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Programable Calculator Programs to Solve Softwood Volume and Value Equations

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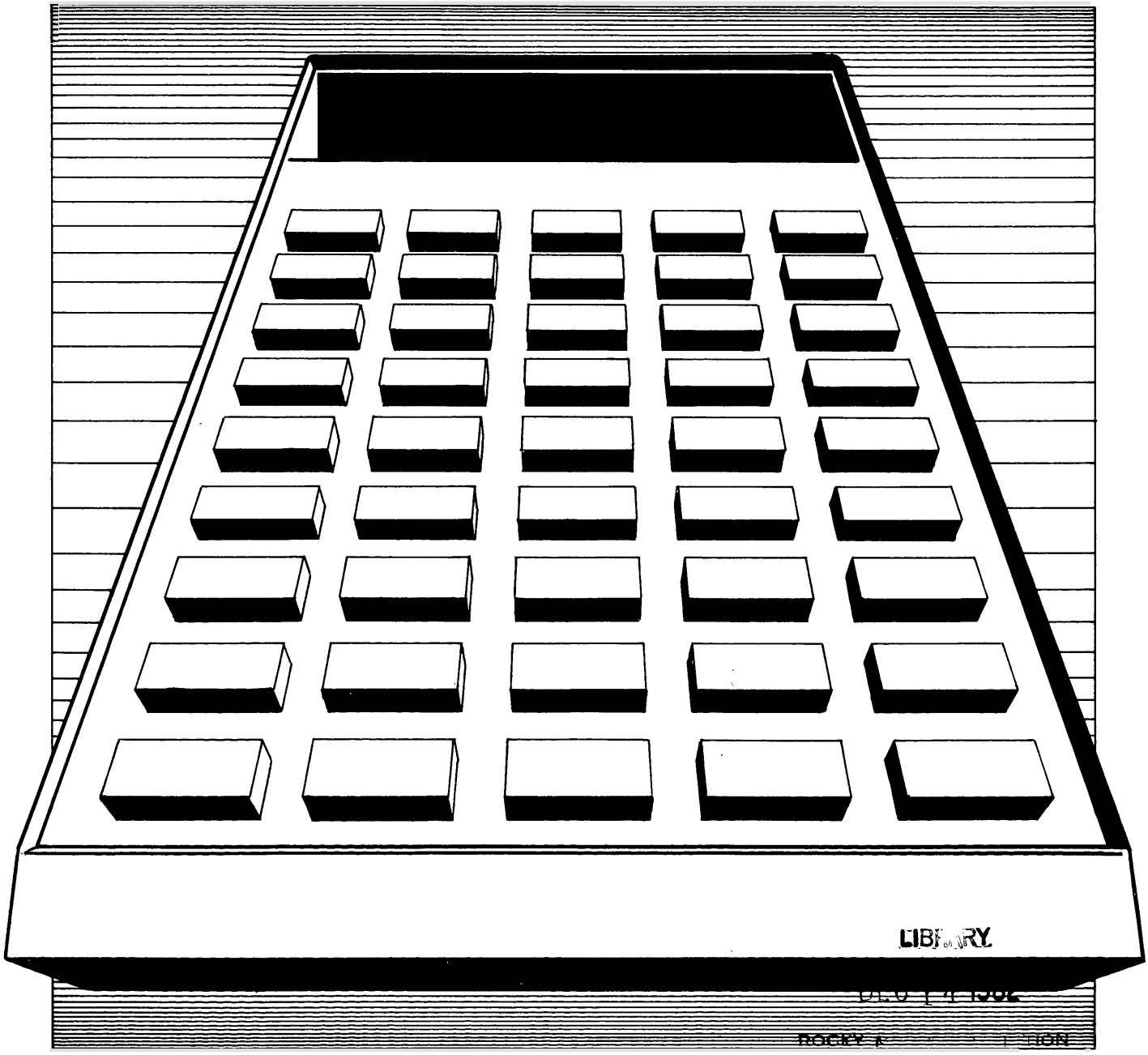

Author

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Abstract

Sachet, Janet K. Ayer. Programable calculator programs to solve softwood volume and value equations. Gen. Tech. Rep. PNW-143. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1982. 12 p.

This paper presents product value and product volume equations as programs for handheld calculators. These tree equations are for inland Douglas-fir, young-growth Douglas-fir, western white pine, ponderosa pine, and western larch. Operating instructions and an example are included.

