

## EFFECT OF SPIKED BOOTS ON FALLER SAFETY, PRODUCTIVITY AND WORKLOAD

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*Figure 1 - Logger walking up stem wearing spiked boots*

### ABSTRACT

*A study was undertaken to investigate the impact of wearing spiked boots on faller workload, productivity and safety. The study involved four fallers who carried out felling and delimbing for ground-based operations and one faller, felling and partial processing for hauler extraction. Results showed that wearing spiked boots significantly increased faller safety while having no detrimental effect on either productivity or workload.*

### INTRODUCTION

Analysis of six years of data from the New Zealand Logging Industry Accident Reporting Scheme revealed that approximately 10% of all lost time accidents occurred as a result of fallers slipping off logs while trimming (Parker, 1991). The injuries sustained from such accidents resulted in 2870 lost days over the period 1985 to 1991. As harvesting moves on to steeper more difficult terrain, the potential for slipping accidents will increase.

To reduce the frequency of slipping accidents, LIRO initiated a study looking at the effects of fallers wearing spiked forestry boots, in terms of safety, productivity and physiological workload compared with wearing conventional rubber soled boots. Spiked boots were chosen for study due to their simple introduction to existing work methods as well as their common, and in some regions compulsory, use (Canada and the United States). New Zealand manufactured spiked boots cost approximately \$288 (including GST) and are available from Protector Safety Limited. The boots used in this study were prototypes and are still under development.

## ACKNOWLEDGEMENTS

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## FALLER SELECTION AND STAND DETAILS

Five fallers were involved in the study and had on average, 11 years' experience in production forestry. Four fallers delimbed at the stump for ground-based extraction, while the fifth undertook partial stem processing for hauler extraction. The physical characteristics of the fallers are shown in Table 1. Faller 5 was not included in all parts of this study.

*Table 1 - Physical characteristics of fallers*

Age (Years)	35 ( $\pm 2.8$ )
Height (cm)	170 ( $\pm 2.2$ )
Weight (kg)	78 ( $\pm 4.7$ )

The study areas consisted of moderate to steep terrain in transition crop radiata pine, with a mean butt diameter of 48 cm (Table 2).

*Table 2 - Stand and terrain characteristics*

ELEMENT	MEAN VALUE ( $\pm$ SD)
Access	Easy - Moderate
Branching	Moderate
Double Leader	Moderate
Tree Lean	Slight Back Lean
Tree Age (years)	32.6 ( $\pm 1.1$ )
Butt Diameter (cm)	48 cm ( $\pm 8.2$ )
Ground Slope	16.7° ( $\pm 9.8$ )
Tree Slope	14.6° ( $\pm 4.1$ )

## STUDY METHOD

### Worker Productivity and Safety

The activities of the fallers' work cycles were standardised into 24 separate elements and recorded using the continuous time study method. This procedure was initially carried out with the fallers wearing conventional rubber soled forestry boots. The number of times each faller slipped, tripped or fell while carrying out his work and what task the faller was doing at that time were recorded. Each faller was supplied with a pair of spiked boots and given four weeks to get accustomed to wearing them. The study was then repeated with the faller using the same work method, in the same stand on similar terrain.

### Physiological Workload

Heart rate data collection techniques were used to estimate physiological workload of the fallers during the two treatments (Åstrand & Rodahl, 1977). Each faller's

*Table 3 - Faller productivity when wearing spiked boots versus conventional boots*

SIGNIFICANT PRODUCTION EFFECTS OF SPIKED BOOTS (95 % CONFIDENCE LEVEL)					
ELEMENT	FALLERS				
	1	2	3	4	5
FELLING CYCLE (DELAY FREE)	SHORTER	SAME	SAME	SAME	SHORTER
DELAYS	LESS	SAME	SAME	SAME	SAME
TOTAL CYCLE TIME (INCL DELAYS)	SHORTER	SAME	SAME	SAME	SHORTER

heart rate was recorded at 15 second intervals using a Polar Electro Sport Tester PE 3000 portable heart rate monitor. The faller's activity, such as walk, trim, etc. was also recorded at the same 15 second interval using activity sampling. These two sets of data were then merged together in a spreadsheet format and average heart rates for each element of the work cycle were calculated.

High air temperature increases workload and heart rate (Rodahl, 1989). Therefore, to ensure comparisons of workload could be made between days (and type of boots worn), dry bulb air temperature was recorded on the felling face as near as practicable to the faller throughout the day.

