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Conversion Table for Sawn Mahogany
(*Swietenia macrophylla*)

Methodology for Developing National Volume Conversion Tables (Standing Volume & Export Grade Sawnwood)

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"Illegal logging and unsustainable export levels are threatening to render big-leaf mahogany commercially extinct in the near future, a trend that has been reflected in recent years by rising prices" ..."By relying on the CITES permit system, exporters, importers and consumers of mahogany can be confident that they are using only legally and sustainably harvested timber. The new regulations will also benefit local and indigenous communities, which until now have not received their fair share of the income from mahogany sales ..."

CITES Secretary-General Willem Wijnstekers

The findings, interpretations, and conclusions expressed here are those of the authors and do not necessarily reflect the views of the participant organizations.

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Cover: Photos by J. Grogan & W. Ccahuana

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1. Introduction

This report outlines a practical methodology designed for stakeholders in mahogany (*Swietenia macrophylla)* producing countries. This includes national CITES authorities, forest administration and customs officers, among others. The principal objective is to contribute to the standardization of field and office procedures for estimating the standing volume of trees selected for harvest and the resulting yield of export grade sawn wood on a per tree basis. We expect that this guide will become a useful tool for complying with the Appendix II procedures of the CITES convention. While this methodology aims to improve estimates of export grade sawnwood volume, it will complement research efforts directed at estimating yields for sub-products and finished goods made from mahogany. It is clear that adequate technical assistance will be necessary to support the development of national volume tables and to guarantee adequate training for the personnel that will apply these tools.

The idea for this initiative came out of meetings held by the Central American CITES authorities. The Central America Commission on Environment and Development (CCAD) sponsored the meetings, as part of the region's effort to improve CITES implementation. The CCAD-USAID framework agreement on environmental management provided the necessary funding. Given the critical importance of illegal logging in the region (especially in relation to mahogany) for forest governance, the World Bank FLEG program and CCAD organized the "Regional Workshop on CITES Implementation: Improving International Trade in Mahogany" in Managua, Nicaragua (August 15-17, 2007). The success of this event was due in large part to the critical support received from the Ministry of the Environment and Natural Resources of Nicaragua (MARENA) and the Nicaraguan National Forest Institute (INAFOR). The bases for the methodology were thoroughly discussed and benefited from additional suggestions from national CITES authorities and forestry sector representatives from each country, as well from participating members of the CITES Plants Committee and CITES International Secretariat.

It should be recognized that this tool has been developed using the scientific information, field data and technical inputs of J. Grogan and J. Schultz as presented during the "International Experts Workshop on preparing low impact mahogany harvesting plans" in Cancun, Mexico. A.C. Sánchez and W. Ccahuana generously provided additional field data from Peru.

2. Mahogany and Forest Sector Governance

Mahogany (known as Atlantic Caoba in Central America, Mara in Bolivia, and Mogno in Brazil) is the single most valuable tropical timber species in international trade. It is also one of the most important tropical species subject to selective harvesting. Excessive commercial harvesting of this species led to its listing in Appendix II of the CITES Convention. Market studies show that the largest proportion of mahogany is exported to the United States, France, Canada, England, Dominican Republic and other European countries.

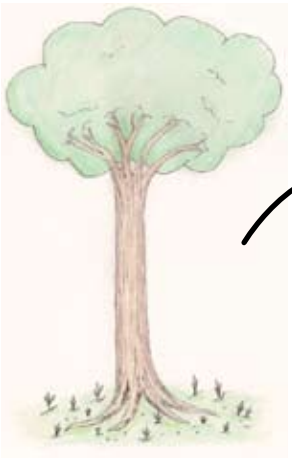
In spite efforts at conservation, supervision and control, the impact of mahogany logging has contributed to the specie's rapid commercial extinction in many parts of its natural distribution. This is one of the causes for the increase in illegal logging in protected areas, protected forests and other areas where harvesting is prohibited.

To date, only limited efforts have been made to avoid "laundering" mahogany illegally cut from protected areas and other unauthorized land. "Laundering", or making illegally harvested timber appear to be legal, can be reduced by revising the conversion factors used to calculate the yield of export grade sawnwood based on estimates of standing timber volume. Logging authorizations typically have the basic information needed to make simple but rigorous calculations of export grade timber production.

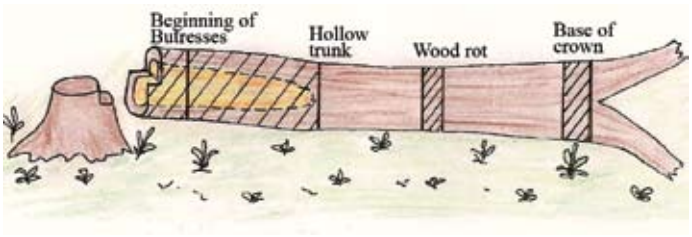
3. Calculating the Volume of Export Grade Mahogany

Frequently, the use of inaccurate conversion factors for calculating export grade sawnwood yields from standing timber estimates is used to hide the laundering of illegally harvested mahogany. The resulting projection of export grade sawnwood overstates the volumes actually produced from legally harvested trees. These inflated figures are then used to justify additional CITES export permits which are used to facilitate the export of timber of illegal origin. If we are to improve the implementation of the CITES convention, it is crucial to revise and standardize procedures for establishing accurate conversion factors for standing timber and export grade sawnwood.

Some mahogany producing countries assume that 100% of the standing volume is transformed to export grade timber. Other countries apply conversion rates of 50-60% of standing volume. In a few exceptional cases, efforts have been made to more precisely determine accurate conversion factors for the entire production chain. Analyses of data for mahogany harvests in Peru and Brazil demonstrate that export grade sawnwood is typically only 20% of the standing volume. This means that between 30% to 80% of the sawnwood exported under CITES permits (justified by conversion factor significantly greater than 20%) is illegal, or at the very least of controversial sources. This situation negatively affects several critical elements, including the sustainability of the species, implementation of national legal norms and international commitments, governance of the forest sector in producer countries and the development of the forest industry in general.



Standing Roundwood
= 100%



Net roundwood removal
= 72 % of standing volume

Ccahuana, W.

Sawnwood (all grades)
= 38 % of standing volume

Ccahuana, W.

Export grade sawnwood
= 20 % of standing volume

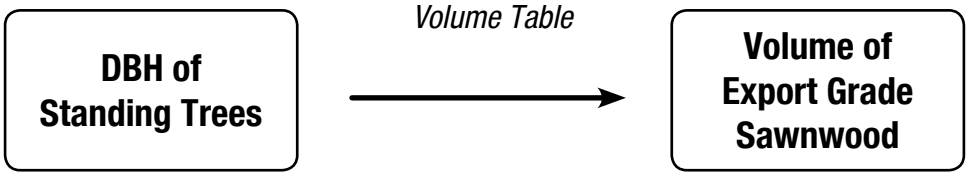
Figure 1. Relative volume reductions, forest to sawmill

3.1. Practical and Effective Options

Given the situation described, it is critical to determine the actual volume of export grade sawnwood produced by logging and processing mahogany trees. This can be accomplished applying simple dasonometric procedures and volume conversion tables. With these tables in hand, estimates of export grade sawnwood can be determined from diameter measurement at breast height (DBH e.g. 1.3 m above the ground). These practical volume tables provide stakeholders with a reliable estimate of the volume of export quality sawnwood that can be expected from a tree with any given DBH.