Keywords: Mathematical programing, calculators, volume estimation, timber value.

Contents

Introduction

This paper presents programs and operating instructions for programable calculators that will solve equations for estimating the product value and product volume for several species of western softwood sawtimber. The timber resource for which equations have been published are: inland Douglas-fir (Lane and others 1970), young-growth coast Douglas-fir (Fahey 1980), western white pine (Snellgrove and others 1973), old-growth ponderosa pine (Plank 1981), and western larch (Plank and others 1978).

The equations provide a method of determining the lumber selling value and product volume of trees from standing tree measurements. They are an improvement over conventional appraisals using discrete log grades. The entire tree bole does not need to be examined for individual log grades because only a few basic tree measurements are required. Also, the equations are capable of showing differences in quality that would conventionally be lumped within the same grade.

As originally published, the equations appear complex and difficult to use. This paper attempts to improve their usability with currently available and inexpensive technology. The prices used for developing the value equations are included, along with instructions for adjusting the values to those in the current marketplace.

Description of the Programs

Two programs have been written for the Hewlett-Packard (HP) 97 and 67 [1] calculators: one for the volume equations and one for the value equations. The operating instructions (see page 2) are the same for both programs. A step-by-step example using the value equation is on page 3.

Information for each species is presented in three parts (see appendix 1). Part 1 gives the breakdown of products manufactured by grade, the 1978 average prices for these items, and the percent of the total lumber (or veneer) tally measured by grade in the study. The second part contains a description of the equations for the species — the variables and the coefficients, and a list of the HP storage registers for the coefficients. Part 3 lists the steps for using the program for the selected species.

Value Adjustment

The six value equations, as originally published, have been updated using average 1978 prices and regression analysis to develop new coefficients. To adjust the value equations to current prices, two approaches can be taken. If the current $/MBF for each lumber (or veneer) grade retain the same relative standings as the 1978 prices (for example, if the price of Utility grade is twice the price for Economy grade), make a percent adjustment to the final tree value. For example, if current prices have increased 5 percent, multiply the tree value by 1.05. If the relative prices for the different grades change, however, develop new coefficients using regression analysis. The data for doing this are available from the Timber Quality Research Project, Pacific Northwest Forest and Range Experiment Station, 809 N.E. 6th Ave., Portland, OR 97232.

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[1] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others that may be suitable.

User's Guide

General Information

Some knowledge of Hewlett-Packard 97 and 67 calculator operation is presumed.

The value program and the volume program each contain six equations; only one equation can be solved at a time.

To store the program on a card, set the calculator switch to PRGM and key in all the steps for one program (appendix 2). To store the entire program, pass both sides of a blank card through the card reader. After the program is recorded on a card, set the calculator switch to RUN.

To store the coefficients on a card, set the calculator switch to RUN and store the coefficients for one species equation in the registers designated in appendix 1, part 2. Press [ ] [W/DATA] and load one side of a blank card into the card reader. Coefficients for two equations can be stored on one card by using sides 1 and 2.

Program Operation

STEP	INSTRUCTIONS
1	Set the calculator switches to RUN (HP-97 and 67) and MAN (manual, HP-97 only).
2	Load side 1 and side 2 of either the value program card or the volume program card.
3	Clear storage registers ([f] [CL REG]).
4	Select the desired species equation and store the coefficients in the registers specified in appendix 1, part 2 for that species. (If the coefficients are stored on a card, load the card.)
5	Press the key for the desired species equation:

[A]		for inland Douglas-fir
[B]		for young-growth coast Douglas-fir lumber
[f]	[b]	for young-growth coast Douglas-fir veneer
[C]		for western white pine
[D]		for ponderosa pine
[E]		for western larch

6	Enter data items one at a time during calculator pauses; follow each entry with [R/S] key. (For order of entry, see appendix 1, part 3.) All variables for an equation must be entered, enter a zero when a variable is undefined or zero. When a mistake is made while entering data, begin the program again by pressing the appropriate key, [A] to [E], then re-enter all the variables.
7	For additional solutions to the same equation, go to step 5.
8	For solutions to a different species equation, go to step 3.

List of Variables and Symbols in the Equations

The following is a description of the variables used in the various equations (appendix 1, part 2). Each equation uses a different combination of the variables in this list.

