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Benchmarking feller-buncher productivity in Western Australian blue gum plantations

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Introduction

The productivity of feller-bunchers in plantation clearfell operations depends highly on average tree size. Other important factors include operator performance, delays, and site factors such as row spacing and slope. Recent productivity trials in Western Australian blue gum (*Eucalyptus globulus*) plantations carried out by researchers with the CRC for Forestry's 'harvesting and operations' program provided the opportunity to 'benchmark' feller-buncher productivity against average tree size. The productivity data used in this benchmarking exercise was collected as part of a larger project covering the full range of harvesting systems used in WA blue gum plantations.

The benchmark can be used by forest owners and contractors to evaluate feller-buncher performance. Productivity substantially above or below the benchmark line can be investigated to determine the causes of the difference as part of continual improvement activities.¹



Feller-buncher harvesting blue gum plantations (left);



close-up of hot-saw head (right)

Methodology

Productivity data (in cubic meters per productive machine hour, m^3/PMH) from twelve short-term studies of feller-bunchers clearfelling blue gum plantations in WA,² and from six overseas studies in which feller-bunchers were used to clearfell a variety of species, were plotted against average tree size (m^3) (see Figure 1). Both hot-saw heads and shear heads were represented in the data. All delays were excluded from the productivity data (PMH_0). PMH_0 productivity is preferred, as it is easiest to collect in the field by users of the benchmark.

¹ For more information about carrying out simple measures of machine performance, contact the CRC for Forestry to obtain a copy of the Machine Evaluation Toolbox (see end of this bulletin for contact information).

² The methodology used to collect the data in these and other studies by the CRC for Forestry is described in the Machine Evaluation Framework, which is available on request from the CRC for Forestry.

A curve fitted to the data gave a good fit (Figure 1). Estimated trees cut per PMH₀ was derived from the regression and plotted against average tree size (m³) (Figure 2). Lines at ±10% were added for guidance when using the benchmark lines.

Results from operations other than clearfelling (e.g. thinning, or other partial-cut operations) were excluded from this analysis, as time taken moving between trees significantly reduced the productivity of these operations relative to clearfelling.

Results

The spread of WA trial results above and below the benchmark line implies that there is room to improve feller-buncher productivity in some operations in WA (Figure 1). Feller-buncher trials in which productivity did not reach the benchmark may reflect the relative inexperience of the feller-buncher operators (less than two years).

The curve reflects that productivity is lower when cutting small stems and that the rate of productivity increase drops as tree size increases, probably due to less stems per accumulation and the difficulty of handling larger stems.