Considering that in the case of mahogany there is a strong correlation between the DBH and the volume of sawn wood of any given standing tree, it is possible to develop a very practical volume table in which the DBH alone is sufficient to calculate immediately the volume of exportable sawnwood that would result from any given tree.

Mahogany: Timber volume from the forest to export markets



3.2. Development of National Volume Tables

Objective

This project aims to help national CITES authorities and forest administrations in mahogany producing countries to develop national volume tables for mahogany using the methodology outlined in this report. The proper development and use of these tables should help eliminate excessively high production estimates of export grade sawnwood, which are used to justify the export of mahogany timber of controversial or illegal origin. Once developed and approved by the appropriate national authorities, these tables can be applied by forest owners, auditors, national forest administration officials and CITES authorities.

Application of the Methodology

National volume tables should be prepared by rigorously applying the methodology outlined below.

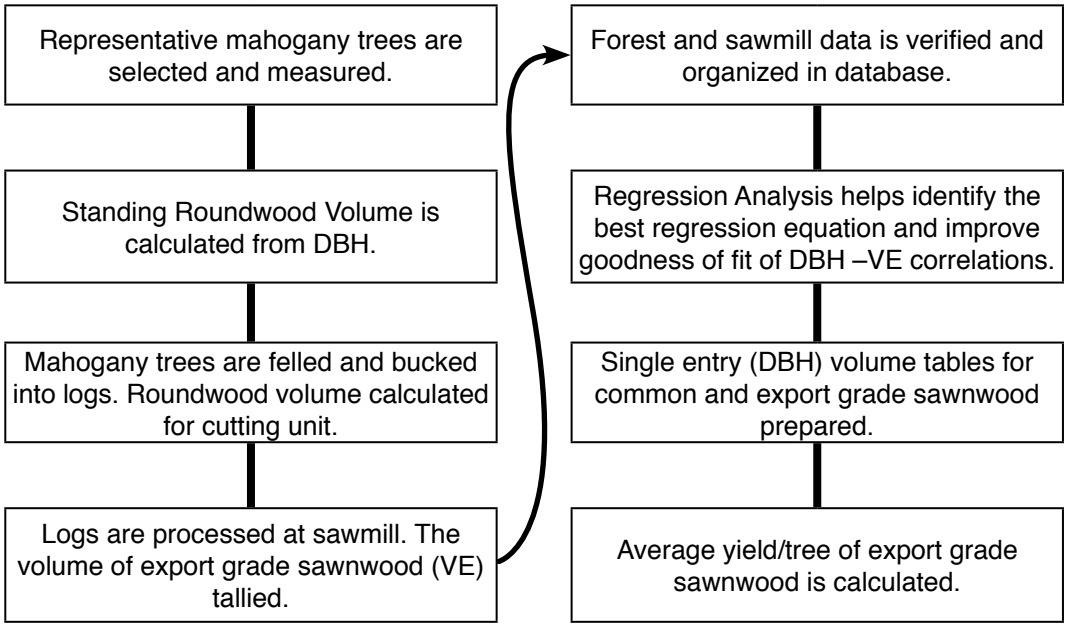


Figure 2. Volume Table Preparation Flowchart

STEP I: Sampling, measurement and standing volume calculations

1. Individual mahogany trees are selected to provide a representative sample of the range of diameters, forms and heights at the national or regional level. The sample should contain at least 100 trees, proportionally selected by diameter class (DC). If each class is 8-10 cm in width, then eight to ten classes will be needed to cover the range of diameters, starting from the minimum allowable diameter. The selection and measurement of these trees can be coordinated with authorized harvesting operations in forest concessions, community forests, or in private holdings. The ideal number of trees to sample should be determined statistically, based on national conditions.
2. Take data necessary to calculate standing roundwood volume from each tree selected. A diameter tape is used to measure diameters starting at 1.3m above the ground (DBH, diameter at breast height) and at the commercial height (usually at the base of the crown). The precise location for taking the diameter is chosen to avoid major trunk irregularities, which can be frequent with mahogany.
3. Calculate standing roundwood volume from DBH.

Photo: J. Grogan.

Figure 3. Measurement of DBH

STEP II: Calculate standing roundwood volume

Once the tree has been felled, additional measurements are taken to calculate the volume of the tree. These include:

- Stump diameter (outside bark, ob)
- Log diameter (ob) outside bark every 2 m
- Log diameter (ob) at the commercial height (e.g. base of crown).

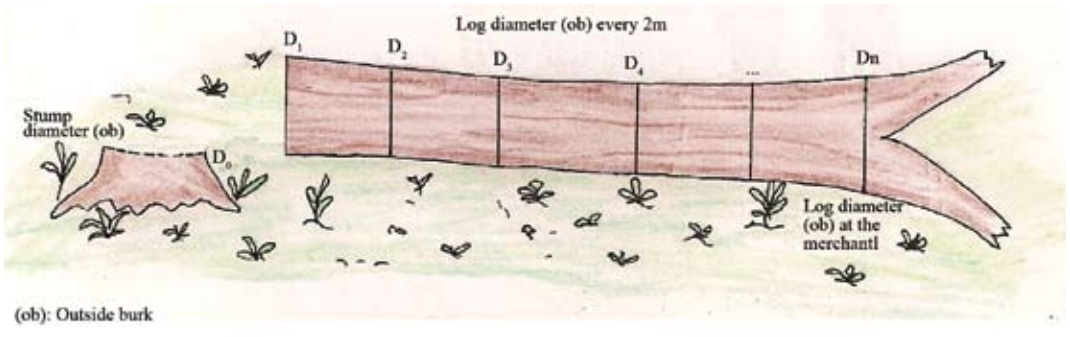


Figure 4. Log diameter measurements

4. Calculation of the standing roundwood volume per tree sampled.

   The volume of each 2 m section is calculated using Smalian's Formula. The sectional volumes are summed to give the standing roundwood volume of the tree.

$$V = \frac{Pi}{4}\left[\frac{D_1+D_2}{2}\right] L$$

V = Roundwood Volume in cubic meters
Pi = 3.1416
D1 = Larger diameter (meters)
D2 = Smaller diameter (meters)
L = Log length (meters)

5. Measurement and volume deduction for defects.

   Once the tree has been felled and bucked into logs, the magnitude of defects can be determined and the resulting volume deductions made. Defects may result from heart rot, irregular form, or logging damage.

   It is critical to recognize the importance of using accurate estimates for defect deductions. Inaccurate calculations will affect both the calculations of standing volume and sawnwood. In this report, the valuable field data and conversion indices prepared by A. C. Sánchez and W. Ccahuana in Peru were enhanced by the work of J. Grogan & J. Schulze on defect indices. Their studies in Brazil have contributed importantly to the design of this methodology.

6. Unusable log sections are left in the forest. The remaining logs which will be transported to the sawmill, and are measured and tallied for each tree.

