ARTICLES

Pruners – are yours tuned to maximize performance?

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ABSTRACT

The design of a pruner determines its ease of use. Pruners of four brands, some as the unmodified design and some with modified blades and/or handles, were compared for their efficiency. The force required by each tool to cut 16-, 23-, or 41-mm-wide water-saturated dowelling was measured by a load cell in the laboratory. Results indicated that careful grinding of the pruner heads reduces the thickness of the blades and markedly increases cutting efficiency. Modified Hit pruners performed the best. Pruner brands varied considerably in their gape and durability: overall, Hit pruners with modified blades were best.

Pine plantations in New Zealand often are pruned to increase production of high-quality sawlogs and peelers. The area pruned in New Zealand has been estimated at 30,000 ha/yr each for low and medium pruning, and 25,000 ha/yr for high pruning. These areas equate to a total cost of $24 million annually. Clearly even quite small improvements in pruning efficiency would result in considerable increases in the profitability of the forest industry.

Contractors frequently attempt to make their operations more efficient by modifying the design of their pruners. Trial and error has resulted in many types of modifications, some of which suit particular circumstances, such as smaller branches or certain pruning regimes. Most contractors use Hit 27 pruners that have been modified by removing the springs, shortening the handles, and reversing the handle orientation so that the leverage slots are hidden under the hand grips (Fig. 1). Also, the stopper pins on the blades are normally removed to increase the pruner's gape so that larger branches can be pruned without having to switch to jacksaws (except for the very largest branches). Thus pruning is more efficient. Further refinements are sometimes made by grinding one or both blades to change the shape of the cutting surfaces.

Pruners modified in different ways have rarely been formally compared. The Forest Establishment and Equipment group of the Forest Research Institute assembled a range of unmodified and modified pruners and tested their cutting efficiency to establish an optimum pruner design. The work described here is part of a major project aimed to improve the ergonomics of pruning operations.

Pruner designs

Seven pruner designs were tested:
1. Hit pruners with no modifications (Fig. 1)

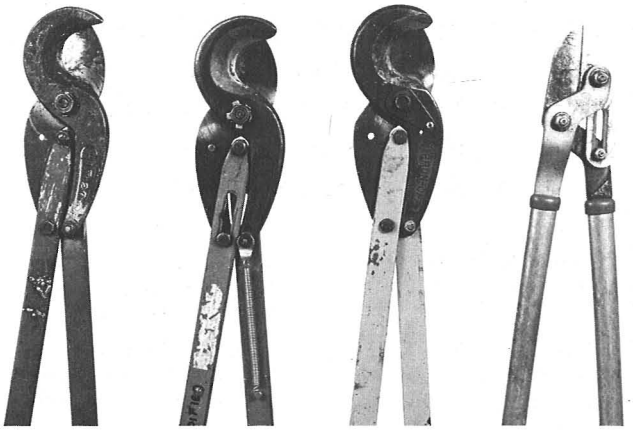

Figure 1 – Four of the seven pruners tested. From left: Modified Hit pruners, Unmodified Hit pruners, Prun-off pruners, and Wolf pruners. Porter pruners are virtually identical in appearance to the unmodified Hit pruners.

2. Hit pruners (handles modified , removing slots and springs, Fig. 1)
3. Hit pruners (handles and blades modified, Fig. 2)
4. Prun-off pruners (unmodified, Fig. 1)
5. Prun-off pruners (blade modified)
6. Porter pruners (unmodified)
7. Wolf pruners (unmodified, Fig. 1)

Since Hit pruners with modified handles are the most commonly used pruners, they were used as a standard in comparisons.

Changes to the blades of Hit pruners and Prun-off pruners were made in 20 minutes using a disc grinder and a vice. The straight blades were ground thinner (see Fig. 3), whereas the curved blades were not only ground thinner but also had the edge removed (Fig. 2). Care was taken not to overheat the blades during grinding, as this ruins the temper of the steel. Both straight and curved blades of the Porter pruners had already been ground to some extent during prior use. However, because Hit pruners and Porter pruners are virtually identical in shape when purchased, the results obtained for unmodified Hit pruners would also apply to Porter pruners.

