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SURVEY OF FIXED FELLING HEADS IN NEW ZEALAND

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TABLE OF CONTENTS

EXECUTIVE SUMMARY	1
INTRODUCTION	2
SURVEY PARAMETERS.....	3
RESULTS – FELLING MACHINES SURVEYED.....	4
CONTRACTOR SURVEY RESULTS.....	6
Responses to the Survey	6
Operation Description	6
Operator Skills	7
Operating Conditions	8
Machine Performance	9
Advantages of Fixed Felling Heads.....	11
Disadvantages of Fixed Felling Heads	11
Repeat Purchase	12
Other Comments.....	13
OPERATOR SURVEY RESULTS.....	13
Responses to the Survey	13
Operator Skills	13
Operating Conditions	15
Advantages and Disadvantages of Fixed Felling Heads.....	16
Repeat Purchase	17
FOREST OWNER/MANAGER SURVEY RESULTS	18
Responses to the Survey	18
OneFortyOne	18
Timberlands	18
Ernslaw One Ltd.....	18
Operation Description	18
Operator Skills	18
Operating Conditions	18
Advantages of Fixed Felling Heads.....	19
Disadvantages of Fixed Felling Heads	19
CONCLUSIONS.....	20
ACKNOWLEDGEMENTS	21
REFERENCES	21
APPENDIX 1: CONTRACTOR SURVEY - Mechanised Felling Heads.....	23

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EXECUTIVE SUMMARY

The introduction of fixed felling heads to New Zealand harvesting operations over the last few years has provided the opportunity to reduce tree breakage during felling, reduce the quantity of unmerchantable tops left on the cutover and improve forest value recovery.

A project was commenced to initially measure the difference in stem breakage using the fixed felling head. This work was covered in an earlier report (Prebble and Scott, 2019). As more of these machines were introduced to New Zealand it was realised that there were varying views on the applicability of the fixed felling head to all harvesting operations. Rather than undertake a series of case studies in different conditions, the study approach was to survey operators, owners and managers of fixed head operations across New Zealand to better understand from their perspective the pros and cons of the fixed felling head type of feller buncher.

A survey of owners and operators of fixed felling heads and forest managers managing these harvesting operations in New Zealand was conducted by Forest Growers Research Ltd. (FGR). A total of 12 contractors, 13 operators and 3 forest owners participated in the survey, which was undertaken between November 2020 and May 2021. Twelve machines, comprising eight different machine models and felling head combinations, were included in the survey results.

The contractors surveyed were mostly in the North Island, ranging from the central North Island (6), the East Coast of the North Island (3), and Coromandel (1). Two contractors were from the Nelson region.

Results showed that the introduction of fixed felling heads to New Zealand harvesting operations has had mixed responses from stakeholders, with some contractors being completely satisfied, while others remained skeptical about the suitability of them in their operations. The fixed felling head has exceeded the expectations of 8% of the contractors surveyed. Half of them thought the fixed head was well suited to their operations, and a further 8% felt it was a happy medium. The remaining 34% thought the fixed felling head was somewhat unsuitable for their situations. Interestingly, no contractor said that his machine was totally unsuitable.

The survey highlighted that much of the success of fixed felling heads was attributable to recruitment, training, and skill of the operator. Experience with other types of felling machines, such as the “dangle head” harvester, did not appear to necessarily make the ideal operator for the fixed head felling machine.

Regarding the machine capability, while there were appeared to be some limitations in terms of shoveling ability and handling windthrow, the expected benefits of reduced breakage, better environmental outcomes and improved value recovery have been realised in most operations surveyed.

Regarding repeat purchase, six contractors (50%) said they would purchase another fixed head, two (17%) said they probably would, but four contractors (33%) replied that they probably would not buy another one.

INTRODUCTION

Mechanising various components of New Zealand tree harvesting operations has been happening since the mid-1970's, (Gleason 1986). The focus for the past three decades has been to reduce the chance of accidents in high-risk tasks such as tree felling and breaking out, (Riddle 1995, Evanson & Amishev, 2009). While early attempts at mechanising these tasks were relatively rudimentary, there was a strong belief held within the industry that productivity gains would also be realised, although the high capital cost of machinery was unlikely to significantly reduce overall logging costs. Later studies of machine productivity showed that there was a “sweet spot” where an optimum piece size would maximise the benefits of mechanised felling, (Visser 2009, Visser, Spinelli *et al.* 2009).

Future Forests Research Ltd., the predecessor of Forest Growers Research, identified the opportunity to improve productivity and reduce costs by at least 25% while, at the same time, reducing the impact of accidents by mechanising harvesting operations on steep country (Raymond 2010). With the high injury and fatality rate associated with manual tree felling, the forest industry was obliged to reduce the harm happening to workers on the job, to “maintain the social license to operate”, (Adams, Armstrong & Cosman 2014). Progress had already been made in the mechanisation of steep slope felling in New Zealand with several European machines evaluated and local development of the winch-assisted harvesting concept (Amishev 2012, Evanson *et al.* 2013).

In partnership with the Ministry for Primary Industries, Future Forests Research embarked on a seven-year programme to develop equipment, reduce steep country harvesting costs and make the harvesting job safer, with the vision to result in “No worker on the slope, no hand on the chainsaw” (Raymond 2014). The industry responded with promising developments in mechanised systems and improvements in safety (Safety News 2016, Perry 2018, Visser, Raymond & Harrill, 2014).

The environmental impact of steep country harvesting came under the spotlight during this period with significant damage occurring to down-stream properties in different regions of New Zealand because of several extreme weather events, (Visser, Spinelli & Brown, 2018). The accumulation of slash from harvesting operations in sensitive areas was one of the contributing factors and measures to mitigate this came into focus, such as reducing tree breakage during felling. One method to do this was the use of a fixed felling head on a feller buncher that would reduce the velocity of the falling tree.



Figure 1: The TimberPro TL765 with KF800 felling head studied in the initial FGR trial in 2018

Fixed felling heads have been around since the 1980's, initially introduced into production thinning operations and clearfell of minor species (Gleason 1986). They have also been popular in the U.S.A. and Australia where the tree size is somewhat smaller than in New Zealand clearfell operations. Until recently, the larger piece size of radiata pine has tended to exclude the use of fixed felling heads in New Zealand's second rotation harvesting operations. A progressive contractor in the Nelson area broke this tradition in 2018 by introducing a fixed felling head machine, the TimberPro TL765 with KF800 felling head (Figure 1), into their clearfelling operation (Ellegard 2019).

A study of this machine in 2019 showed that the stem breakage from using a "dangle head" harvester could be reduced by up to 40% using the fixed felling head, (Prebble & Scott 2019). Anecdotal comments fed back through the Technical Steering Team of Forest Growers Research indicated that not everyone who had invested in this technology was seeing the same benefits. FGR decided to carry out a survey of businesses adopting the concept of fixed felling heads to see if there were any obvious reasons for the differences in opinion. This report summarises the outcomes from that survey.

SURVEY PARAMETERS

To get a balanced range of views on the viability of fixed felling heads, the FGR survey focused on three groups of stakeholders:

- Contractors
- Machine Operators, and
- Forest Owners/Managers

The sections of the survey form were:

- Operation Description, including description of the business and machinery
- Operator Skills and Experience
- Operating Conditions
- Machine Performance / Maintenance
- Advantages / Disadvantages of this type of machine
- Repeat Purchase, whether the contractor would purchase the same type of felling machine again, reasons, and comments on current and future use of the felling machine.