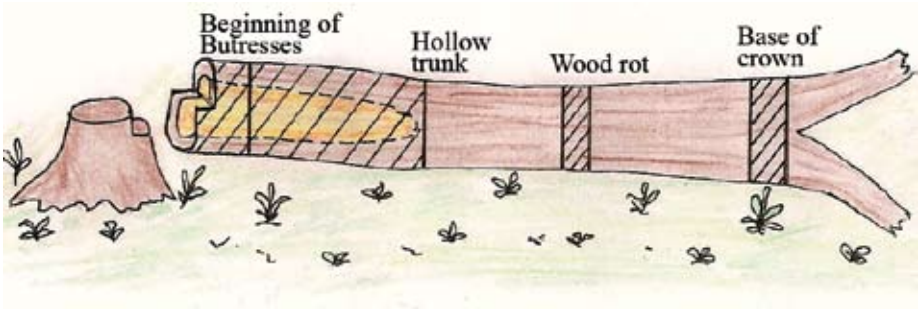


Figure 5. Volume deduction for log defects

7. Useable Volume calculation for each mahogany tree.

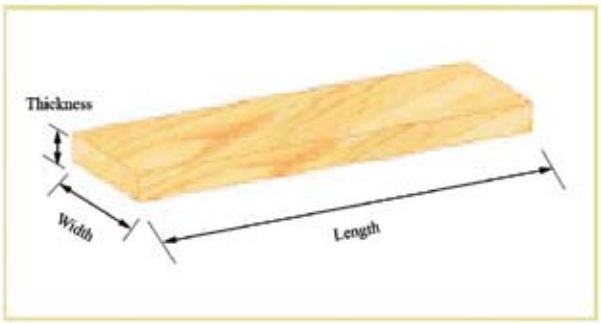
   The useable volume of each tree is the sum of the volumes of all logs sent to the sawmill.

STEP III: Mill processing and board grading:

8. Following transport to the sawmill, the logs are sawn into boards. The boards are then classified by grade and tallied by tree.

Photo: W. Ccahuana.

Figure 6. Timber grading & volume tally



$$V = \frac{T \times W \times L}{12}$$

Where:

V = Board-feet of sawnwood
T = Board thickness (inches)
W = Board width (inches)
L = Board length (feet)

Given the objective of this study, it is especially important to accurately grade and tally board feet of export grade timber.

Photo: W. Ccahuana.

Figure 7. Export grade Sawnwood

STEP IV: Data entry and processing (forest and sawmill)

9. Data entry and processing.

   All data taken in the forest and sawmill for selected trees is entered in the database using the following codes:

DBH: Diameter at breast height: Tree diameter at 130 cm above the ground. Given the variability of field conditions, the point of measurement may be raised or lowered to avoid trunk irregularities. This is frequently true for broadleaf species such as mahogany.

MH: Merchantable height. Height from stump to base of crown, measured in meters.

Standing Timber Volume (m^3): This is the total volume of the tree, calculated from the tree's DBH and commercial height. A form factor of 0.65, corresponding to a truncated cone was applied with the Peru data. Specific form factors should be determined for each country.

Gross Roundwood Volume: This is the total wood volume (m^3) of the felled tree before it is bucked into logs and transported to the sawmill.

Net Roundwood Volume: This is the volume (m^3) of wood removed from the forest following log bucking and elimination of defects.

Sawnwood Volume: This is the volume (m^3) in board-feet of timber produced.

Volume of export grade sawnwood (VE): The volume (m^3) of boards and timbers that meet or surpass requirements for export markets.

Volume Conversion Factor (FCVE): This is the ratio of sawnwood divided by standing timber volume.

Remember that at least 2 members of the team should share data entry and processing. This assures better data cross–checking and verification.

This procedure is illustrated below with a subset of the Peru data from A.C. Sánchez (10). The defect indices were developed by J.Grogan & M. Schulze (6) in Brazil. The yield indices were developed by W. Ccahuana (3) in Peru.

Table 1. Merchantable Height, and Calculated Volumes

1	2	3	4	5	6	7	8	9
Tree ID	**DBH (cm)**	**MH (m)**	**Standing Roundwood Volume/Log Scale (m^3)**	**Gross Roundwood Volume (m^3)**	**Net roundwood volume (m^3)**	**Sawnwood Volume (m^3)**	**Exportable Volume (4 x 9)**	**Conversion Factor**
1	75	12	3.446	3.951	3.6769	1.6381	0.8191	0.2377
2	75	14	4.020	3.933	3.7051	1.6868	0.8434	0.2098
	…	…		…	…	…	…	…
	.							
52	87	14	5.410	5.728	5.0903	2.3576	1.1788	0.2179
53	87	11	4.250	4.474	3.8343	1.8282	0.9141	0.2151
	…	…		…	…	…	…	…
81	93	16	7.065	7.318	6.1967	2.9462	1.4731	0.2085
82	93	13	5.740	5.354	4.8061	2.3138	1.1569	0.2015
	…	…		…	…	…	…	…
215	130	18	15.530	14.423	9.5138	5.4393	2.7196	0.1751
216	130	19	16.392	15.453	10.1351	5.8658	2.9329	0.1789
	…	…		…	…	…	…	…
	…	…		…	…	…	…	…
251	151	20	23.280	20.655	11.4272	6.9976	3.4988	0.1503
252	154	21	25.425	22.425	12.2670	7.4861	3.7430	0.1472
253	156	14	17.393	17.499	8.9404	5.6400	2.8200	0.1621
254	168	16	23.054	21.017	10.4485	6.8601	3.4301	0.1488
255	169	12	17.497	15.386	8.0448	5.2025	2.6013	0.1487

The complete dataset appears in Annex No. 2

STEP V: Regression Analysis & Development of a Single Entry Volume Table

Regression analysis is a statistical technique that increases the precision of estimates of the relation between a quantitative dependent variable (e.g. volume of export grade timber) and one or more independent variables or predictors (e.g. DBH). Regression analysis is very useful for the development of volume tables, given the difficulty of taking more detailed volume measurements in the forest under normal operational conditions. The necessary calculations can be done on a laptop or desktop computer with programs like Micrsoft Excel or MINITAB. The steps to follow are:

10. Graph the correlation between DBH and volume of export grade sawnwood to show tendencies and select the model or formula that best matches those tendencies.

    The following graph shows the relation between DBH and volume of export grade sawnwood reported for 255 mahogany trees.