SYMBOL	EXPLANATION
A	Presence or absence of defect (1 = defect, 0 = none).
B	Diameter (in inches) of the largest limb in the butt 16-foot log.
C	Height to continuous live crown of two or more quadrants (in feet).
D	D.b.h. (in inches).
F_{16}	Number of limb-free and defect-free faces in the butt 16-foot log.
F_{32}	Number of limb-free and defect-free faces in the butt 32-foot log.
H	Total height of tree (in feet).
K	Largest knot in the butt 16-foot log (in inches).
L	Height to the first live limb (in feet).
P	Estimated percent defect of tree or of gross cruise volume.
S	Length of basal scar (in feet).

Example of Program Operation

Determine the lumber selling value of a young-growth Douglas-fir with these field measurements: D.b.h. = 24.5 inches, total height = 142 feet, height to crown = 75 feet, largest knot in the first log = 3 inches, basal scar = 0, and the estimated scaling defect percent = 10.

Load sides 1 and 2 of the value program card. (It is assumed that the program steps have previously been stored on a card. See page 2.)

Store the coefficients:

f CL REG		
15.01	STO	A
- 2.178	STO	
.00512	STO	
- .14475	STO	
- .0001147	STO	
- .00002432		
- .00009637		
- .000208	STO	
- .000126	STO	

Store the coefficients for the young-growth Douglas-fir lumber value equation in the registers specified in appendix 1, part 2. The coefficients for an individual equation can be stored on a card (see page 2). In that case, simply load the card.

Run the program:

B		Initializes the Douglas-fir value equation
24.5	R/S	D.b.h. (inches)
142	R/S	Height (feet)
75	R/S	Height to crown (feet)
3	R/S	Knot (inches)
10	R/S	Percent defect
0	R/S	Basal scar (inches)

Total tree lumber tally value = $273.68.

Literature Cited

Fahey, Thomas D. Grading second-growth Douglas-fir by basic tree measurements. J. For. 78(4): 204-206; 1980.

Lane, Paul H.; Plank, Marlin E.; Henley John W. A new and easier way to estimate the quality of inland Douglas-fir sawtimber. Res. Pap. PNW-101. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1970. 9 p.

Plank, Marlin E. Estimating value and volume of ponderosa pine trees by equations. Res. Pap. PNW-283. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1981. 13 p.

Plank, Marlin E.; Snellgrove, Thomas A. An equation for estimating the value and volume of western larch trees. Res. Pap. PNW-231. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1978. 29 p.

Snellgrove, Thomas A.; Plank, Marlin E.; Lane, Paul H. An improved system for estimating the value of western white pine. Res Pap. PNW-166. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station; 1973. 19 p.

Appendix 1: Information on Species

Inland Douglas-Fir

Part 1.

Lumber grade	$/MBF[1]/	Percent of volume
C & Better Select	671.82	0.7
D Select	512.50	1.0
#2 & Better Common	251.35	.4
#3 Common	168.59	2.5
#4 Common	136.22	2.3
#5 Common	82.51	.5
Select Structural	278.38	9.3
Standard & Better	237.44	56.4
Utility	156.05	19.8
Economy	74.09	7.1

Total lumber tally volume = 733,683 board feet.

Part 2.

Equation variable	H-P storage register	Volume coefficient	Value coefficient
Y-intercept	STO A	-33.763	-3.7635
D	STO B	1.0162	1.599
D^2	STO C	- .1247	- .1536
D^2H	STO D	.01085	.002349
H	STO E	- .3195	- .45195
B	STO 1	- .08339	- .4944
S	STO 2	- .5226	- .2736
DH	STO 4	.06079	.04537
P	STO 5	- .9091	- .277
P^2	STO 6	- .004588	- ,00105

Part 3.

Step	Data input	Press key: [2]/
1	—	A
2	D	R/S
3	H	R/S
4	P (or zero)	R/S
5	S (or zero)	R/S
6	B (or zero)	R/S

To repeat, go to step 1.

[1]/ Prices supplied by the USDA Forest Service, Pacific Northwest Region, Portland, Oregon.

[2]/ The steps are the same for both volume and value.

Young-Growth Coast Douglas-Fir (Lumber)

Part 1.

Lumber grade	$/MBF[3]/	Percent of volume
C & Better Select	**544.24**	**1.7**
D Select & Moulding	**473.16**	.3
Shops & Factory Select	**259.83**	.2
Select Structural	**296.70**	**24.5**
Construction	**278.28**	**45.3**
Standard	**242.97**	**16.8**
Utility	**171.80**	**9.0**
Economy	**79.17**	**2.2**

Total lumber tally volume = **222,817** board feet.

