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EXCAVATOR BUNCHING IN CLEARFELL FOR SKIDDER EXTRACTION

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SUMMARY

The productivity of three excavator-skidder logging operations was investigated to highlight the benefits of using excavators to bunch in clearfell.

In each operation, the excavator was able to bunch pieces faster than the skidder could extract them (Figure 1). This allowed the excavator to shovel bunches closer to the landing, or to fleet logs on the landing.

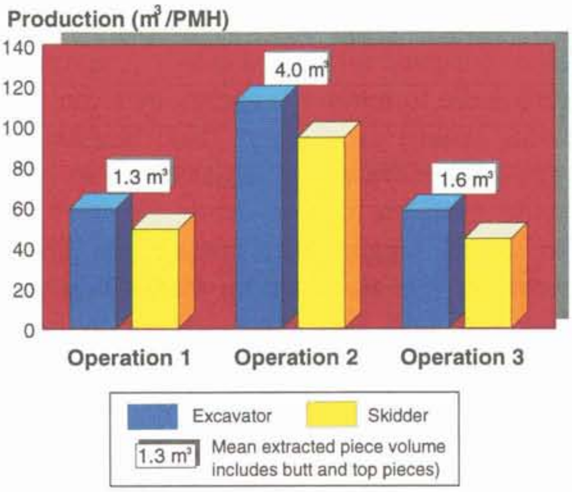

Figure 1 - Excavator and skidder productivity (PMH - Productive Machine Hours)

Figure 2 - Excavator bunching in Douglas Fir

Using excavators to bunch for skidder extraction can:

- increase system productivity by reducing motor-manual delimbing and hook-up times
- reduce the risk of skidder roll over by keeping skidders off the steeper slopes
- reduce risks of accidents to skid workers by decreasing the requirement for motor-manual delimbing
- cause less site disturbance on slopes by reducing tracking.

INTRODUCTION

The use of excavators to bunch or shovel logs (successive swinging of bunches in the direction of the skid) in clearfell is not common in New Zealand. However, there is growing interest in the use of excavators on slopes which are typically logged by either a skidder or skidder and tractor crew. The use of excavators can benefit contractors and companies by increasing production and flexibility, and improving safety. Lower levels of environmental impact may also be achieved.

Previous studies of bunching operations in New Zealand have focused on production thinning operations. Nicolls (1981) and Gleason and Stulen (1984) showed that productivity increased in bunched wood by reducing cycle times and increasing payloads. In clearfell, Hill and Evanson (1992) found that accumulating a drag for a grapple skidder was up to 40% faster in bunched wood.

This report describes three different logging operations in the Bay of Plenty area where excavator bunching was used.

METHODS

Each operation was studied for three to four days using continuous time study. Productivity measures included travel time between bunch areas. Bunches formed by the excavator were coded. When butt pieces were extracted, the number in each drag and the large end diameters (LED) were recorded. A sample of 50 butt pieces were sectionally measured at each site to predict butt piece volumes from LEDs. Mean top piece volumes were also determined for merchantable pieces above the first break. Haul distances were determined from a Global Positioning System (GPS) receiver attached to the skidder at each site.

RESULTS

Operation 1

A Cat EL 240 excavator and a Cat 518 skidder were used to bunch and extract. The site and excavator are described in Table 1. Trees were delimbed and cut to length with a Hahn requiring pieces to be presented butt-first at the landing.

Table 1 - Site and excavator details for Operation 1

Location	*Kinleith Forest*
Soil type	*Silt loam*
Species	*Radiata pine (25 years old)*
Stocking rate	*500 trees/ha*
Excavator	*Caterpillar EL 240C*
Weight	*23.6 tonnes*
Slew torque	*7 164 kg/m*
Reach	*10.5 m*
Grapple	*Prentice 848*
Grapple specs	*Open 1.22 m, closed 0.2 m*
Heel	*Static, contractor built*

Trees were manually felled. On flat terrain, the excavator would handle the pieces by the butts. On slopes, trees were felled downhill and pulled down tip-first, then grabbed near the butt and bunched. In some cases, the heel was used to lift the butt pieces on to the bunch.

The excavator spent time making drag-sized bunches for the skidder. Attempts were made to remove branches by moving pieces against each other. Once bunched, butts were elevated for easier hook-up by laying them on logging debris (Figure 3). No shovel logging was carried out. The excavator was also used on the landing to fleet and shift butt pieces closer to the Hahn Harvester. Figure 4 shows the distribution of productive time for the excavator.

The Cat 518 skidder operated a single long strop. Drags were butt-pulled to two positions on either side of a single landing, and bladed into a stack.

