plots in operational blocks to determine if early growth advantages can be maintained over a rotation.

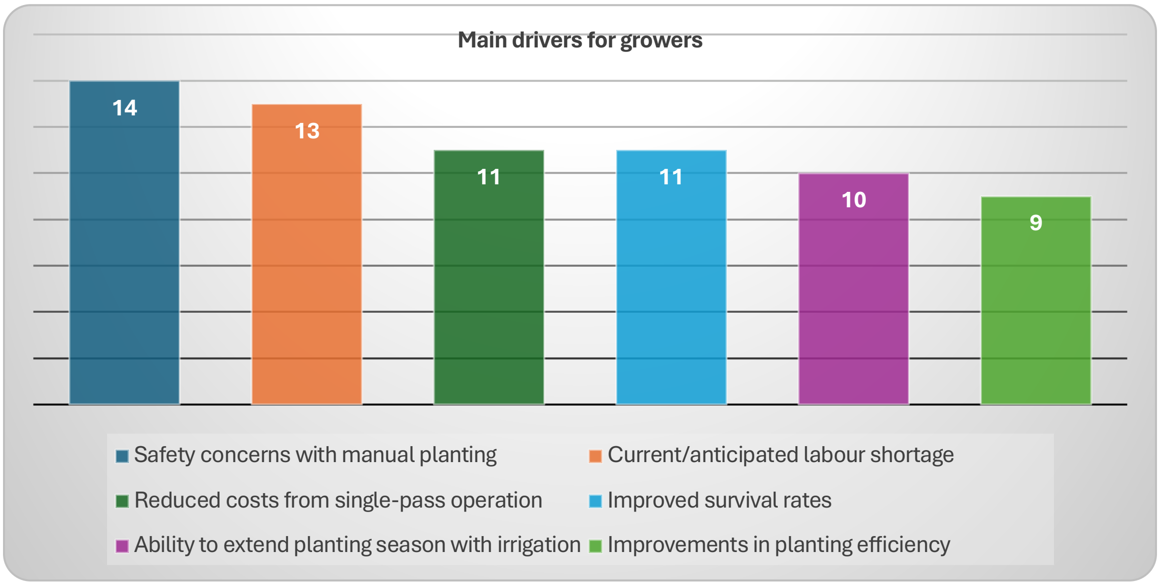

Figure 2: Main factors driving grower decision making
(Source: Mechanised Planting Survey)

[10] Walpole (*pers. comm.*) 2026, Outhwaite (*pers. comm.)* 2026, Kavanagh (*pers. comm.)* 2026

While the key safety concerns identified related to manual planting, especially on steep or slash-heavy 2R sites, manual handling issues associated with loading seedlings into planting machines should also be considered.

Likewise, while availability and continuity of a manual planting workforce is a key driver for considering mechanised planting, some contractors expressed concern about accessing and training suitably qualified operators and retaining them across seasons.

Another driver identified from the survey and in follow-up discussions was that mechanised planting offers the opportunity to plant to a planned plantation layout and collect precise planting location information for each seedling. This is important for audit and compliance and also provides an opportunity to improve long-term stand management and harvesting efficiency.

In practice, no single factor will influence decision making around the use of mechanised planting. Issues including labour availability and safety concerns, as well as cost, planting rate, survival and early growth are all important considerations. This highlights the need for solid and more holistic investigation of the longer-term benefits of mechanised planting.

b) Constraints

Interest in mechanisation is growing, but uptake remains cautious and incremental**.** The most significant constraints limiting uptake of mechanised planting are summarised below.

Financial constraints

High capital cost:

The most consistently reported barrier from both growers and contractors is the high capital cost of mechanised planting machinery. Machines are expensive to purchase or lease, with capital costs in the vicinity of \$1M-\$3M. Currently, this cost is generally borne by contractors.

High operating and maintenance costs:

Contractors need to cover costs associated with high fuel use, wear on hydraulic systems and replacement of parts. Most current planting contracts are short-term (6-12 months) due to high per-hectare costs and the desire for performance evaluation.

One grower survey response noted that “quality and production not up to manual planting in our conditions (steep undulating terrain)” citing mechanised planting as costing more than six times manual planting during a 2025 trial.

Low demand results in economic barriers to investment

Several contractors note that low and inconsistent demand, expressed in short-term contracts or trial-based commitments, is limiting their capacity to scale up or invest in additional machines. Short contract lengths (12 months or less) increase the financial risk for contractors as these do not align with lease or financial planning horizons. Lower costs could be delivered if there was capacity to invest into an expanded fleet.

Machine Reliability, Support and Parts Availability

Mechanical reliability concerns
Many respondents cite frequent breakdowns, under-designed components, or machines not suited to local residue levels or soil types.

Difficulty accessing technical support and spare parts
Accessing support, especially for machines sourced from Europe, was identified as a major barrier for some, but not all, contractors.

"Difficulty in accessing support from overseas manufacturers" was repeatedly raised as an issue, although some contractors have established a strong relationship with the manufacturer and were satisfied with the turn-around time for parts.

Some contractors rely on repairs, use local industry or make parts themselves to keep machines operating.

Where long lead-times for parts does occur, this can cause significant downtime and associated financial impacts.

Frequent modifications needed
There is a general perception that all mechanised planting equipment from Scandinavia needs to be modified in some way for Australian and New Zealand conditions. Growers and contractors report the need to modify rippers, plant compaction systems, seedling feeds and planting tubes, fertiliser application units, hydraulics and irrigation systems because machines are not designed for local second-rotation conditions. This adds cost, time and increases exposure to financial risk.

While some manufacturers are willing to take modifications identified by contractors on board, others argue that, while they have allowed contractors to make modifications in some cases, this is not desirable and ideally improvements should be integrated into machinery design.

Site and Terrain Constraints

Terrain limitations
Steep slopes (especially where >25°) are specifically mentioned as barriers. Growers indicate that machines:

- struggle on steep and/or rocky terrain
- get bogged on wet soils
- become unsafe in mixed or variable topography.

One Australian grower noted, following a 2005/06 trial planting eucalypts, that mechanised planting was considered inefficient as the machine could not handle rocky terrain (or slash levels).

2R slash, residue and stumps
One of the most repeated constraints identified as a barrier to wider use was the complexities of operating on second-rotation sites with heavy slash, large stumps, root mats, variable row width and uneven terrain.

Excavator-based machines are better able to handle these conditions, provided there is sufficient clearance over stumps.

Contractors emphasised that high-capacity forwarder-based planters are designed for 1R conditions and perform best on “greenfield” or fully cleared sites.

The costs and benefits of clearing slash from sites and grinding stumps to improve forwarder-based machine productivity is yet to be quantified.

Soil type limitations
Soils that are rocky, heavy clay, or inconsistent across a block can reduce machine operating speed, affect reliability and create planting quality issues. Heavy soil types can also cause blockages in planting tubes, especially where irrigation is used.

Seasonality, Logistics and Planting Stock

Short and highly seasonal planting windows
Contractors identify low demand and seasonality of work as a major constraint to mechanisation. If machines are idle for long periods, it makes it harder to justify and recoup the financial investment.

Weather-related delays can exacerbate uncertainty associated with short-term work. As heavy machinery incurs significant mobilisation costs, especially across multiple estates or geographically dispersed forests, the cost and complexity of moving machines between sites adds to uncertainty and risk.