A copy of the contractor's survey form is included as Appendix 1. In most cases, field visits were made to the operations and individuals were interviewed on site. In some cases, the contractor/owner was interviewed but in others, the contractor's representative, (i.e., the crew foreman), completed the survey.

To avoid excessive travel costs, some of the stakeholders were sent the forms and asked to participate in the survey by filling it in and returning it. Not everyone who was approached responded to the request.

RESULTS – FELLING MACHINES SURVEYED

A total of 12 contractors, 13 operators and 3 forest owners participated in the survey, which was undertaken between November 2020 and May 2021. Twelve machines comprising eight different machine models/felling head combinations were included in the survey results. These were (alphabetically):

1. Eltec 317LH with Pulpmate 55 head (one).
2. Eltec 317LH with Woodsman Pro CFH1400 head (two).
3. John Deere 953 with Satco 630FH head (one).
4. John Deere 959M with a Satco 630FH head (one).
5. Sumitomo SH370 with Satco 640FH head (one).
6. TimberPro TL765 with Komatsu KF800 head (one).
7. TimberPro TL775Ds with Komatsu KF800 head (three).
8. Tigercat 855 with Tigercat 5158 head (two).

Photos of the various machines and their felling heads are shown in Figures 2 to 7.

TimberPro model TL775D with Komatsu KF800 head.



Figure 2: One of the TimberPro model TL775D machines with KF800 felling head.

Eltec model 317LH with WoodsmanPro CFH1400 head.



Figure 3: One of the Eltec 317LH's with WoodsmanPro CFH1400 felling head.

Tigercat model 855 with Tigercat 5158 head.



Figure 4: One of the Tigercat 855's with the Tigercat 5185 felling head.

John Deere model 959M with a Satco 630FH head.



Figure 5: John Deere 959 with Satco 630FH felling head.

John Deere model 953 with Satco 630FH head.



Figure 6: John Deere 953 with Satco 630FH felling head.

Sumitomo model SH370 with Satco 640FH head.



Figure 7: Sumitomo SH370 with Satco 640FH felling head.

CONTRACTOR SURVEY RESULTS

Responses to the Survey

Of the 12 contractor responses, five were contractor/owners and the remaining seven were foremen or crew bosses. The contractors were surveyed from a range of locations from Nelson (2), the East Coast of the North Island (3), the Coromandel (1) and the rest working in the central North Island (6).

Operation Description

When asked about previous experience with mechanised felling, 42% said the current machine was their first dedicated felling machine, while 25% percent said they had a couple of other felling machines. The remaining 33% had 3 or more machines, mostly dangle heads, but some had experimented with fixed heads and not persevered with them. One contractor could recall owning up to 11 different felling machines.

The average number of hours these machines had worked was 1,512 with the highest being just over 4,000 hours and the lowest being 560 hours. Most of the contractors, (67%) had owned their current machine for 1 year or less. A further 25% had owned their machines for between 1 and 2 years and just one contractor had owned the machine for between 2 and 5 years.

TYPE OF OPERATION:

■ Cable ■ Ground based ■ Roadlining ■ Stems

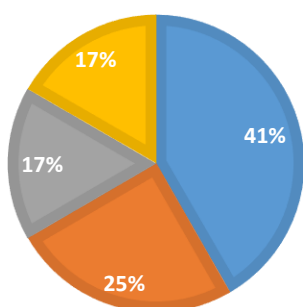


Figure 8: Type of operations in which the fixed felling heads were being used.

Figure 8 shows the type of operation in which the fixed felling heads were being used, the majority being cable operations. In some circumstances, the felling machine serviced additional operations, but the survey only recorded the operation that it was being used in at the time. One third of the operations were using winch assist or had the facility to use winch assist, while the remaining two-thirds did not. A couple of respondents said that they would like to have winch assist available, but were being constrained by the cost, or a lack of interest from the forest company.

Regarding the terrain that had been worked (Figure 9), 14% of contractors had been predominantly in steep terrain (over 45° slope was classified as “steep”). Contractors thought that between 30° and 40° was “steep to moderate” and 36% of them had worked on these sorts of gradients. A further 21% of contractors had worked on “moderate” slopes which were between 20° and 30° in their opinions. The remaining 29% of contractors were on “rolling to flat” ground.

TYPE OF TERRAIN WORKED

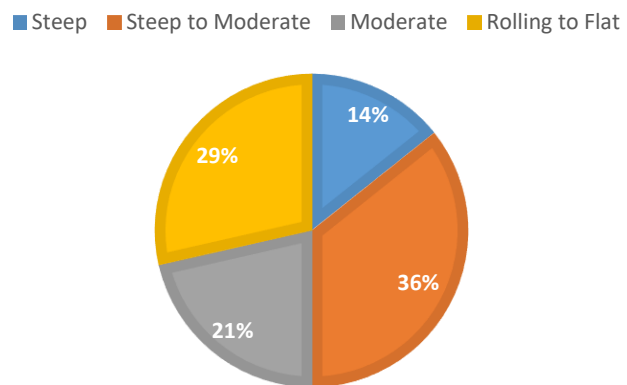


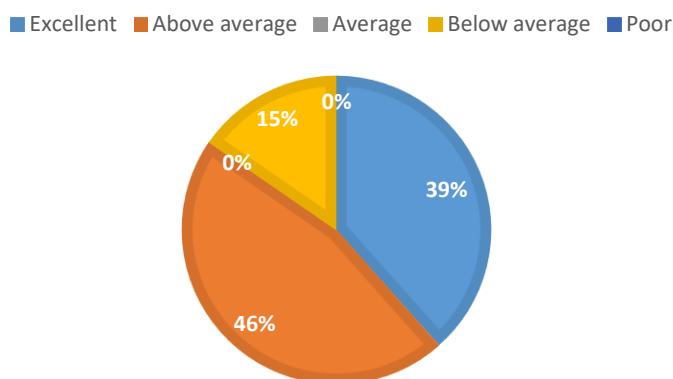
Figure 9: Type of terrain worked since owning machine

The types of soil in the different areas were thought to have almost as much influence over machine performance as slope did. Soil type ranged from a mixture of soft clay/ash on short broken slopes to firm gravel on long even slopes. For those working in the central North Island, soils were mostly pumice or ash with stability, (depending on moisture content), and hidden rocky outcrops being the main issues.

Operator Skills

Employers were asked about the qualifications gained by their operators, and while there was some confusion over what the qualifications actually meant, 25% of them thought their operators held a National Certificate in Mechanised Felling. A further 58% said they held relevant units towards gaining a National Certificate and the remaining 17% were under training.

OPERATOR SKILLS - CONTRACTOR'S OPINION



Contractor/owners and foremen, (employers) were asked to rate their operator's skills against a range of five categories from excellent to poor.

Figure 10 shows that 39% of contractors rated their operators as “excellent” and a further 46% said that their operators were “above average”. The remaining 15% of employers felt that their operators were “below average”.

