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ENGINEERING CHARACTERISTICS OF RADIATA PINE

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INTRODUCTION

Tree characteristics are a most important consideration when designing and selecting harvesting machinery and systems. Because they have a major influence on the productivity and efficiency of an operation, it is most important that they are defined and understood.

Only limited information is currently available in New Zealand on the engineering characteristics (e.g. weight, centre of gravity, overall dimensions) of radiata pine. These characteristics can be used to check the handling capacity of logging machinery. Before highly mechanised harvesting systems can be introduced, they must be defined to ensure the selected system can cope with the crop. This information can also be used to determine optimum payloads for extraction and loading machines, and for planning skyline settings.

In the past, the main purpose of measuring trees was to calculate volume. However, weight is more useful than volume in many aspects of logging and transport, and green weight is now commonly used as a basis for sale.

STUDY OBJECTIVES

The objective of this study was to find the parameters of a tree which could be easily measured in the field or were available from current information, and would give an estimate of the desired characteristics. The characteristics studied were:

Whole tree weight (stump to tree tip including branches and needles)

Stem weight (butt to top of trimmed length including branches)

Centre of gravity of tree and stem

Diameter at ground level

BACKGROUND

A review of overseas literature indicated that the methods of estimating tree weight were relatively simple. The weight of a tree depends largely on shape and volume, wood density, and the amount of water in the wood. These factors were taken into account when setting up the study. The parameters of a tree which are most readily available or measurable are height and diameter at breast height (1.4 metres above ground level). An estimate of wood density and moisture content could only be obtained by sampling the woody material of the tree.

ACKNOWLEDGEMENTS

LIRA wishes to acknowledge the assistance provided by staff in the forests sampled, and the Forest Research Institute, Rotorua.

THE STUDY

Stands of radiata similar to those likely to be harvested in the next 10 to 20 years were chosen. Limited time and resources meant that most stands were in the central North Island. All stands had been treated on regimes which typify current management practices, and are listed in the following table:

Location	Stand Age (years)	No. of trees
Tarawera Forest	9	10
Kinleith Forest	11	12
Tarawera Forest	13	12
F.R.I. grounds	13	6
Kaingaroa Forest	17	30
Kinleith Forest	20	22
Tauhara Forest	33	24
Canterbury area	10	8
Woodhill Forest	22	12

TREE MEASUREMENTS

Selected trees were measured for diameter at breast height, and then felled. Trees close to a road or landing were chosen so that few branches would be broken off during extraction. Some stem breakage did occur in older trees and in these cases the broken tips were extracted with the main stem.

To measure weight and determine centre of gravity, a strop was placed around the tree at or near the balance point. This was attached to a load cell which was then picked up by a log loader. If the balance point had not been correctly estimated the tree was lowered and the position of the strop altered. Some of the larger trees had to be measured in two parts. The weight of the tree (including branches and tip), total tree length, and the distance from butt to balance point (centre of gravity) were measured. The tree was then lowered to the ground, the branches and top trimmed, and the stem re-measured. Other stem measurements were taken but did not prove useful.

Sample cores were taken at breast height; wood density and moisture content were analysed by the Wood Quality Division of the Forest Research Institute.

RESULTS

An analysis of data from 138 trees was undertaken by the Biometrics Section of the Forest Research Institute. Initial screening of the data checked for relationships between factors which have to be estimated (e.g. tree weight) and factors which can be measured (e.g. height and diameter). Regression analyses by computer were used to determine likely relationships.