Logistical coordination issues
Given the high dependence on uniform and reliable planting stock to maintain productivity levels, alignment between nursery stock and machine-compatible containers, scheduling consistency between growers and contractors and well-planned block layout and access are all important contributors to successful planting results.

Stock types unsuitable for machines
Several growers note that existing nursery stock may not meet mechanised planting requirements, citing examples including containerised seedlings with root plugs that don’t feed reliably, fragile stock types and variation in tray formats.

Mechanised planting would benefit from uniformity and improved handling systems, including “speed boxes”, tray or cassette-based reloading. Nurseries may need to be reconfigured to supply seedlings in this format.

Skilled Labour and Training Gaps

Availability of skilled operators

Growers and contractors agree there are too few operators with the skills needed to run and maintain machines. This is exacerbated by the fact that training can be lengthy and costly, especially for newer digital systems. The seasonal nature of work and high operator turnover increases exposure to financial risk.

The supply of skilled operators, the time and cost of training and limited local experience reduce the capacity for contractors to scale up operations. Some contractors are self-training operators due to a lack of structured support.

Cultural and Organisational Barriers

Risk aversion

Survey data suggests contractors perceive a risk-averse approach among growers regarding new technology adoption, as manual planting provides highly predictable operational outcomes within established cost structures. However, from the growers' perspective, incomplete evidence of consistent, cost-effective performance is limiting investment.

Need for changes in relationships and roles

Many respondents note that mechanisation requires new ways of coordinating between nurseries, planting contractors, forest managers, manufacturers and logistics teams. While important, this change is slow and may take time to achieve.

Need for sharing of financial risk

Many survey responses from contractors expressed the opinion that, while mechanisation has the potential to deliver better survival, growth and uniformity at an increasingly competitive establishment cost, there is an associated investment risk, due to the high, up-front capital or leasing costs. There is an opportunity to improve the uptake of mechanised planting if a more equitable sharing of the financial risks can be achieved.

Environmental and Regulatory Concerns

While some growers expressed concerns about environmental impacts such as soil disturbance, soil compaction, erosion and increased fuel use and emissions, this was not rated as an issue of significance when considered across all survey responses.

Some contractors had an expectation of reduced emissions especially if planting can be achieved with fewer heavy machinery passes. Some also noted that increased slash retention could be a potential benefit, reducing erosion risk and providing protection for newly planted seedlings. Others remain cautious about unproven gains under certain slope and weather conditions.

Performance in Different Conditions

Overview

The best performance by both excavator-based and continuous planting machines occurs on well-prepared sites (chopper rolled/windrowed, ripped/mounded) sites with gentle terrain (≤15°), lighter slash loads and using compatible planting stock.

Continuous planters such as the PlantmaX will achieve the best productivity rates on greenfield/ first rotation (1R) sites. Excavator-based planters will also perform well on easy sites, albeit at a lower planting rate than the continuous planters. Operators of excavator-based machines highlight good ergonomics, firm and stable planting, Global Satellite Navigation System (GNSS) recording of planting locations and integrated water/fertiliser systems. Some report improved survival and early vigour and the ability to extend planting season, especially when water, fertiliser, herbicide and potentially biochar can be applied at planting.

Second rotation (2R) sites with stumps/roots and heavy slash were more challenging, as were steep slopes (>25°), rocky sites or very wet soils. Many trials were slower and/or more costly than manual and sometimes delivered inconsistent quality without strong quality control (QC).

Some contractors noted that balancing immediate cost expectations with the learning and development needed to implement mechanised planting is a challenge. Sufficient time is needed to understand the operation of the machinery and, if necessary, to modify equipment. Similarly, allowances need to be made for operator training to build expertise and for the development of workflows needed to get to full production capacity. As it is difficult for mechanised planting to compete on cost on easy-to-plant sites, poorer quality sites are often allocated for mechanised planting. It is important to manage expectations of productivity on these sites, especially when comparing with manual planting on the better sites.

Site specific comparisons

<u>Rotation and slash/stumps (1R vs 2R)</u>

- **1R sites/lighter residue:** Both forwarder- or excavator-based systems can deliver acceptable productivity and quality when planting stock and soils are matched to the machine. Forwarder-based systems can achieve significantly higher planting rates on 1R sites or where sites are cleared and site preparation is integrated.
- **2R sites with stumps/heavy slash:** This was the most frequently cited constraint. Many contractors and growers consider that current heads are not optimised for 2R and reported more blockages, misplacement during planting, slower travel and higher rates of equipment wear. Improving 2R performance is one of the most requested areas of research and development (R&D).

Terrain (slope/roughness)

- **Gentle (≤15°):** This is the generally preferred topography for operating - several growers and contractors operate or would consider operating here.
- **Moderate (15–25°):** These sites produce mixed results. Productivity can drop and reliability/quality issues become more of a problem unless excavators have high-and-wide bases for stump clearance and sufficient power drives.
- **Steep (>25°):** These areas are repeatedly cited as problematic. Trials often show operations are slow and costly and with concerns about quality. Trials in New Zealand (FGR, 2026) found that excavator-based planting rates dropped to one row at a time on steep slopes compared to three rows at a time on gentle slopes. Several growers halted or deferred broader adoption on steeper slopes. Continuous planters encounter operational stability limitations on steep areas and side slopes. Some respondents proposed winch-assistance for planter stability.

Soil wetness/rockiness

- **Wet sites:** These areas increase the risks of bogging, soil damage and downtime. Timing of operations and excavator base selection are critical.
- **Rocky ground:** Early Tasmanian experience noted low efficiency on rocky ground, which resulted in reverting to manual planting. Continuous planters will experience a reduction in both planting rate and stems per hectare on rocky sites as there is less operator control of the planting head compared to excavator-based operations. Equipment modifications and careful site matching based on machine capability is required.

Species and planting stock

- **Radiata pine, Southern pine and Araucaria:** These species were the most widely planted across the survey responses. Several users report the best performance occurs where planting stock is matched to the planter. This relies on working closely with nurseries to ensure planting material is consistent and of an acceptable size for the planting tube. One Queensland contractor noted that the best planting performance was on Araucaria (Hoop pine) sites, as these were generally more difficult to plant by hand[11]. Some New Zealand growers want planting machines that can reliably handle bare-root seedlings. Other responses highlighted the need for machines to handle a broader range of containers (including coir pots). There is an opportunity in Australia and New Zealand for standardising containers which would simplify both nursery and planting operations.
- **Eucalypts:** Seven survey respondents reported planting eucalypt species (mostly *Eucalyptus nitens*). Results were mixed, with some observations of improved survival/early vigour with the concurrent application of water and fertiliser (and potentially biochar). However, others report lower survival without strong quality control on unsuitable sites.

[11] Kavanagh (*pers. comm.(* 2026

Site preparation dependencies

Survey and interview respondents consistently identified that pre-planting site preparation such as chopper rolling, windrowing and ripping and/or mounding materially improves machine access, placement and seedling survival, although this does incur additional costs. This was particularly the case for high-capacity planters, where clearing slash levels and grinding stumps is being considered as an option to achieve full potential.

