

Effect of daily working hours on productivity of mechanised harvesting operations

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Introduction

There is renewed interest in extended shift and multiple shift forest operations in countries such as Australia, Sweden, Brazil, Uruguay, Chile and the south eastern USA. Meeting the growing demand for improved monetary returns, increasing production efficiency and reducing obsolescence of forestry equipment are reasons given for this renewed interest. Over the last three decades extended working hours—multiple shifts in particular—have been tried and failed in some parts of the world (e.g. New Zealand and south eastern USA) but in other parts (e.g. Scandinavia, Canada and parts of the north eastern USA) have been used for many years to increase production.

Previous research has found that, while there is a potential for a reduction in logging costs resulting from increased daily production, the size of the production increase is sometimes insufficient for logging cost reductions to be realised. They also noted that the impact of extended hours on other tangible and intangible costs such as value recovery losses and human factors (e.g. employee turnover rates, accident risk, and opportunity for employees to participate in social affairs and domestic activities) needs to be considered.

In this bulletin, we report on the effects of extended working hours on the productivity of two types of harvesting operations undertaken by a Chilean forest company. Results are based on long-term data from many operators collected using onboard computers.

Study description

The study was conducted using data collected by Forestal Mininco, one of the largest forest companies in Chile. The climate in the study area is temperate with average monthly temperatures ranging from 7 to 19°C and average monthly rainfall ranging from 20 mm to 244 mm. Steep terrain areas were excluded from the study.

The data consisted of shift length production (m³) and hourly productivity (m³/scheduled machine hour (SMH)) figures for roadside processors (Komatsu excavator bases with Waratah 620 and 622 heads) working in radiata pine plantations and Valmet 370 and 380 harvesters working in eucalypt plantations (*Eucalyptus globulus* and *E. nitens*). Production and productivity estimates were calculated using tree counts for each shift obtained from the machine onboard computers and the average tree size for each stand. Mechanical downtime that occurred during each shift was also recorded. Over 22,000 data points were collected from 14 harvesting crews for roadside processors in radiata pine from 2007 and over 9,000 data points from 10 harvesting crews for harvesters in eucalypts from 2009.

Four work schedules are used in both pine and eucalypt plantations:

- Single shift of 9 work hours
- Single shift of 12 work hours
- Double shift of 16 work hours (2 x 8 hour shifts)
- Double shift of 18 work hours (2 x 9 hour shifts)

For each shift there was an additional one hour 'lunch' break.

Results

Daily production levels averaged for all seasons, all forest classes, and all species are shown in Figure 1 for each work schedule length and for each machine type. Increasing the number of hours worked per day generally resulted in greater daily production for both types of operations; processors in radiata pine plantations and harvesters in eucalypt plantations. The exception was for processors where extending the working hours from 16 to 18 resulted in no increase in daily production. However, Figure 1 also shows that increasing the number of hours worked per day resulted in a drop in average hourly productivity for both processors and harvesters; the rate of production decreases as the working day length is increased.

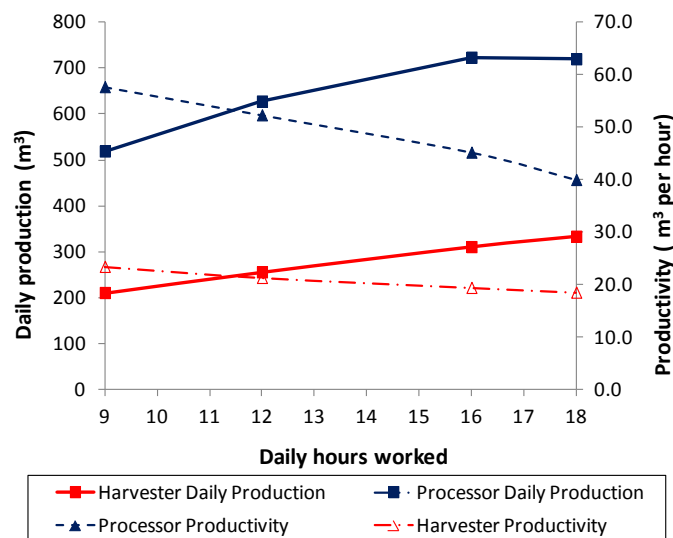


Figure 1. Effect of daily hours worked on daily production and average hourly productivity for mechanised processors operating in radiata pine plantations and harvesters operating in eucalypt plantations. Production and productivity are the averages for all seasons, all forest classes, and all species for each machine type.

The effect of long hours on the machine operator, resulting in physical and mental fatigue, undoubtedly contributed to the drop in productivity. However, longer working days also result in more opportunities for mechanical problems, fewer hours available for equipment maintenance outside of normal working hours, more passing of responsibility onto the next operator to fix any problems, and greater lost time.

Seasonal changes in productivity are compared in Figure 2. Productivity declines with increasing daily hours were greater in summer than in winter. For roadside processors this was largely due to overheating and the increased need to clean air filters due to dusty roads. For harvesters, the hot weather increased mechanical problems but also increased the difficulty in debarking eucalypts. In

both cases, hot weather was also likely to cause greater operator fatigue with a possible impact on productivity.