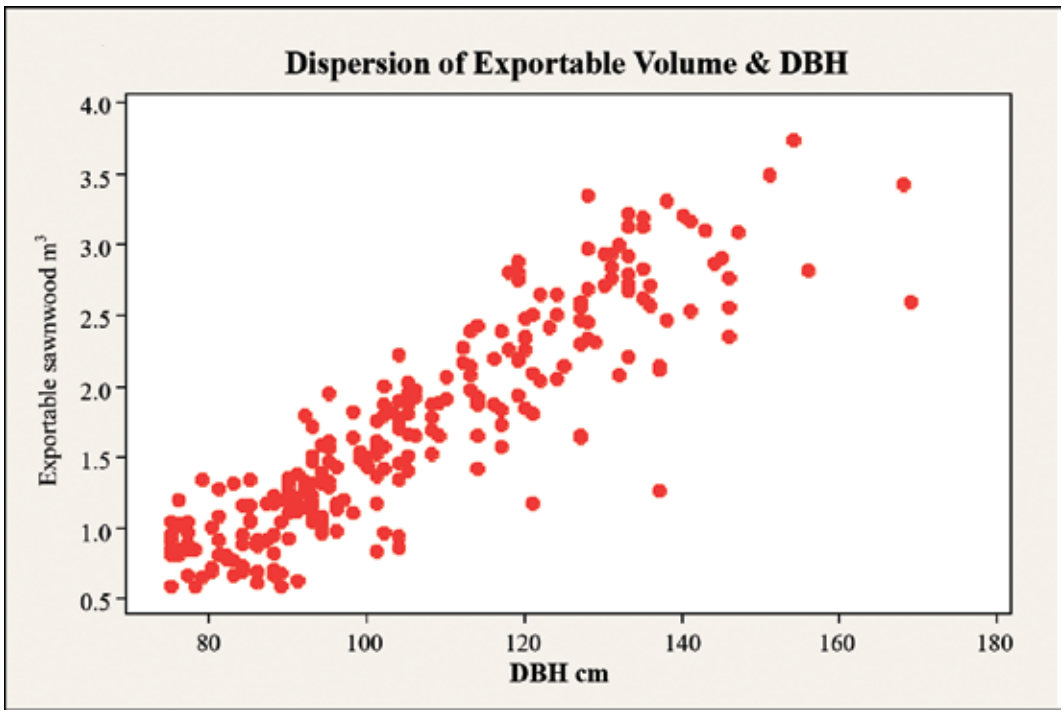


Figure 8. DBH vs. Volume of Export Grade Sawnwood

The positive relation between DBH and volume of export grade sawnwood was expected and is easily observed. This confirms the applicability of the model suggested by Mayhew. & Newton (8) for volume calculations. This is a single entry model, which only requires values for DBH to produce volume estimates. Its applicability has been demonstrated in many studies and in particular for mahogany by Grogan and Schulze (6).

The following model was tested for the regression analysis:

$Y = a + bDBH + cDBH^2$ (Mayhew. & Newton (8))

Where a, b and c are coefficients

11. The coefficients were solved for using the least squares regression analysis.

    The resulting equation:

    $VE = - 2.4403 + 0.046383*DBH - 0.00006461*DBH^2$

12. A goodness of fit analysis checks the adequacy of the equation through several test values. These tests can be done with either Microsoft Excel or Minitab.

    The following tests and parameters are normally used to check goodness of fit of the projected values to the observed values.

R = Correlation Coefficient, Measures the strength of the relation between variables. The closer the coefficient comes to 1 (or –1), the stronger the relation between DBH and the volume of export grade sawnwood.

R^2 = Coefficient of determination, represents the amount of variability that is accounted for by the equation.

F Test, checks whether the dependent variable (VE) has a normal variation or is influenced by the independent variable (DBH). If the calculated F value is greater than the F table value with a confidence interval of 99%, it demonstrates a high relation with the variability of DBH.

The residual analysis shows the distribution of the variance between the estimated and observed values**.** The closer the differences are to zero, the better job the equation does of predicting the real values, or goodness of fit.

R	R^2	Fcalc	Residual distribution
0.897	0.806	522.15	Goodness of fit

F table for 99% confidence interval = 4.69

The higher the R value, the greater the assumed correlation between DBH and VE. This means that a change in DBH will demonstrate a similar change in VE. At the same time, the $\mathbf{R^2}$ value approaches 1, which indicates that the equation adequately expresses the correlation between DBH and VE. This means that the calculated value of VE from DBH is highly reliable.

If the calculated F value is greater than the F table at the 99% confidence interval, then the variability of VE is strongly influenced by the variability of DBH.

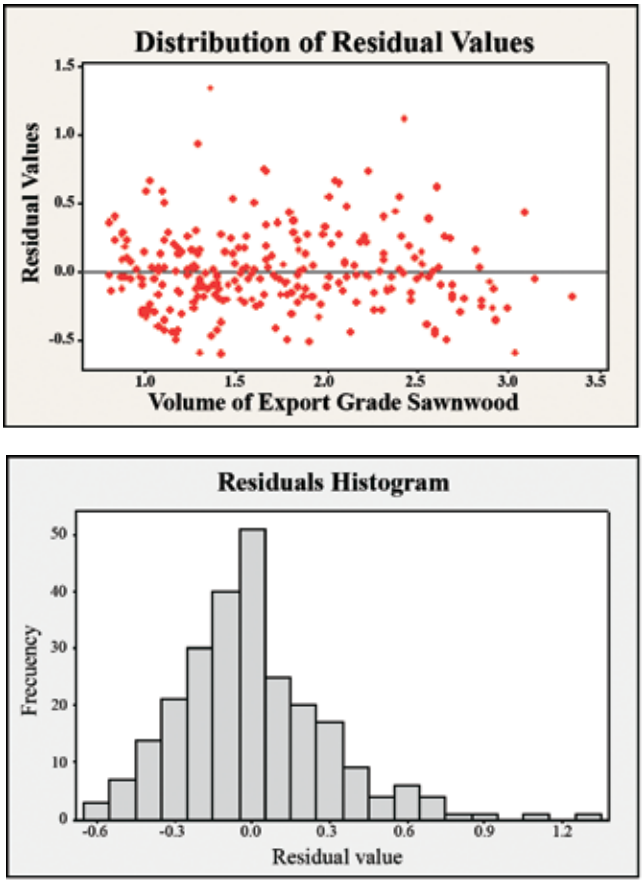


Figure 9. Residual distribution. Residual = VE observed – VE calculated

The residual values are well distributed around zero. The histogram show they are most frequently concentrated around zero. Again, this shows that the equation produces good estimate of the real values.

The graph below illustrates an objective test of goodness of fit between the estimated and observed values.

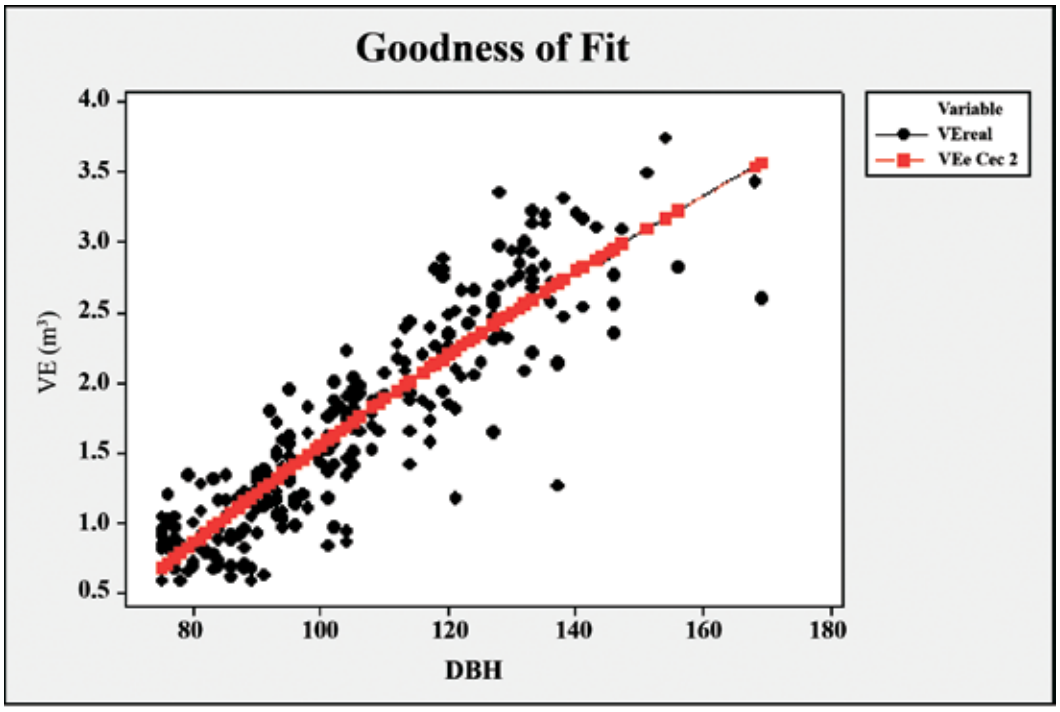


Figure 10. Goodness of Fit: DBH vs. VE Observed & Estimated

The graph shows the goodness of fit between the calculated and the observed values. The test results permit us to conclude that the equation has a good fit with the observed values, and that the volume of export grade sawnwood can be reliably predicted by DBH of the tree. Therefore, the equation is appropriate and can be reliably used to construct the volume table.