Wolf pruners cannot be ground without greatly weakening their thin, straight cutting blades. They are not commonly used by contractors, and were included only to provide further comparisons with the thin modified blades of more commonly used pruners.

Testing pruners

Radiata pine dowelling was used to simulate *Pinus radiata* branches since its uniform diameter, more consistent density

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and hardness meant that results for different pruners would be comparable. The dowelling was saturated with water so that it became less resistant to shearing. Five pieces of each of three sizes of dowelling – 16-, 23-, and 41-mm diameter – were used. Each piece was cut perpendicular to the grain, in four places with each tool, resulting in a total of 20 measurements for each tool and dowel size.

Before each cut, both blades of the pruners were carefully sharpened. The "peak force" that was required to cut through the dowelling was recorded for each cut using a load cell, strain-bridge, and graph recorder. The force (in Newtons) was measured on the handle, 53 cm from the handle pivot of each pruner.

A timing device was used to ensure that cutting rates were kept constant. This meant that the peak force recorded during a cut gave an estimation of the amount of work required to sever the dowelling (measurements of total energy expended could not be made with the apparatus used).

The peak force measurements were subjected to analysis of variance, with separate analyses performed for each size of dowelling. Differences between individual pruners within dowel sizes were assessed using least significant ($p<0.05$) differences.

The best pruner designs

The mean peak force required by each design to cut through the three sizes of dowelling is shown in Figure 4. Most differences between the pruner designs were significant (Table 1). In fact, overall analyses indicated that the effect of pruner type was highly significant ($p<0.001$). Three designs compared favourably against unmodified Hit pruners (modified Prun-off and Hit pruners and unmodified Porter pruners); two compared unfavourably (unmodified Prun-off and Wolf pruners) (Table 2).

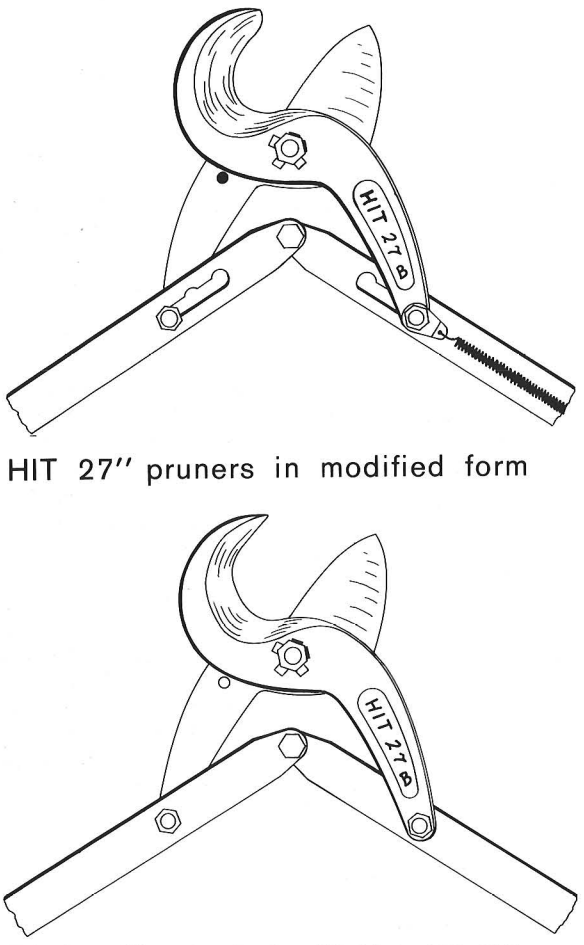

Figure 2 – Unmodified (above) and modified (below) Hit "27" pruners. Note that the jaw opening has been increased by grinding back the hooked blade as shown. Approximately 5 mm was removed, and the jaw is blunted.