Figure 10: Contractor's or foreman's opinion of their operator's skills

When asked to qualify these assessments, a range of comments were received, and a selection of comments are summarised below:

- “It's hard for an operator to adjust to a fixed head after operating a dangle head, felling into standing trees is a good example if this.”
- “He's getting it but has a long way to go, especially controlling the tree off the stump. He's OK working uphill but could do better going downhill.”
- “Excellent operator, very experienced, gets the wood down. Production is the key.”

- “He’s still new on the feller buncher, has the technique right but needs to speed up, which will come with time.”
- “Still room for improvement, particularly laying the wood down for extraction.”
- “Still adjusting from using the dangle head, but now making it work.”
- “A lot of butt damage and broken stems, doesn’t lay them out to suit extraction. Also finds it difficult to double cut.”
- “He’s lost confidence in the machine, feels that there is a lack of stability when handling the larger trees.”
- “Has an excellent understanding of the machine’s performance and understands the logic behind the fixed head.”
- “In full control maneuvering on steep slopes, has an excellent skill set working in large trees, minimising breakage and presenting stems for extraction.”
- “Time in the seat, good attitude, focus is on the whole operation, not just the felling.”
- “One of the best, confident and heaps of experience. The best operator is one who hasn’t used a dangle head.”

Operating Conditions

The survey asked contractors what the average piece size of the trees had been for the blocks they had worked in since owning the machine, and what they thought the optimum piece size was for the machine. From the responses received, the average piece size of stands previously worked was 2.25m³ and the piece size considered optimum for their machines was 2.35m³. Most of the operations, (92%) were in Radiata Pine and one operation (8%) was in Douglas fir.

Parameter	Average	Range
Mean tree height	40.3m	33m – 48m
Ave. piece size	1.9m ³	1.5m ³ – 3.0m ³

Table 1: Tree height and piece size for current stands.

Stand conditions could also be a factor in the success of fixed felling heads and contractors were asked for details of the current stands that they were working in. Responses are summarised in Tables 1 and 2.

Table 1 shows that tree height ranged from 33 to 48m, but general impressions were that tree height didn’t have a significant effect on felling head performance. One contractor commented that tall thin trees could snap if the operator was too aggressive when tilting the stem back over the centre of the machine before slewing. Another commented that they were getting breakage at the butt end of small trees if his operator tried to slow down the fall of the tree too much.

Tree Characteristics	Description of Tree Characteristics		
Tree Form	Good – 25%	Average – 75%	Poor – 0%
Branching	Large – 16%	Average – 67%	Small – 17%
Lean	Good – 33%	Ok – 67%	Bad – 0%

Table 2: Description of tree characteristics for current stands

The contractor working in the 3.0m³ piece size said: “You had to be careful with the really big trees and let some of them go, but generally, the machine was handling them OK.” This was supported by another contractor, also working in larger trees, who made the comment that “if you grab it, you own it”. Generally, the operations using cable extraction were impressed with the reduced breakage from the fixed felling heads, although one contractor pointed out that extracting full stems over steep sided gullies sometimes caused breakage further down the stem, which meant some of the advantage of reducing felling breakage, was lost when they were being extracted.

Another question in the survey asked about the hazards specific to the fixed felling head and while some of the responses were generic to mechanised felling, others were pertinent. The responses received are summarised overpage:

1. Machine sliding backwards when slewing the tree, lack of stability.
2. Dead trees falling on machine, wet gullies and steep terrain.
3. Large piece size.
4. Windthrow, snow and uprooted trees.
5. Soft ground, tall trees and geothermal areas.
6. Traffic on busy roads, power lines and poor radio coverage.
7. Rocky outcrops.
8. Stem breakage during felling, windthrow and bigger trees.
9. Large trees, saw outfeed too slow causing slabbing.
10. Saturated soils and working around powerlines.
11. Multi leaders, broken ground, large edge trees and vines in the crowns.

Machine Performance

Contractors were given five categories to indicate how well suited their fixed felling head was to their operation. The categories ranged from “Over the top” meaning completely satisfied to “Well suited” to “Happy Medium” to “Totally unsuitable” (Figure 11).

The fixed felling head has exceeded the expectations of 8% of the contractors surveyed. Half of them thought the fixed head was well suited to their operations and a further 8% felt it was a happy medium. The remaining 34% thought the fixed felling head was somewhat unsuitable for their situations. Interestingly, no contractor said that his machine was totally unsuitable.

CONTRACTOR'S OPINION - MACHINE SUITABILITY

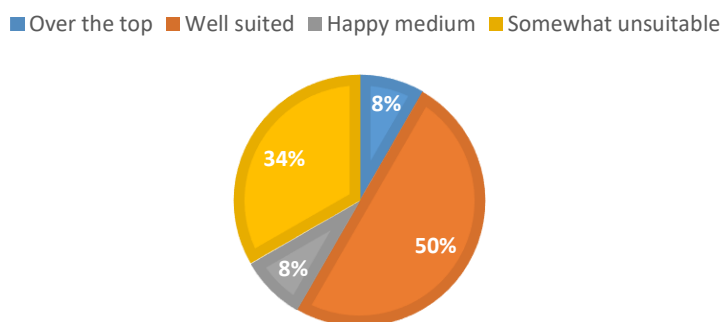


Figure 11: Contractor's opinion of fixed felling head suitability for their operation.

The comment from the one contractor who considered the machine “Over the top” was: “Awesome, the machine has complete control over the tree all the way to the ground.”

Comments from the contractors who felt the fixed felling head was “Well suited” to their operations were:

- “Very clean cutover” (this crew were shoveling after felling).
- “Being able to bunch perfect drag sizes with minimal breakage.”
- “Because you have more control over the tree.”
- “Depends on the operator but superior to the dangle head.”
- “Still learning to align trees but see huge potential in the control it has.”
- “Can’t shovel like a dangle head but still good for bunching, it’s a one-step operation.”

The contractor who said the machine met a “happy medium” commented: “Can’t control the tree if it is too big, need to triple cut.”

Comments from respondents who considered the fixed felling head to be “Somewhat unsuitable” for their operations were:

- “Operational problems with stability, operator losing confidence in big trees.”
- “Need a machine to trim after felling, there is no back-up if one machine breaks down.”
- “Works OK in current situation but wouldn’t have it in overall operation.”
- “Undecided, may be operator related.”

MACHINE MEETS PRODUCTION EXPECTATIONS

■ Exceeded ■ Mostly satisfied ■ Satisfied ■ Unconvinced

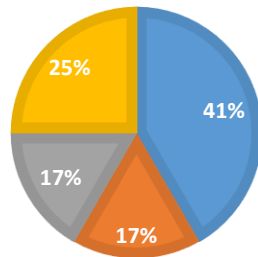


Figure 12: Felling head capability to meet production expectations.

Another question in the survey asked whether the fixed felling head met production expectations. The contractor responses are shown in Figure 12. Five of the contractors, (41%) felt that the fixed felling head exceeded production expectations, even though some of them didn't think the machine was ideally suited to their jobs (25%).

Comments included:

- "Can cut 600 tonnes a day with ease."
- "Machine is very productive; placement of trees can cut down on extra machine movements."
- "Slower felling cycles but saves a lot of time with; less breakage, less handling and no cutover clean-up required."
- "Easily reaches production requirements, felling 2,500 tonnes a week, often finishing that in 3 days."
- "Can get plenty of wood down, up to 600 tonnes a day."