13. Development of the Volume Table for Export Grade Sawnwood from DBH by use of the selected equation[1].

$$VE = - 2.4403 + 0.046383*DBH - 0.00006461*DBH^2$$

[1] The selection of the equation (and coefficients) will depend upon the analyses done in each mahogany producing country and/or region.

Table 2. Single Entry Volume Table Based on Dbh

DBH (cm)	Volume (m^3) of Export Grade Sawnwood per Tree
75	0.675
80	0.857
85	1.035
90	1.211
95	1.383
100	1.552
105	1.718
110	1.880
115	2.039
120	2.195
125	2.348
130	2.498
135	2.644
140	2.787
145	2.927
150	3.063
155	3.197
160	3.327

(*) Details for the calculation of these results can be reviewed in the complete volume table included in Annex 1.

14. Volume Estimate of Export Grade Sawnwood per Mahogany Tree.

    This average is obtained by taking the weighted average of volume per diameter class and the proportion of trees in each class.

Table 3. Volume Table by Diameter Class

Diameter Class (cm)	Percentage of Population in each Diameter Class	Volume (m^3) of exportable sawnwood/tree
75 – 84	6.51	0.857
85 – 94	14.54	1.211
95 – 104	16.03	1.552
105 – 114	11.46	1.880
115 – 124	8.89	2.195
125 – 134	13.15	2.498
135 – 144	10.06	2.787
145 – 154	5.07	3.063
155 - +	14.28	3.327
Weighted Average		2.131

As demonstrated by the analysis of 255 mahogany trees from Peru, the average volume of export grade sawnwood per tree is 2.131 m^3. An average figure like this provides stakeholders with an initial criteria for judging the reasonableness of volumes of export grade sawnwood reported by management unit or nationally, even if the only data available is the number of trees authorized for harvest.

The single entry volume tables based on DBH and/or diameter class using this methodology should prove to be useful, practical and reliable tools for the authorities responsible for monitoring and supervising forest operations, CITES scientific and administrative authorities, field inspectors, government and independent auditors, forest technicians and all persons concerned with responsible forest management.

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Annex 1

Exportable Sawnwood Volume Table for Mahogany

$VE = -2.4403 + 0.046383*DBH - 0.00006461*DBH^2$

DBH (cm)	Volume (m^3) of export grade sawnwood per tree (VE)	DBH (cm)	Volume (m^3) of export grade sawnwood per tree (VE)	DBH (cm)	Volume (m^3) of export grade sawnwood per tree (VE)
75	0.675	114	2.008	153	3.144
76	0.712	115	2.039	154	3.170
77	0.748	116	2.071	155	3.197
78	0.784	117	2.102	156	3.223
79	0.821	118	2.133	157	3.249
80	0.857	119	2.164	158	3.275
81	0.893	120	2.195	159	3.301
82	0.929	121	2.226	160	3.327
83	0.964	122	2.257		
84	1.000	123	2.287		
85	1.035	124	2.318		
86	1.071	125	2.348		
87	1.106	126	2.378		
88	1.141	127	2.408		
89	1.176	128	2.438		
90	1.211	129	2.468		
91	1.246	130	2.498		
92	1.28	131	2.527		
93	1.315	132	2.556		
94	1.349	133	2.586		
95	1.383	134	2.615		
96	1.417	135	2.644		
97	1.451	136	2.673		
98	1.485	137	2.702		
99	1.518	138	2.730		
100	1.552	139	2.759		
101	1.585	140	2.787		
102	1.619	141	2.815		
103	1.652	142	2.843		
104	1.685	143	2.871		
105	1.718	144	2.899		

DBH (cm)	Volume (m^3) of export grade sawnwood per tree (VE)	DBH (cm)	Volume (m^3) of export grade sawnwood per tree (VE)	DBH (cm)	Volume (m^3) of export grade sawnwood per tree (VE)
106	1.750	145	2.927		
107	1.783	146	2.954		
108	1.815	147	2.982		
109	1.848	148	3.009		
110	1.880	149	3.036		
111	1.912	150	3.063		
112	1.944	151	3.09		
113	1.976	152	3.117		

Annex 2

Individual Tree Data Used to Prepare the Mahogany Volume Table

This table was constructed using field data from A.C. Sánchez (10), defect indices by J. Grogan (6) and yield indices developed by W. Ccahuana (3). All values are expressed in cubic meters.

1	2	3	4	5	6	7	**8**	**9**
Tree ID	**DBH (cm)**	**MH (m)**	**Standing Roundwood Volume/Log Scale (m^3)**	**Gross Roundwood Volume**	**Net roundwood volume (log scale)**	**Sawnwood (m^3) (mill scale)**	**Exportable Sawnwood (m^3)**	**Overrun Percentage**
1	75	12	3.446	3.951	3.6769	1.6381	0.8191	0.2377
2	75	14	4.020	3.933	3.7051	1.6868	0.8434	0.2098
3	75	16	4.595	4.586	4.5146	2.0786	1.0393	0.2262
4	75	14	4.020	4.377	4.3427	1.9042	0.9521	0.2368
5	75	15	4.307	4.215	4.1433	1.9129	0.9564	0.2220
6	75	13	3.733	4.244	4.1382	1.8349	0.9175	0.2458
7	75	8	2.297	2.803	2.6099	1.1907	0.5953	0.2592
8	75	12	3.446	3.896	3.6684	1.6224	0.8112	0.2354
9	76	13	3.833	3.702	3.6851	1.6243	0.8122	0.2119
10	76	12	3.538	3.955	3.7396	1.6888	0.8444	0.2386
11	76	12	3.538	4.033	3.7564	1.6976	0.8488	0.2399
12	76	15	4.423	4.750	4.4787	2.0437	1.0219	0.2310
13	76	16.5	4.865	4.727	4.6740	2.0259	1.0129	0.2082
14	76	17	5.013	5.362	5.3475	2.4060	1.2030	0.2400
15	76	15	4.423	4.644	4.5529	2.0709	1.0355	0.2341
16	76	15	4.423	4.788	4.5079	2.0410	1.0205	0.2307
17	77	12	3.632	4.203	3.9093	1.7683	0.8842	0.2434
18	77	12	3.632	4.148	3.8983	1.6999	0.8499	0.2340
19	77	15	4.540	4.779	4.7485	2.0966	1.0483	0.2309
20	77	9	2.724	3.022	2.9531	1.3343	0.6671	0.2449
21	77	13	3.935	4.485	4.1751	1.9214	0.9607	0.2442
22	78	8	2.485	2.724	2.5598	1.1751	0.5875	0.2365
23	78	13	4.038	3.840	3.7723	1.7060	0.8530	0.2113
24	79	8	2.549	3.069	3.0491	1.3162	0.6581	0.2582
25	79	18	5.735	6.015	5.9069	2.6924	1.3462	0.2347
26	80	10	3.267	3.508	3.2597	1.4471	0.7236	0.2215
27	80	13	4.247	4.826	4.5260	2.0041	1.0020	0.2359
28	80	9	2.941	3.264	3.0702	1.3775	0.6887	0.2342
29	81	13	4.354	4.155	4.1207	1.8254	0.9127	0.2096