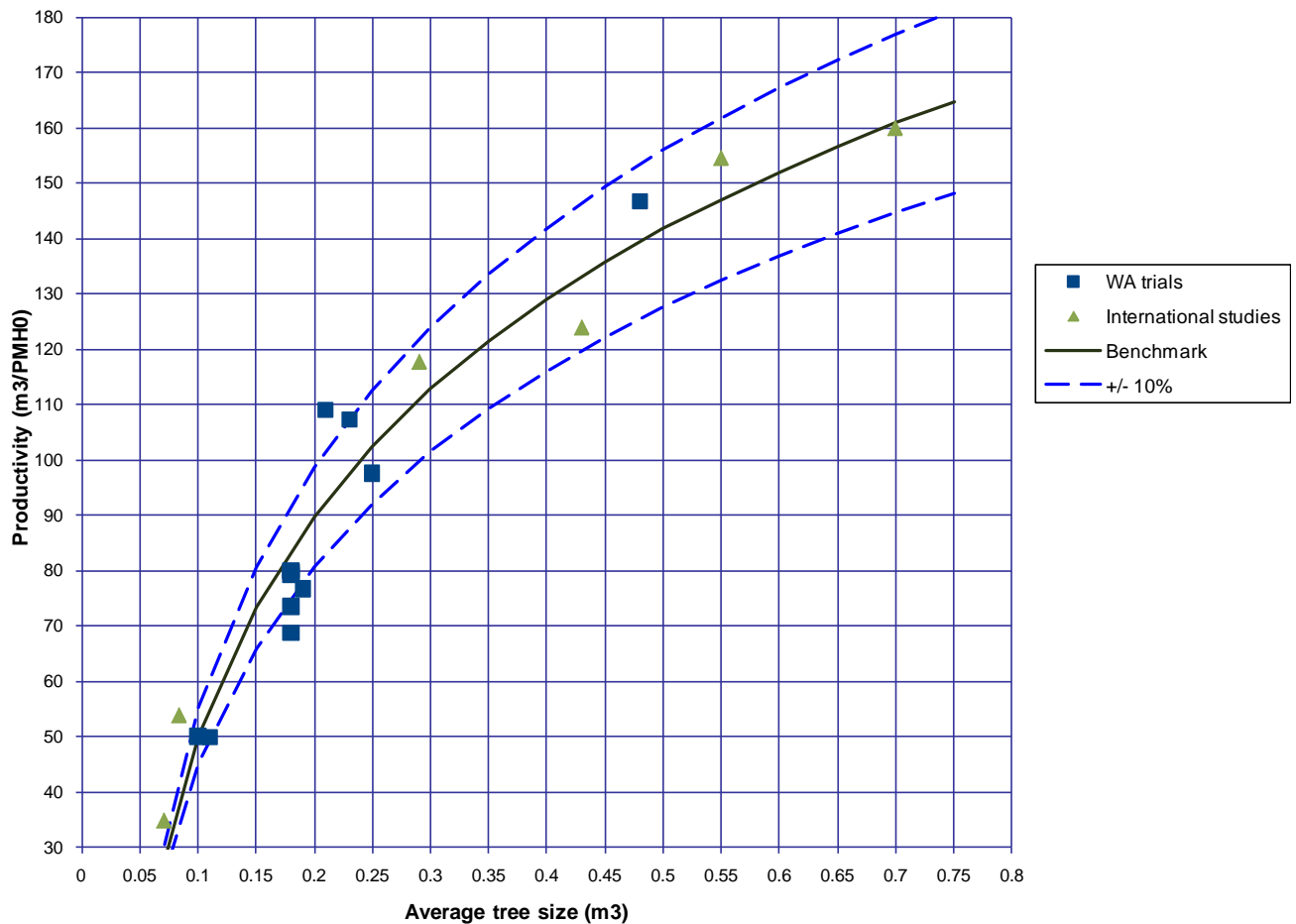


Figure 1. Feller-buncher productivity (m³/PMH₀) against average tree size (m³)