Figure 3 - Bunched stems on bearers

The results of the productivity study were:

Excavator

- Excavator (bunching and positioning)	59 m³/PMH
- Mean bunch size	39 butt pieces

Skidder

- Skidder (extracting)	49 m³/PMH
- Mean haul distance	145 m
- Mean cycle time	6.80 min
- Mean hook-up time	1.53 min
- Mean butt piece volume	1.27 m³
- Mean top piece volume	0.31 m³
- Mean drag volume	5.67 m³
- Mean butt pieces per drag	4.3
- Mean top pieces per drag	0.7

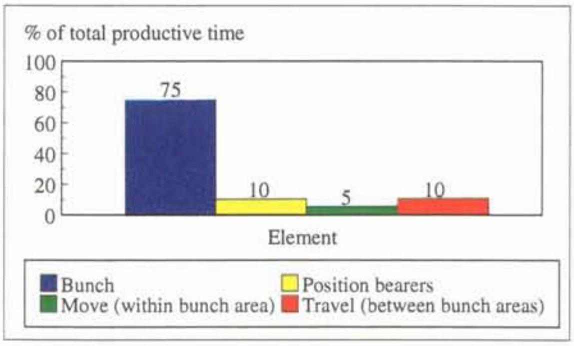

Figure 4 - Excavator utilisation

Operation 2

A Cat EL 300 excavator and a Cat 518 skidder were used to bunch and extract, respectively. The site and excavator are described in Table 2. Trees were manually felled and heads were cut off.

Table 2 - Site and excavator details for Operation 2

Location	*Kaingaroa Forest*
Soil type	*Sandy loam*
Species	*Douglas Fir (70 years old)*
Stocking rate	*224 trees/ha*
Excavator	*Caterpillar EL 300*
Weight	*31.6 tonnes*
Slew torque	*8 591 kg/m*
Reach	*11.84 m*
Grapple	*Rotobec 8566*
Grapple specs	*Open 1.68 m, closed 0.2 m*
Heel	*None*

The preferred felling pattern was long strips parallel to the contour, about a boom-swing wide (approximately 20 m). The excavator operator would begin bunching at the end of the strip closest to the landing (Figure 2), working his way back until the whole strip was bunched. The pieces at the far end of the strip would then be shovel logged on to the next bunch along. This was repeated for a maximum of three swings (approximately 70 m). The bunch then contained up to 80 butt pieces. Top pieces were also handled during the operation, being placed in separate bunches. Figure 5 shows the distribution of productive time for the excavator.

Pieces were extracted either butt or tip-first by a Cat 518 skidder fitted with three or four chain strops. There was no need for the skidder to work on any adverse slopes.

The operation used five landings to de-phase extraction, log making, fleeting and truck loading.

The results of the productivity study were:

Excavator

- Excavator (bunching and shovelling)	112 m³/PMH
- Mean bunch size	42 butt pieces

Skidder

- Skidder (extracting)	94 m³/PMH
- Mean haul distance	173 m
- Mean cycle time	6.32 min
- Mean hook up time	1.73 min
- Mean butt piece volume	3.95 m^3
- Mean top piece volume	0.49 m^3
- Mean drag volume	9.98 m^3
- Mean butt pieces per drag	2.4
- Mean top pieces per drag	0.7

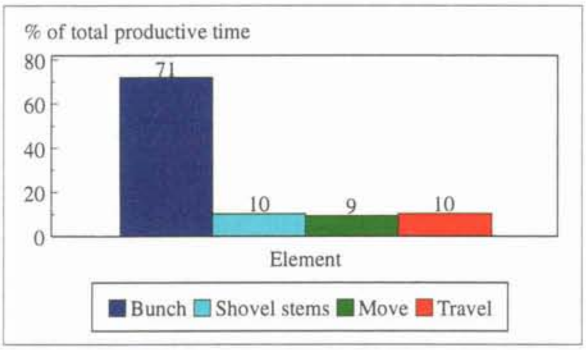

Figure 5 - Excavator utilisation

Operation 3

A Thunderbird 738 excavator was sub-contracted by the principal logging contractor, who owned a Cat 518 skidder and also managed felling and processing. The excavator operator had only three months' experience on the machine. Despite this, the excavator was still able to keep ahead of the skidder. The site and excavator are described in Table 3.

Bunches were formed using a variety of methods. Trees that were felled down-slope were tip-pulled, grappled near the butt and pushed closer to the landing. On flatter terrain, the excavator formed bunches with a maximum of 35 butt pieces. Shovel logging was used in some cases. Figure 6 shows the distribution of productive time for the excavator.