1	2	3	4	5	6	7	**8**	**9**
Tree ID	**DBH (cm)**	**MH (m)**	**Standing Roundwood Volume/Log Scale (m^3)**	**Gross Roundwood Volume**	**Net roundwood volume (log scale)**	**Sawnwood (m^3) (mill scale)**	**Exportable Sawnwood (m^3)**	**Overrun Percentage**
30	81	16	5.359	6.108	5.6781	2.5541	1.2771	0.2383
31	81	14	4.689	5.259	4.9201	2.1708	1.0854	0.2315
32	81	11	3.684	3.932	3.6945	1.6149	0.8075	0.2192
33	82	11	3.776	3.610	3.5614	1.5702	0.7851	0.2079
34	82	10	3.433	3.736	3.7090	1.6174	0.8087	0.2356
35	83	9	3.165	2.989	2.9483	1.3268	0.6634	0.2096
36	83	16	5.627	6.175	6.0588	2.6280	1.3140	0.2335
37	83	10	3.517	3.812	3.5528	1.5381	0.7690	0.2187
38	84	8	2.882	3.270	3.0812	1.3863	0.6932	0.2405
39	84	8	2.882	3.209	3.1907	1.4057	0.7029	0.2439
40	84	11	3.962	4.605	4.2940	1.8972	0.9486	0.2394
41	84	14	5.043	5.702	5.3368	2.3216	1.1608	0.2302
42	84	10	3.602	4.244	3.9888	1.7741	0.8871	0.2463
43	84	9.5	3.422	3.374	3.3109	1.4549	0.7274	0.2126
44	85	13	4.795	5.165	4.3944	2.1114	1.0557	0.2202
45	85	17	6.270	6.158	5.5475	2.6777	1.3388	0.2135
46	85	14	5.164	5.826	4.9836	2.3145	1.1572	0.2241
47	85	13	4.795	5.062	4.4662	2.0845	1.0422	0.2174
48	86	9	3.398	3.469	2.9846	1.3827	0.6913	0.2034
49	86	12	4.531	4.219	3.8720	1.8287	0.9143	0.2018
50	86	8	3.021	2.994	2.6287	1.2423	0.6212	0.2056
51	86	10	3.776	4.449	3.7946	1.7559	0.8780	0.2325
52	87	14	5.410	5.728	5.0903	2.3576	1.1788	0.2179
53	87	11	4.250	4.474	3.8343	1.8282	0.9141	0.2151
54	88	11	4.349	4.517	4.1027	1.9075	0.9538	0.2193
55	88	8.5	3.360	3.179	2.8245	1.3396	0.6698	0.1993
56	88	8	3.163	3.511	2.9993	1.4087	0.7043	0.2227
57	88	10	3.953	3.846	3.4614	1.6424	0.8212	0.2077
58	88	14	5.535	5.799	4.9696	2.3398	1.1699	0.2114
59	88	14	5.535	5.963	5.3113	2.4549	1.2275	0.2218
60	89	8	3.235	3.215	2.8239	1.3530	0.6765	0.2091
61	89	7	2.831	2.923	2.4757	1.1695	0.5847	0.2066
62	89	12	4.852	4.784	4.3489	2.0791	1.0395	0.2142
63	89	14	5.661	5.916	5.0703	2.3883	1.1941	0.2109
64	90	14	5.789	6.157	5.4031	2.5138	1.2569	0.2171
65	90	12	4.962	5.199	4.6675	2.2166	1.1083	0.2234
66	90	15	6.203	6.758	5.7432	2.7046	1.3523	0.2180
67	90	15	6.203	6.053	5.5156	2.6617	1.3309	0.2146
68	90	14	5.789	6.007	5.1543	2.4397	1.2199	0.2107
69	90	13	5.376	5.725	5.1217	2.3893	1.1947	0.2222
70	90	15.5	6.409	6.233	5.4732	2.6068	1.3034	0.2034

Conversion Table for Sawn Mahogany
(Swietenia macrophylla)

1	2	3	4	5	6	7	**8**	**9**
Tree ID	**DBH (cm)**	**MH (m)**	**Standing Roundwood Volume/Log Scale (m^3)**	**Gross Roundwood Volume**	**Net roundwood volume (log scale)**	**Sawnwood (m^3) (mill scale)**	**Exportable Sawnwood (m^3)**	**Overrun Percentage**
71	90	10	4.135	4.583	3.9092	1.8409	0.9205	0.2226
72	91	13	5.496	5.178	4.6658	2.2418	1.1209	0.2040
73	91	13	5.496	5.954	5.1084	2.4121	1.2061	0.2195
74	91	7	2.959	2.860	2.6221	1.2453	0.6226	0.2104
75	91	15	6.341	6.554	5.7996	2.7677	1.3839	0.2182
76	92	14	6.049	6.785	5.7459	2.6618	1.3309	0.2200
77	92	19	8.210	8.683	7.6203	3.5990	1.7995	0.2192
78	92	12	5.185	5.644	4.8768	2.3048	1.1524	0.2223
79	92	14	6.049	6.274	5.5701	2.5757	1.2879	0.2129
80	93	11	4.857	5.167	4.5642	2.1307	1.0654	0.2193
81	93	16	7.065	7.318	6.1967	2.9462	1.4731	0.2085
82	93	13	5.740	5.354	4.8061	2.3138	1.1569	0.2015
83	93	14	6.182	6.456	5.5470	2.6396	1.3198	0.2135
84	93	11	4.857	5.153	4.5208	2.0943	1.0472	0.2156
85	93	17	7.506	7.182	6.5063	3.0114	1.5057	0.2006
86	93	12	5.298	5.778	4.8945	2.3399	1.1699	0.2208
87	93	13	5.740	5.952	5.1981	2.4588	1.2294	0.2142
88	93	18	7.948	8.483	7.2768	3.4406	1.7203	0.2165
89	94	10	4.511	4.716	4.0988	1.9294	0.9647	0.2139
90	94	11	4.962	4.794	4.2403	2.0356	1.0178	0.2051
91	94	14	6.315	6.907	5.8699	2.7778	1.3889	0.2199
92	94	16	7.217	7.578	6.8565	3.1756	1.5878	0.2200
93	94	11	4.962	5.222	4.4889	2.0932	1.0466	0.2109
94	94	13	5.864	6.269	5.5480	2.6377	1.3189	0.2249
95	94	11	4.962	5.313	4.6613	2.1618	1.0809	0.2178
96	95	16.5	7.602	7.345	6.2084	3.1115	1.5557	0.2046
97	95	14.5	6.681	6.462	5.2979	2.5694	1.2847	0.1923
98	95	15	6.911	7.221	5.9749	2.9386	1.4693	0.2126
99	95	14	6.450	6.424	5.3719	2.6521	1.3261	0.2056
100	95	17.5	8.063	7.854	6.4392	3.2204	1.6102	0.1997
101	95	20	9.215	9.647	7.8805	3.8882	1.9441	0.2110
102	96	12	5.646	5.769	4.8141	2.3520	1.1760	0.2083
103	96	12	5.646	5.675	4.5652	2.2941	1.1471	0.2032
104	96	10	4.705	4.671	3.9179	1.9463	0.9731	0.2068
105	96	12	5.646	5.675	4.6896	2.2764	1.1382	0.2016
106	96	15	7.057	7.419	5.8297	2.8678	1.4339	0.2032
107	97	12	5.764	6.143	4.8372	2.3851	1.1926	0.2069
108	98	11	5.393	5.949	4.5950	2.2232	1.1116	0.2061
109	98	18	8.825	8.941	7.4711	3.6423	1.8211	0.2064
110	98	16	7.845	8.502	6.5926	3.2784	1.6392	0.2090
111	99	15	7.505	8.160	6.2438	3.0715	1.5357	0.2046