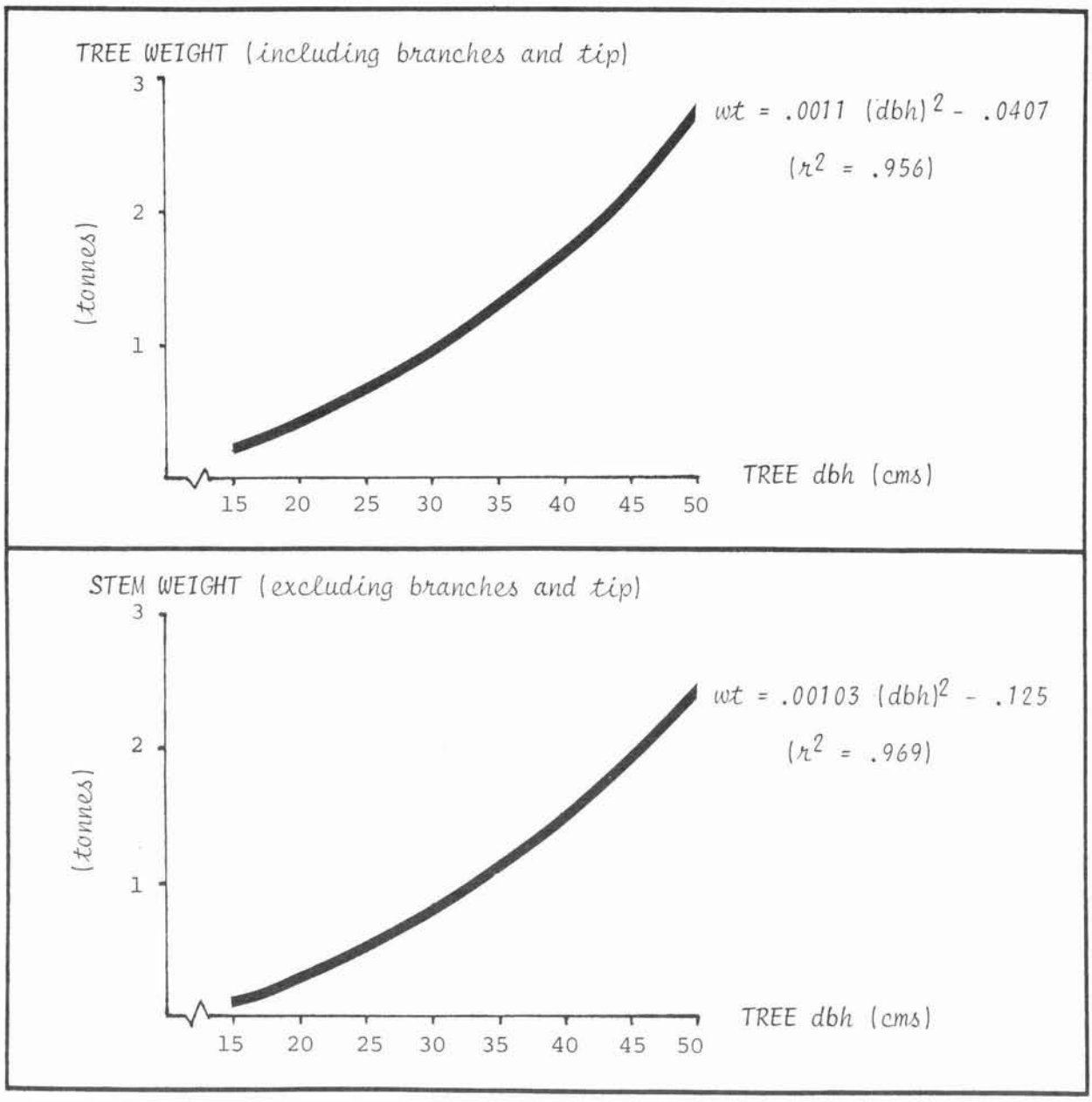
These results are shown in the following tables. The relationships identified by the analyses are relatively simple. Tree and stem weight and diameter at ground level can be accurately estimated from diameter at breast height, provided a minimum of 20-30 trees are measured. Individual tree variation is quite high so these results will not accurately estimate the weight of a single tree. The centre of gravity estimates are less accurate but should be adequate for most purposes.

CONCLUSIONS

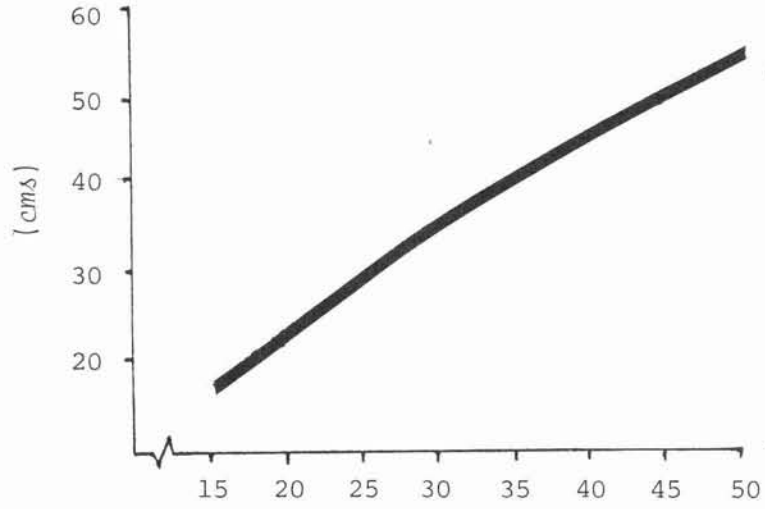
This study set out to measure some engineering characteristics of radiata, and to determine how these could be estimated from existing stand information or from field measurements. The regression equations that have been developed allow tree and stem weight and ground level diameter to be accurately estimated on a stand basis. A reasonable degree of accuracy for tree and stem centres of gravity on a stand basis can also be achieved. This should prove useful for designing or re-designing logging machinery, evaluating new machinery, or planning operations in stands treated under current silvicultural practices. Although no regional differences were apparent in the data, care is needed if applying these equations to stands in other regions.