Comments from the two contractors who were "Mostly satisfied" were:

- "Performance is improving as we get used to it, machine is felling for 3 operations, but the forest company is paying relocation costs. Wouldn't be viable otherwise."
- "Still need more time in the seat to capitalise on the investment, showing promise though."

Two contractors responded with "Satisfied" and their comments were:

- "Lots of potential and has improved production, but not on steep terrain. Plan to increase size of grousers over the break."
- "Reliability issues and not flexible enough."

The three contractors who were not convinced that the fixed felling head had met their production expectations said:

- "OK in the right terrain but the fixed head is not suited to this operation. A "fell and delimb" head would be a much better option."
- "Requires good planning and we find it unsuitable for harvesting windthrow."
- "Hasn't performed to expectations and owners are considering selling it."

When asked about mechanical downtime, half of the contractors said that they had experienced some maintenance issues. Not all the examples given were necessarily related to the fixed felling head. Some of the comments were:

- "Mostly minor, popping "o" rings and bending saw bars, finding the right bar length has been a challenge."
- "Ram failure, not necessarily related to the felling head but could have been exacerbated by the extra stresses imposed on it, pin came out and boom twisted."
- "Crack in boom but we can't say it is directly related to the felling head."
- "Pin failure, had to go back to equipment supplier but great back-up from them."
- "Electrical issues, not structural."
- "Boom linkages require more maintenance because of increased loading caused by the head, but the benefits outweigh the extra costs."

When asked if overall maintenance costs were higher, four contractors stated that they were, and quoted the following examples:

- “Higher monthly maintenance costs but big variation and we expect a downward trend.”
- “Machine had to go back to the workshop but very good back-up from the dealer.”
- “Servicing costs are higher, but warranty is currently covering these.”
- “Mostly failing “O” rings and damaged bars.”

There have been no accidents reported that are directly related to the fixed felling heads surveyed, although 10 contractors reported incidents that have either caused minor property damage or had the potential to cause harm to employees. The feedback was as follows:

1. “Trees falling back over machine.”
2. “A couple of lost trees.”
3. “The odd rotten tree and occasional broken top.”
4. “Levelling ram failed, spear came out of cylinder.”
5. “Boom pin came out, could have been dangerous, lost a couple of days fixing it.”
6. “Just falling tops, not unusual with mechanised felling.”
7. “Top came down and broke guard, damaging hoses. Also losing traction on rocky ground.”
8. “Tops breaking off through whiplash, as trees are tilted back over the centre of the machine.”
9. “Falling head broke top window, incorrect Mar-glass installed.”
10. “Tops breaking out and landing on machine.”

Advantages of Fixed Felling Heads

Respondents were asked what the main advantages were with the fixed felling head and given a selection of answers such as: “Fast cycles”, “Bunching ability”, “Reduced Breakage”, “Steep Terrain”, (ability to handle) and “Other”.

Figure 13 summarises responses, and reduced tree breakage was considered the main advantage.

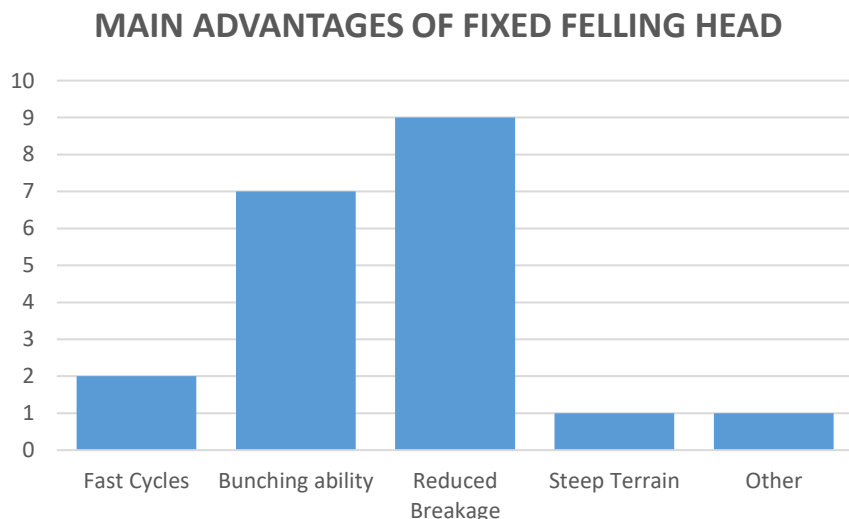


Figure 13: Main advantages with fixed felling heads.

Clearly, reduced tree breakage and bunching ability were seen as the main benefits of the fixed felling head. The comments associated with this question were:

- “Getting a job, we wouldn’t have purchased it if it wasn’t specified in the contract.”
- “Less breakage expected but it just hasn’t happened.”
- “Reduces processing time and no clean up required.”
- “Made a huge difference getting full stems to the skid.”
- “Wood placement, much tidier bunches.”
- “Speeds up processing and significantly improves value recovery.”

Disadvantages of Fixed Felling Heads

When asked about the main disadvantages of the fixed felling head, responses were mixed and sometimes repetitive, but all were relevant. Main comments were:

- “It is one dimensional, you must get behind the tree to control it. Once you’ve grabbed it, you own it.”
- “Limitations with shoveling, but this improves on steeper slopes.”
- “Shorter reach, a longer boom would give you more reach but might affect stability. It’s not easy to shovel with, especially with the self-leveling machine.”
- “Weight in wet areas and shoveling is limited.”
- “Can’t shovel with it, hard to find a balance.”
- “High cost is the main disadvantage.”
- “No real disadvantages, except perhaps the high cost.”
- “Downtime, no options if the machine breaks down, you can’t get far enough ahead to have a buffer.”
- “More expensive than a dangle head, higher maintenance costs and the extra weight of the machine is a problem in the pumice.”
- “Operator not felling for extraction, the wind does affect control and the machine is not easy to use in windthrow.”
- “Inflexibility in terms of terrain and fewer options to multi-task.”
- “Lack of reach restricts felling direction; you have to get down below the trees and it is more difficult to shovel with.”

Repeat Purchase

Looking to the future, respondents were asked if they would purchase another fixed felling head machine. Their responses are shown in Figure 14.