Excavator-based machines are less reliant on clean sites. Some respondents argued that the sub-surface site preparation, with appropriate ripper design on the planting head, is the best way to deal with 2R roots.

As one of the benefits of mechanised planting is the potential for a single-pass operation, the cost of pre-plant site preparation needs to be considered in the context of overall economic benefit across the rotation. However, some respondents caution that a single-pass operation may not suit wetter sites where mounding may be required to achieve optimal planting results.

Equipment and operating model insights

Machine types and generations

Excavator-based machines (Generation 2) are the most commonly used among contractors and are valued for:

- Terrain versatility
- GNSS guidance, precision planting and planning
- Flexible cultivation options including ripping, mounding and the ability to vary planting depth
- Irrigation systems, especially where quick fill delivery systems are available
- Fertiliser application systems
- Ability to run multiple shifts, including operating under lights.

However, the use of excavator-mounted machines may be limited by:

- Low productivity rates (100-200 stems per hour)
- Track speed and machine clearance which can be affected by residue levels, stumps, slope and soil conditions
- Variable quality and cost of guidance systems
- Compatibility issues between planting stock and planter head.

Respondents frequently modify planting heads (including changes to compaction systems, planting tubes, ripper design, fertiliser and irrigation systems and cameras).

Excavators can sustain planting in areas where forwarders cannot operate, but productivity remains sensitive to slash density.

High-capacity continuous planters (Generation 3) were reported by fewer respondents for this survey. Generally, these machines are forwarder-based (e.g. PlantmaX) and designed for higher productivity (1,600 – 3,000 seedlings per hour). The forwarder-based configuration performs best and achieves higher production rates on clear sites with long, straight runs. The machines have the option to integrate third-party guidance systems with the GNSS tracking system, add subsoil ripping to the standard scarifying discs and include fertiliser at the time of planting. Due to the large seedling carrying capacity (10,000 – 20,000 seedlings), there is limited capability to irrigate planted seedlings (around 1 litre per tree[12]) compared to excavator-based systems which can apply up to 4 litres per tree from a 4,000 litre water tank[13]. There is interest in bringing continuous planters to Australia and New Zealand for plantation establishment and potentially carbon planting where terrain permits. The high capital cost of these systems could limit suitability for carbon planting work.

<u>What works well (user-reported)</u>

Users of excavator-based systems reported that, with modifications, the equipment performed well in the following areas:

- Planting technique, including adjustable planting depth, compaction systems and seedling firmness providing stronger seedling stability and early growth.
- Operator display/ergonomics.
- Smart systems and advanced technology to address most issues from within the cab.
- GNSS and guidance systems (although this was variable and the cost of a higher-specification system was a disincentive).
- Plantation planning and collection of production data.
- Integrated irrigation and fertiliser application (after modification), with contractors noting that “irrigation was key” and that “economics improve dramatically when mechanised planting includes under-tree fertilising and irrigation”.
- On-board storage/handling solutions incorporating quick-refill carousels, storage boxes and trailers to reduce down-time when reloading seedlings.
- The availability of a lighting package to allow night operation.
- Using locally-sourced replacement parts for improved uptime.

The current use of high-capacity systems is limited in Australia and New Zealand. However, users indicated that these planting systems offer consistent productivity, low staff turnover and predictable daily output compared to hand-planting crews. On optimal sites, there was very little modification needed to start using the equipment, although some modification and optimisation was done to improve performance.

[12] Outhwaite (*pers. comm.*) 2026
[13] Kavanagh (*pers. comm.)* 2026

Productivity is high when these machines are able to operate without site-related hindrances. In Australia, a strong relationship with the manufacturer, including communication via WhatsApp support groups, has enabled rapid troubleshooting and a quick turnaround for parts.

In New Zealand the Forest Growers Research Precision Forestry program has focused on investigating a Morooka machine base as an alternative to the forwarder-planter combination that is the standard PlantmaX configuration. While this has resulted in an improved turning circle, but there are still operator comfort, stability and machine reliability issues, including track wear, that need to be addressed as part of this project (FGR, 2026).

<u>Pain points and desired improvements</u>

The following concerns and issues have been identified based on survey responses, interviews and trial reports.

- **Seedling throughput/delivery capacity for excavator-based systems** – improvements in seedling carrying capacity and faster carousel loading would reduce downtime and improve productivity. Blocked planting tubes can be a problem where they are not compatible with planting stock, or where there is too much seedling variability. In some cases, planting tubes may become blocked with mud in some soil types due to irrigation at time of planting. This could be addressed by improved planting tube design, more consistent and compact seedlings, water flushing or air injection between planting cycles.
- **Site access on 2R sites** - stumps, roots and surface slash are the main factors that can reduce production rates. This can be addressed by designing heads and guides that can clear surface slash and manage underground obstructions with improved subsoil cultivation and ripping.
- **Guidance and better planting location information** – while all machines use some form of GNSS to record the placement of seedlings, more expensive, higher-specification guidance systems will be needed if higher precision location information is required for machine guidance, uploading terrain maps and plantation planning to improve placement and maintaining stocking accuracy on variable sites. While the additional cost may be a disincentive, if it is done properly, the information collected can also be used to plan future silviculture, to optimise future plantation harvesting and management and potentially to facilitate autonomous planting.
- **Adaptability to terrain** – as noted previously, operations on steeper slopes may require specialised equipment, including integrated levelling systems, high-and-wide tracks and, in New Zealand, winch-assistance for steep slope planting. Self-levelling cabs and a tilt-levelling function on the planting head will allow safe operation on slopes and the ability to plant seedlings in an upright position, even when the machine base is on an incline.
- **Improved single-pass operations** - the economic feasibility of mechanised planting systems, particularly excavator-based machines, can be improved if single-pass operations can replace conventional multiple pass site preparation and pre-planting treatments. In addition, a number of respondents noted that irrigation not only provides the opportunity to extend the planting season but

also resulted in superior compaction around seedlings[14] and improved survival and get-away of newly planted seedlings. Increased capacity to deliver irrigation and fertiliser at the time of planting will improve survival, seedling performance and potential future growth.

- **Limited data** – several respondents have raised the need for rigorous time and motion studies to identify workflow problems and solutions to improve overall productivity. For example, time and motion analysis by Ribeiro *et al (*2024) found that the presence of harvesting slash was a significant factor affecting productivity. For sites where slash was present, 30% of the planting cycle was spent clearing the planting spot, 29% for soil preparation and 20% for planting. FGR (2025) used time and motion studies during PlantmaX trials in New Zealand to analyse machine utilisation, operational efficiency and the effect of planting locations. Initial study results indicated that the PlantmaX only achieved an average planting rate of 941 trees per hour, with machine utilisation of 61%. This highlighted operational inefficiencies and avoidable delays for this machine configuration in the variable New Zealand terrain. Information gained from time and motion studies such as these can be used to achieve incremental, significant improvements in overall productivity.
- **High initial capital expenditure** remains the primary economic constraint limiting broader market adoption in Australia and New Zealand. With capital costs in the order of $1M-$3M, while contract lengths are generally 12-months or less, there is an opportunity to better share the financial risks, so that contractors do not end up carrying a large proportion of the start-up costs.

[14] Kavanagh (*pers. comm.*) 2026

Seedling Survival and Health

Stakeholders consistently report improved early survival and vigour under mechanised planting when planting stock specification, irrigation and post-planting compaction are optimised.