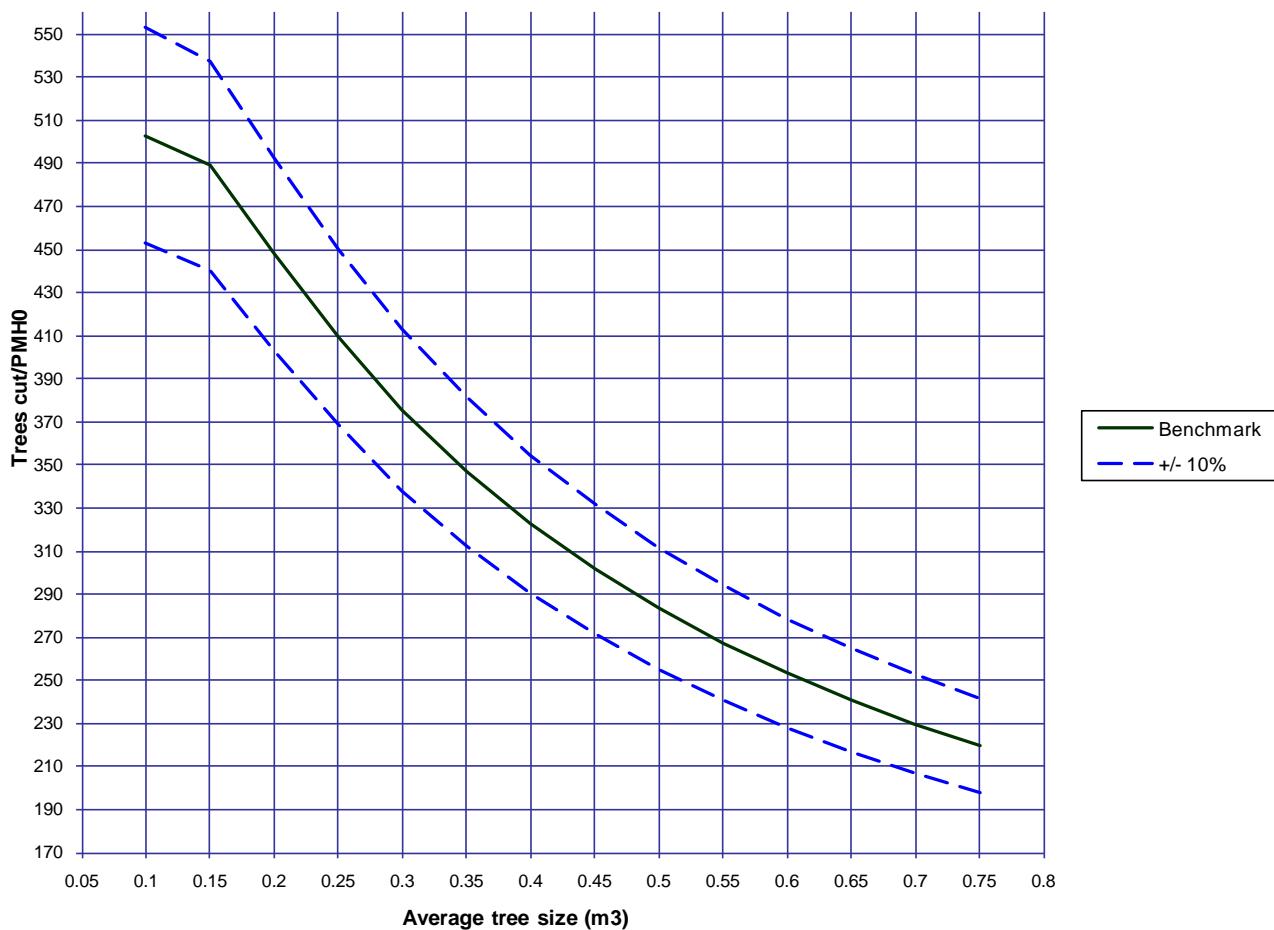


Figure 2. Trees cut per PMH₀ against average tree size (m³)

Using the benchmark line

Average tree size (m³) of the stand is needed to use the benchmark line. Average tree size can be calculated by dividing volume per hectare by the number of stems per hectare.

To use the benchmark, find where the average tree size of the stand is along the bottom of Figure 1, and imagine a vertical line extending from this point to where it crosses the benchmark line. Then imagine a horizontal line extending to the left to where it crosses the productivity axis. The point where the horizontal line crosses the productivity axis is the estimated productivity for a feller-buncher clearfelling that stand. For example, Figure 1 shows that a feller-buncher working in a stand with an average tree size of 0.25 m³ would be expected to cut between 90 and 110 m³/PMH₀.

If your estimated productivity is outside the 10% ranges indicated by the dashed lines, it should be checked as part of your continual improvement effort. Productivity below the benchmark can be investigated and addressed, while investigation of productivity above the benchmark may enable transfer of the improvement to other parts of the operation or may improve planning and costing.

A similar approach can be applied when using Figure 2 to estimate trees cut per PMH₀ by a feller-buncher. Trees cut per PMH₀ is an easier figure to use in a quick study of a feller-buncher's productivity by using a short-term tree count (e.g. 20 minutes) and multiplying it to get the rate per PMH₀. For example, a feller-buncher in a stand with an average tree size of 0.25 m³ would be expected to cut between 123 and 150 trees every 20 minutes. Longer tree counts will increase accuracy. (Remember that the count must not include

delays.) Some machines have onboard tree counters that can be used to simplify longer counts. Be aware that tree counters tend to overestimate the true tree count.

For more information about carrying out a tree count or other simple measures of machine performance, contact the CRC for Forestry (see below) to obtain a copy of the Machine Evaluation Toolbox.

The following two cautions should be observed when using the benchmark lines:

- The lines are based on only a small number of points, so the results should only be used for guidance as part of a larger pool of information. As more data is collected by CRC for Forestry researchers, the benchmark lines will be reviewed and modified if necessary.
- As the results are based on PMH_0 (i.e. no delays), they will not reflect long-term performance, as delays and breaks will reduce the working time available.

Take-home messages

- Benchmark lines can be useful, simple tools to evaluate the performance of feller-buncher operators. Techniques used by high-performing operators can be identified, and can be adopted by underperforming operators to improve their performance.
- Evaluations of feller-buncher productivity against the benchmark should be integrated with a broader range of tools and techniques as part of an effective continual improvement program.
- The WA trial results suggest there is room to improve feller-buncher productivity in some operations.
- Productivity, and hence cost, is very sensitive to average tree size, particularly when trees are small.

More information

For more information, visit the CRC for Forestry website at
<http://www.crcforestry.com.au/research/programme-three/index.html>
or contact the project scientist: Martin Strandgard: mnstra@unimelb.edu.au