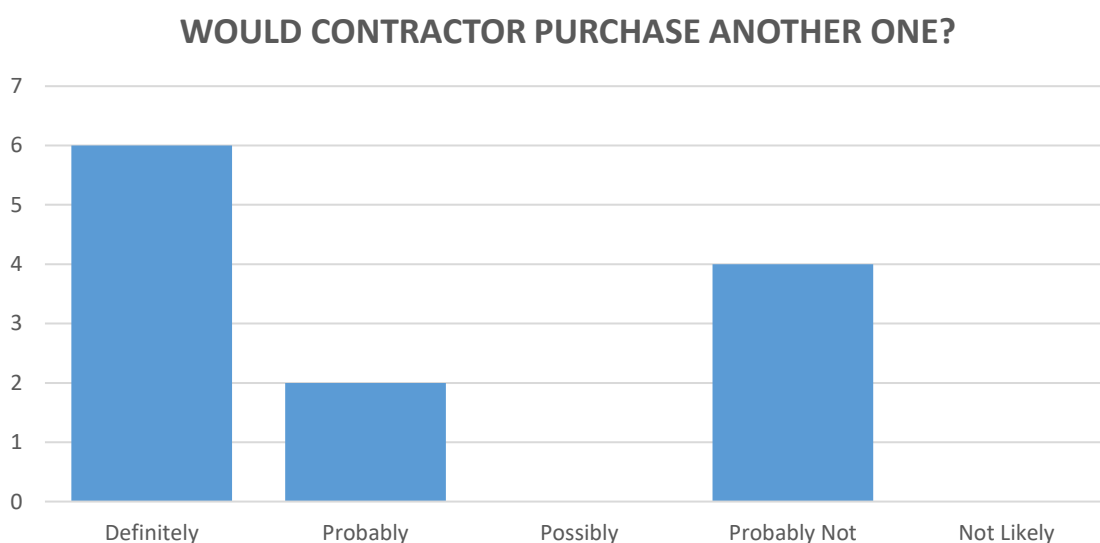


Figure 14: Responses to question whether they would purchase another fixed felling head.

Six contractors said they would purchase another fixed head (50%). Two (17%) said they probably would but four contractors (33%) replied that they probably wouldn’t buy another one. Some interesting reasons were given when asked to elaborate on this decision:

- “Would never go back to a dangle head.”
- “Wished he had purchased a dangle head.”
- “Would prefer a longer boom and the ability to fell and delimb.”
- “The inability to adapt to changing piece sizes.”
- “High cost, so sensitive to the volume it can cut.”
- “Not even in a ground-based operation.”
- “Not in the current application.”
- “Advantages far outweigh the disadvantages, but you have to have a good operator.”
- “Powerful machine that easily handles full length stems and maximises recovery. No clean-up required.”

- “Benefits outweigh disadvantages, great back-up from suppliers.”
- “No qualms, only reason not to would be if you had a lot of shoveling to do.”

Other Comments

At the end of the survey, participants were invited to add any other comments they would like to make. The following comments (in no particular order) were made:

1. “Machine is not being used at the moment, unlikely to replace it.”
2. “The head is heavier but the benefits out-weigh the disadvantages. Being able to fell for two crews would be ideal.”
3. “While controlling felling increases stem length, the longer stems tend to break off shorter when extracted over broken or sharp gullies. Will most likely get a tether in the future.”
4. “Better planning will reduce unnecessary walking, also avoiding turning stems during extraction will reduce breakage, especially in ground-based operations.”
5. “Need to be able to fell and delimb to meet production demands, will be replacing the fixed head with a fell and delimb head as soon as possible.”
6. “The fixed head has increased production by 3 loads per day, but the cost of machinery to balance production is also much higher.”
7. “Fixed felling heads should be fitted to purpose-built machines, it’s a waste of time putting them on a converted excavator because the boom geometry is all wrong.”
8. “Ground clearance with this machine is a big advantage in soft soils.”
9. “Inability to handle windthrow is the main criticism, this may be an operator issue, but we are also having difficulty handling heavy leaners.”
10. “A fell and delimb machine would give you a lot more options.”
11. “To get the maximum benefit out of a fixed felling head, you need a robust main boom and shorter stick to keep the weight in close to the machine.”
12. “Operators have to have an open mind when learning to operate these machines, they will get better and better with time.”
13. “Having a self-leveler is the best option, you can get yourself in the right position to hold the tree vertical while you are slewing around.”
14. “Purchasing a fixed felling head has been an excellent decision for us, will definitely replace with the same style of head.”

OPERATOR SURVEY RESULTS

Responses to the Survey

A total of 13 operators responded to the survey. It should be noted that one of the operators surveyed had replaced the original operator who had left that contractor’s employment.

Many of the questions asked in the Contractor’s survey were repeated in the Operator’s survey so where there is duplication and no significant difference in the responses, the operator responses have been combined with the contractor results, e.g., stand and terrain details.

Operator Skills

Questions about the operator’s experience in mechanised felling operations are shown in Table 3.

Operator Experience:	Average:	Range:
Years in Logging?	20.4	7 – 40
Years on Feller Buncher?	8.8	0.25 – 25
Number of Feller Bunchers?	4.5	1 – 12
Time on Current Machine?	0.9	0.25 – 2.5

Table 3: Summary of Operator Experience (years)

The operators of fixed felling heads have had a wide range of experience, from as little as 3 months to over 25 years. With the same options as in the contractor's survey, operators were asked to rate their own skills.

Figure 15 shows the operator's opinions of their own skills. While 39% of contractors rated their operators as 'excellent', the operators themselves were a little more conservative with only 23% rating themselves as 'excellent'. Rating of 'Above average' on the other hand was 69% for the operators versus 46% for contractors' views of their operators.

OPERATOR SKILLS - OPERATOR'S OPINION

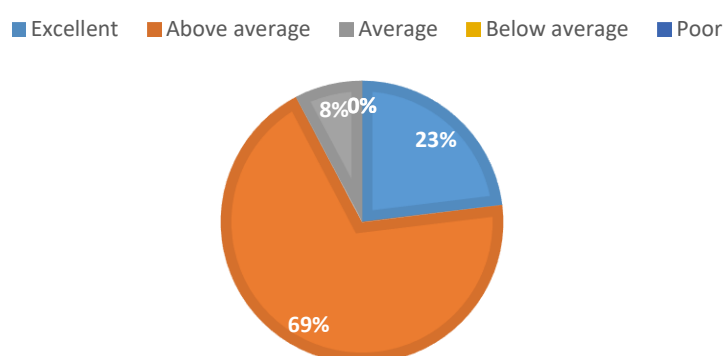


Figure 15: Operator's opinions of their skills at operating fixed felling heads.

When the figures are combined, 92% of the operators considered themselves as above average or better, compared to 85% of contractors with the same view. The interesting statistic was that only 8% of operators considered themselves 'average' and none of them thought they were 'below average', in contrast to 15% of contractors considering their operators 'below average'. This is consistent with the Kruger-Dunning effect which is a recognised cognitive bias stating that people with lower ability at a task overestimate their own ability.

Qualifications held:	Contractor's View:	Operator's View:
Holds National Cert	25%	54%
Holds relevant Units	58%	38%
Under Training	17%	8*

Table 4: Comparison of Contractor's vs Operator's understanding of qualifications held.

When asked about the qualifications they held, there was a difference in opinion over what the contractors thought and what the operators believed.

Table 4 highlights these variations, but unfortunately there was no opportunity during the survey to check operators' Records of Learning. Several employers complained about the lack of training facilities and the unavailability of assessors to carry out assessments. There was definite interest in getting people recognised for their skills, and for the opportunity to pick up new skills, such as operating a Winch Assist Machine.

Figure 16 shows the other types of forestry machines on which the operators had previous experience. Over 60% of the operators had previously operated tracked excavators (loaders), harvesters and feller bunchers. About 15% of operators had operated excavators and feller bunchers

in the past, and 8% had used an excavator and harvester. Only 15% of operators had used just one of these three machine types previously.

