20. DERIVATION OF A ONE WAY SINGLE TREE VOLUME TABLE FOR SMALL-SCALE FORESTRY

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INTRODUCTION

Single tree volume tables are a decision support tool which enable farmers to estimate the total or commercial volume of a tree by measuring tree diameter over bark (DBHOB, measured at 1.3 m above the ground). Because of the high variability in commercial volume of individual trees, they are most often used in conjunction with the diameter distribution of the trees in a stand to estimate stand volume. If farmers know the area of their forest and they can measure a sample of tree diameters, the availability of a volume table can be very useful in estimating the value and volume of a stand.

The derivation of a single tree volume tables is a precursor to the development of a yield table (Vanclay, this volume) which estimates volume growth of the stand over time. The yield table models tree growth over the life of the forest whereas the single tree volume table provides a 'snapshot' of stand volume at the time at which it is measured. Hypothetically, if farmers were to measure and record the volume of their forest, each year for a number of years, then they would be deriving their own yield table from a series of single tree volume table measurements.

The purpose of this paper is to outline the procedures by which the Australian Centre of International Agricultural Research (ACIAR) Project ASEM/2003/052 'Improving financial returns to smallholder tree farmers in the Philippines' may assist farmers by deriving a single tree volume table which farmers could use to estimate the volume and values of their trees. The procedures for deriving a single tree volume table are outlined and the limitations to its use are discussed.

METHOD AND DATA REQUIREMENTS

The method for deriving a single tree volume table has been described in texts for many years (e.g. Bruce and Schumacher, 1942; West, 2003) and should follow the procedures described in detail by Philip (1983) in the textbook 'Measuring Trees and Forests – a Textbook written for students in Africa,'. The procedure may be summarized as several steps, the first of which is to derive bark thickness so that diameter measurements are taken overbark but are related to volume underbark. The procedure to derive this relationship is to measure bark thickness for a number of trees, selected over the diameter range. Diameter measurements over bark and underbark are collected for each species and the relationship between them established by regression analysis so that under-bark diameter can be predicted from any over-bark measurement.

Secondly, over the diameter range, total volume and commercial volume are measured for a number of trees in each species. Commercial volumes are assessed using sawmillers log specifications, including log small end diameter (sed) and minimum log length. A simple method of estimating permissible bend in each log section is suggested in Vanclay (this volume). Traditionally, the volume of logs is calculated in 3 m sections from ground level to the commercial sed or the top of the tree, using Huber's formula. Each tree usually has a final 'odd log' length at the end of the 3 m sections. The usual formula for calculating the volume of each section of log is:

- $v = \pi L d_m^2 / 4$ (Huber's formula)
- or $v = \pi L(d_1^2 + d_2^{2)}/8$ (Smalian's formula)

where
d_1 = diameter at base of log
d_2 = diameter at top of log
d_m = diameter at middle of log
L = log length.
v = volume of log

The form of *Gmelina arborea* in Leyte is so poor that it is unlikely that 3 m sections of log length will be common. This suggests that with relatively untrained measurement crews, it may be better to measure each section as an 'odd log.'and measure its top and bottom diameter, rather than calculate the mid diameter position. This procedure would use Smalian's formula.

Whichever formula is used, the sections of log volume are summed for each tree and then the relationship between tree diameter over bark and tree volume is derived for the sample of trees. The graph of predicted tree volume for any measured diameter is likely to be similar to that depicted in Figure 1.
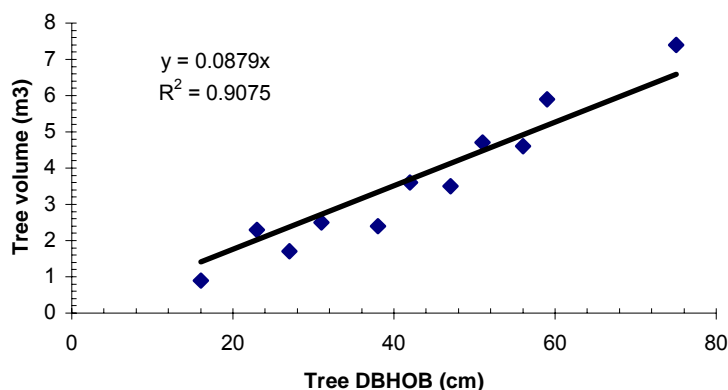

Figure 1.   Typical relationship of tree volume to diameter

LIMITATIONS

The tables will always be used to predict the volume of a number of trees, as the precision of the volume prediction of a single tree will be poor, but that of a larger number of trees will be within some predetermined error limits. The variation of tree volume with diameter may be high in small-scale plantations, particularly for *Gmelina. arborea*. However, the variation may be used to highlight the need for early age silviculture to produce trees oriented towards a particular market.

When farmers are using the volume table to measure their own plots, they must be encouraged to measure greater rather than smaller numbers of trees because the variation of the estimate decreases exponentially with increased sample size. Philip (1983) recommends that a minimum of 20 trees should be measured to construct a single tree volume table, but from the author's observations in Leyte, double this number may be required. In estimating the volume of their woodlots, farmers must also be encouraged to

stratify the woodlots into better and poorer growth types, even if this stratification is subjective. Initially, the volumes tables should be restricted to monocultures. The age of measurement should be as close to clear fall age as possible so that site limitations have been expressed in the growth rate of the trees for the maximum period of time.

MERCHANTABLE STANDARDS OF THE TREES MEASURED

In Leyte, only one merchantability standards will be used as most trees may eventually be processed as lumber. The main bole of each tree will be measured, as well as major limbs which could be sold as firewood. Volume will be measured to a sed, of 12 cm over-bark which will allow for bark thickness and a small allowance for bent logs. Some sawmillers pay for wood on a recovered board foot basis and some purchase wood as chainsawn flitches, but for simplicity, the volume table will estimate round wood volumes only.

TREE PARAMETERS TO BE MEASURED

As much data as possible will be collected while crews are at the measurement site This includes:

- DBHOB (over a range 10-50 cm)
- bark thickness (@1.3 m and up stem)
- diameter at ground level
- diameter and length of tree log sections
- total height
- presence of spiral grain
- tree form as expressed by the occurrence of double or multi leaders
- presence of wind damage/borers/defoliators
- internal defect (for destructively sampled trees)

CONCLUSION: VALUE OF THE VOLUME TABLE AND YIELD TABLE TO SUBSEQUENT PROJECT WORK

The volume table will be the main input into modeling financial return from small-scale forestry. Because the main measurement criteria are tree diameter and log diameter, it will establish an awareness of the trees which need looking after and those which need to be thinned. It will introduce farmers to the concept of continuous stand management.

Because the volume table uses merchantability standards, it will widen farmers' appreciation and understanding of the need to grow trees for a specific market. It will highlight how much of their wood is valuable and how much of it is useful as firewood only. It will also heighten their appreciation of silvicultural inputs to order to manipulate a stand for a specific log and diameter class. The expected high variability of tree volume with tree diameter for *G. arborea* will be treated as a logical consequence of growing wild stock with inherent poor form in fast grown short rotations.

From the sawmillers perspective, the volume table will establish their log pricing table as the criteria to which trees are grown. The volume table will provide a link between sawmillers and growers.

REFERENCES

Bruce, D. and Schumacher, F.X. (1942), *Forest Mensuration*, McGraw-Hill, New York.
Philip, M.S. (1983), *Measuring Trees and Forests: A Textbook Written for Students in Africa*, Division of Forestry Dar es Salaam, Aberdeen University Press.

West, P.W. (2003), *Tree and Forest Measurement*, Springer Verlag, Berlin.