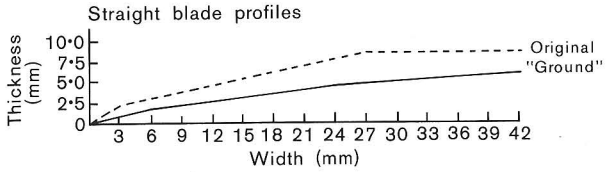

Figure 3 – Profile of the cross-section of the middle portion of the straight blade of Hit "27" pruners showing the change made by grinding.

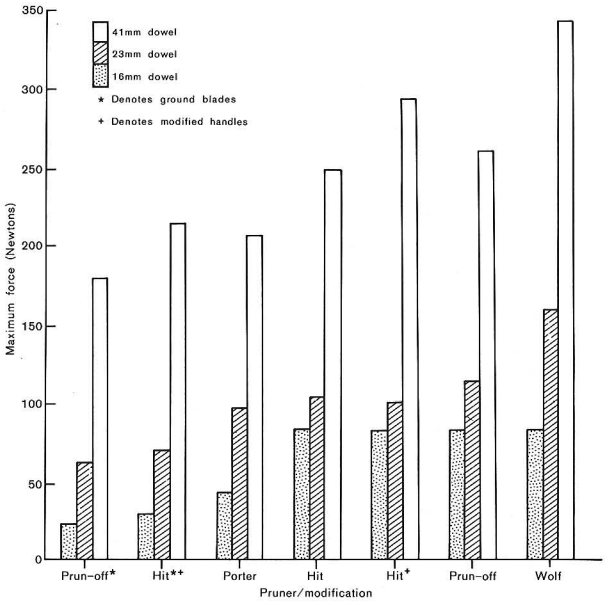

Figure 4 – The peak force required by different pruners with different sized dowelling.

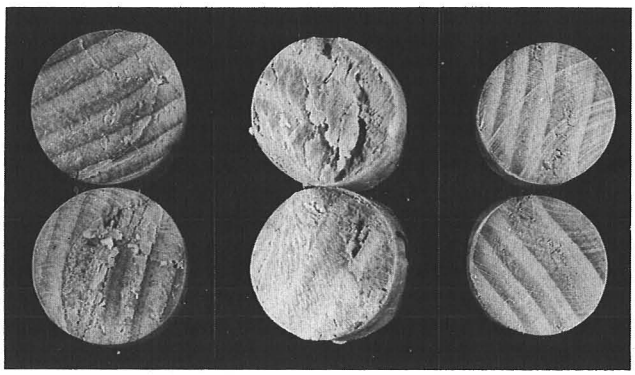

Figure 5 – Cut surfaces of 41-mm-wide dowelling produced by unmodified Hit pruners (left), unmodified Prun-off pruners (middle), and ground Hit pruners (right). Hit pruners with ground blades produced a smooth cut. The other two pruners crushed the wood and pushed it outwards, against the tensile strength of wood fibres, resulting in a rough cut surface.

(a) Blade modification and shape

The thickness and shape of the cutting blades had a profound influence on cutting efficiency. "Off the shelf" Hit pruners initially cut well but as the cut proceeded the pronounced thickness of the blades began to force the dowelling outwards, as it acted against the tensile strength of wood fibres. In contrast, Hit pruners and Prun-off pruners with blades which had been ground back to have low shoulders sliced through the dowelling more easily, consequently requiring much less force (Table 1 and 2, Fig. 5). The Porter pruners used had already been sharpened to have blades with slightly lower shoulders than the unmodified Hit pruners, and therefore they had greater cutting efficiency than any unmodified pruners (Table 1 and 2, Fig. 5). (It is likely that modifications of Porter pruners like those made on Hit pruners would bring about the same improvements in efficiency.)

