LOGGING INDUSTRY RESEARCH ASSOCIATION

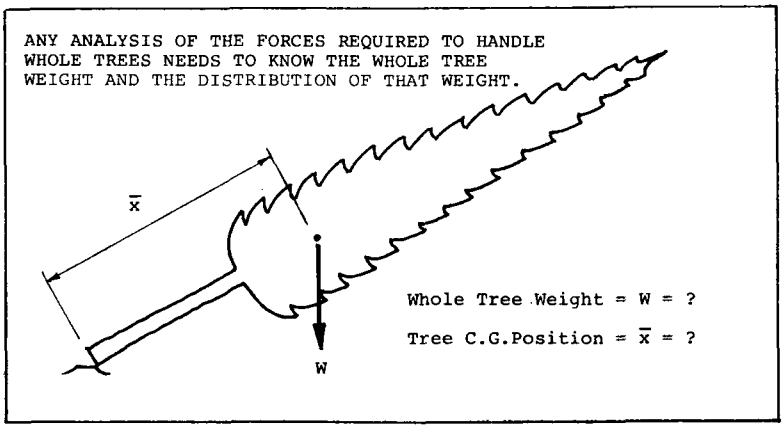
# TREE WEIGHT STUDIES

## INTRODUCTION.

Little is known in New Zealand of the weights and weight distribution of our exotic forest trees. Forest assessment to date has concentrated on establishing stem volumes and weight to volume conversion factors for stems. There has not been any need to identify the actual whole tree weight, including crown, and the distribution of that weight. Recent industry developments, however, indicate the need to know more in this field particularly now that:

(a) Machines that handle whole trees are being developed and applied, particularly for felling and delimbing.

(b) New methods for the harvesting and transport of whole trees may develop to meet the need for producing liquid fuels from wood.




As part of a wider project aimed at compiling data on the raw material we handle in the New Zealand logging industry, LIRA sees as a priority the need to establish the weights and weight distribution of whole trees. In particular this should be done for the pine species which are most likely to be either mechanically harvested or used as an energy crop, (e.g.Radiata, Corsican and Ponderosa).

*ACKNOWLEDGEMENTS:*

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## PAST TRIALS.

During 1977 data on three small trials, which measured tree weight, was gathered and compared. The trials were done separately by J.Leitch (while at the University of Canterbury Forestry School), LIRA, and NZFP and each used a different method.

This brief report is aimed at outlining some initial results on tree weight and at indicating different means of obtaining the data. LIRA aims to seek Industry's assistance in doing this work on a broader scale and a procedure for measurement that will enable this work to be co-ordinated is presented.

The extent of the three earlier trials is as follows:-

| TRIAL | LOCATION | SPECIES | No.of TREES | TREE AGE | DBH RANGE | AVE.TREE HEIGHT |
|---|---|---|---|---|---|---|
| Cant.Univ. | Eyrewell | Radiata | 8 | 10 yrs | 11.3-14.7 cm | 9.3 m |
| LIRA | Rotorua | Radiata | 6 | 13 yrs | 19.8-39.9 cm | 20.8 m |
| NZFP | Kinleith | Radiata | 1 | 14 yrs | 25.4 cm | 16.2 m |

The Canterbury University trial carried out in 1975 was on Radiata trees previously pruned to a height of 3.6 m. The method involved felling the selected trees with a chainsaw, then cutting the stem at the base of the green crown. A platform scale was used for weighing. The clear section of stem was weighed as one piece and the green crown weighed in one or two pieces, both with the branches on and then the stem without the branches. In each weighing the stem balance point was used to establish the centre of gravity of that particular section. Calculation then provided the whole tree weights and the whole tree centre of gravity position. This method used three people, a weighing platform and chainsaw, and it took from one to one and a half hours to process each tree.

During 1976 LIRA, with the assistance of the NZFS and Cable-Price Corporation Limited, used a feller-buncher to establish tree weight data on Radiata trees previously pruned to 6.1 m. The trees were from an FRI tree improvement stand which had been established from grafts and thinned to a 3.6 m x 3.6 m spacing. In this trial the trees were felled by feller-buncher and the weights of selected whole trees and stems (trimmed by chainsaw to 10 cm s.e.d.) were measured using the feller-buncher to suspend the trees with a hydraulic force-measuring link. Suspending the trees or stems at their balance points gave the centre of gravity positions required. The method used four people, a feller-buncher with force-measuring link and a chainsaw, and took approximately half an hour per tree.

In a single tree trial during 1977, NZFP selected a representative dominant tree from a stand for production thinning and measured its weight. The tree had been previously pruned to 1.5 m. The method here was to fell the tree with chainsaw, then cut the stem into seven lengths for easy transport and weighing. The lengths were then trimmed separately and, in each case, the trimmed stem section and branches trimmed off were weighed. Calculation then provided estimated centre of gravity position of whole tree and whole stem. The method required one person, a chainsaw and a weighing platform, and for the one tree took approximately two hours.