1	2	3	4	5	6	7	**8**	**9**
Tree ID	**DBH (cm)**	**MH (m)**	**Standing Roundwood Volume/Log Scale (m^3)**	**Gross Roundwood Volume**	**Net roundwood volume (log scale)**	**Sawnwood (m^3) (mill scale)**	**Exportable Sawnwood (m^3)**	**Overrun Percentage**
112	99	14	7.005	7.237	5.9068	2.9621	1.4811	0.2114
113	100	14	7.147	7.759	5.9452	2.9945	1.4973	0.2095
114	100	13	6.637	7.318	5.9037	2.8657	1.4329	0.2159
115	101	14	7.291	7.945	6.2292	3.0381	1.5191	0.2084
116	101	11	5.728	6.196	4.7409	2.3456	1.1728	0.2047
117	101	13	6.770	6.667	5.4463	2.7438	1.3719	0.2026
118	101	8	4.166	4.271	3.4378	1.6608	0.8304	0.1993
119	101	15	7.812	8.005	6.5335	3.2291	1.6145	0.2067
120	101	15	7.812	7.946	6.4733	3.1341	1.5670	0.2006
121	101	16	8.332	8.998	7.0450	3.5070	1.7535	0.2104
122	102	9	4.780	5.171	3.9678	1.9281	0.9640	0.2017
123	102	18	9.560	10.524	8.2784	4.0132	2.0066	0.2099
124	102	13	6.905	7.428	5.6837	2.8485	1.4242	0.2063
125	102	17	9.029	9.465	7.7042	3.7365	1.8682	0.2069
126	102	16	8.498	8.895	7.1694	3.6013	1.8007	0.2119
127	102	14	7.436	8.294	6.5050	3.1433	1.5716	0.2114
128	103	16	8.666	8.937	7.2942	3.6480	1.8240	0.2105
129	104	8	4.417	4.439	3.7526	1.8909	0.9454	0.2140
130	104	13	7.178	7.393	5.9667	2.9151	1.4576	0.2031
131	104	19	10.491	11.057	9.0564	4.4560	2.2280	0.2124
132	104	15	8.282	8.629	7.2155	3.5086	1.7543	0.2118
133	104	16	8.835	9.015	7.1931	3.5672	1.7836	0.2019
134	104	16	8.835	8.826	6.9354	3.4845	1.7423	0.1972
135	104	12	6.626	6.751	5.4205	2.6728	1.3364	0.2017
136	104	16	8.835	8.258	6.8834	3.4027	1.7014	0.1926
137	104	17	9.387	8.974	7.0526	3.4531	1.7265	0.1839
138	104	7	3.865	4.361	3.4148	1.7110	0.8555	0.2213
139	104	18	9.939	9.280	7.6888	3.8041	1.9021	0.1914
140	105	13	7.317	7.111	5.2823	2.8137	1.4068	0.1923
141	105	16	9.005	9.180	6.7653	3.6171	1.8086	0.2008
142	105	18	10.131	10.290	7.7697	4.0530	2.0265	0.2000
143	105	18	10.131	9.907	7.3539	3.9079	1.9539	0.1929
144	105	17	9.568	9.648	7.1111	3.7341	1.8670	0.1951
145	105	14	7.880	7.597	5.6832	3.0093	1.5047	0.1910
146	105	15	8.443	8.574	6.2775	3.3432	1.6716	0.1980
147	106	17	9.751	10.165	7.5935	3.9603	1.9801	0.2031
148	106	17	9.751	10.149	7.4658	3.8490	1.9245	0.1974
149	106	15	8.604	8.539	6.1823	3.2964	1.6482	0.1916
150	108	13	7.741	7.845	5.8149	3.0418	1.5209	0.1965
151	108	16	9.527	9.766	7.4052	3.7353	1.8677	0.1960
152	108	15	8.932	9.243	7.0028	3.5522	1.7761	0.1989

1	2	3	4	5	6	7	**8**	**9**
Tree ID	**DBH (cm)**	**MH (m)**	**Standing Roundwood Volume/Log Scale (m^3)**	**Gross Roundwood Volume**	**Net roundwood volume (log scale)**	**Sawnwood (m^3) (mill scale)**	**Exportable Sawnwood (m^3)**	**Overrun Percentage**
153	108	14	8.336	8.675	6.5555	3.3886	1.6943	0.2032
154	109	14	8.491	8.633	6.1673	3.2929	1.6464	0.1939
155	109	16	9.705	9.808	7.0256	3.7592	1.8796	0.1937
156	110	18	11.119	11.047	8.1841	4.1317	2.0658	0.1858
157	110	16	9.883	10.407	7.4999	3.8138	1.9069	0.1929
158	112	18	11.527	11.336	8.3875	4.3471	2.1735	0.1886
159	112	18	11.527	12.051	8.6745	4.5405	2.2702	0.1970
160	113	15	9.778	10.287	7.5791	3.9599	1.9800	0.2025
161	113	16	10.430	10.798	8.0041	4.2837	2.1418	0.2054
162	113	18	11.734	11.957	9.0531	4.7747	2.3874	0.2035
163	113	16	10.430	10.870	8.1805	4.1616	2.0808	0.1995
164	114	11	7.298	7.630	5.5179	2.8459	1.4229	0.1950
165	114	14	9.288	9.464	7.0120	3.7535	1.8767	0.2021
166	114	13	8.625	8.557	6.3046	3.3106	1.6553	0.1919
167	114	15	9.952	10.023	7.6340	3.8508	1.9254	0.1935
168	114	19	12.606	12.680	9.3820	4.8723	2.4362	0.1933
169	116	16.5	11.335	11.598	8.1364	4.3938	2.1969	0.1938
170	116	15	10.304	9.605	6.7931	3.7347	1.8674	0.1812
171	117	18	12.579	12.200	8.6150	4.7807	2.3903	0.1900
172	117	13	9.085	8.797	6.2598	3.4678	1.7339	0.1909
173	117	14	9.784	9.562	6.7276	3.6711	1.8356	0.1876
174	117	12	8.386	8.211	5.8332	3.1378	1.5689	0.1871
175	118	16.5	11.729	11.952	8.2227	4.5285	2.2642	0.1930
176	118	20.5	14.572	14.873	10.2327	5.5999	2.8000	0.1921
177	119	14	10.121	10.630	7.0940	3.8719	1.9359	0.1913
178	119	19	13.736	13.003	10.2777	5.6127	2.8064	0.2043
179	119	19.5	14.097	14.430	10.0912	5.5140	2.7570	0.1956
180	119	20	14.459	13.709	10.4793	5.7723	2.8862	0.1996
181	119	17	12.290	12.010	8.1405	4.3832	2.1916	0.1783
182	119	16	11.567	10.711	7.8847	4.3754	2.1877	0.1891
183	120	17	12.497	12.531	8.5716	4.7089	2.3545	0.1884
184	120	18	13.232	13.656	9.0857	4.9723	2.4861	0.1879
185	120	16	11.762	12.133	8.4227	4.5174	2.2587	0.1920
186	120	18	13.232	12.769	8.9897	4.9584	2.4792	0.1874
187	120	14	10.292	9.997	6.7584	3.6936	1.8468	0.1794
188	120	16.5	12.130	12.375	8.7131	4.6686	2.3343	0.1924
189	121	13	9.717	9.751	6.5244	3.6192	1.8096	0.1862
190	121	8	5.979	6.265	4.2580	2.3571	1.1785	0.1971
191	121	15	11.212	10.991	7.8260	4.1966	2.0983	0.1872
192	121	18	13.454	13.719	9.3560	5.0210	2.5105	0.1866
193	122	14	10.638	11.151	7.4024	4.0736	2.0368	0.1915