Part 2.

Equation variable	H-P storage register	Volume coefficient	Value coefficient
Y-intercept	STO A	**61.3**	15.01
D	STO B	**- 8.6935**	**- 2.178**
D^2H	STO D	.01828	.00512
H	STO E	- .5325	- .14475
$K(D^2H)$	STO 2	—	- .0001147
$P(D^2H)$	STO 3	- .0000871	- .00002432
$S^{1/2}(D^2H)$	STO 4	- .000285	- .00009637
$((H-C)/H)\ (D^2H)$	STO 5	- .0003175	- .000208
$(D^2/H)\ (D^2H)$	STO 6	- .0004725	- .000126

Part 3.

Step	Volume data input	Press key:	Value data input	Press key:
1	—	B	—	B
2	D	R/S	D	R/S
3	H	R/S	H	R/S
4	C	R/S	C	R/S
5	P (or zero)	R/S	K (or zero)	R/S
6	S (or zero)	R/S	P (or zero)	R/S
7	—	—	S (or zero)	R/S

To repeat, go to step 1.

[3]/ Prices supplied by the USDA Forest Service, Pacific Northwest Region, Portland, Oregon.

Young-Growth Coast Douglas-Fir (Veneer)

Part 1.

Veneer grade	$/M ft² [4]/	Percent of volume
A	397.45	0.2
B	391.19	4.9
C	150.75	49.4
D	150.38	45.6

Total volume (3/8-inch basis) = 179,824 square feet.

Part 2.

Equation variable	H-P storage register	Volume coefficient	Value coefficient
D	STO B	-86.039	-14.38
D^2	STO C	3.4517	.6608
D^2H	STO D	.04427	.006106
$K(D^2H)$	STO 2	—	- .0004559
$P(D^2H)$	STO 3	- .0002302	- .00002344
$S^{1/2}(D^2H)$	STO 4	- .002399	- .0004998
$((H-C)/H)\ (D^2H)$	STO 5	- .006215	- .0001437
$(D^2/H)\ (D^2H)$	STO 6	- .002535	- .0002548

Part 3.

Step	Volume data input	Press key:	Value data input	Press key:
1	—	f 1	—	f b
2	D	R/S	D	R/S
3	H	R/S	H	R/S
4	C	R/S	C	R/S
5	P (or zero)	R/S	K	R/S
6	S (or zero)	R/S	P (or zero)	R/S
7	—	—	S (or zero)	R/S

To repeat, go to step 1.

[4]/ Prices supplied by the USDA Forest Service, Pacific Northwest Region, Portland, Oregon.

Part 1.

Lumber grade	$/MBF[5]/	Percent of volume
C & Better Select	888.64	5.6
D Select	655.26	7.2
Moulding	438.78	2.9
#3 Clear	316.41	1.8
Shop	330.71	3.5
#1 Common	499.80	1.3
#2 Common	463.82	22.6
#3 Common	293.08	39.0
#4 Common	183.46	13.4
#5 Common	94.06	2.6

Total lumber tally volume = 131,724 board feet.

Part 2.

Equation variable	H-P storage register	Volume coefficient	Value coefficient
Y-intercept	STO A	-393.0	-147.099
D	STO B	88.954	38.517
D^2	STO C	- 3.1485	- 1.5008
D^2H	STO D	.02347	.01009
H	STO E	- 5.6184	- 2.5272
L	STO 1	.4015	.090
$(H/D)^2$	STO 2	2.2715	.9355
$P(D^2H)$	STO 3	- .00005126	- .00002092
$P^2(D^2H)$	STO 4	- .0000008985	- .0000004476
$B(D^2H)$	STO 5	- .0001316	- .0001095
$F_{16}(D^2H)$	STO 6	- .0003235	.00002648

Part 3.

Step.	Data input	Press key:[6]/
1	—	C
2	D	R/S
3	H	R/S
4	L	R/S
5	B (or zero)	R/S
6	F_{16} (or zero)	R/S
7	P (or zero)	R/S

To repeat, go to step 1.

[5]/ Prices supplied by the USDA Forest Service, Northern Region, Missoula, Montana.

[6]/ The steps are the same for both volume and value.

Ponderosa Pine (Old-Growth)

Part 1.