To date, most of the evidence has been anecdotal or from short-duration trials. Some examples of this are:

- Trials in Victoria showed major early growth advantages for machine-planted trees, with independent measurements showing machine-planted trees were 67% taller and 43% larger in diameter than hand-planted controls in identical conditions[15].
- In Western Australia, machine-planted bluegum seedlings showed improved survival and early growth, particularly in moisture-limited environments. One trial showed a 38% increase in growth at 6 months[16].
- Trials in Western Australia have also demonstrated “faultless delivery of insecticide to seedlings at planting” and the potential to reduce the active chemical application rate as this is a more direct application method[17].
- 50% of survey respondents who have used or are using mechanised planting cited improvements in survival as an important factor for use of mechanised planting.

Survival and early growth were also top evaluation criteria in the survey with 53% of respondents rating “survival rates” as Very Important and 41% rating “get-away and early growth” as Very Important.

The case for improved and sustained growth following good site preparation is well established. For example, Balneaves *et.al.* (1996) showed that best-practice establishment (seedling quality, cultivation and weed control) can translate into large, persistent growth benefits. Geddes *et.al.* (2025) highlight the importance of site preparation, competition control and nutrition in overcoming second rotation decline and increasing productivity in South Australian *Pinus radiata* plantations. Mechanised planting provides an opportunity to consistently achieve that “best practice” at scale by creating microsites, precision planting and incorporating fertiliser and irrigation in a single-pass operation.

However, it must be noted that the benefits of mechanised planting can be less reliable on challenging 2R sites with stumps/slash or steep terrain, unless technology and work methods are adapted.

The importance of good quality control was noted by one respondent, who commented that previous experience had showed poorer survival and that site type needs to be considered and followed up with sound quality control by walking behind the machine.

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[15] Walpole (*pers. comm.)* 2026
[16] Outhwaite (*pers. comm.)* 2026
[17] Bradshaw (*pers. comm.) 2026*

Other quality control techniques, including cameras and in-cab monitoring systems, are also available.

The main issue is that the evidence base to support mechanised planting is still developing. Robust, replicated trials with measurements to at least age 2–3 years are needed to quantify the benefits offered by mechanised planting, rather than relying on anecdotal evidence.

Almost 30% of survey respondents explicitly asked for more robust, formal, or better-documented trials to quantify the real benefits of mechanised planting, indicating a strong demand for evidence to support wider investment.

Survey responses were backed up by interview comments that highlighted that long-term robust trials are urgently needed. While contractors report improved survival, better early growth and irrigation benefits, forest managers also require credible multi-year data demonstrating long-term estate-level benefits before investing[18,19,20] . Ideally, operational scale Permanent Sample Plots (PSPs) would be established in production areas to demonstrate real-world, long-term outcomes. Large side-by-side plantings with integrated PSPs will build confidence in productivity, growth and economics and help determine if early gains are maintained for the full rotation. If this can be achieved, it may significantly alter the economics of mechanised planting.

Forest Growers Research in New Zealand have committed to measuring PSPs established on industry sites until 2029, at the end of the FGR Precision Silviculture program[21]. It is hoped that industry will continue to measure these plots as part of the standard PSP program.

[18] Rolando (*pers. comm.)* 2026
[19] Radcliffe (*pers. comm.)* 2026
[20] Last (*pers. comm.)* 2026
[21] Stewart (*pers. comm.)* 2026

Equipment Modifications Required or Undertaken

Grower and contractor survey respondents indicate that imported machines used in Australia and New Zealand all require some degree of adaptation to work with local species and conditions and to improve performance.

Most field modifications are about “making the (planting) head fit the site”, with the aim of improving planting quality and reducing stoppages in 2R sites with high slash/stump levels and providing flexibility to operate on mixed soil types.

Extra guarding and tilt couplers are other practical upgrades that can also improve planting quality and productivity.

Common modifications include:

- Machine balance and guarding
- Tilting couplers and boom hydraulics
- Adding/modifying hydraulics to power add-ons or improve reliability
- Adjusting ripper style or adding/optimising ripping tools to suit local soils, residue and root conditions for improved planting and seedling stability on sites
- Improvements to seedling feed tube and beak design and planting tube to reduce blockages and improve placement
- Changes to planting compactors to improve planting quality and root–soil contact and to facilitate irrigation
- Changes to integrated herbicide and/or fertiliser units
- Fabricating a water tank to replace the counterweight on an excavator base
- High-flow irrigation for excavator-based machines with filtration and fast refill systems (e.g. filling 1,000 litre tanks in ~45 seconds)
- Reinforced tracks and stability packages on machine bases
- Seedling logistics, including preloaded carousels, cassette systems and specialised trailers
- Auto-reload systems for carousel heads to relieve reload bottlenecks
- Cameras and improved operator vision to aid precise planting and quality control.

Machine modifications and optimisations can often span multiple seasons and require consistent and accessible engineering support. Modifications or adjustments will vary with forest type, soil and terrain. Contractors expressed the desire for access to stable and ongoing support to be able to refine their systems.

Responses from manufacturers (e.g. Risutec/John Deere, Komatsu/Bracke) demonstrate that these companies are willing to receive feedback from growers and contractors and involve them in new product developments. They are also prepared to travel to receive feedback and discuss issues and solutions *in situ*. While allowing contractors to make modifications, manufacturers aim to integrate these into machinery design for subsequent models.

Extent of Operational Adoption

At the time of the survey, operational, day-to-day use of mechanised planting across the whole sample was limited (~6%), with most still relying on manual crews.

Although only a small portion are currently using mechanised planting, 35% have used mechanised planting in the past, including several who have stopped. Of the remaining respondents, 27% had not used mechanised planting in the past and 38% gave no answer.

Half of the survey respondents are actively considering mechanised planting in the future, 12% are not and 38% did not provide a response.

Over the next five years about one third of respondents are planning to increase or start mechanised planting and nearly one third remain unsure. One fifth of respondents do not intend to adopt mechanised planting.

Several growers are planning further short-term trials. While important for determining operational feasibility, contractors feel that multi-year contract certainty (minimum 3–5 years) will support investment in multiple machines and the development of supporting logistics that underpin reliability and thus the capacity to reduce prices. Larger fleet sizes would also improve the capacity of manufacturers to provide local support and spare parts. This in turn will affect the level of support available for field-based developments and modifications.

However, most grower responses in Australia and New Zealand indicate a cautious approach to operational implementation, prioritising immediate cost efficiency and continuation of established practices. In some cases, trials which could demonstrate the mid-term benefits of mechanised planting have been discontinued.

In contrast, where contractors do receive good support from grower clients, significant progress can be made in running machines at operational scales and identifying modifications and improvements needed using real-world experience. This support can take the form of minimum guaranteed hectares or negotiated rates. Some contractor responses suggest a motivated and visionary approach. These respondents are committed to future mechanised systems and are open to considering ways to share costs and risks to improve uptake.

Financial performance is also impacted by limited seasonal utilisation. In some cases, short planting seasons (~80 days/year) constrain economic viability. It is difficult for contractors to redeploy or repurpose machines due to the setup costs. Although planting seasons may be extended by irrigation, this issue highlights the need for cooperative working arrangements and partnerships between contractors and growers, especially in the initial set up stages. Setting up, modification and fine-tuning of new equipment and practices all take time. Allowances need to be made if aiming for operational equivalence with manual planting.