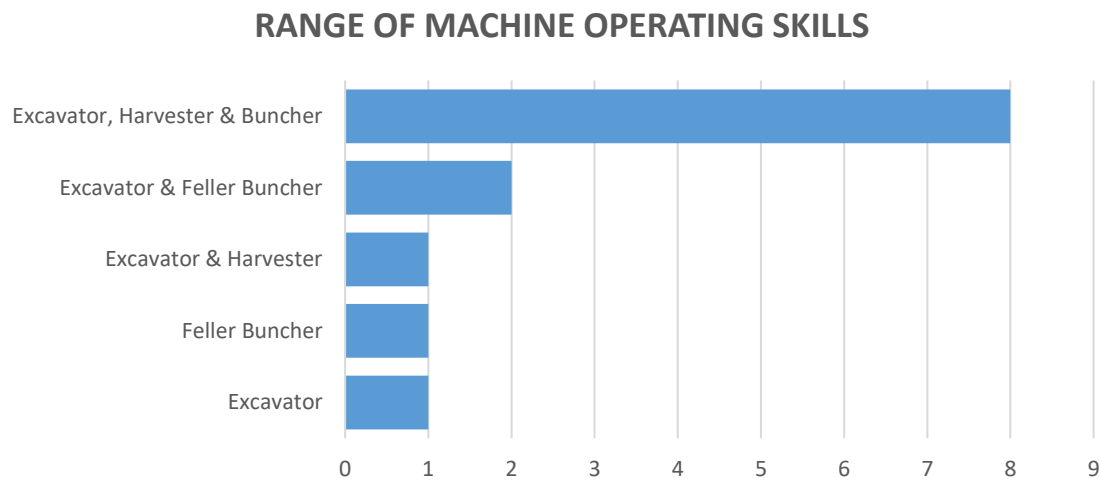


Figure 16: Range of machines that Fixed Head Operators had previously operated.

Operating Conditions

None of the operators liked working on soft ground and a few of them had got their machine stuck (bogged). A couple of operators working on wet clay soils commented about their machines sliding backwards down slope when slewing around with a stem in the head. Generally, the operators commented on their experience with fixed felling heads as follows:

- “Enjoy the challenge.”
- “Can really get the wood down, sometimes cut for two crews.”
- “It takes about a year to make the adjustment from a dangle head.”
- “Think I’m doing a good job, picked it up after the first operator left.”
- “Able to manage most situations.”
- “Have done the time on different felling heads.”
- “Spent a lot of time on machines, can cut for three crews.”
- “Still working on technique”, calls the machine a “pit bull”.
- “Have done up to 1,100 tonnes in a day.”
- “Eight out of ten in this block, did struggle with other blocks though.”
- “Have spent a lot of time on the cutover.”
- “Doing some steep country now, way better than the previous operator.”

Identifying and managing hazards is an important part of an operator’s responsibilities. Responses to the question about hazards were similar to the contractor’s responses. There were however a few subtle differences, specific comments were:

- “Malformed trees and soft soils. Have lost traction a number of times working alongside native bush.”
- “Stems bending back over the machine, heavy tops, in particular.”
- “Operating a heavy machine in thermal areas.”
- “Dealing with windblow and small piece sizes.”
- “Double leaders are the main issue.”
- “Rock bluffs and rocky outcrops that you can’t always see from the cab.”
- “Tops falling onto the machine, also traffic on public roads.”
- “Bent trees and V-bladed windrows.”
- “Steep gullies and loss of traction in saturated soils, also working around roads and powerlines.”
- “Snow and wind damage and working alongside native bush.”

- “Heavy leaners.”
- “Tops breaking out and dealing with windthrown trees.”



Figure 17: Bundling stems for extraction was seen as one of the limitations of the fixed felling head by some operators.



Figure 18: Minimal breakage reduced the amount of time an operator would have to spend going back over their cutover.

When asked about incidents and accidents, 54% of the operators said that they had experienced either an incident or accident, while 46% said they hadn't. Of that 46% however, falling tops were mentioned on several occasions, but were deemed as “part of the job”. The explanations from the 54% that had experienced incidents or accidents makes interesting reading, the responses are listed below.

1. “Walking down steep track, hit stump causing the undercarriage to spin sideways and the machine to tip, just managed to stabilise with the head.”
2. “Spear end came off the main ram causing damage, incorrect bolts were used in assembly.”
3. “Heads breaking off and falling on machine, the escape hatch has been damaged.”
4. “Broke dipper arm pin and saw box has been damaged.”
5. “Fell in a soak-hole, tree came back over machine.”
6. “Machine got stuck in a swamp.”
7. “Felling head broke window in roof of machine, incorrect materials used in construction.”

Twelve of the operators said that they felt completely safe in their machines and one operator said he felt “quite safe”. When asked how easy it was to learn how to operate the fixed felling heads, 84% of the operators said it was ‘hard’, 8% said it was ‘easy’ and 8% said that they were ‘still learning, so too early to say’.

Advantages and Disadvantages of Fixed Felling Heads

The operators were asked what they particularly liked and disliked about their fixed felling head machines. The answers were not brand specific and are summarised in Table 5.

Likes about the machine:	Dislikes about the machine:
Maneuverability, ground clearance, power, accessibility and vision.	Loud noise and limited storage in the cab.
Versatility, using the head as a shovel and control over the falling tree.	Nothing.
Wouldn't go back to a dangle head, more control.	Slower felling cycle and damage to pruned trees.
Smooth to operate, plenty of power & comfortable, (job satisfaction).	Head needs adjustments, waiting for parts.
Power, easy to use, bunching ability.	Can't get below the trees sometimes, top window gets covered in s**t.
Power and control, minimising breakage.	Nothing.
Required specialist skills to operate.	Not suited to stem operation, can't delimb and still get a lot of breakage.
Control over tree, minimises breakage & has good bunching ability	Nothing.
Efficiency, can fell up to 1,200 stems a day.	Lack of flexibility, not so good when extracting downhill.
Easier to operate, more control over falling tree.	Nothing.
Minimal breakage, not having to go back over the cutover.	Some limitations when bunching and guarding a bit light in places.
Levelling facility, being able to bunch stems, its best working from the bottom up.	Lack of control over big trees and sliding backwards in soft soils.
Stability and power, in both track operation and felling functions.	Unable to see the toes of the tracks, have to slew slightly.

Table 5: Summary of operator likes and dislikes of fixed head felling machines.

Repeat Purchase

Figure 19 shows the operators' general opinions on whether they would like their employers to purchase another fixed felling head machine.

OPERATOR'S VIEW ON FUTURE PURCHASES

- Would never go back to a dangle head
- Much better job satisfaction
- Very happy with fixed felling head
- Generally happy with fixed head
- Not suited to this application

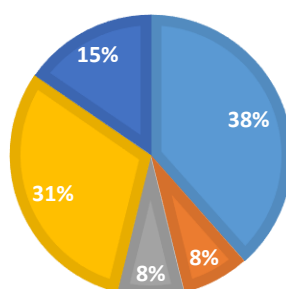


Figure 19: Operator's view on future felling machine purchases.

FOREST OWNER/MANAGER SURVEY RESULTS

Responses to the Survey

Three representatives of forest owners participated in the survey. Where specific questions about the operations were duplicated in the contractor's and operator's surveys, they have been excluded from this report.

OneFortyOne

After more than 5 years of experience with mechanised felling operations, Nelson based company OneFortyOne New Zealand reported that they had 16 mechanised felling machines in their forests, but until recently (2018), most of them were dangle heads.