Lumber grade	$/MBF[7]/	Percent of volume
C & Better Select	1,015.00	4.4
D Select	751.00	4.4
Moulding	672.40	8.8
#3 Clear	427.79	.2
#1 Shop	425.01	6.2
#2 Shop	318.10	20.4
#3 Shop & Shop Out	322.29	14.1
#2 & Better Common	355.73	11.5
#3 Common	229.12	19.7
#4 Common	169.48	8.1
#5 Common	96.42	1.6
Pitchy Select	751.00	.6

Total lumber tally volume = 130,998 board feet.

Part 2.

Equation variable	H-P storage register	Volume coefficient	Value coefficient
Y-intercept	STO A	-3.007	8.0025
D^2	STO C	—	- .04757
D^2H	STO D	.01552	.007859
H	STO E	- .8265	—
L	STO 1	.4220	—
F_{32}	STO 4	—	15.80
$P(D^2H)$	STO 3	- .00008439	- .00001319
$P^2(D^2H)$	STO 4	.0000008298	—
DH	STO 4	—	- .05932
$A(D^2H)$	STO 5	—	- .0003604

Part 3.

Step	Volume data input	Press key:	Value data input	Press key:
1	—			D
2	D		D	R/S
3	H		H	R/S
4	L		F_{32} (or zero)	R/S
5	P (or zero)		P (or zero)	R/S
6	—			R/S

To repeat, go to step 1.

[7]/ Prices supplied by the **USDA** Forest Service, Northern Region, Missoula, Montana.

Western Larch

Part 1.

Lumber arade	$/MBF[8]/	Percent of volume
C & Better Select	671.92	7.1
D Select	512.50	7.4
#2 & Better Common	251.35	2.4
#3 Common	168.59	10.2
#4 Common	136.22	7.2
#5 Common	82.51	2.2
Select Structural	278.38	3.5
Standard & Better	237.44	39.1
Utility	156.05	14.7
Ecomony	74.09	6.2

Total lumber tally volume = 342,691 board feet.

Part 2.

Equation variable	H-P storage register	Volume coefficient	Value coefficient
Y-intercept	STO A	80.454	2.5682
D	STO B	—	- .8174
D^2	STO C	.6770	- .01769
D^2H	STO D	.008336	.003893
H	STO E	- 5.5433	.03806
F_{16}	STO 1	2.4064	2.5928
H^2	STO 2	.03391	—
$P(D^2H)$	STO 3	- .00008872	- .00003574
$P^2(D^2H)$	STO 4	- .0000004194	.000000008396
H/D	STO 5	8.9652	-2.2164
$(H/D)^2$	STO 6	.07783	—

Part 3.

Step	Data input	Press key:[9]/
1	—	E
2	D	R/S
3	H	R/S
4	F_{16} (or zero)	R/S
5	P(or zero)	R/S

To repeat, go to step 1.

[8]/ Prices supplied by the USDA Forest Service, Pacific Northwest Region, Portland, Oregon,

[9]/ The steps are the same for both volume and value.