It is interesting to compare approaches in Australia and New Zealand with those in Brazil, where significant support is provided through the Cooperative Program for Forestry Mechanisation and Automation (PCMAF)[22] . This program is an initiative of the Institute of Forestry and Research Studies (IPEF) which is supported by 24 forestry companies.

As highlighted earlier, a more holistic approach is needed to assess the lifecycle value of mechanised planting. A longer-term view is needed, informed by robust and reliable data from repeated measurements of plots established in production blocks. For example, if anecdotal early growth gains are shown to be maintained well into the rotation, this will change the economics of mechanised planting, especially if it translates to a reduction in rotation length.

Other factors to be considered include:

- Benefits of highly accurate planting with location data removing the need for post-planting stocking check plots.
- Productivity improvements across the rotation if forests are planted, monitored and thinned using coordinated technology systems.
- Planting to achieve specific silvicultural outcomes, for example double-planting of planned extraction rows to increase pulp yield, site-specific stocking, extraction row design for steep slopes, integrated harvest planning to reduce windthrow risks and planning establishment to require fewer silvicultural operations.

[22] https://www.ipef.br/pcmaf/

Problems Encountered

As noted previously, growers and contractors consistently describe mechanised planting as promising but not production-ready for many Australian and New Zealand sites. The main issues identified earlier are summarised below.

- Operational
- Economic
- Logistics
- Support.

Operational

- Machines are frequently unsuited to complex 2R terrain, leading to slash-related downtime.
- Planting tube jams, mud ingress in planting tube, especially with irrigation, requiring modifications or adjustments.
- Machines often require local modifications including ripper design, compaction systems and guarding) and redesign of add-on equipment including irrigation systems and fertiliser application units.
- GNSS accuracy and cost issues.
- High rates of breakdowns, need for in-field modifications and components not designed for second-rotation stump/roots.
- Strong reliance on operators to provide basic mechanical maintenance, problems accessing mechanics when working in remote locations.
- Planting quality issues can occur due to operator inexperience, stock incompatibility or challenging microsites, although most contractors report generally good survival outcomes.
- Significant terrain limitations: steep slopes, heavy slash, stumps and roots, wet soils, rocky sites, heavy mounding.
- Safe machine operation on steep sites, particularly stability on side slopes.
- Some concern was expressed about environmental risks – soil disturbance, compaction, erosion potential on slopes, fuel and oil leaks (particularly on steep terrain or wet sites).

Economic

- High capital, operating and maintenance costs, including difficulty accessing spare parts and transport between sites, is a significant factor.
- Sourcing skilled operators adds to labour costs, although excavator-based systems may require fewer specialised skills than forwarder-based machines.
- Contract lengths and unclear allocation of R&D and downtime costs.

- Limited planting windows reduce annual utilisation, further affecting return-on-investment for equipment.
- Current low demand for mechanised services weakens contractor business cases.

Logistics

- Sound end-to-end logistics are needed to improve planting efficiency, particularly nursery-to-site seedling flow.
- Problems with seedling loading, limited onboard storage, slow reloading and slow machine travel speeds impact workflow.
- Planting stock compatibility issues: current machine configurations are highly sensitive to variation in seedling sizes, species and container types, creating bottlenecks in supply chain and nursery processes. There is an additional issue in New Zealand where bare-rooted seedlings are still in use.
- A lack of region-wide of standardisation in planting stock specifications and site preparation reduces logistical consistency.

Support

- Varying risk tolerance among growers, coupled with a natural reliance on familiar establishment practices and expectations of high productivity in early stages of implementation.
- Geographic supply chain constraints, particularly localised technical support from international manufacturers; machines often require substantial local modifications to suit 2R conditions.
- Training gaps and limited training pathways, supply of skilled operators and varying levels of technical support from manufacturers and growers.
- Limited data sharing and alignment between growers can affect collaborative improvement opportunities.

Future Plans

Growers

Many growers remain cautious or undecided with many respondents still unsure (45%) or not intending to use (23%) mechanised planting in the next five years citing capital cost, reliability, parts/support, seasonality, 2R slash/stumps, terrain limits and training/logistics as the main obstacles.

Costs and production rates remain at the core of growers' concerns. There is recognition among some for the need to establish soundly designed and robust trials in operational blocks to provide reliable long-term comparisons of mechanised and manual planting. Data from these trials could be used to develop a more holistic business case.

There are similarities between the reluctance of growers to commit to supporting mechanised planting with longer-term contracts and experiences with the introduction of early mechanised harvesting operations (see Box 1).

Box 1:

Following the 1983 Ash Wednesday fires, growers in the Green Triangle introduced new types of harvesting machinery (eg. Kockums single grip harvesters) and also moved from negotiation-based contracts to a tender process. Contract terms of five years were proposed to cover the time required to cover machinery lease payments (Geddes *et al*, 2025). Parsons (2026)[23] highlighted that this experience demonstrated that giving the contractor a 5-year contract was a good way to promote innovation. In the harvesting case, where the contractor worked out a better way to do something, while achieving the same result, the contractor kept the savings under the terms of the contract. This was a huge motivator for the contractor to innovate. Contract rates were kept down as experience showed that when the next contract was tendered, savings identified in the improved process will get built into the new price.

The experience provides useful insights into how long-term operational partnerships can support innovation and technology development.

The key lessons from the introduction of mechanised harvesting that could be used in developing contracts to support innovation in mechanised planting are:

- Be fair
- Work out how contractors think.
- Provide support in the form of contract size and duration that are consistent with machinery lease payment terms.
- Let the contractor manage; define the outputs, not the process.
- Define the job very accurately.
- Encourage innovation.

[23] Parsons (*pers. comm.)* 2026

Options to improve the productivity of high-capacity planters are being considered. These include improved ground preparation such as line raking and stump grinding and designing blocks for straight, longer runs where feasible.

Growers recognise the need to work closely with nurseries to produce mechanisation-ready seedlings. Issues to be considered include standardised containers, height, diameter and bushiness of seedlings and the use of suitable media to ensure plug integrity during transport, loading and planting.

Growers have indicated an interest in participating in trans-Tasman data-sharing and joint trials and adopting standard formats for performance reporting.

Contractors

Contractor respondents were generally motivated, passionate and visionary ("mechanical is the future") and recognised opportunities for gains from partnerships and sharing of risk. Their ability to provide planting services will be further improved by local equipment adaptation and standardised performance reporting to build the business case.

Contractors providing mechanised planting services are looking for opportunities to expand their fleet to increase efficiency and to help "revolutionise the industry". Operating a fleet of three machines could significantly improve productivity, logistics planning and operator utilisation. An additional benefit of multi-machine fleets would be facilitating the expansion of the distributor network and improving the availability of parts, technical support and training opportunities. However, due to high capital costs, contractors indicated that it is difficult to make this commitment without 3 to 5-year contract certainty.

However, there may be an opportunity to demonstrate the benefits of a three-machine fleet of excavator-based planters using a leasing/rental model and mobile, shared fleets as an alternative to the high capital costs of purchasing a fleet.