## RESULTS AND DISCUSSION

### Productivity and Safety

Analysis of the stand and terrain data confirmed that there were no significant differences in access and tree characteristics between the comparative studies. However, both ground slope and tree trimming slope were significantly steeper (at the 95% level) for the second part of the study when the fallers wore spiked boots.

Productivity effects are shown in Table 3, e.g. Faller 1 had a shorter felling cycle time when he worked wearing spiked boots. Overall results showed that wearing spiked boots does not decrease productivity.

The occurrence of slips was separated into three distinct groups for analysis. These consisted of trimming on bare ground, trimming while standing on slash and trimming while standing on the stem.

During both the studies Faller 5 worked in the rain. Results indicated spiked soles gave superior traction to conventional soles under wet conditions. There was a dramatic reduction in slipping while trimming in slash when spiked boots were worn (Table 4). This is an important finding as a common misconception is that spiked boots are only advantageous when trimming on the stem. This result, therefore, shows that spiked boots have application under a variety of conditions.

There was an additional advantage in that all fallers said that they felt more confident when wearing spiked boots. That the fallers themselves detected the increased stability offered by the spiked boots reinforces the results shown in Table 4.



*Table 4 - Slipping analysis*

Location and frequency of slips (per 100 stems trimmed)			
Location of slip	Bare ground	Slash	Stem
Faller 1			
Conventional	2	26	4
Spiked	3	2	1
Faller 2			
Conventional	6	26	5
Spiked	4	2	0
Faller 3			
Conventional	26	14	28
Spiked	8	5	9
Faller 4			
Conventional	9	10	19
Spiked	4	6	3
Faller 5			
Conventional	13	12	6
Spiked	3	1	1

Analysis of the hazards showed a significant decrease (at the 99% level) in the occurrence of slipping accidents on dirt, slash or the stem when spiked boots were worn.

Standing on the stem to delimb places significantly greater forces on the spine than delimbing from beside the stem (Gaskin, 1990). A concern in the initial stages of the study was that the introduction of spiked boots would encourage fallers to stand on the stem rather than stand beside it to delimb, thus

increasing the probability of back injury. It was apparent from this study, however, that only one faller increased the proportion of trimming time he spent trimming on the stem while wearing spiked boots.

*Table 5 - Proportion of delimbing time fallers stand on the stem (Faller 5 excluded)*

Boots	Fallers			
	1	2	3	4
Conventional	55%	3%	38%	72%
Spiked	60%	5%	52%	31%
Significant difference	no	no	yes	yes

### Physiological Workload

Calculation of the average working heart rate excluded heart rate when resting, refuelling or during delays. For three of the four fallers there was no difference in their working heart rate when wearing conventional or spiked boots (Table 6).

Faller 2 had a slightly higher heart rate when wearing spiked boots compared with wearing conventional boots. A possible explanation is that he was working well below his work capacity so could easily increase his heart rate and still work comfortably.

Workload studies in other industries have shown people doing physically demanding work tend to work at their own pace so keep their average heart rate similar from day to day (Åstrand, 1967). If the work becomes too physically demanding, the workers will decrease their productivity to maintain a similar heart rate. The loggers in this study did not decrease their productivity indicating their workload was unaltered by wearing spiked boots.

Table 6 - Average working heart rate of fallers and average air temperature during work period (Faller 5 excluded)

Faller		1	2	3	4
Heart rate (beats/minute) ± SD	Conventional	118.2 ± 13.4	101.1 ± 6.7	126.9 ± 13.5	121.6 ± 13.3
	Spiked	118.3 ± 14.0	104.4 ± 13.9	128.1 ± 17.0	121.1 ± 10.0
Difference (95% level)		no	yes	no	no
Air temperature (°C) ± SD	Conventional	20.5 ± 7.6	18.8 ± 2.0	17.9 ± 6.3	19.6 ± 3.6
	Spiked	16.6 ± 5.0	18.0 ± 7.6	21.0 ± 5.4	23.0 ± 6.9
Difference (95% level)		no	no	no	no

## CONCLUSION

The wearing of spiked forestry boots significantly reduced the occurrence of slipping and falling hazards experienced by fallers operating in clearfall radiata pine logging operations.

There was no detrimental effect on productivity or increase in workload when spiked boots were worn.

Spiked boots can be introduced into a faller's existing work routine with minimal disruption.

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*LIRO NOTE : Spiked boots used in this study were prototypes and are still under development. LIRO will continue to monitor and report on this development.*

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