Appendix 2: Programs

Value Program

	HP 97	HP 67
001	*LBL A	f LBL A
002	GSB 1	f GSB 1
003	RCL 7	RCL 7
004	RCL 8	RCL 8
005	RCL 4	RCL 4
006	x	x
007	x	x
008	STO + 0	STO + 0
009	RCL 5	RCL 5
010	R/S	R/S
011	x	x
012	STO + O	STO + O
013	f **LASTx**	h LSTx
014	x^2	g x^2
015	RCL 6	RCL 6
016	x	x
017	STO + O	STO + O
018	2	2
019	STO I	h STI
020	GSB 2	f GSB2
021	RCL 0	RCL 0
022	PRINTx	f -x-
023	RTN	h RTN
024	*LBL B	f LBL B
025	GSB 1	f GSB 1
026	*LBL 3	f LBL3
027	RCL 8	RCL 8
028	R/S	R/S
029		
030	RCL 8	RCL 8
031	—	—
032	RCL 9	RCL 9
033	x	x
034	RCL 5	RCL 5
035	x	x
036	STO + O	STO + O
037	RCL 2	RCL 2
038	GSB 5	f GSB 5
039	RCL 3	RCL 3
040	GSB 5	f GSB 5
041	RCL 4	RCL 4
042	RCL 9	RCL 9
043	R/S	R/S
044		f $\sqrt{x}$
045	x	x
046	x	x
047	STO + O	STO + O
048	RCL 7	RCL 7
049	x^2	g x^2
050	x^2	g x^2
051	RCL 6	RCL 6
052	x	x
053	STO + O	STO + O
054	RCL 0	RCL 0
055	PRINTx	f -x-
056	RTN	h RTN
057	LBLf **b**	g LBLf **b**
058	GSB 1	f GSB 1
059	GSB 3	f GSB 3
060	RTN	h RTN
061	*LBL C	f LBL C
062	GSB 1	f GSB 1
063	1	1
064	STO I	h STI
065	GSB 2	f GSB 2
066	RCL 8	RCL 8
067	RCL 7	RCL 7
068	—	—
069	x^2	g x^2
070	RCL 2	RCL 2
071	x	x
072	STO + O	STO + O
073	RCL 5	RCL 5
074	GSB 5	f GSB 5
075	RCL 6	RCL 6
076	GSB 5	f GSB 5
077	GSB 4	f GSB 4
078	RCL 0	RCL 0
079	PRINTx	f -x-
080	RTN	h RTN
081	*LBL D	f LBL D
082	GSB 1	f GSB 1
083	1	1
084	STO I	h STI
085	GSB 2	f GSB 2
086	RCL 3	RCL 3
087	GSB 5	f GSB 5
088	RCL 5	RCL 5
089	GSB 5	f GSB 5
090	RCL 7	RCL 7
091	RCL 8	RCL 8
092	x	x
093	RCL 4	RCL 4
094	x	x
095	STO + O	STO + O
096	RCL 0	RCL 0
096	PRINTx	f -x-
098	RTN	h RTN
099	*LBL E	f LBL E
100	GSB 1	f GSB 1
101	1	1
102	STO I	h STI
103	GSB 2	f GSB 2
104	RCL 8	RCL 8
105	RCL 7	RCL 7
106	—	—
107	RCL 5	RCL 5
108	x	x
109	STO + O	STO + O
110	GSB 4	f GSB 4
111	RCL 0	RCL 0
112	PRINTx	f -x-
113	RTN	h RTN
114	*LBL 1	f LBL 1
115	RCL A	RCL A
116	STO O	STO O
117	RCL B	RCL B
118	R/S	R/S
119	STO 7	STO 7
120	x	x
121	STO + O	STO + O
122	RCL C	RCL C
123	f LASTx	h LSTx
124	x^2	g x^2
125	x	x
126	STO + O	STO + O
127	f LASTx	h LSTx
128	R/S	R/S
129	STO 8	STO 8
130	x	x
131	STO 9	STO 9
132	RCL D	RCL D
133	x	x
134	STO + O	STO + O
135	RCL 8	RCL 8
136	RCL E	RCL E
137	x	x
138	STO + O	STO + O
139	RTN	h RTN
140	*LBL 2	f LBL 2
141	R/S	R/S
142	RCL (i)	RCL (i)
143	x	x
144	STO + O	STO + O
145	f DSZ I	f DSZ
146	GT 02	GTO 2
147	RTN	h RTN
148	*LBL 4	f LBL 4
149	RCL 3	RCL 3
150	RCL 9	RCL 9
151	x	x
152	R/S	R/S
153	x	x
154	STO + O	STO + O
155	f LASTx	h LSTx
156	x^2	g x^2
157	RCL 4	RCL 4
158	RCL 9	RCL 9
159	x	x
160	x	x
161	STO + O	STO + O
162	RTN	h RTN
163	*LBL 5	f LBL 5
164	RCL 9	RCL 9
165	R/S	R/S
166	x	x
167	x	x
168	STO + O	STO + O
169	RTN	h RTN