Contractors plan to focus on continued engineering improvements in seedling handling (reloading of seedlings and mitigation of planting tube jams), guidance systems and robustness for 2R sites.

As one of the opportunities of mechanised planting systems is single-pass operation, contractors are looking to expand multifunction capability (fertiliser, herbicide, biochar, irrigation) to improve whole-of-operation economics. However, some respondents think that the primary focus should be on improving planting technique before adding further functionality[24].

Manufacturers and Research Entities

Manufacturers are aiming to increase their market presence and are looking to co-develop solutions. They see an opportunity to analyse results from existing trials to provide evidence of costs and benefits.

[24] Kavanagh (*pers. comm.*) 2026

Research targeting the interaction between seedling biology, site preparation and machine capability would materially improve reliability and de-risk investment for forestry operations.

Manufacturers also highlight the fact that the key to mechanised planting in Australia and New Zealand is survival and growth rate and that the focus should be on these areas rather than looking for a solution that is cheaper than manual planting.

John Deere acquired the intellectual property and related assets of Risutec in February 2026. The Risutec line of tree planters, such as the SKB and PM heads, will be sold and serviced through select John Deere and Waratah forestry equipment dealers globally, expanding the mechanised planting capability and dealer/service coverage for the Risutec excavator-mounted planters.[25]. A priority for John Deere will be to develop a "seedling-to-harvest" information chain, enabling planning of extraction rows, thinning and inventory with location-level precision.

To date, the most significant research entity input has been through the New Zealand-based Forest Growers Research (FGR) Precision Silviculture Program, which will run through to 2029. FGR has facilitated time and motion studies of existing PlantmaX and Risutec SKB-240 equipment in an attempt to enhance the suitability for New Zealand sites. A recent workshop (FGR, 2026) investigated ways to improve current low productivity rates, including pursuing purpose-built variants of the PlantmaX to handle 2R sites and steep terrain as well as enhancing planning and land preparation.

In Australia, researchers at the University of the Sunshine Coast have previously undertaken investigations of mechanised planting (Ghaffariyan, 2021). They have identified future priorities to be comparing the cost and efficiency versus manual planting and developing a decision support system to implement mechanised planting in larger scale.

Adelaide University (formerly the University of South Australia) would like to see large-scale trials to compare the alternative technologies, noting that the scale of the trials needs to be sufficient to provide an idea of operational considerations and potentially planting costs. South Australian researchers also have access to the Agricultural Engineering group at the Waite Institute which could contribute to any future investigations.

Industry-level initiatives

Survey and interview respondents identified a number of opportunities for collaborative development. These include:

- Exploring opportunities for coordinated multi-year mechanised planting trials involving structured data collection, operational learning and knowledge sharing.
- Creating a trans-Tasman collaborative platform (working groups, field days, standard reporting) to accelerate learning and reduce duplicated effort.

[25] Janer (*pers. comm*) 2026

- Updating funding models to emphasise applied operational research and development in preference to academic research.
- Including operational support and engineering/CAD capacity for in-field changes.
- Supporting structured operator training and knowledge transfer.
- Collaborating on auto-reload systems such as MagMat (Ersson *et al,* 2014) and seedling logistics
- Integrating high-accuracy GNSS and tree-level data to improve planning, tree-level management and auditability.

Recommendations

1. Change evaluation criteria from planting rates and unit costs only to a whole-of-operation and whole-of-rotation value, by establishing coordinated, industry-supported multi-site field trials with consistent measurement frameworks. Analysis should include avoided site-preparation costs, single-pass benefits, robust and structured assessment of survival and long-term growth (including ongoing measurement of Permanent Sample Plots) and evaluation of safety outcomes.

2. Establish a Trans-Tasman Mechanised Planting Network among growers, contractors, manufacturers and researchers to accelerate regional knowledge transfer, reduce duplication of effort and build shared capability.

3. Encourage collaborative applied research between growers, contractors, manufacturers and researchers with a focus on operational outcomes and practical implementation.

4. Evaluate the effectiveness of longer-term collaborative pilot projects involving growers and contractors, supported by agreed KPIs, operator training, time and motion studies and independent monitoring.

5. Investigate alternative equipment deployment models, including leasing and shared fleet arrangements, to better understand their potential operational and commercial benefits.

6. Pilot three-machine excavator-based fleets to quantify real productivity and logistics gains and benchmark downtime, parts usage and utilisation against single-machine and manual planting baselines.

7. Invest in machine designs or modifications that increase productivity rates while enabling single-pass delivery to reduce operational costs and extend planting season windows.

8. Standardise seedling specifications for mechanised planting in partnership with nurseries; implement pre-shipment quality control and field fit-for-purpose checks.

9. Focus development on improving the seedling feed pathway, compatibility with multiple stock types and operator-assistance technologies. Invest in reload automation and seedling logistics (cassettes/carousels, tray-to-carousel automation) as the fastest route to productivity gains across platforms.

10. Prioritise “good-fit” sites first (1R or well-prepared 2R on ≤15°) with compatible planting stock. Codify site selection criteria and track productivity, quality and cost against manual planting using a standard template.

11. Design sites for high-capacity machines, including long straight runs to minimise turning/repositioning, site clearing and slash management.

12. Build operator capability through structured training, mentoring and simulation where available to provide optimal operation on different sites.

13. Formalise data standards for time-and-motion studies, collecting GNSS tree position data and quality audits to enable like-for-like benchmarking across trials and seasons.

14. Integrate digital data from seedling to harvest by standardising data collection and linking establishment data to thinning/harvest planning and associated workflows.

15. Expand hands-on demonstration opportunities and create regular practice-sharing forums (including field days and informal networking) across Australia and New Zealand.

16. Align product development with local conditions focused on 2R, slash/stumps and terrain challenges. Incorporate operator feedback and collaboration with users to guide refinement of equipment. Include local field testing early in the development cycle to ensure machinery meets Australian and New Zealand conditions and to accelerate feedback to manufacturers.

17. Focus R&D on 2R performance including head geometry, cultivation designed for roots and slash, planting tubes and seedling feed systems and guides/compaction, ensuring that machines maintain quality and productivity under real-world conditions.

18. Continue to investigate a purpose-built steep-terrain/2R-capable platform for New Zealand conditions, combining excavator agility with improved stability, auto-reload, high-flow irrigation and optional tethering for extreme slopes.

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Appendix 1. Glossary

1R (First-Rotation): Greenfield plantation sites being established on land not previously forested, such as pasture conversions.

2R / 3R (Second / Third-Rotation): Replanting operations on forestry sites that have already been harvested once or twice before, often characterised by challenging slash and root loads.

Biochar: A carbon-rich biomass charcoal product added to the soil at planting to boost early seedling performance and moisture retention.

Carousel: A rotating circular storage compartment on planting heads used to hold and feed individual seedlings into the planting tube.

Continuous Planter: Generation 3 heavy planting machinery designed to continuously place seedlings into the ground while the prime mover is in motion.

Coir Pot: Biodegradable seedling containers made from natural coconut husk fibres.

Establishment Window: The seasonal timeframe during which weather, moisture, and soil conditions are optimal for successful tree planting.

Excavator-Mounted System: Generation 2 boom-operated planting head attachments fitted onto a tracked excavator base.