In summary, pruners with modified blades required significantly less force to prune all sizes of dowelling than unmodified pruners (Fig. 5). Caution during blade modification is necessary, however, since the extent to which blades can be ground thinner is limited by strength. Blades that were ground thinner than the recommended profile indicated in Figure 3 were not strong enough to endure extensive testing. In addition, blades should not be ground too thin because room for future sharpening is required.

Pruners with one curved and one straight blade were more efficient than those with two straight blades (Table 1 and 2, Fig. 5). The straight blades of the Wolf pruners allowed branches to slip along the blades during cutting, reducing leverage. This effect was most pronounced on the large dowelling.

While the tests described here used water-saturated dowelling instead of branches, the relative rankings (Table 2) of peak forces required by the pruners studied should also apply to the use of pruners in the field.

(b) Handles

Although modified Prun-off pruners were the most efficient cutters, their handles were weak, and they bent during the tests.

The force data for unmodified and modified Hit pruners shows that the reduction in handle length resulted in a slight increase in the maximum force required to sever the dowelling. However, most operators prefer shorter handles because the pruners are then much easier to manipulate, which may more than compensate for any increase in force required.

(c) Gape

Modifying the hooked blade (grinding back the cutting edge – Fig. 2) of either Prun-off or Hit pruners allowed the pruners to fit over larger dowelling than Hit pruners with modified handles and no stopper pin. For example, the maximum dowelling capacity of Prun-off pruners was 49mm. Hit pruners with the stopper pin removed have a maximum capacity of 58mm, but grinding of the hooked blade increases the gape to 63mm.

(d) Cut quality

The quality of the cuts made varied between the different pruner designs (Fig. 5). Pruners with modified blades produced the smoothest cut. All other pruners compressed and tore or split wood during cutting, leaving a rough surface.

(e) Weight

The weights of the tools tested ranged from 2.59 kg (Prun-off) to 1.46 kg (Wolf).

Although the Wolfs are very light they are not a commonly used tool. The most popular tool, Modified Hits, weighed 2.14 kg. The other tools commonly used were within 0.25 kg either side of this.

The minor differences in weight are not considered as an important criterion in ranking the tools.

Comments were made by some users on the weight of the Prun-offs – generally that they were outside of the preferred weight range.

TABLE 1 – Maximum force (Newtons) required to cut different dowel sizes with various modified and unmodified pruners.

Pruning tool	Wood diameter		
	16mm	23mm	41mm
Prun-off pruners (mod. blade)	25 a	65 a	181 a
Hit pruners (mod. handles and blades)	29 a	71 a	216 b
Porter pruners (original)	42 b	97 b	208 b
Hit pruners (original)	81 c	103 b	250 c
Hit pruners (mod. handles)	81 c	99 b	295 d
Prun-off pruners (original)	84 cd	115 c	262 c
Wolf pruners (original)	87 d	158 d	345 e

Values with the same letter are not significantly different ($P<0.05$, LSD test) within dowel diameter classes.

TABLE 2 – Average percentage differences in force required compared to "standard" (Hit pruners with modified handles). Pruning tools ranked by decreasing cutting efficiency.

Pruning tool	% less force	% greater force
Prun-off pruners (modified blade)	47.76	–
Hit pruners (modified handles/blades)	40.56	–
Porter pruner (original)	26.53	–
Hit pruners (original)	4.82	–
Hit pruners (modified handles)	–	–
Prun-off pruners (original)	–	2.26
Wolf pruners (original)	–	30.96

(e) Best pruner overall

Hit pruners with modified blades and handles were the best pruners tested. The reduction in peak force gained by modifying both blades and handles was second only to that of Prun-off pruners with modified blades. However, the overall design of Hit pruners was more robust than Prun-off pruners. The gape of the modified Hit blades would be able to accommodate the largest branches, up to 63mm in diameter.

There is clearly a huge potential for the improvement of "off the shelf" pruners. If this potential is realized, the cost-effectiveness of pruning operations should increase because of reduced operator fatigue (less force required per cut) and therefore greater production. Further research should examine the work actually expended during a pruning operation, the methods used, and the capabilities of the operators. Such research could lead to even further reductions in pruning costs.