Volume Program

	HP 97	HP 67
001	*LBL A	f LBL A
002	GSB 1	f GSB 1
003	RCL 7	RCL 7
004	RCL 8	RCL 8
005	RCL 4	RCL 4
006	x	x
007	x	x
008	STO + 0	STO + 0
009	RCL 5	RCL 5
010	R/S	R/S
011	x	x
012	STO + O	STO + O
013	f LASTx	h LSTx
014	x^2	g x^2
015	RCL 6	RCL 6
016	x	x
017	STO + O	STO + O
018	2	2
019	STO I	h STI
020	GSB 2	f GSB 2
021	RCL 0	RCL 0
022	PRINTx	f -x-
023	RTN	h RTN
024	*LBL B	f LBL B
025	GSB 1	f GSB 1
026	GSB 3	f GSB3
027	RTN	h RTN
028	*LBL f b	g LBLf b
029	GSB 1	f GSB 1
030	*LBL 3	f LBL3
031	RCL 8	RCL 8
032	R/S	R/S
033		
034	RCL 8	RCL 8
035	—	—
036	RCL 9	RCL 9
037	x	x
038	RCL 5	RCL 5
039	x	x
040	STO + O	STO + O
041	RCL 3	RCL 3
042	GSB 5	f GSB 5
043	RCL 4	RCL 4
044	RCL 9	RCL 9
045	R/S	R/S
046	$\sqrt{x}$	f $\sqrt{x}$
047	x	x
048	x	x
049	STO + O	STO + O
050	RCL 7	RCL 7
051	x^2	g x^2
052	x^2	g x^2
053	RCL 6	RCL 6
054	x	x
055	STO + Θ	STO + O
056	RCLO	RCLO
057	PRINTx	f -x-
058	RTN	h RTN
059	*LBL C	f LBL C
060	GSB 1	f GSB 1
061	1	1
062	STO I	h STI
063	GSB 2	f GSB2
064	RCL 8	RCL 8
065	RCL 7	RCL 7
066	—	—
067	x^2	g x^2
068	RCL 2	RCL 2
069	x	x
070	STO + O	STO + O
071	RCL 5	RCL 5
072	GSB 5	f GSB 5
073	RCL 6	RCL 6
074	GSB 5	f GSB5
075	GSB 4	f GSB 4
076	RCL 0	RCL 0
077	PRINTx	f -x-
078	RTN	h RTN
079	*LBL D	f LBL D
080	GSB 1	f GSB 1
081	1	1
082	STO I	h STI
083	GSB 2	f GSB 2
084	GSB 4	f GSB4
085	RCL 0	RCL 0
086	PRINTx	f -x-
087	RTN	h RTN
088	*LBL E	f LBL E
089	GSB 1	f GSB 1
090	RCL 8	RCL 8
091	x^2	g x^2
092	RCL 2	RCL 2
093	x	x
094	STO + O	STO + O
095	RCL 5	RCL 5
096	RCL 8	RCL 8
097	RCL 7	RCL 7
098	—	—
099	x	x
100	STO + O	STO + O
101	f LASTx	h LSTx
102	x^2	g x^2
103	RCL 6	RCL 6
104	x	x
105	STO + O	STO + O
106	1	1
107	STO I	h STI
108	GSB 2	f GSB 2
109	GSB 4	f GSB4
110	RCL 0	RCL 0
111	PRINTx	f -x-
112	RTN	h RTN
113	*LBL 1	f LBL 1
114	RCL A	RCL A
115	STO O	STO O
116	RCL B	RCL B
117	R/S	R/S
118	STO 7	STO 7
119	x	x
120	STO + O	STO + O
121	RCL C	RCL C
122	f LASTx	h LSTx
123	x^2	g x^2
124	x	x
125	STO + O	STO + O
126	f LASTx	h LSTx
127	R/S	R/S
128	STO 8	STO 8
129	x	x
130	STO 9	STO 9
131	RCL D	RCL D
132	x	x
133	STO + O	STO + O
134	RCL 8	RCL a
135	RCL E	RCL E
136	x	x
137	STO + O	STO + O
138	RTN	h RTN
139	*LBL 2	f LBL 2
140	R/S	R/S
141	RCL (i)	RCL (i)
142	x	x
143	STO + O	STO + O
144	f DSZI	f DSZ
145	GTO 2	GTO 2
146	RTN	h RTN
147	*LBL 4	f LBL4
148	RCL 3	RCL 3
149	RCL 9	RCL 9
150	x	x
151	R/S	R/S
152	x	x
153	STO + O	STO + O
154	f LASTx	h LSTx
155	x^2	g x^2
156	RCL4	RCL4
157	RCL 9	RCL 9
158	x	x
159	x	x
160	STO + O	STO + O
161	RTN	h RTN
162	*LBL 5	f LBL 5
163	RCL 9	RCL 9
164	R/S	R/S
165	x	x
166	x	x
167	STO + O	STO + O
168	RTN	h RTN

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This paper presents product value and product volume equations as programs for handheld calculators. These tree equations are for inland Douglas-fir, young-growth Douglas-fir, western white pine, ponderosa pine, and western larch. Operating instructions and an example are included.

Keywords: Mathematical programing, calculators, volume estimation, timber value.

The Forest Service of the U.S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation.

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