Forwarder-Based System: High-throughput planting platforms built directly onto or towed by multi-wheeled log-forwarder chassis.

Get-Away: Early survival and initial growth of newly planted seedlings.

GNSS (Global Navigation Satellite System): Satellite positioning technology used to map precise spatial coordinates.

High-and-Wide Frame: Heavy machinery undercarriage configurations with raised ground clearance and widened tracks to navigate stumps and slash.

MagMat: An automated, tray-based seedling reloading system designed to reduce manual handling delays on excavator-mounted systems.

Microsite: The localised patch of cultivated, fertilised, or irrigated soil prepared specifically to receive a single seedling.

Morooka Platform: A rubber-tracked vehicle base trialled in New Zealand as an alternative transport mechanism to improve planter manoeuvrability.

Mounding: A site preparation method where soil is formed into raised mounds to elevate new seedlings above waterlogged or cold ground.

Pass (Single-Pass / Multi-Pass): An operational trip across a forestry block by heavy machinery; single-pass operations combine cultivation, planting, and treatment into one trip.

PCMAF: The Cooperative Program for Forestry Mechanisation and Automation, a collaborative research initiative backed by forestry companies in Brazil.

Plug Integrity: The structural firmness and cohesion of a containerised seedling's root-and-soil mass.

PSP (Permanent Sample Plot): Formally designated forest research plots monitored over multiple years to gather robust growth and yield data across the rotation.

Ripping: Mechanical fracturing of compacted sub-surface soil layers using a heavy tine to facilitate deep root penetration.

Rotation: The complete lifecycle of a forest stand from establishment through to final clearfall harvest.

Scarifying Discs: Rotating metal plates that cultivate and clear away surface organic debris to expose bare mineral soil before planting.

Silviculture: The establishment, growth, and overall management of forest stands.

Slash: Branches, tops, and woody debris left on the ground following a timber harvesting operation.

Slewing: The horizontal pivoting or rotational movement of an excavator's upper cabin and boom structure to place seedlings precisely.

Speed box: A specialised, open-structured storage container designed to rapidly deliver containerised seedlings into an automated planting head.

Stems per Hectare (Stocking): The density metric measuring the total number of live trees established.

Stump Grinding: A site preparation process where logging stumps are mechanically shredded to ground level.

Tilt Coupler: A hydraulic joint enabling planting heads to angle independently of the boom, ensuring seedlings are planted vertically on slopes.

Tracks (excavator): Continuous steel or rubber heavy-duty belt system that distributes excavator weight evenly across a large surface area.

Vigour: The measure of healthy, rapid, and robust early plant development following planting.

Winch-Assist: Cable anchoring systems used to tether heavy machinery to hilltops, ensuring traction and safety on steep slopes.

Windrows: Lines of heaped logging slash to clear site for planting.

Appendix 2. Survey summary

Grower Reponses

- Intention over next 5 years:
    - Increase/maintain use of mechanised planting (5)
    - Start to use mechanised planting (2)
    - Not intending to use mechanised planting (5)
    - Unsure (11)
- Main reasons growers are using or considering mechanised planting:
    - Safety improvements compared to manual planting
    - Labour supply and workforce risk
    - Improving planting efficiency and productivity
    - Potential cost reductions through single pass operations
- Main benefits for growers (all rated ‘very important’):
    - Improved planting and survival rates
    - Get away and early growth
    - Improved safety performance
    - Improved planting quality, consistency, and survival
- Preferred ways to access information about mechanised planting:
    - Facilitated collaborative working groups
    - Trans-Tasman collaboration
    - Informal networking
    - Field days
- Improvements or innovations in mechanised planting machines to improve performance:
    - Improvements in productivity/planting rate
    - Better performance on 2R sites (slash and stumps)
    - Multifunction operation (concurrent herbicide, fertiliser or biochar application)
    - Better adaptability to terrain.

- Barriers to use and provision of mechanised planting services:
    - High operating costs
    - Machine availability
    - Terrain limitations (slope)
    - High capital cost and seasonality of work

Contractor Responses

- Preferred ways to access information about mechanised planting:
    - Field days
    - Facilitated collaborative working groups
    - Researcher-led investigation
- Barriers to use and provision of mechanised planting services:
    - High capital cost
    - Terrain limitations (slope)
    - High operating costs
    - Seasonality of work.
- Improvements or innovations in mechanised planting machines to improve performance:
    - Handling/loading of seedlings
    - Capacity to handle a range of planting stock/species
    - Improved guidance systems
    - Multifunction operation (concurrent herbicide, fertiliser or biochar application).

Manufacturer/Distributor Responses

- Modifications to equipment by contractors is allowed, but not desirable. The aim is to integrate improvements for global markets.
- Australia and New Zealand are no different from any other region with large corporate growers accustomed to a very cheap cost per plant.
- The key to mechanised planting is the survival and growth rate. There is not enough value being placed on these two items.
- Mechanised tree planting succeeds when seedling biology, site preparation and machines all line up. Targeted R&D would materially improve reliability and de-risk investment.

Research Entity responses

- Factors relating to mechanised operations:
    - Total cost per ha
    - Survival rates
    - Planting rates
    - Get-away/early growth
    - GPS capability/accuracy in planting, stocking and layout).
- Observed reasons for grower/contractor interest in mechanised planting:
    - Reduced costs from single-pass operation (cultivation, herbicide, fertiliser in conjunction with planting)
    - Current/anticipated labour supply issues
    - Safety concerns with manual planting
    - Improved planting efficiency.

Appendix 3: Machinery comparison

Excavator-Based Mechanised Planters Comparison

Machine	Platform / Carrier	Planting Capacity	Core Functions	Key Features	Strengths	Weaknesses	Sources
M-Planter M-160R	20-ton excavator	~160 seedlings/hour	Mound, rip, plant, fertilise, water	160-seedling carousel, ripper 700–900mm, optional GPS, herbicide	Sub-soiling ripper; good compaction; operational flexibility	Quality sensitive to operator speed/skill; susceptible to soil type	1
Risutec ASP-720	18-ton excavator	Up to 720 seedlings/load	Pitting, planting, fert/gel/pesticide	ASTA/TASK guidance, remote diagnostics	Cassette-based reloading; multi-tasking capability	ASP cultivation may not be suitable; visibility issues with cassette system; susceptible to field vibration	2
Risutec PM-Series	>14t excavator	150-160 cassette	Mounding/inverting	Easy load, PM160/120	Improved reliability; smaller excavator requirement; site versatility	Susceptible to high slash levels	3

Machine	Platform / Carrier	Planting Capacity	Core Functions	Key Features	Strengths	Weaknesses	Sources
Risutec SKB-120/240	15-25t excavator	120/240 seedling carousel	Cultivation (ripping) + planting with optional irrigation, fertiliser and herbicide application	Excavator agnostic; seedling cassette option available	Slash clearing; deep planting; good compaction (especially with irrigation)	Manual loading of carousel; operator skill requirement	4,5
Bracke P11.a	14–20t excavator	Up to 300/hour	Scarify + plant	PLC control, adjustable depth, 72–88 seedling magazine	Inverted mounding; flexible scarification options; terrain adaptability	Limited seedling capacity; operator skill dependency	6
Bracke P12.b	20-24t excavator	196 cells, ~250-350 seedlings/hour	Scarify/rip + plant + optional irrigate /fertilise	Larger carousel than P11.a	Planting hole creates micro-climate; improved structural engineering	Heavier excavator base; manual loading of seedlings	7
Komatsu D61EM w/ Bracke heads	Tracked dozer	900/hour	Triple-head plant + irrigate	Autopilot, GNSS guidance, 3 heads x 196 seedlings	Multi-row planting; dynamic row width; autopilot operation	No integrated site prep; strict terrain limitations; requires clean site	8
Novelquip PP1	5.5t excavator	(Testing phase)	Pit + plant + irrigate	T-slide high-torque auger-style pitting, GPS option	Lower cost; minimal ground disturbance	Low capacity; vulnerable to roots and slash	9