## RESULTS.

The tree weight data collected from these three separate trials is tabulated as follows:-

| TRIAL | SAMPLE No. | DBH (cm) | TREE HEIGHT (m) | CROWN LENGTH (m) | STEM WEIGHT (kg) | BRANCHES WEIGHT (kg) | TREE WEIGHT (kg) | STEM C.G. HEIGHT (m) | TREE C.G. HEIGHT (m) |
|---|---|---|---|---|---|---|---|---|---|
| Cant.Univ. | 1 | 12.3 | 9.0 | 5.3 | 54 | 15 | 69 | | 3.2 |
| | 2 | 14.7 | 10.7 | 6.1 | 87 | 30 | 117 | 2.8 | 3.7 |
| | 3 | 11.3 | 8.4 | 4.6 | 47 | 22 | 69 | 2.4 | 3.3 |
| | 4 | 14.5 | 10.7 | 5.2 | 89 | 32 | 121 | 2.9 | 3.8 |
| | 5 | 11.5 | 8.7 | 7.0 | 48 | 15 | 64 | 2.3 | 3.1 |
| | 6 | 12.5 | 9.1 | 5.4 | 64 | 19 | 83 | 2.5 | 3.3 |
| | 7 | 12.0 | 8.7 | 5.6 | 61 | 21 | 82 | 2.3 | 3.1 |
| | 8 | 11.3 | 9.1 | 6.0 | 54 | 17 | 71 | 2.6 | 3.3 |
| LIRA | 1 | 38.1 | 24.5 | 17.6 | 1270 | 490 | 1760 | 7.0 | 8.9 |
| | 2 | 34.8 | 16.8 | 10.2 | 710 | 290 | 1000 | 4.6 | 7.0 |
| | 3 | 28.2 | 18.9 | 11.4 | 590 | 270 | 860 | 5.9 | 7.7 |
| | 4 | 30.2 | 21.9 | 15.4 | 640 | 190 | 830 | 6.4 | 7.2 |
| | 5 | 19.8 | 19.2 | 12.7 | 270 | 20 | 290 | 6.5 | 5.8 |
| | 6 | 39.9 | 23.8 | 17.0 | 1320 | 640 | 1960 | 6.6 | 8.5 |
| NZFP | 1 | 25.4 | 16.2 | 14.6 | 384 | 298 | 682 | 4.2 | 5.7 |

As the data comes from unco-ordinated trials involving some very small samples, it must be taken as indicative only of the factors that influence tree weight and weight distribution. Many factors are involved, including those tabulated, as well as others not tabulated such as stem taper, component densities, pruned height, tree spacing, etc.

Two reasonably strong relationships do however evolve as shown in *Figures 2 & 3,* and these are presented to illustrate the influence of dbh on weight, and tree height on centre of gravity position. It also shows the wide range of results achieved indicating that other factors such as those outlined above are important.

Tree weight and stem weight vary with dbh as indicated in *Figure 2,* with stem weight not being a constant proportion of tree weight.

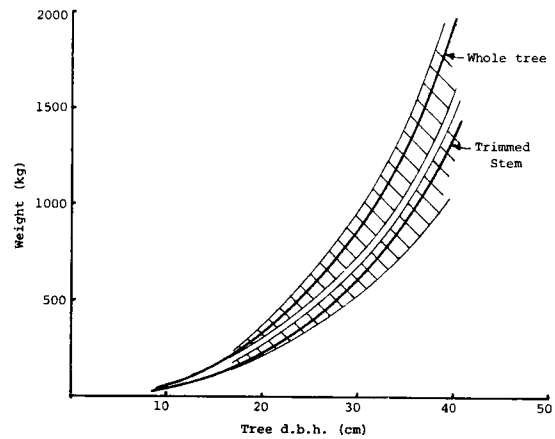


FIG.2 TREE WEIGHT PATTERN

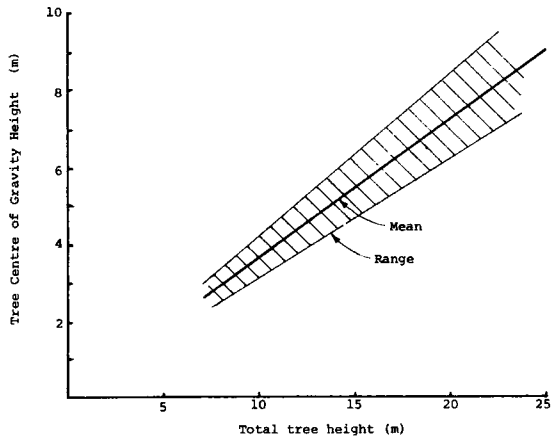


FIG.3 TREE C.G.POSITION

Tree centre of gravity height varies with tree height as indicated in *Figure 3*, being from 30% to 40% of overall tree height.

The wide range of results indicates that there is a need to collect data from many sample trees covering a wide range of conditions if more accurate relationships are to be obtained.

## FUTURE LIRA WORK.

Future LIRA work will concentrate on setting up trials around the country aimed at collecting more tree weight data for representative present and future forests. The species Radiata, Ponderosa and Corsican pines will be included. Data collection will concentrate on trees up to 50 cm dbh or 2 $m^3$ stem volume, and attempts will be made to establish the affect of stocking density and pruning height on the data.

For simplicity LIRA considers a method using a log loader to suspend whole trees or trimmed stems at their balance points; with a force-measuring link, should be most versatile. A recommended procedure is as follows:-

- Fell trees for minimum breakage.
- Select trees with minimum breakage for measurement.
- Record measurements of tree dimensions.
- Suspend tree at balance point with force-measuring link on log loader.
- Record tree weight and balance point.
- Trim branches and top.
- Record measurements of stem dimensions.
- Suspend stem at balance point with force-measuring link on log loader.
- Record stem weight and balance point.

Specific organisations will be approached in due course to assist. Anyone interested in aiding LIRA should contact us.

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