DBH (cms)	Tree Weight (tonnes)	Stem Weight (tonnes)	Centre of Gravity (metres above stump)		Diameter at Ground Level (cms)
			Tree	Stem	
15	.21	.11	5.0	3.8	17.0
20	.40	.29	6.2	5.1	22.9
25	.65	.52	7.2	6.2	28.6
30	.95	.80	8.1	7.1	34.0
35	1.31	1.14	8.8	7.9	39.2
40	1.72	1.52	9.4	8.6	44.2
45	2.19	1.96	9.8	9.1	49.0
50	2.71	2.45	10.1	9.5	53.6

SOME ENGINEERING CHARACTERISTICS OF RADIATA PINE



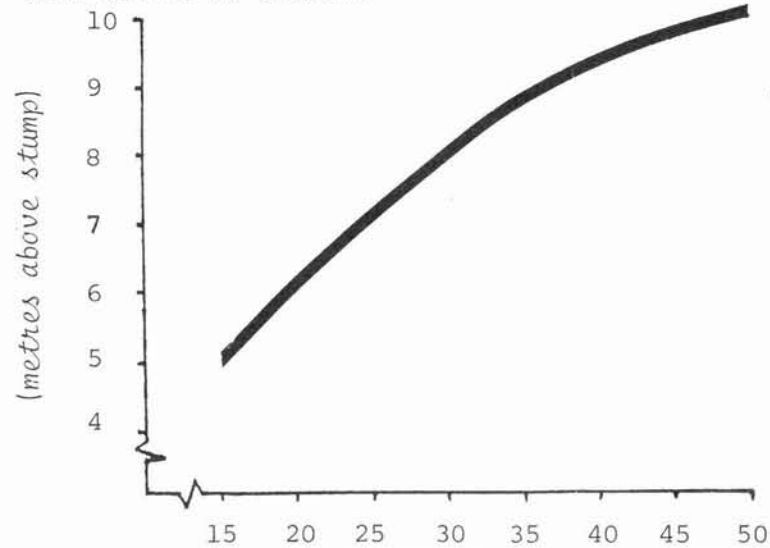
DIAMETER AT GROUND LEVEL



$dgl = -1.95 + 1.33\ (dbh) - .0044\ (dbh)^2$

$(r^2 = .97)$

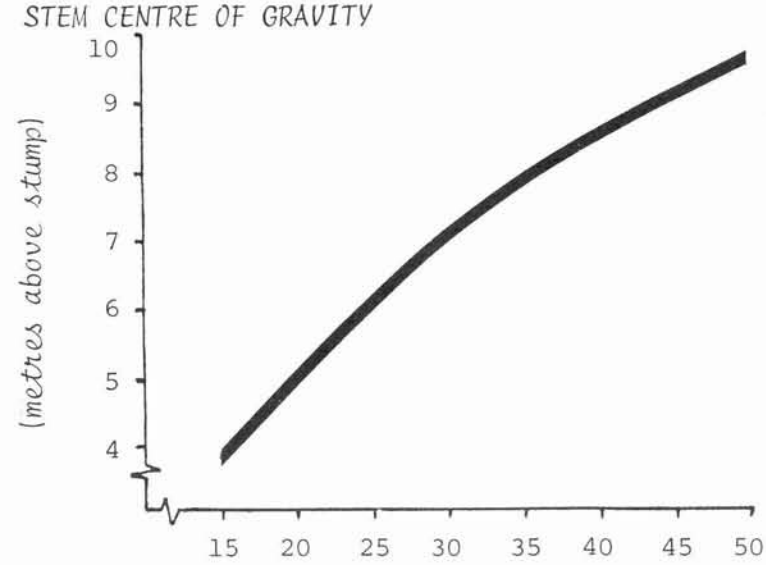
TREE CENTRE OF GRAVITY



$cog(tree) = .61 + .34(dbh) - .003\ (dbh)^2$

$(r^2 = 0.71)$

STEM CENTRE OF GRAVITY



$cog(stem) = -.77 + .35(dbh) - .0029\ (dbh)^2$

$(r^2 = .73)$

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