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High-Capacity Mechanised Planters Comparison

Machine	Platform / Carrier	Planting Capacity	Core Functions	Key Features	Strengths	Weaknesses	Sources
PlantmaX (Plantma Forestry)	Forwarder-mounted (EcoLog 574E or similar); also adapted to Morooka base in NZ	Up to 3,000 seedlings/hour (demo); capacity test 2,800/hour; NZ adaptation 1,440/hour	Cultivates soil, compacts, plants seedling in one pass	Twin planting arms; scarifier/subsoiler options; continuous planting; clip-on/clip-off adaptation	High speed planting, seedling capacity; obstacle sensing	Best performance requires uniform site; reliance on manual seedling feed; manoeuvrability; payload weight	1, 2, 3
John Deere Mechanised Seedling Planter (prototype)	John Deere 1510G (current production forwarder base)	≈1 seedling every 3 seconds (~1,200/hour); 2,400 seedlings on carrier; 7,000 L irrigation	Irrigation + seedling placement (soil prep independent)	Automated path planning and steering; precision ag integration	Integrated precision automation, 7,000 litre water capacity	Requires independent sub-soil preparation; manoeuvrability; payload weight	4, 5
Risutec Forest Maker (prototype)	Forwarder or tractor with propelled trailer (modular platform)	Load capacity: 2,880 seedlings (6C) / 1,920 (4C)	Soil preparation + automatic planting + fertiliser/ herbicide integration	Can handle moderate levels of slash. Digital twin data capture; adjustable mounding spacing; continuous/ intermittent modes	Autonomous seedling feeding; single pass operation	Limited planting width; best performance requires uniform site; manoeuvrability	6, 7

Machine	Platform / Carrier	Planting Capacity	Core Functions	Key Features	Strengths	Weaknesses	Sources
GN Corporation Rapid Planter (prototype)	Excavator-based	Load capacity: 1,000 to 5,000. 3 trees every 15 sec (720 per hour)	Revolutionises process by automating and streamlining tree planting operations	Precision and consistency of mechanised tree planter also reduce the risk of errors and improve the survival rates of the planted seedlings. Cameras in planting head provide QC	Better manoeuvrability; lighter footprint; good planting depth	May require site preparation; logging slash could be problem; not yet demonstrated in the field	8
Forest Bot (AutoAgroMachines, Brazil) (prototype)	Autonomous electric 9-ton ground robot	14,000+ trees/day	Drills hole, places seedling, covers, geotags each tree	AI + GPS navigation; soil/microclimate sensing; automated nutrient/irrigation	Electric drive; onboard sensor analytics	High capital cost; clearance limitations; complex maintenance; smaller seedling capacity	9, 10, 11
BraSatt (Södra, Sweden) (prototype)	Autonomous 8-wheel self-propelled platform (Ebeaver base)	Single-seedling planting (capacity not published)	Scarification + autonomous spot selection + planting	Robotic arm; RTK-GPS autonomy; remote operator supervision; award-winning concept	Fully autonomous/ robotic operation; smart site selection	High capital cost; very complex robotics and software	12, 13

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Appendix 4: Images

Description		Source
Risutec SKB-120		Matt Kavanagh (KS Contracting)

Description		Source
Risutec SKB-120		Matt Kavanagh (KS Contracting)

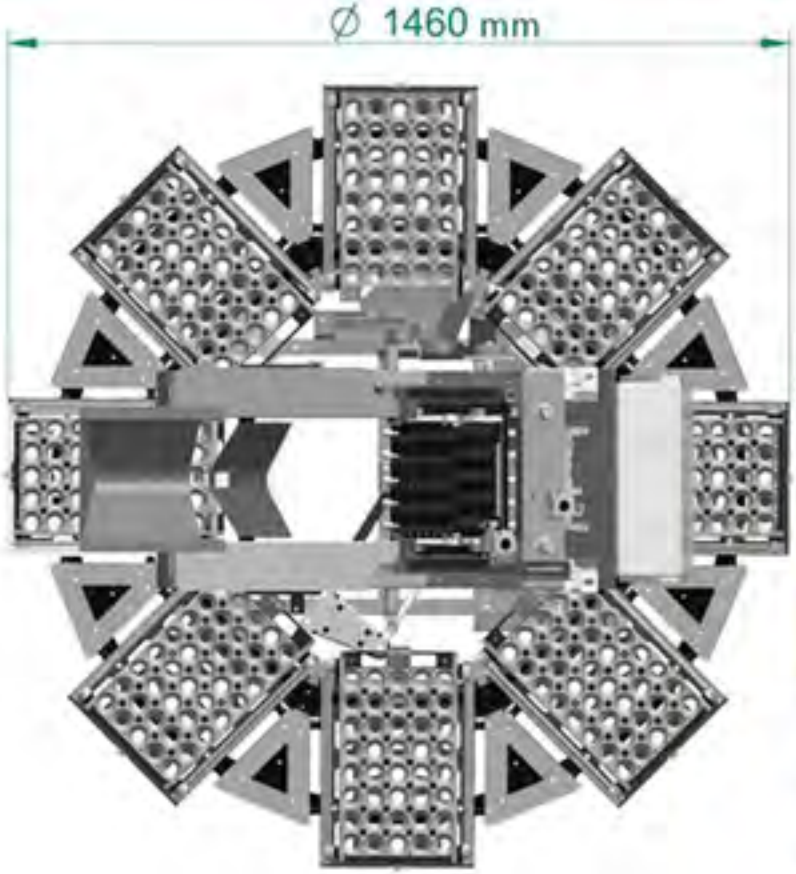
Description		Source
Bracke 12.b	    	Brett Jones (Komatsu Forest)

Description		Source
PlantmaX		Darryl Outhwaite (Form Forestry)

Description		Source
PlantmaX on Morooka base		Forest Growers Research (NZ)[26]

[26] https://fgr.nz/plantmax-adaptation-project-breaks-new-ground-in-mechanised-planting/

Description		Source
GNC Rapid Planter		Peter Plesa (GN Corporations)

Description		Source
MagMat tray carousel (left) and the test-rig mounted on a Bracke Planter during field testing (right)	 	Ersson *et. al.* (2014)[27]

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Disclaimer

This report compiles findings provided by participating growers and contractors across Australia and New Zealand, together with industry and research entity responses to surveys conducted in November and December 2025, with selected follow-up interviews with grower, contractor and manufacturing representatives. It is intended for information and discussion and should not be relied upon as the sole basis for investment decisions. All costs and performance values are indicative and site-specific results will vary.