Timberlands

Timberlands Ltd has had many years of experience with mechanised felling, but in the last 2-5 years they have introduced 8 fixed felling heads to their Central North Island operations.

Ernslaw One Ltd

The third company response was from Ernslaw One Ltd in Whangapoua, Coromandel. They had only one mechanised felling machine and it had been in the forest for less than a year.

Operation Description

One company had made winch-assisted machinery mandatory on slopes above 26° while the other two said that it was optional. One of these latter companies stated that only a handful of their contractors had winch-assist machines and the other commented that 'tethering' was encouraged because it allowed higher utilisation of mechanised felling, but it was not mandatory.

Operator Skills

Only two companies rated the overall skill level of their contractors using fixed felling heads, one said it was excellent and the other said it was above average. The third company said that it was too early to rate their contractor's performance. When those that did rate their contractors were asked to justify their ratings, their comments were:

- "Consistently getting reduced breakage and improved value recovery."
- "Most crews were above average, but some have struggled with production and quality issues."

Operating Conditions

To test consistency of responses from contractors and operators, forest company managers were asked to categorise the terrain on which their mechanised felling operations were working. There was general agreement that slopes over 25° was considered steep, and the rest of the slope classes were being applied consistently. All companies reported having soil types that affected machine performance, but none of them felt that these specifically affected the fixed felling heads. The extra weight of fixed head felling machines was thought to be a disadvantage in soft soil conditions.

Interestingly, all three companies said that the average piece size in their operations was 1.7m³. Two of the three thought the optimum piece size for mechanised felling was 1.3 – 1.5m³ while the third company felt 1.6 – 2.4m³ was the ideal size. All companies had operations working in stands between 1.0-2.0m³ and one company had previously harvested stands between 2.0-3.0m³.

Advantages of Fixed Felling Heads

The main advantages, cited by all three companies, for using fixed felling heads were; reduced breakage and improved value recovery. Two mentioned improved safety in felling as an advantage and one spoke about managing environmental impacts as a specific advantage. Two companies reported the fixed felling heads were well suited to their operations.

Generally, from the companies' perspective, the mechanical availability of fixed felling heads has been very good although one company noted availability issues when a felling machine was shared between crews.

No significant environmental issues had been reported with fixed felling heads, in fact, the general opinion was that environmental outcomes had been improved, except when dealing with large edge trees requiring multiple felling cuts.

When asked about accidents and incidents, one company reported they had experienced machine rollover incidents, but this was prior to winch assist being available and didn't have anything to do with the type of head being used.

Two companies recorded reduced slash on the cutover as an advantage for re-establishment, but both also commented on the effect this might have on nutrient recycling. The third company thought it was too early to say whether the fixed felling head would offer any re-establishment advantages.

When asked whether the forest company would encourage its contractors to use fixed felling heads in the future, two said "probably" and one said "definitely". The main reasons given were reduced stem breakage and improved safety. Other comments offered by the forest owners were:

- "Some contractors don't like the fixed felling head because of reduced maneuverability and the inability to shovel log efficiently."
- "The large Satco 640 head was too big and heavy but the smaller heads such as the Satco 630, Rosin/Quadco and Tigercat achieved much better results."
- "It would be good to install "Shape files" in the onboard computer to improve communication and control access to areas where the machines should not go."
- "The spikes on some heads have caused stem damage but one contractor has replaced them with a steel bar and that has eliminated the damage."

Disadvantages of Fixed Felling Heads

The main disadvantages were:

- "Inability to operate on steeper terrain."
- "Successful operation was very dependent on operator skills."
- "In some situations, breakage hasn't been reduced."
- "Under utilisation of machine capacity."

Despite two companies reporting that the fixed felling heads were well suited to their operations, the third company has mixed results with some crews achieving outstanding production figures, (>1,500 tonnes per day) and others finding the heads unsuitable for their operations. In these instances, the main issues were the inability to delimb stems as part of the felling process. With the exception of these crews, all forest owners were satisfied with the production levels achieved using fixed felling heads.

CONCLUSIONS

There appeared to be a higher level of satisfaction with fixed felling heads amongst contractors using cable extraction methods. While slope did affect machine performance, the type of soil on the terrain was thought to be equally as important. Using winch-assist to stabilise felling machines on steeper steep slopes was considered an option. General impressions were that it was much better to fit a fixed felling head on a purpose-built base machine as opposed to a converted excavator. The main reasons given were the inadequacy of the boom geometry of converted excavators and the limitations of the base unit to access the terrain on which these machines were expected to be used.

Most contractors rated their operators “above average” and generally, this was reflected in the operator’s opinions as well. Where operators had not met expectations, it transpired that their previous experience operating a dangle head had not been of any assistance when it came to operating the fixed head. Several contractors expressed the view that it was better to train someone from scratch, rather than try and convert them over from a dangle head. Some operators confirmed this, stating that they found difficulty adapting to a fixed head and others saying it took over a year to get used to it.

There appeared to be a lot of confusion over the qualifications for mechanised felling operators with significant differences between what the contractors thought they had, and what the operators said they held. Unfortunately, this could not be verified in this survey (due to no access to individuals’ Records of Learning) but this issue may need to be addressed separately during the training and assessment process. It could have implications for both parties in the event of an accident.

No serious harm accidents had been recorded involving fixed felling heads in this survey (according to the respondents) however there were some incidents of property damage that had occurred. There did not appear to be a direct link with the type of head being used.

In terms of machine maintenance, it is possibly too soon to make any recommendations as the oldest machine had done just over 4,000 hours. There was no evidence to suggest that fixed felling heads are going to have increased maintenance requirements, although some contractors have reported higher costs.

In most cases, the expected benefits of reduced stem breakage and improved value recovery have been realised. Where these expectations have not been met, it is usually linked to the operator not adapting to the concept of the fixed felling head. Some of the operational constraints mentioned were:

- “Inability to shovel log effectively.”
- “Difficulty handling windthrown trees.”
- “Problems aligning stems for extraction.”
- “The need to start felling from the back (or bottom of slope) of a setting.”
- “Slow felling cycles.”

These constraints appeared to be attributed more to operator skill or attitude and could be addressed by targeted training. There might also be mechanical reasons why the heads cannot perform some of these functions effectively. For example, not having a “float” facility on the rotator affecting shoveling ability. This survey however did not seek to answer those questions.

General impressions were that to get the most out of the fixed felling head, operators had to adopt the same principles as those applied to manual falling, which involved working from the back of the setting to the front, or the bottom of the setting up to the top, and felling into open spaces, not into standing trees.

Overall, most contractors were satisfied with their fixed felling heads except in full stem operations where the inability to delimb during the process of felling was the main disadvantage.

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APPENDIX 1: CONTRACTOR SURVEY - MECHANISED FELLING HEADS

BACKGROUND

FGR has recently conducted a short study to compare the amount of breakage occurring from two different types of felling head, a feller director (commonly known as a 'dangle head') and a feller buncher (fixed wrist type). The study showed that breakage during felling could be significantly reduced using the fixed head feller buncher.