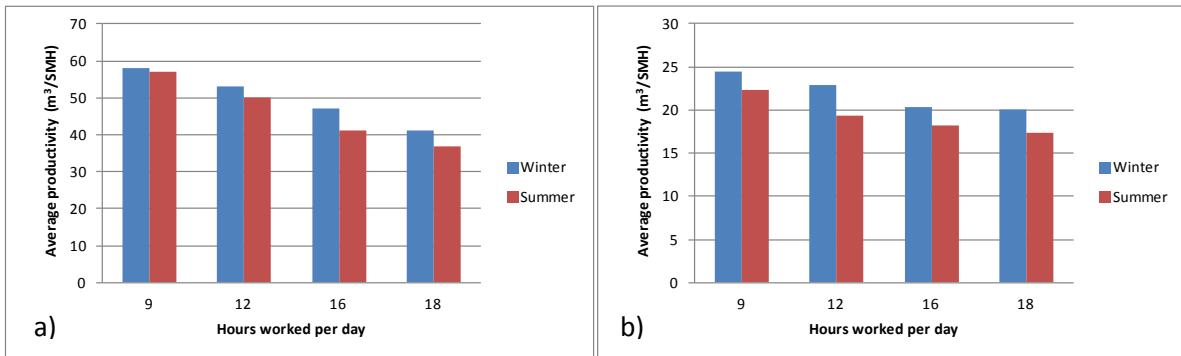


Figure 2. Effect of season on the decline in hourly productivity with increasing hours worked per day. (a) Processors working in radiata pine plantations; (b) Harvesters working in eucalypt plantations.

Decreases in processor productivity with increasing hours worked were exacerbated by increasing tree size in radiata pine stands (Figure 3). The bigger pine trees being heavier produced more mechanical problems. They can also produce a greater range of products and hence required more attention from the operator during processing. Strict length and diameter controls also meant the processors needed to be frequently calibrated. Unlike the processor, there was no clear trend for decreases in harvester productivity being exacerbated by increasing tree size in the eucalypt plantations.

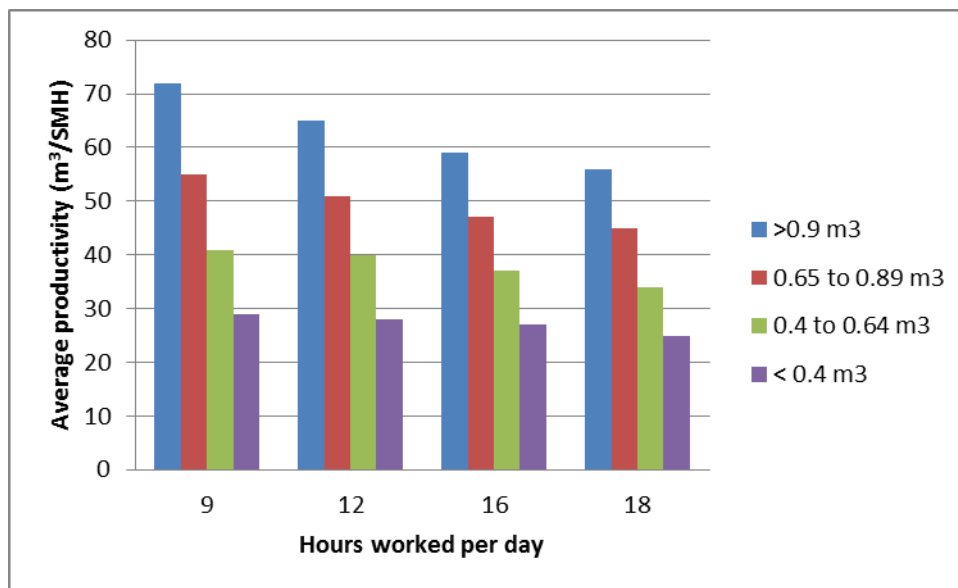


Figure 3. Effect of tree size on the decline in hourly productivity with increasing hours worked per day.

Access to the harvesting contractors' financial records was not available so costs were estimated. Changes in estimated costs due to changes in work schedules may, or may not, reflect changes to actual costs. Estimated costs per unit of production increased by approximately 30% for the processors and 15% for the harvesters when scheduled hours per day were increased from 9 to 18 hours. Unit production costs were greater for all three work schedules above 9 hours per day. Lower

hourly productivity associated with longer work schedules negated the reduction in hourly fixed costs.

Take home messages

- Increased working hours per day increased daily production but decreased hourly productivity because of greater operator fatigue and mechanical problems combined with reduced repair and maintenance time.
- Productivity was less in summer than in winter because of greater operator fatigue and mechanical problems due to overheating and, in eucalypt stands, difficulty with debarking.
- Larger radiata pine trees caused a greater drop in hourly productivity because of the increased mechanical damage from heavier trees and the increased number of products which required greater operator concentration and more time spent in calibration.
- Lower hourly productivity associated with longer work schedules negated the reduction in hourly fixed costs.

Acknowledgements

This bulletin is a summarised version of a paper published in the New Zealand Journal of Forestry Science. For further details refer to this paper:

Passicot and Murphy: Effect of work schedule design on productivity of mechanised harvesting operations in Chile. New Zealand Journal of Forestry Science 2013 43:2.

More information

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