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THE BUTT DIAMETER/DIAMETER BREAST HEIGHT RELATIONSHIP

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ABSTRACT

A relationship between diameter at breast height over bark and the diameter at the butt over bark is presented in the form of two equations. These data should allow logging managers to match machine capacity with the tree characteristics that are vital to satisfactory technical and budget performances.

INTRODUCTION

Further mechanisation of harvesting operations in the felling and the delimbing phases is likely to occur in the future.

The felling operation is one of the most hazardous in the harvesting operation (Gaskin et al., 1989) and where terrain and tree size will allow, felling is a very suitable candidate for mechanisation (Figure 1).

Figure 1 - Bell Feller-Buncher felling radiata pine

The power saw delimbing operation occupies about 60% of the logger time in the new crop stands (Hall and Terlesk, 1991). Accidents are relatively frequent and the work arduous and monotonous, characteristics which often make mechanisation and automation attractive (Figure 2).

Figure 2 - Two grip harvester delimbing radiata pine

In addition to terrain and tree weight considerations, an important factor limiting the application of mechanised system is tree diameter. Pre-harvest inventory of a stand provides data that covers; stems/ha, volume/ha (m^3), diameter at breast height, etc. A potentially useful piece of information for the harvest planner considering the introduction of a feller director, or harvester, is the diameter size and range of the stems at close to ground level (butt diameter). These data would allow the planner to analyse and to introduce the most appropriate machine to the operation to fell and delimb a sufficient number of stems to be an economic alternative to motor manual methods.

This Report presents equations representing the relationship between diameter at breast height over bark and diameter over bark at the butt.

DATA SOURCE

Data from six stands of radiata pine were collected by Forest Research Institute personnel for branch size analysis which also included butt and breast height diameter measurements.

The radiata pine stands sampled included "transition", "young crop", "agroforestry" type stands, and a stand due for production thinning.

The transition crop describes a tree crop which has received some silviculture pruning and thinning treatments. This silvicultural treatment distinguishes the transition crop from the untended old crop stands. Stocking rates and stems pruned per hectare are variable. However, the target final stocking is around 300 stems/ha.

"Young crop" radiata is defined as stands planted after 1960, that have received extensive silvicultural treatment. The target final crop stocking in the Bay of Plenty region is 200-250 stems/ha.

Agroforestry has been described as "dual agriculture and forestry production on the same unit of land". It is typified by a relatively low initial stocking (400-600 stems/ha), heavy and early thinning to waste to final crop stocking (225 stems/ha), and pruning to 6.3m. (FRI 1991).

The production thinning regime approximates a reduction from around 600

NOTE: MODEL FORCED THROUGH ORIGIN

PREDICTOR VARIABLES	COEFFICIENT	STD ERROR	STUDENT'S T	P
Youngtran	4.8416	6.6296E-01	7.30	0.0000
Agrothin	2.8979	6.3244E-01	4.58	0.0000
DBH	1.0236	1.4484E-02	70.67	0.0000

CASES INCLUDED	396	MISSING CASES 0	
DEGREES OF FREEDOM	393		
OVERALL F	2.371E+04	P VALUE 0.0000	
ADJUSTED R SQUARED	0.9945		
R SQUARED	0.9945		
RESID. MEAN SQUARE	13.36		

Table 1 - Unweighted Least Squares Linear Regression of Butt

stems/ha to a final crop of 250-300 stems/ha at age 16-18 years, giving an extracted merchantable piece size of around 0.35 to 0.45m^3.

Therefore the sample in the analysis covers a range of stand, and treatment approaches that will be with the forest industry for some years into the future.

ANALYSIS OF DATA

Four regressions from the collected data could have been developed, one for each class of observation. The main analysis technique used was the comparison of a Family of Regression lines or Giant Size Regression (GSR).