Table 3 - Site and excavator details for Operation 3

Location	*Matahina Forest*
Soil type	*Sandy loam*
Species	*Radiata Pine*
Age	*26*
Stocking	*487 trees/ha*
Excavator	*Thunderbird 738*
Weight	*34.9 tonnes*
Slew torque	*10 207 kg/m*
Reach	*11.6 m*
Grapple	*Thunderbird high pressure*
Grapple specs	*Open 1.47 m*
Heel	*Live*

Drags were butt or tip-pulled with a Cat 518 skidder using four or five chain strops. Bunches were extracted until the closest landing was full, at which point the skidder would extract from another bunch. Five landings were used.

The results of the productivity study were:

Excavator

- Excavator (bunching and shovelling)	58 m³/PMH
- Mean bunch size	21 butt pieces

Skidder

- Skidder	44 m³/PMH
- Mean haul distance	182 m
- Mean cycle time	6.95 min
- Mean hook-up time	1.97 min
- Mean butt piece volume	1.57 m^3
- Mean top piece volume	0.59 m^3
- Mean drag volume	5.20 m^3
- Mean butt pieces per drag	2.9
- Mean top pieces per drag	1.1

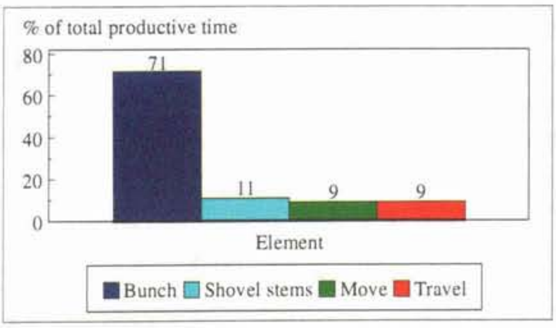

Figure 6 - Excavator utilisation

DISCUSSION

Production Flexibility

Measurements were made to characterise the bunching and extraction phases for the three operations.

In each case, the excavator was able to bunch pieces faster than the skidder could extract them. The excavator did not move across the block as frequently as the skidder, which moved to a new area once a landing was full. This was often completed with pieces from only one bunch. In contrast, the excavator would remain in an area until two or three bunches were formed.

The difference in productivity between the excavator and skidder allowed the excavator to do other work, such as fleeting and assisting with the felling of leaning trees.

This "buffer" in system capacity could also be used to increase production by:

- shovel logging the bunches closer to the landing (this was done in Operations 2 and 3)
- shovel logging the wood directly to the landing and laying it out for the processing crew
- decreasing hook-up times by more careful presentation of pieces.

Safety

Eliminating skidder travel on the steeper slopes reduces the risk of skidder roll over. In the case of Operations 2 and 3, this was one of the primary reasons for introducing the excavator into the operation.

Operation 1 tip-pulled pieces off a maximum 26° slope while sitting on flat ground at the base of the slope. Unlike the other excavators, this machine was not fitted with appropriate guarding to allow operation on slopes. The aim was to utilise the excavator's boom reach to tip pull pieces off the slope.

The excavator in Operation 2 would climb the slope and position itself on a small flat excavated platform to increase the volume of wood that could be reached. This allowed pieces to be extracted approximately 70 m on 25° slopes. The other alternative would have been pulling winch rope and/or operating a skidder on the slope.

Delimbing

Less delimbing was required on the cutover or at the landing. Large branches were trimmed motor-manually in the cutover in Operation 3 to reduce the hindrance to tip-first extraction. In the other operations, fallers were only required to head off, thereby increasing the number of trees they could fell in a day. The multiple handling of pieces by the excavator appeared to cause most of the branches to be broken off prior to extraction. Often the excavator operation would aim to remove branches by sliding the pieces against each other. This did not eliminate the need for motor-manual delimbing on the landing, but resulted in easier delimbing (Quentin Tombleson, B.C. Adams, pers comm.) (Figure 7).

Figure 7 - Residual branching on bunched butt pieces

Environmental Impacts

A potential benefit of excavator bunching is the reduction in soil disturbance on slopes. At all three sites, disturbance on the slopes comprised surface soil mixing, with occasional subsoil exposure (Figure 8). From observations, compaction associated with tracking was either absent or isolated. The excavator in Operation 2 utilised short sections of stub track from which the excavator could work. However, these were generally less than 10 m in length.

Figure 8 - Minimal soil disturbance on a steep slope

The incidental delimbing during handling by the excavator meant that slash was retained in the cutover. This material was concentrated at bunch sites. Depending on site preparation requirements, there is potential for the excavator to pile or redistribute the slash and the heads across the bunched area.

ACKNOWLEDGMENTS

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