This survey of felling machine operators aims to gather more information on the following: Types of felling machines across the industry, their capability (piece size and terrain limitations etc.), operator skills and experience, machine maintenance requirements and terrain limitations, which can't easily be picked up in a short-term study situation.

INTRODUCTION:

Discuss the survey with the contractor and fill out his or her responses in the spaces provided.

BUSINESS / MACHINE DESCRIPTION

Fill in relevant details.

Business Name:				Contractor Name:			
Operator Name:				Years in logging:		Years on FB:	
Date:		Location:			Forest Owner:		
Machine make:				Model:			No of hours:
Make of felling head:				Model:			No of hours:
Type of head:	<input type="checkbox"/> <i>Feller director</i>	<input type="checkbox"/> <i>Feller buncher</i>	<input type="checkbox"/> <i>Harvester</i>	<input type="checkbox"/> <i>Shear or disc</i>			
Type of operation:	<input type="checkbox"/> <i>Cable</i>		<input type="checkbox"/> <i>Ground based</i>		<input type="checkbox"/> <i>Road lining</i>		
<i>Other (state):</i>							
Winch-assist used with felling machine?				<input type="checkbox"/> <i>Yes</i>		<input type="checkbox"/> <i>No</i>	
<i>Describe utilisation of Winch-assist:</i>							
No. of mechanised felling machines the business has owned:						<input type="checkbox"/> <i>First</i>	
<i>If more than one, give details of other felling machines:</i>							

OPERATOR SKILLS AND EXPERIENCE

Tick the box or boxes that best represent the contractor's experience with mechanised felling machines:

How long has the contractor owned the current mechanised felling machine?				
<input type="checkbox"/> <i>Less than 1 year</i>	<input type="checkbox"/> <i>1 – 2 years</i>	<input type="checkbox"/> <i>2 - 5 years</i>	<input type="checkbox"/> <i>More than 5 years</i>	
Contractor rating of skills of the felling machine's regular operator:				
<input type="checkbox"/> <i>Excellent</i>	<input type="checkbox"/> <i>Above average</i>	<input type="checkbox"/> <i>Average</i>	<input type="checkbox"/> <i>Below average</i>	<input type="checkbox"/> <i>Poor</i>
<i>Reasons:</i>				
What other machines has the regular operator operated before this felling machine:				
<input type="checkbox"/> <i>Other felling machines</i>	<input type="checkbox"/> <i>Harvesters/processors</i>	<input type="checkbox"/> <i>Tracked excavator loaders</i>		
What training has the regular operator had on mechanised felling machines:				
<input type="checkbox"/> <i>Holds NZ Qualification</i>	<i>Type:</i>			
<input type="checkbox"/> <i>Holds Unit Standard(s)</i>	<i>Specify:</i>			
<input type="checkbox"/> <i>Under training</i>	<i>Describe:</i>			

OPERATING CONDITIONS

Terrain worked:	<input type="checkbox"/> <i>Steep</i>	<input type="checkbox"/> <i>Moderate</i>	<input type="checkbox"/> <i>Rolling/Flat</i>		
	<i>Slope:</i>	<i>Slope:</i>	<i>Slope:</i>		
<i>Describe Soils types/condition:</i>					
What is the average piece size that the felling machine has been used in:					
<input type="checkbox"/> <i>Under 1m³</i>	<input type="checkbox"/> <i>1 – 2m³</i>	<input type="checkbox"/> <i>2 – 3m³</i>	<input type="checkbox"/> <i>3 – 4m³</i>	<input type="checkbox"/> <i>4 – 5m³</i>	<input type="checkbox"/> <i>Over 5m³</i>
<i>Optimum piece size (contractor's opinion):</i>					
What is the Mean Tree Height for the current stand: Check Felling Plan					<i>m</i>
General Description of the Stand:		<i>Species:</i>		<i>Piece size:</i>	
<i>Form:</i>		<i>Lean:</i>		<i>Branching:</i>	

Hazards: (Specify)					
Contractor's opinion on suitability of the felling machine to the current operation:					
<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 20%; border: 1px solid black; padding: 5px; text-align: center;"> <input type="checkbox"/> <i>Over the top</i> </td> <td style="width: 20%; border: 1px solid black; padding: 5px; text-align: center;"> <input type="checkbox"/> <i>Well suited</i> </td> <td style="width: 20%; border: 1px solid black; padding: 5px; text-align: center;"> <input type="checkbox"/> <i>A happy medium</i> </td> <td style="width: 20%; border: 1px solid black; padding: 5px; text-align: center;"> <input type="checkbox"/> <i>Somewhat unsuitable</i> </td> <td style="width: 20%; border: 1px solid black; padding: 5px; text-align: center;"> <input type="checkbox"/> <i>Totally unsuitable</i> </td> </tr> </table>	<input type="checkbox"/> <i>Over the top</i>	<input type="checkbox"/> <i>Well suited</i>	<input type="checkbox"/> <i>A happy medium</i>	<input type="checkbox"/> <i>Somewhat unsuitable</i>	<input type="checkbox"/> <i>Totally unsuitable</i>
<input type="checkbox"/> <i>Over the top</i>	<input type="checkbox"/> <i>Well suited</i>	<input type="checkbox"/> <i>A happy medium</i>	<input type="checkbox"/> <i>Somewhat unsuitable</i>	<input type="checkbox"/> <i>Totally unsuitable</i>	
Reasons:					

MACHINE PERFORMANCE/MAINTENANCE:

How well has the felling machine met the production expectations of the contractor:				
<input type="checkbox"/> <i>Fully satisfied</i>	<input type="checkbox"/> <i>Mostly satisfied</i>	<input type="checkbox"/> <i>Satisfied</i>	<input type="checkbox"/> <i>Unconvinced</i>	<input type="checkbox"/> <i>Dissatisfied</i>
Reasons:				
Have there been any maintenance Issues with the felling machine:			<input type="checkbox"/> <i>Yes</i>	<input type="checkbox"/> <i>No</i>
<i>If "Yes", describe the issue(s) and explain how they were addressed.</i>				
Have these maintenance costs been higher than expected:			<input type="checkbox"/> <i>Yes</i>	<input type="checkbox"/> <i>No</i>
<i>If "Yes", give details of the type of costs, and estimates (\$):</i>				

Have there been any accidents or incidents with the machine	<input type="checkbox"/> Yes	<input type="checkbox"/> No
If "Yes", give general details (do not provide sensitive information): 		

Contractor's opinion on the main advantages of using this type of machine?				
<input type="checkbox"/> Fast Cycle Times	<input type="checkbox"/> Bunching Ability	<input type="checkbox"/> Reducing Breakage	<input type="checkbox"/> Steep Terrain	
Other (state):				
Contractor's opinion on the main disadvantages with this felling machine?				
<input type="checkbox"/> High Cost	<input type="checkbox"/> Weight	<input type="checkbox"/> Ground Disturbance	<input type="checkbox"/> Downtime, Maintenance	
Other (state):				
Would the contractor purchase the same type of felling machine again:				
<input type="checkbox"/> Yes definitely	<input type="checkbox"/> Probably	<input type="checkbox"/> Possibly	<input type="checkbox"/> Possibly not	<input type="checkbox"/> Not likely
Reasons:				
Any other comments relating to the <u>current use</u> of the felling machine:				
Any other comments relating to the <u>future use</u> of the felling machine:				