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Pruned logs – how well can we find them?

A. Twaddle

ABSTRACT

Many stands of radiata pine have been pruned in the anticipation that pruned logs will be recovered during their subsequent harvest. A set of six measurements were made in harvesting operations where completely pruned or partially pruned logs were being produced. The objective was to determine what proportion of the pruned stems had been correctly cut to maximize pruned log recovery.

A high proportion of the pruned logs were found to be out of specification, with the most common error being the inclusion of sections of unpruned stem, although other types of error were also prevalent. The proposed reasons why skidworkers make errors associated with the recovery of pruned logs include the difficulty in spotting branches; the limited time available to inspect stems; the complexity of log specifications; and a skidworker's skill and motivation.

INTRODUCTION

Much of the philosophy of New Zealand foresty regimes hinges upon the production of clearwood. Pruning can produce clearwood on a standing tree but until that pruned zone is identified and segregated during harvesting there is no guarantee that the potential of the stand to yield clearwood will be realized.

Logs of the "pruned" grades are expected to have a high value premium. However if these premium logs cannot be produced consistently within specification, log buyers will tend to offer lower prices to counteract the effect of the sub-grade material. The same holds true for logs in the partially pruned grades. If a log does not contain at least the minimum specified length of pruned material, the buyer is unlikely to make a profitable return on the log.

It is up to the skidworker to separate the valuable pruned material from the unpruned material. Just how difficult is this task? A skidworker must detect the upper end of the pruned zone to segregate pruned from unpruned material, 20 to 25 years after pruning has taken place. While the absence of branches is an obvious clue that the stem has been pruned, many stands have a mixture of pruning heights. This means that the skidworker cannot take for granted the approximate position of the end of the pruned zone but must carefully examine each new stem. The skidworker, as well as having to face these problems of quality identification and allocation decisions, must also contend with working in an uncontrolled environment. He must continue to function in the heat and cold, dust and mud.

To see how well a typical cross-section of skidworkers are able to identify pruned log grades, an evaluation of previously collected information was undertaken.

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DATA BASE

Over the last two years the Forest Research Institute has carried out a number of studies on value recovery during log-making at the skid site using the AVIS system (Assessment of Value by Individual Stems). These studies consisted of measuring the dimensions and qualities of what were essentially random samples of trees before they were processed at the skidsite. The dimensions and qualities of the resultant logs were also recorded. The measurements of the pruned section of the stem have been re-evaluated to determine how well the skidworkers allocated this high value component of the tree into high value logs; into either pruned or partially pruned log grades.

The age of the stands (see Table 1) which provided the data for this study varied from 30 (Stands C and E) to 40 (Stand D) years at the time of clearfelling. All had received at least some thinning and pruning. However, these treatments varied considerably among (and often within) stands. Final crop stockings also varied, with a range of 150 (Stand A) to 300 (Stand B) stems per hectare.

TABLE 1 – Sampled Stands

Stand	Location	Pruned log grades cut from stand	No. trees in sample	% trees able to produce at least one pruned log
A	Patunamu	Pruned peelers 5.3m Pruned sawlogs 4.9-6.1m Partially pruned peeler 5.3m Partial pruned sawlog 6.1m	41	100
B	Kaingaroa	Pruned peelers 5.3m Pruned sawlogs 2.5-7.6m	200	92
C	Ngaumu	Pruned sawlogs #1 5.2-6.9m Pruned sawlogs #2 4.6-6.9m Partially pruned sawlogs 4.9m	86	90
D	Whakarewarewa	Pruned peelers 2.0, 2.7 and 5.3m Partially pruned peelers 5.3m	194	63
E	Kinleith	Pruned peelers 5.3m and 7.9m	267	58
F	Kinleith	Pruned sawlogs 5.5-11.0m	150	51