The technique makes use of indicator or dummy variables in the multiple regression analysis to test for assumptions about common slope and intercepts. The ANOVA Table from the GSR model provides some of the information required for common slope and intercept tests - F and R^2 statistics.

The analysis showed that the data from the young crop and transition crops (Youngtran) could be combined. The data from thinning and agroforestry (Agrothin) was combined to yield another equation (Table 1). These data are consolidated into two equations shown in Table 2.

YOUNG CROP AND TRANSITION CROP
Equation 1
Butt diameter (cm) = 4.84 + 1.024 x DBH (cm)
THINNING AND AGROFORESTRY
Equation 2
Butt diameter (cm) = 2.90 + 1.024 x DBH (cm) R^2 = 0.94

Table 2 - Equations Butt/Diameter Breast Height (O.B.) Relationship

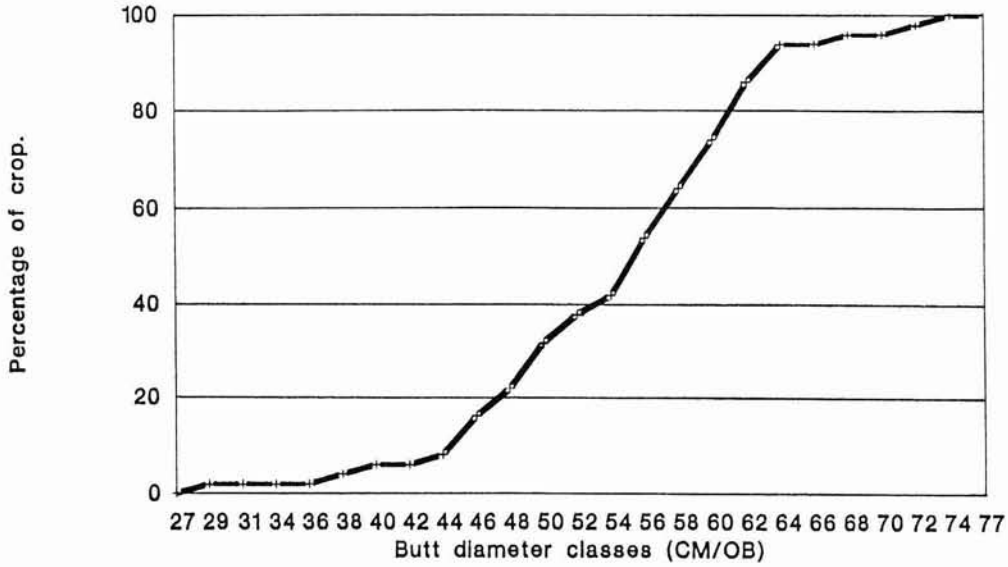

Figure 3 - Cumulative % butt diameter distributions (young crop)

EXAMPLE USE OF THE DBH/BUTT DIAMETER RELATIONSHIP

The equations will be useful in matching felling/harvesting head to tree size and for assessing the percentage of stems within a given stand that can or cannot be processed by a particular type or class of felling/processing head.

As an example, Figure 3 relates butt diameter classes (2cm steps) to a cumulative percentage of the crop stems/ha from the young crop stand. The breast diameter measurements have been converted to butt diameter over bark using Equation 1. The graph indicates that a feller buncher with a design capacity of 56cm could fell between 50-60% of the stems in the stand. The graph also provides a measure of the number of trees at or close to the design capacity of the equipment, an important factor in repair and maintenance costs. For example, around 23% of this stand is within 10% of the maximum capacity of the felling head (i.e. 50-56 cm butt diameter).

CONCLUSIONS

Forest managers with inventory data collected from stands to be harvested should apply this analysis to determine the theoretical feasibility of mechanised harvesting. Further studies of feller bunchers and processor/harvesters will allow calculation of productivity over a range of tree size. Greater knowledge of stand characteristics and machine performance should allow the cost-effective introduction of the most appropriate machine to match the stand characteristics.

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