1	2	3	4	5	6	7	**8**	**9**
Tree ID	**DBH (cm)**	**MH (m)**	**Standing Roundwood Volume/Log Scale (m^3)**	**Gross Roundwood Volume**	**Net roundwood volume (log scale)**	**Sawnwood (m^3) (mill scale)**	**Exportable Sawnwood (m^3)**	**Overrun Percentage**
194	122	19	14.437	13.915	9.6542	5.2996	2.6498	0.1835
195	123	17	13.130	12.808	9.0156	4.8440	2.4220	0.1845
196	124	14	10.989	11.006	7.5595	4.1061	2.0530	0.1868
197	124	16.5	12.952	13.253	9.1615	5.0205	2.5102	0.1938
198	124	18	14.129	13.556	9.5334	5.2893	2.6447	0.1872
199	124	17	13.344	13.923	9.3842	5.0272	2.5136	0.1884
200	125	15	11.965	12.017	7.6361	4.3000	2.1500	0.1797
201	127	11.5	9.469	8.666	5.6375	3.3142	1.6571	0.1750
202	127	16	13.174	12.426	7.8699	4.5886	2.2943	0.1742
203	127	11	9.057	9.453	5.7892	3.2740	1.6370	0.1807
204	127	18	14.821	14.137	8.9848	5.1236	2.5618	0.1728
205	127	17	13.998	13.588	8.8216	4.9305	2.4653	0.1761
206	127	18	14.821	13.619	8.7833	5.1507	2.5754	0.1738
207	127	18	14.821	13.907	8.8271	5.1867	2.5933	0.1750
208	127	18	14.821	14.990	9.1875	5.1206	2.5603	0.1727
209	128	18	15.056	14.925	9.4023	5.3735	2.6868	0.1785
210	128	17	14.219	13.387	8.7706	4.9140	2.4570	0.1728
211	128	22	18.401	16.648	11.6344	6.7005	3.3503	0.1821
212	128	16	13.383	13.483	8.2957	4.6827	2.3414	0.1750
213	128	20	16.728	15.389	10.3069	5.9490	2.9745	0.1778
214	129	15	12.743	13.537	8.2970	4.6373	2.3187	0.1820
215	130	18	15.530	14.423	9.5138	5.4393	2.7196	0.1751
216	130	19	16.392	15.453	10.1351	5.8658	2.9329	0.1789
217	131	19	16.646	15.129	9.9688	5.8596	2.9298	0.1760
218	131	17.5	15.331	15.595	10.0327	5.6896	2.8448	0.1856
219	131	18	15.770	15.593	9.9326	5.5348	2.7674	0.1755
220	132	14	12.453	11.089	7.1708	4.1494	2.0747	0.1666
221	132	19	16.901	15.848	10.3249	6.0071	3.0035	0.1777
222	133	14	12.643	12.026	7.6077	4.4158	2.2079	0.1746
223	133	20	18.061	18.255	11.1943	6.2496	3.1248	0.1730
224	133	17	15.352	15.880	9.7330	5.5932	2.7966	0.1822
225	133	20	18.061	17.636	11.5542	6.4530	3.2265	0.1786
226	133	17	15.352	14.586	9.4698	5.4529	2.7265	0.1776
227	133	17	15.352	14.818	9.4220	5.3443	2.6721	0.1741
228	133	17	15.352	15.531	9.6604	5.4399	2.7200	0.1772
229	133	17.5	15.803	16.039	10.1138	5.8396	2.9198	0.1848
230	135	18	16.747	15.480	9.5418	5.6637	2.8319	0.1691
231	135	17	15.817	14.560	8.8127	5.2614	2.6307	0.1663
232	135	20	18.608	17.323	10.6386	6.4018	3.2009	0.1720
233	135	20	18.608	17.105	10.4297	6.2673	3.1337	0.1684
234	136	15	14.164	14.547	8.6398	5.1573	2.5787	0.1821

Conversion Table for Sawn Mahogany
(Swietenia macrophylla)

1	2	3	4	5	6	7	**8**	**9**
Tree ID	**DBH (cm)**	**MH (m)**	**Standing Roundwood Volume/Log Scale (m^3)**	**Gross Roundwood Volume**	**Net roundwood volume (log scale)**	**Sawnwood (m^3) (mill scale)**	**Exportable Sawnwood (m^3)**	**Overrun Percentage**
235	136	17	16.052	15.234	9.0994	5.4422	2.7211	0.1695
236	137	14	13.414	11.933	7.1538	4.2876	2.1438	0.1598
237	137	14	13.414	12.326	7.1724	4.2498	2.1249	0.1584
238	137	7.5	7.186	7.364	4.2155	2.5389	1.2695	0.1766
239	138	20	19.444	18.390	11.0805	6.6142	3.3071	0.1701
240	138	15	14.583	13.446	8.2730	4.9305	2.4653	0.1690
241	140	19	19.011	17.443	10.5345	6.4122	3.2061	0.1686
242	141	19	19.284	18.149	10.5668	6.3498	3.1749	0.1646
243	141	14.5	14.717	14.923	8.5593	5.0733	2.5366	0.1724
244	143	17.5	18.269	18.773	10.5488	6.2160	3.1080	0.1701
245	144	16	16.937	16.070	9.7446	5.7318	2.8659	0.1692
246	145	17	18.247	17.103	9.3907	5.8185	2.9093	0.1594
247	146	14	15.235	14.557	7.5712	4.6935	2.3468	0.1540
248	146	15	16.323	15.749	8.3567	5.1296	2.5648	0.1571
249	146	15.5	16.867	17.348	9.0423	5.5334	2.7667	0.1640
250	147	18	19.857	18.366	9.8217	6.1722	3.0861	0.1554
251	151	20	23.280	20.655	11.4272	6.9976	3.4988	0.1503
252	154	21	25.425	22.425	12.2670	7.4861	3.7430	0.1472
253	156	14	17.393	17.499	8.9404	5.6400	2.8200	0.1621
254	168	16	23.054	21.017	10.4485	6.8601	3.4301	0.1488
255	169	12	17.497	15.386	8.0448	5.2025	2.6013	0.1487